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RELATIONSHIP BETWEEN MACROECONOMIC VARIABLES AND CORPORATE HEALTH OF MANUFACTURING FIRMS IN INDIA

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Abstract

This paper aims at examining the link between macroeconomic variables and the corporate health indicator (in the form of Z scores) of the Indian manufacturing firms under BSE 200 during 1990 to 2009. The macroeconomic variables taken were the bank rate, GDP, inflation and trade openness. The long run relationships are identified using panel unit root test, panel cointegration analysis and panel long run causality. The findings of the study reveal the existence of a two-way causal relationship between the Z score and GDP, Z score and Bank rate, Z score and WPI and Z score and trade openness.

Keywords: Z score, Panel cointegration analysis, Panel long run causality.

JEL Classification: G32, C23.

1. Introduction

The common sense suggests that a firm's health could be affected by the economic circumstances within which the firm is operating. The manufacturing sector being one of the traditional sectors is most likely to be affected by changes in the macroeconomic conditions. The earlier research confirms the interlinking relationship between macro economy and corporate distress.

A firm usually fails because of a combination of factors. The failure rates of corporations are determined by three factors i.e. firm risk which is dependent on the effectiveness of the management and adequacy of its capital; industry risk i.e. a shock to a specific industry such as its exposure to import reform, tariff reform etc.; and macroeconomic risk i.e. risk deriving from the macroeconomic or monetary factors (Sharabany,2004).

It is seen that the number of failures rise during a crisis or a recessionary phase. But the company failures also affect the bank capital. If the realised losses on the company loan book are unanticipated, the bank capital gets eroded and hence weakens the banking system. In this way both corporate distress and macro economy are interlinked. Therefore it can be said that there is every chance of having some causal relationship between the macro economic indicators of a nation and the health of corporations.

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The primary objective of this paper is to examine the link between the macroeconomic factors and the corporate health indicator in the form of Z scores. Here the macroeconomic variables taken were the bank rate, GDP, inflation and trade openness measured as the ratio of exports plus imports to GDP. The long run relationships were identified using panel unit root test, panel cointegration analysis and panel long run causality. This methodology has been widely used in recent studies.

2. Macro Economy and Corporate Health

The economic literature contains studies focused on explaining the relationship between business failures and fluctuations in aggregate measures of economic activities. The cyclical variations in business failures and macroeconomic aggregates are actually correlated in two ways. When companies are in distress, they are likely to cut investment and production, weakening economic growth. In addition, the expected economic downturn heightens corporate sector vulnerability. It is also observed that corporate failures occur frequently in recessionary periods which show the importance of factors external to the company.

First the macroeconomic conditions affect the health of firms. Altman (1983) used augmented distributed lags (ADLs) to demonstrate that GNP, gross corporate profits and money supply have impacts on a marginal firm's ability to survive. Following a different, though related, line of research, Liu and Wilson (2002) constructed measures of the effects of the macro economy using error-correction information, showing that interest rate and insolvency legislation are the important variables in determining business failures in the long run.

Secondly the corporations' health also influences the macro economy through the following links. When firms experience financial difficulties they dispose assets at 'fire-sale' prices so that net worth reduces and asset values falls (Pulvino, 1998); firms bear the risk of being excluded from access to credit, with an accompanying collapse in investment demand (Bernanke and Gertler, 1995). Corporate balance sheets become weakened when distressed firms incur high direct costs to stay afloat financially, which offset the value of tax relief of an increasing debt level, hence exerting a negative effect on firm value. These two mechanisms lead firms to curtail investment plans and cut down productions, thus causing economic downturns and significantly impairing economic growth (Vlieghe, 2001).

The current global economy which is characterised by economic slowdown, deflation, reduced interest rate, worsening government budget deficit, elevated credit risk, tighter credit and other economic difficulties etc. makes the firms to think of necessary adjustments for their businesses to survive in view of the changing macroeconomic conditions. It is worth exploring the relationship between firms' health and the major macroeconomic factors or how the firm responds to the changes in the macroeconomic conditions.

Against this backdrop the current study explores the relationship between the corporate health indicators of the manufacturing firms (i.e. the Z scores) and the macroeconomic variables like Inflation, GDP, Bank rate and trade openness for the Indian scenario.

3. Theoretical Support

Corporate distress prediction models were being initiated by Beaver (1966) and Altman (1968) using univariate test and multivariate discriminant analysis. Since then the prediction of corporate failure became a topic of much interest and the recent works have extended this line of research in three areas: statistical techniques, definitions of bankruptcy and a wider variety of explanatory variables. The third area involves some adjustments of explanatory variables either by including variables other than financial ratios or industry-adjusted ratios. Some studies include macroeconomic variables to control for changes in the business environment. Most of the empirical research, not to forget the recent global meltdown shows that the incidence of default rises during economic recession. Several studies have used macroeconomic variables for corporate distress prediction.

Wadhwani (1986) examined the determinants of corporate liquidations to test the hypothesis that inflation played a significant role. In theory, firms financed by variable-rate debt should not be affected by inflation in a perfectly indexed economy, because the increase in interest payments due to higher nominal rates can be financed by an increase in debt, to match the increase in the nominal value of assets. However in the absence of perfect capital markets, firms may be unable to increase their borrowing and therefore, face a cash flow shortage as the increase in interest payments is proportionally larger than the increase in revenues.

To test this hypothesis, Wadhwani regressed with the liquidation rate of firms (as measured by the ratio of compulsory and creditors' voluntary liquidations divided by the number of active companies on the register) a number of macroeconomic and financial variables. He found that real wages, real input prices, capital gearing (using market values), the real interest rate, the nominal interest rate and measures of aggregate demand are significant. The rate of new company registrations is not reported in the final specification and a measure of the standard deviation of prices was not significant. The fact that both real and nominal interest rates are significant is taken as evidence that inflation directly affects the liquidation rate.

Cuthbertson and Hudson (1996) in their ADL model demonstrated that interest rate, profits and income-gearing variables are the key variables influencing compulsory liquidations. Vlieghe (2001) examined UK aggregated corporate liquidations within the ADL framework and found that real interest rate and debt-to-GDP ratio are the long-run determinants of liquidation rate, while property prices, nominal interest rate and business birth rate had significant short-term effects. Following a different, though related, line of research, Liu and Wilson (2002) constructed measures of the effects of the macro economy using error-correction information, showing that interest rate and insolvency legislation to be the important variables in determining business failures in the long run.

Liu and Pang (2009) tried to investigate whether macroeconomic factors accounted for the observed fluctuations in the UK business failures during the period of 1966-2003, using vector error correction model. The major finding was that macroeconomic variables, i.e. credit, profits, inflation and company births, appeared to be the important factors influencing business failures. It was suggested that the interest rate, could be used as a feasible policy instrument to reduce the incidence of failures. It was also found that corporate failures played a significant role in macroeconomic fluctuations.

Bhattacharjee and Han (2010) studied the impact of microeconomic factors and macroeconomic conditions as well as institutional influences on financial distress of Chinese listed companies over the period 1995-2006. The findings revealed substantial effect of firm level covariates (age, size, cash flow and gearing) on financial distress. Also macroeconomic instability and institutional factors have a significant impact on the hazard rate of financial distress. Chen and Mahajan (2010) showed that all macroeconomic variables had a direct impact on corporate cash holdings.

The health of manufacturing firms has not received much attention from macroeconomic theory. However, logic suggests that macroeconomic developments or changes may have an important role in explaining corporate distress. It is for this reason that an attempt is being made here to study the relationship between macroeconomic conditions and corporate health of manufacturing units in India.

4. Methodology

The analysis is based on the recently developed panel integration, cointegration and causality test. These tests are used to determine the long-run dynamic linkages between the variables under consideration in a panel set up.[2] For gaining statistical power over time series tests and to avoid the low power of classical panel tests which have an assumption of series being stationary, we have applied these tests to a panel data set here in this study. Moreover, these panel data techniques allow for heterogeneity among cross-sections and individual intercept for each cross-section to capture the firm specific effect. This allows us to test directly for the existence of long run equilibrium functions.

Given the time series element present in the panel data, in the first step we determine the order of integration of each of the data series. The concept of cointegration is associated with the long-run equilibrium relationship between two or more variables, so in the second step we test for the existence of long run relationship between the variables using cointegration test developed by Pedroni (1999). If the series are cointegrated, the long run relationship between the variables is estimated by employing the Fully Modified Ordinary Least Square Method (FMOLS) developed by Pedroni (2000). This is followed by investigating long run dynamic linkages between the variables, using panel long run causality test developed by Canning & Pedroni (2008) based on Engle & Granger (1987) specification.

The independent macro variables are GDP at Factor cost at Constant Prices, Bank rate, WPI and trade openness [(Exports+Imports) / GDP]from 1990 to 2009. The data on macroeconomic variables are collected from 'Handbook of Statistics on Indian Economy' from Reserve bank of India (www.rbi.org.in).

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2 The firm specific variables along with macro economic variables are used in the panel regression model with a view to assess the fixed effects of macro economic variables on the firm specific financial health indicator i.e. Z scores. The idea is taken from 'Firm Defaults and Aggregate Fluctuations' by Jacobson et al. (2011) and 'A Study of the Roles of Firm and Country on Specific Determinates in Capital Structure: Iranian Evidence' by Salehi and Manesh (2012).

Financial health indicator via Z score

The research on Indian companies to predict corporate health is meagre due to lack of proper bankruptcy laws which stops from identifying the distressed firms and due to non-availability of data. For computing the Z scores, based on NIC two digit 2004 classification the total number of manufacturing units identified for the study was 73 firms listed under BSE 200.

The samples were matched by industry affiliation, devised average net worth criterion and the period of analysis. The criterion for division was based on the average net worth of the companies during the year 1990 to 2009. A company having the average net worth value greater than 1,250 rupees crore is classified as a healthy company; a company with average net worth value greater than 450 rupees crore but less than 1,250 rupees crore is taken as moderately healthy and a company with average net worth value less than 450 rupees crore is taken as not-so-healthy. This study was exploratory in devising the average net worth criteria for division and we have taken open-end classes in this study to divide the data into 3 groups based on average net worth value. The reason is when we use Multiple Discriminant Analysis (MDA) technique the number of groups in the study should have more or less same number of sample size. So as the technique demands it, we had to take open end classes. Out of the total sample of 73 firms, the development sample consists of 63 firms (23 healthy, 18 moderately healthy and 22 not-so-healthy firms) and a hold-out sample of 10 firms.

15 financial ratios covering various aspects of profitability, liquidity, solvency, capital structure, efficiency, financial leverage, sales generating capacity, etc. were taken and Z score model was calculated by the Multiple Discriminant Analysis (MDA) technique. Out of 15, four ratios entered the Z score model.

The dependent variable is the Z scores of the 73 firms obtained from equation 1 given below:

$$Z_I = 0.945X_1 - 0.976X_2 + 1.026X_3 + 0.180X_5 \qquad \text{... (1)}$$

where X_1 = working capital to total assets;

X_2 = retained profits to total assets;

X_3 = profit before interest and taxes to total assets;

X_5 = debt-equity ratio;

Z_I = the Z score for Indian manufacturing firms.

This model resembles the EMS model for emerging markets developed by Altman in 1995 except for the fact that the EMS model used inverse of Debt-equity ratio, and also three variables of this model resemble the Altman’s original Z score model (1968).

To take care of linearity property, we have taken the log of each of variables. We explain the independent variables and their expected relationship with Z score below.

Gross domestic product (GDP) refers to the market value of all final goods and services produced within a country in a given period. It is often considered an indicator of a country's standard of living. It aims to represent the total economic activity of a specific country by totalling the value of its production, the income earned from this production or series of more complex assessments. Moreover, in the recent literature (e.g. Liou & Smith (2007), Chen & Mahajan (2010), etc.) it has been taken. GDP is expected to be positively associated with the Z score as when growth in GDP takes place it creates better investment opportunities for firms and also increases corporate liquidity so the corporate health is likely to improve. But GDP will have positive or negative relation with Z score depending on whether it is taken at current price or constant price.

Bank rate, also referred to as the discount rate, is the rate of interest which a central bank charges on the loans and advances that it extends to commercial banks and other financial intermediaries. Changes in the bank rate are often used by central banks to control the money supply, and hence is a very crucial variable. So, we have used it in our analysis. When the central bank reduces the bank rate, it increases the attractiveness for commercial banks to borrow, thus increasing the money supply. So, commercial banks start extending their loan base without much stringent rules which increases the risk of default. Whereas when the central bank increases the bank rate, it decreases the attractiveness for commercial banks to borrow and the lending rates of commercial banks rises. The commercial banks will be cautious about the credit worthiness of the firms while giving loans and moreover as the commercial banks will be charging higher rates healthy firms can only afford it. Therefore, we can say that bank rate is expected to be positively related to Z score.

The Wholesale Price Index or WPI is the price of a representative basket of wholesale goods. It is used as a measure of Inflation. The Wholesale Price Index focuses on the price of goods traded between corporations, rather than goods bought by consumers, which is measured by the Consumer Price Index. The purpose of the WPI is to monitor price movements that reflect supply and demand in industry, manufacturing and construction. Inflation correlates with the increasing prices and the direct costs of material, labour, operations, R&D, etc. So, it would favour larger and healthier companies with well established economies of scale relative to smaller and newer firms. Thus, WPI is expected to be positively associated with Z score in the short run but the higher a firm's sensitivity to inflation, the more likely the firm's exposure to financial distress in the long run.

The trade openness variable measured as the ratio of sum of exports and imports to GDP tells us about the share of trade in the income of a given country. The good manufacturing firms are likely to have higher trade openness. However, if imports exceed exports for a particular firm, it would adversely affect the financial health of that firm. So, this can be positively or negatively related to Z score depending on the net exports.

To investigate the relationship between Z score and the macro economic variables the following model is used:

$$LZ_{it} = \beta_0 + \beta_1 LGDP_t + \beta_2 LBR_t + \beta_3 LWPI_t + \beta_4 LTRADE_t + e_t \qquad \text{... (2)}$$

where LZ_{it} is the logarithm of the averaged Z score obtained from equation 1 for firms i = 1 to 73 for t = 20 years, $LGDP_t$ is the logarithm of averaged Gross Domestic Product at Factor cost at Constant Price for all firms for 20 years ; LBR_t is the logarithm of the averaged Bank rate for all firms for 20 years, $LWPI_t$ is the logarithm of averaged Wholesale Price Index for all firms for 20 years and $LTRADE_t$ is the logarithm of averaged trade openness for all firms for 20 years, and e_t is the error term. Equation 2 can be considered as the long run equilibrium relation.

4.1. Panel Unit Root Test

While estimating the panel data models, the time-series properties of the cross-sections will have an important influence on the specification of the econometric model and the choice of estimators. Therefore, testing for stationarity is very crucial for analysing panel data models. A stochastic process is said to be stationary if it is oscillating around the constant mean over the period with some confidence interval. Most of the financial and macroeconomic time-series data are non-stationary and testing for non-stationarity means testing for presence of a unit root.

When dealing with panel data, because the procedure is more complex, the conventional ADF and DF tests can result in inconsistent estimators. So, several statistical methods (Levin, Lin and Chu, 2002; Im, Pesaran and Shin, 2003; Choi, 2001; Breitung, 2000; and Hadri, 2000) are constructed to test for unit roots in panel data.

In this study, we use panel unit root test proposed by Hadri (2000). It is similar to the KPSS unit root test and has a null hypothesis of stationarity or no unit root in any of the series in the panel. Just as the null of the KPSS test differs from that of Dickey–Fuller style tests in assuming stationarity rather than nonstationarity, Hadri's test generalizes this notion to the panel context. The test statistic is distributed as standard Normal under the null hypothesis. As in the univariate KPSS test, the series may be stationary around a deterministic level (specific to the unit–i.e. a fixed effect) or around a unit–specific deterministic trend. The error process may be assumed to be homoskedastic across the panel or heteroskedastic across units. Serial dependence in the disturbances may also be taken into account using a Newey–West estimator of the long–run variance. The residual–based test is based on the squared partial sum process of residuals from a demeaning (detrending) model of level (trend) stationarity.

Like the KPSS test, the Hadri test is based on the residuals from the individual OLS regressions of y_{it} on a constant, or on a constant and a trend. For example, if we include both the constant and a trend, we derive estimates from:

$$y_{it} = \delta_i + \eta_i t + \varepsilon_{it} \qquad \text{... (3)}$$

Given the residuals $\hat{\varepsilon}$ from the individual regressions, we form the LM statistic:

$$LM_1 = \frac{1}{N}\left(\sum_{i=1}^{N}\left(\sum_t S_i(t)^2 / T^2\right) / \bar{f}_0\right) \qquad \text{... (4)}$$

Where $S_i(t)$ are the cumulative sums of the residuals,

$$S_i(t) = \sum_{s=1}^{t} \hat{\varepsilon}_{it} \qquad \text{... (5)}$$

And $\bar{f}_0$ is the average of the individual estimators of the residual spectrum at frequency zero:

$$\bar{f}_0 = \sum_{i=1}^{N} f_{i0} / N \qquad \text{... (6)}$$

Hadri shows that under mild assumptions,

$$Z = \frac{\sqrt{N}(LM - \xi)}{\zeta} \rightarrow N(0, 1) \qquad \text{... (7)}$$

where $\xi = 1/6$ and $\zeta = 1/45$, if the model only includes constants (η_i is set to 0 for all *i*), and $\xi = 1/15$ and $\zeta = 11/6300$, otherwise. The Hadri panel unit root tests require only the specification of the form of the OLS regressions: whether to include only individual specific constant terms, or whether to include both constant and trend terms.

Here we have used both individual effects and individual linear trends.

4.2. Panel Cointegration Analysis

To test the cointegration relationship we use Pedroni's method (1999, 2004) which extends the idea of residual based cointegration, proposed by Engle and Granger (1987). Pedroni's formulation allows for the heterogeneity across the cross-sections by permitting individual specific fixed effect, slopes and deterministic time trend for each cross-section. To test the cointegration, we estimate the following bi-variate regression equation:

$$Y_{i,t} = \alpha_i + \delta_i t + b_t + \beta_i X_{i,t} + e_{i,t} \qquad \text{... (8)}$$

where *i* is the index for the *N* cross-sections, *t* is the index for time over the sample period of length *T*. The same equation can be extended for the multi-variate specification. Each firm has its own relationship between variables $Y_{i,t}$ and $X_{i,t}$. The slope coefficient β in cointegrated relationship is permitted to vary across individual member of the panel. The parameter α_i is the member specific fixed effect or intercept and the parameters $\delta_i t$ represent individual specific deterministic time trend. The time specific dummies b_t capture the common time specific effect that would tend to cause the individual firm variables to move together over time. The variable $e_{i,t}$ represents the individual panel specific error term. If the long run cointegration relationship exists between $Y_{i,t}$ and $X_{i,t}$, then the error term $e_{i,t}$ should be stationary. Under the null hypothesis of no cointegration in heterogeneous panels i.e. $e_{i,t}$ is non-stationary, Pedroni (1999, 2004) develops seven different test statistics based on the estimated error term $e_{i,t}$ in equation. These test statistics are divided in two groups. The first group, "within dimensions" contains four test statistics termed as panel - v panel - ρ panel - t non-parametric (PP), and panel - t parametric (ADF). The panel - v and panel - ρ statistics are similar to the Phillips and Perron, (1988) test. Likewise panel - t non-parametric (PP), and panel - t parametric (ADF) are similar to the single equation Augmented Dickey-fuller (ADF) test. The second group "between dimensions" contains three test statistics termed as group - ρ, group - t non-parametric (PP), and group - t parametric (ADF). These test statistics are comparable to the group mean panel tests of Im *et al.*, (2003). Both panel and group statistics are based on the Augmented Dickey Fuller (ADF) and Phillips-Perron (PP) method. These heterogeneous panel and heterogeneous group mean panel test statistics to test panel cointegration are as follows *(Pedroni, (1999, Pages: 660-661, Table: 1)* :

1. Panel v-statistic:

$$T^2 N^{3/2} Z_{\hat{v},N,T} = T^2 N^{3/2} \left(\sum_{i=1}^{N} \sum_{t=1}^{T} \hat{L}_{11i}^{-2} \hat{e}_{i,t-1}^2 \right)^{-1}$$

2. Panel ρ-Statistic:

$$T\sqrt{N}Z_{\hat{\rho}N,T-1} = T\sqrt{N}\left(\sum_{i=1}^{N}\sum_{t=1}^{T}\hat{L}_{11i}^{-2}\hat{e}_{i,t-1}^{2}\right)^{-1}\sum_{i=1}^{N}\sum_{t=1}^{T}\hat{L}_{11i}^{-2}\left(\hat{e}_{i,t-1}\Delta\hat{e}_{i,t}-\hat{\lambda}_{i}\right)$$

3. Panel t-Statistic (non-parametric):

$$Z_{tN,T} = \left(\tilde{\sigma}_{N,T}^{2}\sum_{i=1}^{N}\sum_{t=1}^{T}\hat{L}_{11i}^{-2}\hat{e}_{i,t-1}^{2}\right)^{-1/2}\sum_{i=1}^{N}\sum_{t=1}^{T}\hat{L}_{11i}^{-2}\hat{e}_{i,t-1}^{2}\left(\hat{e}_{i,t-1}\Delta\hat{e}_{i,t}-\hat{\lambda}_{i}\right)$$

4. Panel t-Statistic (parametric):

$$Z_{tN,T}^{*} = \left(\tilde{s}_{N,T}^{2}\sum_{i=1}^{N}\sum_{t=1}^{T}\hat{L}_{11i}^{-2}\hat{e}_{i,t-1}^{*2}\right)^{-1/2}\sum_{i=1}^{N}\sum_{t=1}^{T}\hat{L}_{11i}^{-2}\hat{e}_{i,t-1}^{*}\Delta\hat{e}_{i,t}^{*}$$

5. Group ρ-Statistic:

$$TN^{-1/2}\tilde{Z}_{\hat{\rho}N,T^{-1}} = TN^{-1/2}\sum_{i=1}^{N}\left(\sum_{t=1}^{T}\hat{e}_{i,t-1}^{2}\right)^{-1}\sum_{t=1}^{T}\left(\hat{e}_{i,t-1}\Delta\hat{e}_{i,t}-\hat{\lambda}_{i}\right)$$

6. Group t-Statistic (non-parametric):

$$N^{-1/2}\tilde{Z}_{tN,T^{-1}} = N^{-1/2}\sum_{i=1}^{N}\left(\sum_{t=1}^{T}\hat{e}_{i,t-1}^{2}\right)^{-1/2}\sum_{t=1}^{T}\left(\hat{e}_{i,t-1}\Delta\hat{e}_{i,t}-\hat{\lambda}_{i}\right)$$

7. Group t-Statistic (parametric):

$$N^{-1/2}\tilde{Z}_{tN,T}^{*} = N^{-1/2}\sum_{i=1}^{N}\left(\sum_{t=1}^{T}\hat{s}_{i}^{*2}\hat{e}_{i,t-1}^{*2}\right)^{-1/2}\sum_{t=1}^{T}\hat{e}_{i,t-1}^{*}\Delta\hat{e}_{i,t}^{*}$$

where

$$\hat{\lambda}_{i} = \frac{1}{T}\sum_{s=1}^{k_i}\left(1-\frac{s}{k_i+1}\right)\sum_{t=s+1}^{T}\hat{\mu}_{i,t}\hat{\mu}_{i,t-s} \qquad \hat{s}_{i}^{2} = \frac{1}{T}\sum_{t=1}^{T}\hat{\mu}_{i,t}^{2} \qquad \hat{\sigma}_{i}^{2} = \hat{s}_{i}^{2}+2\hat{\lambda}_{i}$$

$$\tilde{\sigma}_{NT}^{2} = \frac{1}{T}\sum_{t=1}^{T}\hat{L}_{11i}^{2}\hat{\sigma}_{i}^{2} \qquad \hat{s}_{i}^{*2} = \frac{1}{T}\sum_{t=1}^{T}\hat{\mu}_{i,t}^{*2} \qquad \tilde{s}_{N,T}^{*2} = \frac{1}{N}\sum_{i=1}^{N}\hat{s}_{i}^{*2}$$

$$\hat{L}_{11i}^{2} = \frac{1}{T}\sum_{t=1}^{k_i}\hat{\eta}_{i,t}^{2}+\frac{2}{T}\sum_{t=1}^{T}\left(1-\frac{s}{k_i+1}\right)\sum_{i=s+1}^{T}\hat{\eta}_{i,t}\hat{\eta}_{i,t-s}$$

where the residuals $\hat{\mu}_{i,t}$, $\hat{\mu}_{i,t}^{*}$ and $\hat{\eta}_{i,t}$ are obtained from the following regressions:

$$\hat{e}_{i,t} = \hat{\gamma}_{i}\hat{e}_{i,t-1}+\hat{\mu}_{i,t}$$

$$\hat{e}_{i,t} = \hat{\gamma}_{i}\hat{e}_{i,t-1}+\sum_{k=1}^{K_i}\hat{\gamma}_{i,k}\Delta\hat{e}_{i,t-k}+\hat{\mu}_{i,t}^{*}$$

$$\Delta Y_{i,t} = \sum_{m=1}^{M}\hat{b}_{mi,t}\Delta X_{mi,t}+\hat{\eta}_{i,t}$$

The “within dimension” test statistics are constructed by summing both numerator and denominator terms over the individual separately, whereas in “between dimension” numerator is divided by denominator prior to the summation. Moreover, the autoregressive parameter in “within dimension” statistics is restricted to be the same across all cross-sections. The rejection of null of no cointegration indicates that the variables under consideration are said to be cointegrated for all panel members. However, the autoregressive parameter in “between dimension” statistics is allowed to vary across cross-sections. The estimated statistic will be the average of individual statistics. The rejection of null of no cointegration indicates that the cointegration holds at least for one individual. Therefore, “between dimension” statistics offers an additional source of heterogeneity among the panel members. Pedroni standardized all these statistics to the standard normal distribution, based on the moments of the vector of Brownian motion function. Using simulated moments, Pedroni constructed approximations for the asymptotic distributions, and consequently computed approximate critical values for different values of number of regressors. The asymptotic distributions for each of the seven panels and group mean statistics can be expressed as follows:

$$\kappa = \frac{\kappa_{N,T} - \mu\sqrt{N}}{\sqrt{v}} \Rightarrow N(0,1)$$

Pedroni (1999) reports the critical values for μ and v for different values of number of regressors in cointegration relationship. The reported values are with and without intercepts and deterministic trends. The small sample size and power properties of all seven tests are discussed in Pedroni (1997). He finds that the change in test statistics due to size are minor, the power of the tests are high for all statistics when the time period is long. Panels with shorter size and time period shows more varied evidence. However, in the presence of a conflict in the evidence provided by each of the statistics, Pedroni shows that the Group-ADF statistic and Panel-ADF statistic generally perform best.

While performing the Pedroni’s cointegration analysis, we assume an intercept and deterministic trend for the variables in the tests.

4.3. Panel Fully Modified Ordinary Least Square (FMOLS)

To estimate the long run relationship between the heterogeneous cointegrated panels, Fully Modified Ordinary Least Square (FMOLS) method is used. FMOLS regression was originally introduced by Phillips and Hansen (1990) to provide optimal estimates of cointegrating regressions. The cointegrating links between the non-stationary series can lead to endogeneities in the regressors that cannot be avoided by using vector auto-regressions (VAR'S) as if they were simply reduced forms. In FMOLS setting, non-parametric techniques are exploited to transform the residuals from the cointegration regression and can get rid of these nuisance parameters. Pedroni (1996, 2000, and 2001) extended the idea of FMOLS to panel data and accounted for the serial correlation effects and the endogeneity in the regressors that resulted from the existence of a cointegrating relationship in panel data. It also allowed for the heterogeneity in short run dynamics and the fixed effects. This methodology allows consistent and efficient estimation of cointegrating vector and also addresses the problem of simultaneous bias. The cointegrated regression for estimation is:

$$Y_{i,t} = \alpha_i + \beta X_{i,t} + e_{i,t} \qquad \text{... (9)}$$

$$X_{i,t} = X_{i,t-1} + e_{i,t} \qquad \text{... (10)}$$

where *i* is the index for the *N* cross-sections, *t* is the index for time over the sample period of length *T*. The vector error process $\xi_{i,t} = \left(e_{i,t}, \varepsilon_{i,t}\right)'$ is stationary with asymptotic covariance matrix Ω_i The asymptotic covariance matrix Ω_i is given by $\lim_{T\to 0} E\left[T^{-1}\left(\sum_{t=1}^{T}\xi_{i,t}\right)\left(\sum_{t=1}^{T}\xi_{i,t}\right)\right]$. The estimator β will be consistent when the error process $\xi_{i,t} = \left(e_{i,t}, \varepsilon_{i,t}\right)'$ satisfies the assumption of cointegration of order one between $Y_{i,t}$ and $X_{i,t}$. A semi-parametric correction can be made to the OLS estimator that eliminates the second order bias caused by the fact that the regressors are endogenous.

Pedroni (1999, 2000) estimate the test statistic for both “within dimension” and for “between dimension” estimators. Test statistics constructed from the within-dimension estimators are designed to test the null hypothesis H_0: $\beta_i = \beta_0$ for all *i* versus the alternate hypothesis H_a: $\beta_i = \beta_a \neq \beta_0$ for all *i* against where the value β_a is the same for all *i*. Test statistics constructed from the between-dimension estimators are designed to test the null hypothesis H_0: $\beta_i = \beta_0$ for all *i* versus the alternate hypothesis H_a: $\beta_i \neq \beta_0$ for all *i,* where values for β_i are not same under the alternative hypothesis. Clearly, this is an important advantage of “between-dimension” that it does not restrict the value of β to a common value. Another advantage of the “between-dimension” is that the estimator is a point estimate and has a more useful interpretation by providing additional source of heterogeneity in cointegrating vectors. The group mean fully modified *t*-statistic (between dimension) can be calculated as:

$$\bar{t}_{\beta^*_{NT}} = \frac{1}{\sqrt{N}}\sum_{i=1}^{N}\hat{L}_{11i}^{-1}\left(\sum_{t=1}^{T}\left(X_{it} - \bar{X}_i\right)^2\right)^{-1/2}\left(\sum_{t=1}^{T}\left(X_{i,t} - \bar{X}_i\right)Y^*_{i,t} - T\hat{\gamma}_i\right) \Rightarrow N(0,1)$$

where $Y^*_{i,t} = \left(Y_{i,t} - \bar{Y}_i\right) - \frac{\hat{L}_{21i}}{\hat{L}_{22i}}\Delta X_{i,t}$

The test statistic is distributed standard normal and can be interpreted as the mean value for the cointegrating vectors. The “between-dimension” estimate is better in case of small panels as compare to “within-dimension” estimators (Pedroni, 2001).

4.4. Panel Long Run Causality

To identify the direction and sign of long run causality in Cointegrated panels we use methodology developed by Canning and Pedroni (2008) based on Granger representation theorem (Engle and Granger, 1987). According to Granger representation theorem, the series that are individually non-stationary but together cointegrated can be represented in the form of a dynamic error correction model. To construct this dynamic error correction model first we calculate the disequilibrium term $\hat{e}_{i,t}$ by using the long run Cointegrated relationship estimated in previous section. This can be calculated using the following equation:

$$\hat{e}_{i,t} = Y_{i,t} - \hat{\alpha}_i - \hat{b}_t - \hat{\beta}_i X_{i,t} \quad \ldots (11)$$

This disequilibrium term is further used to construct the dynamic error correction model. This can be represented as follows:

$$\Delta Y_{i,t} = c_{1,i} + \lambda_{1,i}\hat{e}_{i,t-1} + \sum_{j=1}^{k}\varphi_{11,i,t}\Delta X_{i,t-j} + \sum_{j=1}^{k}\varphi_{12,i,t}\Delta Y_{i,t-j} + \varepsilon_{1,i,t} \quad \ldots (12)$$

$$\Delta X_{i,t} = c_{2,i} + \lambda_{2,i}\hat{e}_{i,t-1} + \sum_{j=1}^{k}\varphi_{21,i,t}\Delta X_{i,t-j} + \sum_{j=1}^{k}\varphi_{22,i,t}\Delta Y_{i,t-j} + \varepsilon_{2,i,t} \quad \ldots (13)$$

where i is the index for the N cross-sections, t is the index for time over the sample period of length T and k is the number of lags selected for the VAR representation. $\lambda_{1,i}$ and $\lambda_{2,i}$ are adjustment coefficients or correction to the disequilibrium term, so that it causes the variable to adjust towards equilibrium and keep the long run relationship intact. At least one of them must be non-zero if a long run relationship between the variables is to hold. Based on the Granger representation theorem for time series models, Canning and Pedroni (2008) developed the similar methodology for panel data and showed that:

1. The coefficient λ_1, on the lagged equilibrium cointegrating relationship in the dynamic error correction equation for ΔY_i is zero if, and only if, innovations to X_i have no long run causal effect on Y_i. Similarly, the statement is true for λ_2.
2. The ratio of the coefficients $-\lambda_2/\lambda_1$, on the lagged equilibrium cointegrating relationship in the dynamic error correction equation for ΔY_i and ΔX_i, has the same sign as the long run causal effect.

The test of significance (on either tail) for coefficient $\lambda_{1,i}$, for the null hypothesis $H_0 = \lambda_{1,i} = 0$ can be interpreted as $X_{i,t}$ has a long run causal effect on $Y_{i,t}$. Similarly, a test of significance (on either tail) for coefficient $\lambda_{2,i}$, for the null hypothesis $H_0 = \lambda_{2,i} = 0$ can be interpreted as $Y_{i,t}$ has a long run causal effect on $X_{i,t}$. The coefficients λ_1 and there tests of significance are associated with individual firm in the panel. However, in practice the reliability of these various point estimates and associated test for any one firm are likely to be poor given the relatively short time sample over which data is observed (Canning and Pedroni, 2008). To test whether on average there exists a long run causal relationship in either direction between Y_t and X_t for the panel as a whole; the group mean panel estimate is computed as the sample average of the individual firm's λ coefficient i.e. $\bar{\lambda} = \frac{1}{N}\sum_{i=1}^{N}\hat{\lambda}_i$. Similarly, the group means panel test statistic for panel as a whole is computed as the average of individual country test statistic i.e. $\overline{t}_{\lambda} = \frac{1}{N}\sum_{i=1}^{N} t_{\lambda_i}$. The test statistic $\overline{t}_{\lambda}$ has a standard normal distribution under the null hypothesis of no long run causal effect. The null hypothesis can be rejected on either tail of the distribution.

Canning and Pedroni (2008) also defined the Lambda-Pearson panel test to compute the accumulated marginal significance associated with these test statistics. The p-values associated with each of the individual firm test statistic are used to compute the Lambda-Pearson panel test statistic. The Lambda-Pearson panel test statistic can be computed as $P_{\lambda} = -2\sum_{i=1}^{N} \ln p_{\lambda_i}$, where $\ln p_{\lambda_i}$ is the natural log of p-values associated with individual panel member test statistic. The value P_{λ} has a chi-square distribution with *2N* degrees of freedom, under the null hypothesis of no long run causal effect. The null hypothesis can be rejected only on the right tail of the distribution. They also suggested that there could be the possibility that in some cases $\overline{t}_{\lambda}$ fails to reject the null whereas P_{λ} rejects the null. In those cases also we can still say that there exists a long run causal relationship. In those cases we do not reject that average value for λ_i is zero but we reject that it is pervasively zero in the panel.

Furthermore, they also defined sign ratio - λ_2 / λ_1 , which can be interpreted as the sign of long run causal effect between the two variables and constructed a panel based test to test the significance of this ratio. Since the ratio follows a Cauchy distribution, this test is based on group median estimator and associated standard errors for the panel. The distribution of each individual ratio is formed from the ratio of dependent non-identical normal distributions. Moreover, the variance of each panel member, for each variable is simulated in order to get the corresponding group median estimate.

5. Empirical Results

5.1. Descriptive Statistics of Variables

Table 1 shows the descriptive statistics of the variables used in the panel analysis in the study from 1990 to 2009. The standard deviation shows small statistical dispersion in data used for panel regression analysis. This also means that the data points are not highly variable.

Table 1. Descriptive Statistics of the Panel Variables

Variables	Observations	Mean	Std. Dev.	Maximum	Minimum
LZ-score	1460	0.362905	0.123751	0.578942	0.133348
LGDP	1460	14.50211	0.455672	15.31820	13.89577
LBR	1460	2.098804	0.292751	2.484907	1.791759
LWPI	1460	1.818921	0.424141	2.617396	1.193922
LTRADE	1460	-1.549058	0.562816	-0.630780	-2.660573

5.2. Results of Unit Root Tests

Table 2 below gives the results of the Hadri panel unit root test.

Table 2. Hadri Panel Unit Root Test

Null Hypothesis: Stationarity (Absence of Unit root)
Exogenous variables: Individual effects, individual linear trends
Newey-West automatic bandwidth selection and Bartlett kernel
Total (balanced) observations: 1460

For Levels				
Panel	*Period*	*Number of firms*	*Hadri Z-stat*	*Prob.*
LZ-score	1990-2009	73	3.01161	0.0013*
LGDP	1990-2009	73	24.6991	0.0000*
LBR	1990-2009	73	21.5120	0.0000*
LWPI	1990-2009	73	16.7565	0.0000*
LTRADE	1990-2009	73	25.8243	0.0000*
For First Differences				
Panel	*Period*	*Number of firms*	*Hadri Z-stat*	*Prob.*
LZ-score	1990-2009	73	-2.97115	0.4178
LGDP	1990-2009	73	0.09892	0.4606
LBR	1990-2009	73	0.11704	0.4534
LWPI	1990-2009	73	-2.46559	0.9932
LTRADE	1990-2009	73	4.88769	0.0000*
LTRADE (2^{nd} diff.)			-0.45672	0.6761

Note: Probabilities are computed assuming asymptotic normality.
* Significance at 1% level.

In this we reject the null hypothesis of stationarity at 1% level of significance for all the variables in the log levels. But when we take first difference all variables except the LTRADE happens to be a stationary process, which is stationary after second differencing. Therefore, it can be concluded that the panel variables follow I (1) process.

5.3. Panel Cointegration Results

Table 3 depicts the Pedroni residual panel cointegration results. Under the null hypothesis of no cointegration and deterministic intercept and trend assumption, seven test statistics are computed namely the Panel v - statistic, panel ρ - statistic, panel PP statistic, panel ADF statistic, the group ρ statistic, group PP statistic and group ADF statistic. The first four tests are known as the 'within dimension' panel tests while the last three are known 'between dimension' group tests.

Table 3. Pedroni Residual Cointegration Test Results

Null Hypothesis: No cointegration

Trend assumption: Deterministic intercept and trend

Period: 1990 – 2009

Number of Firms: 73

Newey-West automatic bandwidth selection and Bartlett kernel

Panel	*Panel ν - stat*	*Panel ρ - stat*	*Panel PP-stat*	*Panel ADF-stat*	*Group ρ - stat*	*Group PP-stat*	*Group ADF-stat*
LZ-score on LGDP	7.846118 (0.0000)*	-22.31830 (0.0000)*	-29.89603 (0.0000)*	-19.13725 (0.0000)*	-6.268278 (0.0000)*	-13.03388 (0.0000)*	-11.66925 (0.0000)*
LZ-score on LBR	7.887722 (0.0000)*	-22.43278 (0.0001)*	-32.11369 (0.0000)*	-21.53465 (0.0000)*	-5.877649 (0.0000)*	-12.71575 (0.0000)*	-11.28437 (0.0000)*
LZ-score on LWPI	9.032705 (0.0000)*	-22.93017 (0.0000)*	-30.96008 (0.0000)*	-19.81974 (0.0000)*	-4.610541 (0.0000)*	-9.963259 (0.0000)*	-4.413291 (0.0000)*
LZ-score on LTRADE	7.764925 (0.0000)*	-22.02221 (0.0000)*	-30.72052 (0.0000)*	-20.16369 (0.0000)*	-6.499469 (0.0000)*	-12.12742 (0.0000)*	-10.53644 (0.0000)*

Note: Pedroni Panel ν, panel ρ , panel PP and panel ADF statistics alternative hypothesis: common AR coeffs. (within- dimension) and Pedroni Group ρ , group PP and group ADF statistics alternative hypothesis: individual AR coeffs. (between-dimension).

* Significance at 1% level.

It can be seen from table 3 that the null of no cointegration is rejected for all seven tests for all panels at the conventional level.

Moreover, the Panel ADF statistic and Group ADF statistic for all panels reject the null of no cointegration. Taken together, there is reasonable evidence from Pedroni's residual cointegration test that Z score and GDP, Z score and bank rate, Z score and WPI and Z score and Trade openness are panel cointegrated and have long term relationships. So, we can conclude that the presence of long term relationship for all 4 panels.

5.4. Panel FMOLS Results

Table 4 gives the panel FMOLS results. The coefficients of log of bank rate and log of WPI are positive, which shows that these variables are positively related with Z score. But log of GDP and log of trade openness are negative. However, the t-statistic shows that all variables are significant. That means all variables have significant impact on health of corporations or Z score.

Table 4. Panel Group FMOLS Results

Number of Cross sections (Firms): 73

Time periods: 20

Number of Regressors: 1 (LZ-score)

Variables	*Coefficients*	*t-statistic*
LGDP	- 0.31	-25.07*
LBR	0.49	23.77*
LWPI	0.34	14.36*
LTRADE	- 0.22	-23.79*

Note: * Significant

5.5 Panel Long-run Causality Results

The long-run Granger causality results are reported in table 5. Results are reported for each of the four panels and their associated Group Mean and Lambda Pearson test statistics.

Table 5. Long-Run Panel Causality Test Results

LZ-score on LGDP							
$\lambda_2 : LZ_{it} \rightarrow LGDP_{it}$				$\lambda_1 : LGDP_{it} \rightarrow LZ_{it}$			$-\lambda_2/\lambda_1$
	Estimate	Test	p-value	Estimate	Test	p-value	Median
Group mean	-0.10	-0.29	(0.39)	-1.04	-2.06	(0.02)*	-0.04
Lambda Pearson		210.60	(0.00)*		580.09	(0.00)*	(0.05)
LZ-score on LBR							
$\lambda_2 : LZ_{it} \rightarrow LBR_{it}$				$\lambda_1 : LBR_{it} \rightarrow LZ_{it}$			$-\lambda_2/\lambda_1$
	Estimate	Test	p-value	Estimate	Test	p-value	Median
Group mean	0.47	1.32	(0.91)	-1.38	-2.33	(0.01) *	0.37
Lambda Pearson		457.69	(0.00) *		694.01	(0.00) *	(0.07)
LZ-score on LWPI							
$\lambda_2 : LZ_{it} \rightarrow LWPI_{it}$				$\lambda_1 : LWPI_{it} \rightarrow LZ_{it}$			$-\lambda_2/\lambda_1$
	Estimate	Test	p-value	Estimate	Test	p-value	Median
Group mean	0.37	0.16	(0.56)	-0.87	-1.79	(0.04)**	0.24
Lambda Pearson		168.84	(0.09)**		530.06	(0.00) *	(0.48)
LZ-score on LTRADE							
$\lambda_2 : LZ_{it} \rightarrow LTRADE_{it}$				$\lambda_1 : LTRADE_{it} \rightarrow LZ_{it}$			$-\lambda_2/\lambda_1$
	Estimate	Test	p-value	Estimate	Test	p-value	Median
Group mean	-0.17	-0.34	(0.37)	-1.23	-2.18	(0.01)*	-0.09
Lambda Pearson		232.83	(0.00)*		656.94	(0.00) *	(0.05)

Note: * Significance at 1% level.
** Significance at 5% level.

We first consider the panel long-run causality running from Z score to GDP, Z score to Bank rate, Z score to WPI and Z score to Trade openness. Based on the Group mean test statistic, we cannot reject the null of no long run causal effect for all the panels. That is to say for all the panels the Group mean test statistic, accept the null of no Granger causality.

The Lambda Pearson test statistic rejects the null of no long run causal effect for all the panels. The null is rejected at 1% level for the panel Z score to GDP, Z score to Bank rate and Z score to Trade openness and at 5% level for Z score to WPI.

We then consider the panel long-run causality running from GDP to Z score, Bank rate to Z score, WPI to Z score and Trade openness to Z score. Based on the Group mean test statistic, we reject the null of no long run causal effect for all the panels. That is to say for all the panels the Group mean test statistic shows presence of long-run Granger causality running from GDP to Z score, Bank rate to Z score, WPI to Z score and Trade openness to Z score. The null is rejected at 1% level for the panel from GDP to Z score, Bank rate to Z score and Trade openness to Z score and at 5% level for WPI to Z score.

The Lambda Pearson test statistic rejects the null of no long run causal effect for all the panels. The null is rejected at 1% level for all the panels from GDP to Z score, Bank rate to Z score, WPI to Z score and Trade openness to Z score. So, there is presence of long-run Granger causality running from GDP to Z score, Bank rate to Z score, WPI to Z score and Trade openness to Z score.

In choosing between the two tests, the nature of panel is of importance. As noted by Canning and Pedroni (2008) if the panel consists of a heterogeneous set of countries then the Group Mean test statistic, by its construction can be dictated by those countries having high (in absolute values) *t* - statistics. In this case, as the Lambda Pearson test is based on *p* – values, it is a more reliable test.

Thus, taking evidence from the Lambda Pearson test, we find significant evidence of long-run panel Granger causality running from Z score to GDP, Z score to Bank rate, Z score to Trade openness and Z score to WPI. Similarly, we also find the long-run panel Granger causality running from GDP to Z score, Bank rate to Z score, WPI to Z score and Trade openness to Z score.

So, we can say there is existence of two-way long run Granger causality between Z score and GDP, Z score and Bank rate, Z score and WPI and Z score and Trade openness.

So, as expected the macroeconomic variables have significant impact on the health of corporations via Z score and vice-versa.

The sign effect based on the ratio of λ coefficients, which proffer the sign of the long-run causality reveal a positive sign for all the panels in terms of Lambda Pearson test. It is negative for the panels from Z score to GDP and Z score to trade openness. For these panels evidence suggests that GDP at constant price and negative net exports can adversely affect the health of corporations.

6. Conclusion

In this study an attempt was made to examine the influence of macro economic variables on the corporate health in terms of Z score in panel framework for a sample of 73 firms during 1990 to 2009. The macroeconomic variables taken were the GDP, the bank rate, inflation rates and the trade openness. The long-run relationships are identified using panel unit root test, cointegration analysis, Panel FMOLS and panel long-run causality tests.

The findings of the study reveal the existence of a two-way causal relationship between the corporate health and GDP, corporate health and Bank rate, corporate health and WPI and corporate health and trade openness. The sign effect reveals a positive sign for all the panels for Lambda Pearson test.

The implications of the study are in terms of growth of the Indian economy in terms of GDP and increased bank rate that could lead to successful manufacturing units and better firms again would lead to increased output and growth of the economy. So, it is a vicious circle and hence policy makers should be cautious of the link between macroeconomic variables and corporate health while targeting such variables mainly inflation rates. Another implication is that financial fragility of the corporate sector in the worsening macro economic environment can play a role in triggering the financial and monetary instability and prolonging recessions. Therefore the role of financial distress in the macro economic fluctuations and the transmission of recessions deserve further attention.

The limitations of the study are in terms of macro variables taken as more of such variables can be taken and even the study period can be extended. The interesting area for future research could be to verify with more macro economic variables and interlink both macro and micro variables and check their impact on corporate health.

Notes

Table 6 . The Distribution of 3 Categories of Firms for Calculating the Z score is given below:

Number of firms	*Healthy*	*Moderately Healthy*	*Not-so- Healthy*	*Total*
Development Sample	23	18	22	63
Hold out Sample	3	4	3	10
Total				73

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