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An Econometric Modelling and Prediction of the Pattern of Corporate Failure in Periods of Financial and Currency Crisis: A Conceptual Analysis on the Asian Continents

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Abstract

Exchange rate misalignment (which is a prelude to financial crisis), macroeconomic volatility, linear and non-linear exchange rate exposure, financial crisis, contagion, and spillovers are key vices that often pose significant threats to corporate survival. In view of this, this paper shows how the 1966 corporate failure models failed to reflect the challenges of the 21st century's economic dynamics and experiences of corporate failure, particularly in Asia. The paper exposes the weakness of the 1966 models and makes the case for the need for more cogent models that can parsimoniously capture lingering and untamable systematic risks in an economy. To do this, we argue that there is a chicken and egg relationship between corporate failure and the range of financial and macroeconomic crisis indicators in order to determine if corporate failures can be efficiently predicted by ratios or by exogenously induced catastrophic factors. We do this by applying the teaching and philosophy of the concept of catastrophe theory. The result of our theoretical and conceptual analysis indicates that modern corporate failure prediction is not able to rely on the ordinary ratio. As a result of this, we recommend and establish a procedure for an *ex ante* econometric estimation and prediction model of corporate failure that has generally encompassing features relevant particularly during an incoming financial crisis.

Key Words: Corporate failure; Catastrophe theory; Financial crisis; Macro-financial
JEL Classification: F3; F31; L26; M21; M16; G32

1. Introduction

Corporate organizations the world over are propellers of economic growth and development. They also serve as a distinct path through which national economic objectives are formulated and implemented in order to shield economies against endogenous and exogenous shocks. Similarly, the implementation of national economic objectives cannot in any way be possible without viable, real sector corporate entities.

Notwithstanding these laudable objectives, the consensus view of the majority of the literature surveyed considers that exchange rate misalignment is a prelude to a financial crisis. It also considers that exchange rate misalignment crucially impedes corporate competitiveness, reduces production below the scale required for maximum efficiency, and also produces dismal policy responses, particularly in emerging market economies. The menace of exchange rate misalignment, as documented in the empirical work of Claessens, Djankov, and Xu (2000) showed how corporate financial structures tend to became too weak to withstand the combined shock of increased interest rates, a devalued currency, exchange rate misalignment, exchange rate volatility, and sharp declines in domestic demand that may arise through macroeconomic volatility and other exchange rate vagaries. Dornbusch (2001), on the other hand, documented that there is a considerable link between misaligned exchange rates and corporate balance sheets. Aguiar (2004), Bénassy *et al*. (2009) and Prasetyantoko (2007), expanding upon the assertion made by Dornbusch (2001), emphatically agreed that currency depreciation could affect corporate entities through two principal channels: the competitive effect and the net worth or balance sheet effect. Priestley and Ødegaard (2007), in their classic findings, stated that in typical periods of exchange rate misalignment, indigenous and non-indigenous firms suffer from exchange rate exposure that is non-linear in its direction and magnitude and that will intrude upon their earning streams.

According to the World Bank (2000), macroeconomic volatility weakens national 'shock absorbers', to the extent that external fluctuations will have a strong influence on real economic sectors. In a related development, Aghion, Bacchetta, Ranciere, and Rogoff (2006) showed how macroeconomic volatility that is driven by nominal exchange rate variability constrains firms' viability and inhibits their capacity to innovate and remain responsive to changing circumstances, particularly in economies with under-developed financial institutions. Kremer, Pritchett, and Summers (1993) established that the catastrophic effects of macroeconomic volatility could endanger the existence of corporations as economic entities. In another perspective, Kihangire and Abukar (2005) and Koren and Tenreyro (2007) documented that macroeconomic volatility is a catastrophic phenomenon that distorts central economic fundamentals and in turn creates high economic costs that jeopardize corporate survival. Similar in line to these arguments and according to Frankel and Rose (1996) and Kaminsky and Reinhart (1999), exchange rate misalignment is a prelude to the financial crisis, and an economic system may be volatile but not necessarily misaligned or may be misaligned but not necessarily volatile. These authors argue, however, that if chronic exchange rate misalignment is greeted with macroeconomic volatility, the end result is a financial crisis.

The question that continues to be ignored by researchers in the field of empirical financial economics is whether the confluence of macroeconomic volatility, exchange rate misalignment,the menace of financial crises, spillovers, and contagion can be be inputs in the construction of an *ex ante* corporate failure prediction model, particularly during a period of the financial crisis. This is because exchange rate misalignment, being an important prelude to crises, tends to have strong impacts upon macro-financial variables upon which most corporate entities depend.

It is against this backdrop that this paper will answer this challenging question by examining the pattern of corporate failure in the Asian setting using macro-financial indicators. The paper will equally assess why the 1966 corporate failure models are not able to capture the reality of corporate failure before an incoming financial crisis. Section 2 focuses on a review of the empirical literature. Section 3 provides an overview of the implications of financial crises, contagion, and spillovers for the real sector corporate entities. Section 4 identifies why the 1966 corporate failure models cannot predict firm failure before an incoming financial crisis. This leads into a discussion of the 'chicken and egg' relationship between corporate failure and the range of financial and macroeconomic crisis indicators and a consideration of the question of whether corporate failures can be efficiently predicted by ratios or otherwise. The same section provides a conceptual mechanism for modelling corporate

failure using macro-financial variables and the concepts of catastrophe theory. Section 5 delineates the theoretical framework of the study and constructs a model that depicts the pattern of corporate failure in the Asian setting. Section 6 explains the methodology for estimating this model with a view to the realization of an *ex ante* corporate failure predictive model, particularly before an incoming financial crisis. Finally, we conclude and make recommendations.

2. Empirical Review

Asian countries are not free from exchange rate misalignment. A report of the Asian Development Bank (2009) examined the implications of real exchange rate (RER) and currency misalignment in eight Asian economies—PRC, Hong Kong, China, India, Indonesia, Korea, Malaysia,Singapore, and Thailand—in the period between 1995 and 2008. The report asserts that the aftermath of currency misalignment caused the dwindling of national fortunes in terms of massive corporate failure, capital repatriation, and heavy depletion of national reserve holdings. This situation caused the stagnation of economic growth. The report maintained that the magnitude of real currency overvaluation in the economies increased significantly to a margin of 10-15% in 1997. Korea, Malaysia, and Thailand had the least detrimental impacts, while Indonesia suffered the worst, with a margin of 20%. The study also showed how Hong Kong, China and India exhibited undervaluations in the lead-up to the crisis period. This reflects reduced vulnerability of the countries in facing currency speculation and currency crises.

The relationship between macroeconomic volatility and exchange rate misalignment was further reiterated in the studies of Moore and Phylaktis (2000), Williamson (1994), Miles-Feretti and Raziun (1996), Hinkle and Monteil (1999), Razin and Collins (1997), Naseem, Hui-Boon, and Hamizah (2009), and Edwards and Savastano (1989). The authors argued that exchange rate variability and macroeconomic volatility are independent from one another. Aghion *et al.* (2006) established that macroeconomic volatility, combined with nominal exchange rate movements or exchange rate misalignment, tends to affect organizational cash flows, particularly if the organization has international trading linkages. In such a case, it is extremely likely that firms will be catastrophically influenced by liquidity constraints and this will hinder innovation and reduce corporate value. Baum, Caglayan, and Barkoulas (2001) complement the above findings by asserting that macroeconomic volatility has an indeterminate effect on the earnings growth rate of corporate entities. Finally, Addison, Douglas,Wodon, and Quentin (2007, p. 128) modeled the relationship between macroeconomic volatility and private investment as follows:

$$\ln (IP/Y) = ŋ0 + ŋ1\ GOV + ŋ2\ (X+M/Y) + ŋ3\ DCP/Y - ŋ4\delta\ (TOT) + ŋ5\delta\ (TOT)\ X+M/Y + ŋ6\delta\ (TOT)\ DCP/Y + \varepsilon$$

The authors argued that the following variables are key variables that are influenced by macroeconomic volatility (which, in turn, influences the earnings growth of corporate entities – see Baum, Caglayan, and Barkoulas, 2001): the level of trade openness (proxied by the volume of exports and imports as a share of GDP); the influence of the financial system (proxied by national credit to the private sector as a share of GDP); RER uncertainty (proxied the standard deviation in the growth rate of the RER or the terms of trade (TOT)); the interaction between RER or TOT volatility and trade; and the interaction between RER or TOT volatility.

Apart from exchange rate misalignment and macroeconomic volatility, work on exchange rate exposure also reaffirms its detrimental effects upon the profitability of corporate entities.Prominent authors like Jorion (1990), Amihud (1993), and Bartov and Bodnar (1994), while studying the causes of the volatility of profits of US multinational firms, discovered that exchange rate volatility has a negative effect on firm profitability. Similarly, Shapiro (1974) and Dumas (1978) investigated the extent to which exchange rates impact on corporate investment. They established that exchange rate variability impacts positively upon a wide range of corporate investment, regardless of the hedging mechanism used.

Miller and Reuer (1998) found that between 13% and 17% of US real sector corporate entities are influenced by foreign exchange rate variability. Choi and Cheol (2002), in their classic investigation of similar Asian countries, were able to find signs of both contemporaneous as well as

lagged changes in the movements of RERs during the 1997 Asian crisis period. The authors further asserted that the signs of exposure coefficients were generally positive and negative, which reflected the heterogeneous nature of the effects of exchange rate movement on corporate value.

Complementing the findings of Choi and Cheol (2002), Batram and Boardnar (2012) focused on the relationship between estimating exchange rate exposure and stock return of real sector corporate entities in 34 countries. They discovered that an overwhelming percentage of firms, mostly in emerging market economies like Brazil, South Africa, Indonesia, Argentina, and Thailand,were significantly exposed to foreign exchange rate risk. They also established that exposure was more than 1% for a single local currency appreciation and 3% for a single local currency depreciation.

3. The Implications of Financial Crises, Contagion, and Spillover to Real Sector Corporate Entities: An Overview

The expression 'financial crisis' is a broad term commonly applied to a continuum of economic situations. It is a phenomenon that directly results in the loss of the quality of paper wealth, which in turn creates currency collapses, banking panics, bursting of financial asset bubbles, stock market crises, sovereign defaults, and weakening of the prosperity of real sector corporate entities, among others. The menace of the financial crisis inversely affects the national economy through persistent market failure. Cavallo, *et al* (2002) documented that during any period of the financial crisis, corporate entities with substantial foreign currency liabilities tend to have a massive increase in the value of their gearing level relative to revenues, thereby crippling insufficiently hedged debtors and leading to a contraction in corporate fortunes and prospects and a decline in productive possibilities. Providing more detailed explanation of the phenomenon, Gerald (2010, p. 2) noted that:

> *"In recent years, the pace of change and innovation in financial markets and institutions here and around the world has increased considerably in complexities as have the speed, volume and value of financial transactions. The period has also seen a greatly heightened degree of aggressive competition in the financial sector.* ***All of this is taking place in the context of a legal and a regulatory framework which is increasingly outdated and ill-equipped to meet the challenges of the day. This has led to…concern that the fragility of the system has increased, in part because the degree of operational, liquidity and credit interdependency has risen sharply"***

Similarly, Merali (2009, p. 1) observed that:

> *"The global financial system as a CAS illustrates the importance of network topology and diversity in system robustness and resilience. The density and complexity of the financial network led to profound structural vulnerabilities and amplified uncertainties in the pricing of assets, causing seizures in particular financial markets. Network feedback effects under pressure (hoarding of liabilities and fire-sales of assets) coupled with the dominant positions of leading players and the erosion of diversity in institutions' business and risk management strategies resulted in the current crisis."*

Among the notable theories on financial crises is the famous world systems theory, which has as its starting point the economic havoc that developed and emerging market countries face at the end of an economic cycle. The theory, according to its proponents,finds its first proof in the period after the oil crisis of1973. In this era, there was considerable economic devastation as a result of a serious decline in production,increases in production costs, failures in global demand, and global decline in international trade. The trend then continued to spillover to the current period. These factors, combined with the vast economic sophistication, innovation, and complexity of the industrial nations, culminated in myriads of financial and economic disturbances that may not be so easy to moderate in the short run. Financial reform was unable to repair systemic deficiencies, thus leading to recurring and devastating financial crises. Other theories that endeavor to explain the direction and extent of financial crises include coordination games theory, Minsky's theorization of financial crises, and the herding and learning theory of financial crises.

Kaminsky and Reinhart (1999) established that the primary source and barometer of crises in the 21st century is RER appreciation. They argued that exchange rate misalignment in a country, combined with other macroeconomic inconsistencies, transcends into a financial crisis. They explained that exchange rate misalignment exists in a country whenever monetary expansionary policies are pursued. In the light of this, they proceed to model the recurrence of financial crises according to six types. Four such types emanate directly from currency crises, and are current account deterioration; fiscal failure; poor monetary economic policies, poor responses to policy action and policy guides; and massive non-performing foreign debt. The other two types are the sudden-stop phenomenon and volatile economic fundamentals.

Bracke and Fidora (2012) also established a strong line of argument indicating how the global financial crisis of 2007–2009 was a manifestation of (i) gentle, beneficial, favorable, and non-detrimental financial market conditions as mirrored in historically low risk premia and positive asset price developments; and (ii) an unprecedented widening of external imbalances. These two conditions became obscured to policy makers, thus precipitating as (i) monetary shocks (the 'excess liquidity' hypothesis); (ii) preference shocks (the 'savings glut' hypothesis); and (iii) investment shocks (the 'investment drought' hypothesis). Juxtaposing this argument with the argument of Ghura and Grennes (1993), the authors established that a decline in corporate profitability will tend to result due to preference shocks (the 'savings glut' hypothesis) and investment shocks (the 'investment drought' hypothesis). As a consequence, the tradable and non-tradable sectors of the economy,upon which most corporate entities depend for profitability, became fragile.

From the above arguments and synthesizing from the theoretical models, it is evident that the repercussions of the periods of the financial crisis in the Asian areas and to Asian corporate entities can be categorized as follows:

- Reductions in consumption and output;
- Reversals of international capital flows;
- Sudden distortions in net exports, which created current account imbalances and eventual reductions in domestic and international reserve holdings;
- Distortions in asset prices, runs on banks, and bursting of financial asset bubbles;
- Creation of long phenomenal business cycle asymmetries;
- High costs of doing business;
- Devalued currencies;
- Persistent exchange rate instability; and
- Investment instability.

In regard to the above points and having regard to Gerald (2010), Merali (2009), Kaminsky and Reinhart (1999), Kaminskey (2003), Kaminsky, Lizindo, and Reinhart (1997), and Bracke and Fidora (2012), financial crises breed insidious and destructive risk syndrome factors. Further, because of weak shock observers and weak and out-dated gauging mechanisms, corporate organizations in most Asian countries will not be able to assess, determine, or predict their likelihoods of survival. The problems of financial crises will continue to produce dismal outcomes for corporate entities through various types of undervisifiable risk unless preventative measures are taken. According to Dewaelheyns and Van Hulle (2007), systematic risk factors that arose as a result of deteriorating macro-financial fundamentals such as currency collapses or financial crises are undiversifiable at the industry or firm level.

The nature, complexity, and severity of most financial crises tend to vary among different Asian continents depending on such factors as their market structures; economic fortunes; economic diversification; their level of economic advantage; and efficiencies already in place and consistently being explored and exploited for better quality innovation that can help deal with changing circumstances. A significant threat, however, is the possibility of a speculative attack in a country that will continue to escalate in line with other countries that are in the same economic position or possess the same dysfunctionalities. Obstfeld (1994), Eichaigreen, Rose, and Wyplosz (1997) argued that speculative attacks are like balloons in the sense that squeezing one side leads to the other side being pushed out; a speculative attack in one geographic area will almost certainly have a contagion or spillover effect to the nearest region, and the authors estimate that this crisis aggravation occurs at a level of about 8%.

Spillovers from one crisis country into neighboring Asian countries occurs for a number of reasons. According to Kaminskey (2003), the degree of severity of financial or currency crises is directly linked to the nature of the crisis. He found that crises emanating from financial excesses will have the worst effects on the real sector entities, particularly in Asian countries because of the similarity of their economic fundamentals. Further, to this it was also argued that crises tend to trigger sudden stops especially when met with strong capital repatriation by foreign investors.

3.1. Taming the Financial Crisis: Is it Possible?

There are a number of features of the world economy that make it difficult to tame financial crises:

- Globalization has, among other things, eliminated national barriers,which makes the taming process quite impossible;
- There has been a 'dollarization' of all transactions and the anchoring of the economic systems of all countries to the US without varying alternatives;
- There are dynamic, complex, and interwoven architectural networks or chains of economic, business, and financial systems and subsystems that are too large and spread too far beyond borders and outside the realm of ordinary speculation to allow them to be repaired overnight;
- Financial liberalization and elimination of regulation has continued to create an exceptional financial environment that aggravates regional and national financial instability, and which is driven by the political and economic conditions of most countries (Mussa &Goldstein, 1993);
- Corporate entities can only maintain their respective growth margins and high returns on invested capital if they have a well-defined competitive advantage, supported by a favorable macroeconomic environment and a sound and harmonious real exchange rate system that is devoid of chronic misalignment; and
- There is total and absolute reliance on the US, the International Monetary Fund (IMF), and the World Bank for regional and national policy guides and for the influence of monetary policy (foreign exchange policy, etc.).

3.2. Why Are The 1966 Corporate Failure Models Unable To Predict Firm Failure Before An Incoming Financial Crisis?

The mid-1960s marked a turning point in research on corporate failure with the publication of Beavers' seminal work in 1966. This was then followed by Altman (1968), Tamari (1966), Deakin (1972), Trieschmann and Pinches (1973), Taffler (1977, 1982, 1983) Ohlson (1980), Mensah (1984), Moses and Liao (1987), Dichev (1998), and Shumway (2001) amongst others. The most pioneering work in the field of corporate failure prediction and modeling was that of Beaver (1966). In his study, he showed that corporate failure can be predicted with the help of financial ratio analysis. The findings of this author were, however, seriously criticized on the ground that they are of univariate essence. In 1968, Edward Altman extended the work of Beaver (1966) to have a multivariate dimension rather than univariate functions.

Market-based corporate failure prediction models, on the other hand, tried to explain how information derived from a microeconomic interpretation could be handled to predict corporate failure. Notable researchers such as Xu and Zhang (2008) believe that, since market information is inherently forward looking, it is imperative to use a firm's future profitable performance to predict its direction of sustainability or otherwise. The argument about market-based failure prediction emanated from the work of Black and Scholes (1973) and Merton (1974). These authors used option pricing theory to suggest that the probability of corporate failure is a function of any likely event or source of macroeconomic volatility that suppresses the market value of a firm's assets and the strike price (the value of debt obligations). The logic to the authors'argument can be presented as follows. When the net worth of a firm's assets falls below a certain level such that it can no longer continue to meet its financial obligations, the firm is judged as being incapacitated and is thus classified as a failing entity. The major shortcoming of this model is that it does not involve consideration of incremental information regarding respective market positions of strong or semi-strong forms of efficiency. Hillegeist, Keating, Cram, and Lundstedt (2004), Crosbie and Bohn (2002), Brockman and Turtle (2003), and Vassalou and Xing (2004) are among the prominent researchers and proponents of market predictive failure models.

In another attempt at corporate failure prediction, Charitou, Neophytou, and Charalambous (2004) argued that technological advancements in computer science and the development of high-level computer programming software has led to the rapid blossoming of artificial intelligence (AI) that can be exploited as an empirical method for modeling and estimating corporate failure and for deriving multiple corporate failure prediction models. AI methods of analyzing corporate bankruptcy include decision trees, fuzzy set theory, genetic algorithms, support vector machines, data envelopment analysis, case-based reasoning, rough set theory, and various types of neural networks such as Probabilistic Neural Networks (PNN), Back Propagation Trained Neural Networks (BPNN), Self-Organizing Maps (SOM), Cascade Correlation Neural Networks (Cascor), and many others (Min & Jeong, 2008).

Balcaen and Ooghe (2004) state that other notable methods of developing predictive models of corporate bankruptcy include survival analysis, decision tree analysis, the fuzzy rules-based classification model, the multi-logit model, the Cambridge University Small UK Model (CUSUM), dynamic event history analysis, the catastrophe theory and chaos theory model, multidimensional scaling, linear goal programming, the multicriteria decision aid (MDA) approach, rough set analysis, and expert systems and self-organizing maps.

Corporate failure predictive models of the type mentioned above have been classified by researchers into three groups: accounting-based corporate failure prediction models (Altman, 1968); market-based corporate failure prediction models; and AI-based corporate failure prediction models.

There are, however, strong criticisms about the efficiency and effectiveness of these models in yielding valid predictions of corporate failure. For instance:

- Appiah and Abor (2009) argued that the typically globalized, dynamic, complex, and super national corporate entities render the MDA and the Univariate Discriminant Analysis (UDA) versions of corporate failure models void as a result of the sudden collapse of profit superstars like Enron and WorldCom. The authors continued to argue that the models are not designed from the perspective of predicting *ex ante* corporate failures but rather they have only *ex post* predictive power and are usually only suited to small to medium enterprises (SMEs)because in the case of large enterprises, they produce inconsistent guides because of independent variables that could create conflicting and inaccurate forecasts when values are too large.
- Balcaen and Ooghe(2004) have noted that, to date, there is no complete overview and analysis of a new alternative method of corporate failure prediction.They note that varied approaches and designations or names have been used to describe what is, in fact, one method, which, in itself, is neither up-to-date nor efficient in capturing the realities of corporate bankruptcy in the 21st century with high precision.They argue that most research findings that claim to predict corporate failure empirically are prone to type I and type II errors.
- Sanda *et al*. (1998) in complementing the above points, established that the MDA was based on a univariate not a multivariate study and therefore is likely to lead to significant bias in final results.
- Deakin (1976), Taffler and Tisshaw (197) and Barnes (1987) have also argued that the MDA assumption of multivariate normality is often not warranted and that this results in significant bias in tests and high test error rates. Eisenbeis (1977), Richardson and Davidson (1984) and McLeay and Omar (2000) have supported this claim.
- In the same vein, various researchers have shown dissatisfaction with Altman's (1968) work based on its inability to represent *ex ante* predictive possibilities (Joy &Tollefson, 1975; Moyer, 1977). Moyer (1977), for instance, pointed out that better explanatory power can be obtained if the market values of equity/book value of debt and sales/total asset variables were deleted in the model.
- Bagley, Ming, and Watts(1995), in their criticism of Altman (1968), argued that most existing corporate failure models have exceeded their lifespan. The authors continued to argue that any continuous use of these models in the 21st century will only produce shallow and biased results given the massive level of financial sophistication in the world.Similarly,it is argued that the financial realities of modern corporate

entities,whether they are local or multinational, are far above the ordinary prognostications of ratios.

3.3. The Chicken and Egg Relationship

In determining the chicken and egg relationship between corporate failure and the range of financial and macroeconomic crisis indicators to determine if corporate failures can be efficiently predicted by ratios or whether they have some exogenously induced catastrophic factors as the main cause of failure, Sharma and Mahajan (1980) state that a systematic study of corporate failures requires a model of the underlying failure process. The authors further argued that the cash flow performance and profitability of an enterprise are susceptible to a variety of factors that emanate from outside the business itself and are thus beyond the control of business managers (uncontrollable variables). Such environmental conditions include, among other things, the rate of growth of the economy; the economy's macroeconomic reliability or otherwise; market efficiency; exchange rate conditions; shifting market priorities as a result of changes in time; the behavior of consumers; the changing structure and operating characteristics of the marketplace; and the market strength of individual businesses. All these cannot be captured by the ordinary prognostication of ratios. According to Sharma and Mahajan (1980), the other crucial variables that tend to influence the performance of a business enterprise come directly from within the firm, including its ability to use its resources to adapt to and capture an advantage in the consistently changing environment and to turn threats into opportunities. According to Sharma and Mahajan (1980), ratios are only efficient in showing how an enterprise can convert opportunities into threats.

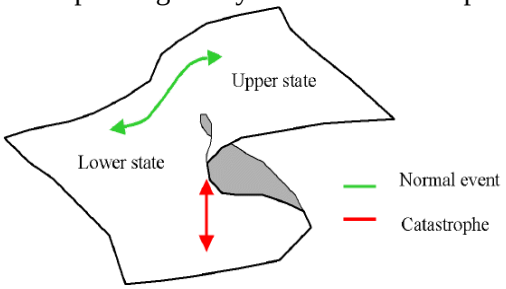
Finally, Merali (2009), Kaminsky and Reinhart (1999), Kaminsky (2003), Kaminsky *et al.* (1997), and Bracke and Fidora (2012) show that a period of the financial crisis breeds an insidious destructive risk syndrome that is far beyond the ordinary prognostication of ratios. The ballooning effects of the Asian Financial Crisis, which led to massive failures of corporate entities in Asia and the rest of the world, yielded an answer to the contentious argument on the chicken and egg relationship.

3.4. Modeling Corporate Failure Using Macro-Financial Variables and the Concepts of Catastrophe Theory

Jakimowicz (2010) documented that economic institutions created through different human entrepreneurial capacities are usually besieged with many catastrophic events that can, at times, lead to the melting down of the already accumulated level of hard work and preserved values. The author continued to assert that catastrophic events occur suddenly, often with insignificant warning, and that this occurs as a result of economic friction, economic disruptions, contagion, and spillovers. Sudden changes occur easily and unpredictably; this type of situation is known as the presence of 'discontinuities'. When a high degree of discontinuities create havoc to human lives in a tragic way,a 'discontinuity'is referred to as a 'catastrophe'.

Currency collapses, exchange rate misalignments, macroeconomic volatility, linear and non-linear exchange rate exposure, contagion, and spillovers are catastrophic phenomena to entrepreneurial activity.Catastrophe theory (CT) is a dynamic system theory that falls within the mathematical concepts of topology that attempts to explain how a running system exhibits erratic behavior under a continuous stimulus. It explains, in particular, how erratic effects (macroeconomic volatility, exchange rate misalignment, firm characteristics, exchange rate exposure, and currency collapse) appear to be affected from continuing causes (corporate value). This theory simply merges two seemingly opposite and distinct kinds of phenomena and descriptions to form one coherent idea system: continuity and discontinuity (Rene,1975) Similarly, the theory allows the possibility of presenting a perfect way of how an object (a corporate entity) is affected by continuous variability that is interrupted by sudden quality changes. Following this, an 'event' (corporate failure) may be expected to occur basically as a result of some common causes that could lead to changes in some basic occurrence such as a macro-financial complication. The extent of changes that could affect an event may occur slowly or may take place abruptly. A gradual change will most likely have no effect and can be managed by a healthy entrepreneurial firm. An abrupt change, however, such as during periods of currency collapse or financial crisis, could be considered a catastrophic phenomenon (Jakimowicz, 2010). Figure 1 provides the pattern and the direction of the effects leading to catastrophic events.

Figure-1. Explaining the dynamics of catastrophic events



The figure demonstrates a clear position of cusp catastrophe position. For instance, if the degree that led to any change in an economic system is at the short-run equilibrium position, this is demonstrated by the upper leaf of the cusp catastrophe figure. The green line depicts a situation in which the level of the short-run equilibrium change will vary so that the event (change) falls over the fold. Whenever the economy is in a long-run disequilibrium, however, an event (a change) due to the variables that necessitated that change or event will move down – i.e., in-between the lower leaf. This is because there are only two paths to the movement that can necessitate a change. What type of return occurs depends entirely on the nature and force of dynamics that triggered the event (change), and the extent of the perturbations.Whenever the movement of return to the equilibrium falls within the axis below the red arrow line, then an abrupt change that is catastrophic is said to occur, which arises as a result of chronic economic circumstances or due to some key variable that necessitated the abrupt change.

In the above example, movement from one position (either from the lower state to the upper state or vice versa) to the other and the direction of the movement is called the transitory position linking to an event. As a result, if the transition occurs on the back edge of the surface following the green line, the event will be normal and continuous. If, however, the transition occurs along the front edge following the red line, then the event is a sudden and abrupt change, which is a catastrophe. This situation was postulated by Rene Thome in 1973 and the preceding explanation follows Jakimowicz (2010).

Scapens, Ryan, and Flecher (1981) were early scholars who extended the concept of catastrophe theory to the field of empirical economics. The authors used the concept to explain how corporate entities fail as a result of some key selected economic variables.

4. Theoretical Framework

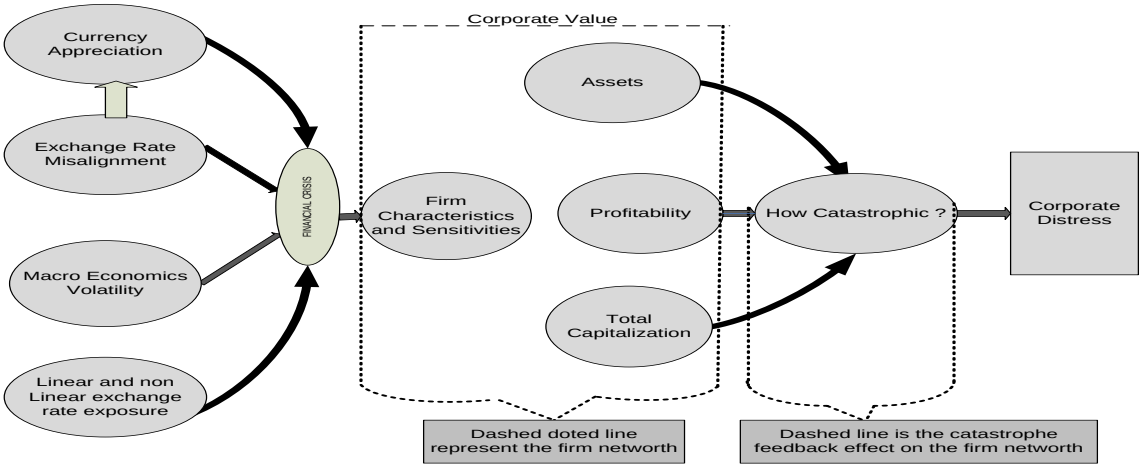
The linking theories that led to the conceptualization of this idea that will also aid in its theoretical conceptual and empirical accomplishment are:

1. The financial economic theory, which established a clear fact that exchange rate misalignment is independent of macroeconomic volatility and macroeconomic volatility is also independent of exchange rate movement, while exchange rate misalignment is a prelude to crisis. (This is the leading theory)
2. The systematic risk theory.
3. Institutional theory of corporate failure, which asserts that a corporate entity is widely seen as a reservoir of cash holding (value). The firm is then considered as being in bankruptcy (a going concern problem) only when the reservoir (value) becomes empty (Walters, 1957).
4. The positive and normative theories of corporate failure established that there exists a fundamental correlation between the phenomenon of corporate failure as being induced by structural macroeconomic and microeconomic dynamics such as structural market changes, supply, economic cycles, inflation, international trade, and foreign exchange and its attendant exposures as well as preceding macroeconomic volatility.
5. Normative corporate failure theory is directed at shaping the rules necessary for regulating the interaction of these phenomena.
6. The concepts of catastrophe theory will be applied, which will enable us to know at what level of economic catastrophe, in terms of the selected variables (macroeconomic volatility, exchange rate misalignment, exchange rate exposure, linear and non-linear exchange rate

exposure, firm characteristics, and periods of financial crisis)can lead to corporate value destruction, in line with Jakimowicz (2010)

7. First generation theory of currency crises.
8. Second generation theory of currency crises.
9. Third generation theory of currency crises.

Figure-2. Conceptual modeling



Source: Designed by the researcher,Rafindadi, A. A.

From the above conceptual and theoretical models, we follow the conceptual framework of Shin and Stulz (2000) and the theoretical models ofBenoit *et al*. (2013) and Brownless and Engle (2012). The theoretical model of these authors shows how the value of firm *N* can be affected by its r_{it} , the return of firm *i* at time *t*. Through periods of crisis or rising economic uncertainty, the authors argue that the market return is the value-weighted average of the total firm return $rmt = \Sigma_{i=1}^{N} \omega_{it} r_{it}$, where ω_{it} denotes the relative total corporate value in this context. The concept of systematic risk can affect an entity *i* through systematic risk, as measured by the expected shortfall (ES) of the system equation proposed by Acharya *et al.* (2010) By definition, the ES is a position at which the firm value can be affected at an α% level; the expected return in the worst-case scenario can also be affected by α%. Theoretically, this can be expressed in the following equation:

$$ES_{mt}(C) = E_{t-1}(r_{mt} \mid r_{mt} < C) = \sum_{i=1}^{N} \omega_{it} E_{t-1}(r_{it}(r_{mt} \le C) \ldots\ldots 1$$

$$MES_{it} = (C) = \frac{\partial ES_{mt}(C)}{\partial \omega_{it}} = E_{t-1}(r_{mt} \le C) \ldots\ldots .. 2$$

The marginal expected shortfall (MES) is a coherent risk measure formulated by Artzner *et al*. (1999).This measures the increase in the risk of an entity, which is measured by ES, which tries to identify the level of a firm's risk factor to the entirety of the risks factors inherent in the financial system. These can also be extended by the following System Expected Shortfall (SES):

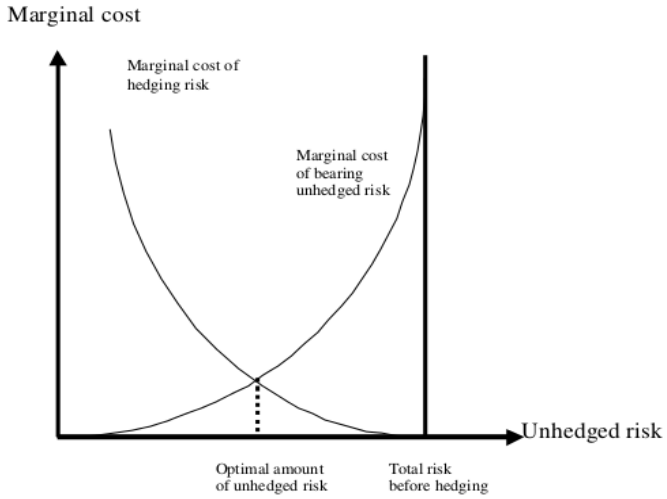
$$\frac{SES_{it}}{W_{it}} = kL_{it} - 1 - E_{t-1}(r_{it}(\Sigma_{i=1}^{N} W \angle k \Sigma_{i=1}^{N} A_{it} \ldots\ldots 3$$

Where L_{it} (the leverage) is $(\frac{A_{it}}{W_{it}})$, A_{it} refers to the total assets of the firm, and W_{it} is the total corporate value. According to Acharya (2010), the above expression can be also be expressed in a linear form:

$SES = (k\ L_{it} - 1 + \theta\ MES_{it} + \Delta_i)\ W_{it}$ ……..4.

where θ and Δ_i are constant terms. Graphically, we use the concepts of Shin and Stulz (2000) in demonstrating how firm value and risk can arise to escalate total corporate risk to the point of bankruptcy. These concepts are graphically illustrated in Figures 3, 4, and 5.

Figure-3. Showing marginal cost of unheadgeable risk **Figure-4.** Showing marginal cost of bearing unheadgeable risk



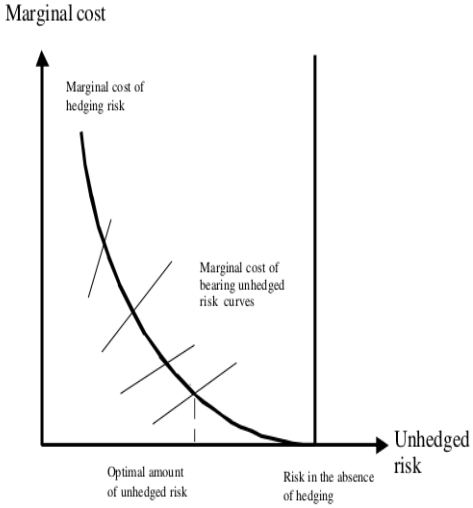


Figure-5. Showing the total cost of unheadgeable risk leading to bankruptcy

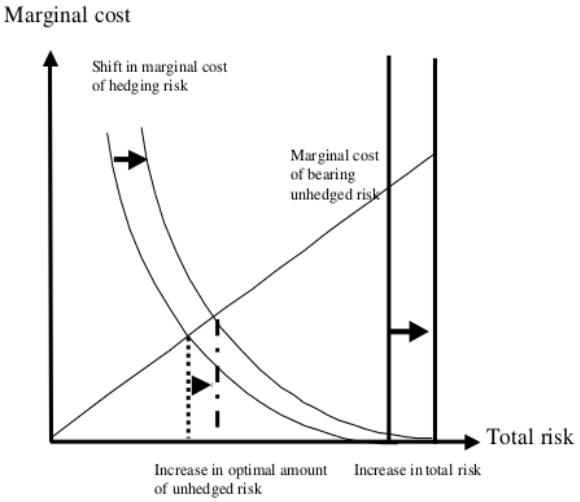


Figure 3 is a depiction of the assumption that the marginal cost of unhedged risk being borne increases with unhedged risk. It also shows that the marginal cost of hedging risk decreases in unhedged risk. In Figure 4, there is a depiction of the assumption that is made that all firms possess identical marginal cost functions of hedging risk. Figure 4 also shows that firms have differing marginal cost functions associated with the bearing of unhedged risk as the risk factors continue to rise. In Figure 5, there is a depiction of the impact of optimal unhedged risk and how it rises with the risk stream of the firm. It reveals that as there is an increase in a firm's unhedged risk, the marginal cost for a certain amount of reduction in risk stays as it is, so the marginal costs curve for hedging risk moves rightward. With an increase in the firm's unhedged risk, the marginal cost of bearing unhedged risk does not change for each degree of unhedged risk.

5. Methodology

Data collection and analysis will first involve six countries or more grouped into pairs. The first group will comprise at least two highly macroeconomically volatile countries that have evidence of exchange rate misalignment and that have poor economic growth. The second grouping will consist of

relatively low macroeconomically volatile countries with fairly low levels of exchange rate misalignment and relatively modest economic growth. The third group will consist of relatively less macroeconomically volatile countries with fairly stable exchange rate misalignment and relatively high economic growth. This grouping follows the pioneering work of Addison and Wodon (2007), Bleaney and Greenaway (2000), Serven (2002), and Marchat *et al*. (2001).

The justification for the selection and grouping of these countries is also found in the empirical findings of Bleaney and Greenaway (2000) in their pioneering investigations of the effects of macroeconomic volatility and investment in developed and developing nations. The authors contend with the fact that RER misalignment depresses investment value. This finding was further complimented by Serven (2002), who argued that macroeconomic volatility tends to have a negative impact on RER, and this implies a threshold effect. Belaney and Greenaway (2000) continued to argue that the severity of the repercussions will depend on the level of trade degradation, the impact of the financial system of a given country, and how effective are its monetary policies, trade policies, and economic diversification.

Moreover, Serven (2002) asserts that what harms the economy's long-run performance is not the volatility due to normal fluctuations but the volatility due to crises. He argues that the impact of a single increase in standard deviation frequently leads to an increase in crisis volatility, which has a two-fold effect that sums up to the total volatility. In other words, if a country loses2.15% of its per capita GDP growth, this will then change the entire basis of that country's economic growth. It is with reference to this that this study grouped the selected countries in order to determine the extent of the effects of macroeconomic volatility given different levels of economic sophistication attained. This will, among other things, enable this research work to assess and monitor the effects of macroeconomic volatility within countries with low, medium, and high levels of economic growth. With this in mind, the research will then be able to ascertain the direction of these effects of macroeconomic volatility and exchange rate misalignment under different economic crisis and non-crisis periods and identify how they combine to influence the value of corporations as going concerns so that the model will cover all that is expected from it. Finally, this study and the data collection process will not include SMEs because of their small size and likely lack of participation in international trading.

5.1. Econometric Methodology for Model Estimation

When estimating misalignment of exchange rates, use of a behavioral equilibrium exchange rate /permanent equilibrium exchange rate (BEER/PEER) model is recommended. This is due to its decomposition effects. Researchers like Rano (2010), Iimi (2006), Iossifov and Loukoianova (2007), and Maesofernandez, Osbat, and Schnatz (2001) have found this methodology to be robust.

In circumstances such as this, misalignment of RERs is ascertained through the use of the variables now described. Firstly, the only key exogenous and endogenous variable is the exchange rate (*rer)*, which includes an index of productivity (pro); an index of monetary policy performance (mop); an index of openness (opn); the government's fiscal spending (gov); terms of trade shocks (tot); and net foreign assets (nfa). A generic formulation of the long-run relationship that exists between RER and RER's fundamentals as outlined by theory is as follows:

$lne^{*} = \beta' F^{p,\ldots} \cdot (1)$

The first thing that needs to be done is to ascertain the vector β of the long-run parameters that are of interest in the study. Next, a set of constant values for the fundamentals in period *t* needs to be selected. The basic idea is that the underlying variables might reveal that there is much short-term 'noise' but that *rer*, the long-run equilibrium, should not have such noise'. Next, in order to smooth the estimated equilibrium *rer*, a Hodrick-Prescott (H-P) filter is used. This assists in achievement of the 'permanent', 'steady state', or long-run values of economic fundamentals. This is because the time series is decomposed into both a stable component, xt – μt, and a trend, μt. This is done by minimizing:

$$\sum_{t=1}^{T}(X_t-\mu_t)^2+\lambda\sum_{t=2}^{T-1}\left[(X_{t-1}-\mu_t)-(X_t-\mu_{t-1}\right]^2 \ldots\ldots \quad (2)$$

In equation (1), the preferred key variables' expected signs are, consistent with MacDonald and Ricci (2003) and MacDonald (1997):

rer = *f*(*nfa, tot, iov, gov, rsv, mop, opn, pro*) . . . (3)

So that the chance of spurious regression is avoided to the greatest extent possible, it is necessary to check the series' order of integration for all series of the variables' forms for a certain selected period (e.g., 30 years) while acknowledging financial crisis periods with the use of the Phillips-Perron and Augmented Dickey Fuller (ADF) tests in two regression specifications (one with a constant and a trend and one with a constant).

In modeling linear and non-linear exchange rate exposure, the method applied by Adler and Dumas (1984) will be adopted in this research work with only a little modification by summing up the total cash flows that accrue from different corporate investment outlets. The authors identified exchange rate exposure as the elasticity of corporate cashflows with regards to unexpected exchange rate changes. They used the following regression in the estimation of linear exchange rate exposure:

$$\sum CF_t = \alpha + \sum_{i=j}^{n} \delta_i R_{FX,t}^{(I)} + \phi_1 R_{ST,t} + \phi_2 R_{DS,t} + \varepsilon_t \text{.....(1)}$$

In this regression, $\sum CF_t$ is the total composition of the variable for corporate cash flow which comprises its ultimate value. ($R^{(i)}_{FX,t}$)represents the foreign exchange rate (*i*)'s relative change. Alternatively, the model uses a group of multilateral or bilateral exchange rates or a foreign exchange rate index that are most applicable to the study's different firm features. A term spread variable ($R_{DS,t}$) and a short-term interest variable ($R_{ST,t}$) are used as a control variable. The exchange rate variable's coefficient shows how sensitive the cashflows are to a change in the exchange rate and therefore is a way of measuring exposure to foreign exchange. A similar framework was used by Stulz and Williamson (2007) to regress real sector entities' cash flows. This method was supported by Bartov and Boardner (1994).

In the establishment of non-linear exposure, the methodology adopted bySohanke and Bodnar (2007) will be used. The following regression model is estimated using OLS:

$R_{jt} = \alpha_j + \beta_j R_{Mt} + x_j R_{St} + \varepsilon_{jt}$.....(1)

where R_{jt}represents the monthly stock return of company *j* in period *t*, $R_{Mt}$is the return on the capital market index *M* in period *t*, and R_{St} the percentage change of currency *S* in period *t*.

Nonlinear: $R_{jt} = \alpha_j + \beta_j R_{Mt} + x_j \boldsymbol{f(R_{St})} + \varepsilon_{jt}$.....(2)

where the hyperbolic sine function describes the following relationship: $f(x) = \sinh(x) = (e^x - e^{-x})/2$ and the inverse hyperbolic sine function is defined as $f(x) = \ln(x + \sqrt{x^2 + 1})$, and both are characterized by a positive slope in the origin.

$$R_{jt} = \alpha + \beta_j R_{Mt} + x_j R_{St} + \varepsilon_{jt}$$

$$\frac{\varepsilon_{jt}}{\sigma\varepsilon_{jt}} = \sum_{i=j}^{n} \delta_j + \phi z_{st} + \lambda_j z_{st} + \omega_j z_{st} + R_{st} + \vartheta_{jt}$$

With $Z^-_{St} = \begin{cases} 1 \text{ if } RSt < 0 \\ 0 \text{ otherwise} \end{cases}$ and $Z^+_{St} = 1 - Z^-_{St}$

Another general requirement in examining the assumption of non-linear exposure is to use a relatively nonparametric regression. The model is specified as:

$$R_{jt} = \alpha_j + \beta_j R_{Mt} + x_j R_{St} + \delta_{j1} D_{1t} + \delta_{j2} D_{1t} R_{St} + \delta_{j3} D_{2t} + \delta_{j4} D_{2t} R_{St} + \varepsilon_{jt}$$

With $D_{1t} = \begin{cases} 1 \text{ if } -0.5\sigma Rst < R \leq 0.5\sigma_{Rst} \\ 0 \text{ otherwise} \end{cases}$

While $D_{2t} = \begin{cases} 1 \text{ if } -0.5\sigma Rst < RSt \\ 0 \text{ otherwise} \end{cases}$

The above linear regression that is in a piece-wise component allows for different relationships between exchange rate risk and firm value for large (exceeding 0.5 standard deviations) and negative and positive as well as intermediate exchange rate shocks. It thus accommodates asymmetry in the exposure and small exchange rate changes being irrelevant for exposure.

The multifactor portfolio model of theoretical risk analysis, as adopted in the classic study of Vermeulem *et al*. (1993) is used to investigate the sensitivities of firm characteristics to exogenous

variables and the amount of influence they have on the value of corporations as ongoing concerns. Vermeulem *et al.* (1993) applied the methodology to the uncertain values of performance measures where the following model following the theoretical model of risk analysis was used, and this will also be the guiding principle for measurement of sensitivity and firm characteristics:

$$\bar{R}_{nt} = E(\bar{R}_{nt}) + b_{1nt}\Delta\bar{f}_{1t} + ... + b_{knt}\Delta\bar{f}_{kt} + \bar{\epsilon}_{nt} \quad (1.1)$$

Where *n* denotes the firm and *t* time, $\bar{R}_{nt}$ is the uncertain value of firm *n* at some future time *t*,$E(\bar{R}_{nt})$ is the expected value of the performance measure, b_{1nt} is the sensitivity to any unexpected changes in environmental factors *i* at time *t*, $\Delta\bar{f}_{1t}$ denotes any unexpected changes of factor *i*,and $\bar{\epsilon}_{nt}$ is an error term. Note that the sensitivities b_{int} represent the influence of a marginal unexpected change of the exogenous factor on the value measure. Next, the sensitivity to a factor is assumed to be explained by *m* firm characteristics, i.e.,

$$\bar{b}_{int} = \gamma_{0i} + fc_{jnt}\cdot\gamma_{1i} + \ldots + fc_{mnt}\cdot\gamma_{mnt}\cdot\gamma_{mi} + \bar{\eta}_{int} \quad i = 1, \ldots, K, t = 1, \ldots T. \quad (1.2)$$

In the above expression,$\bar{b}_{int}$ is the sensitivity to an unexpected change of exogenous factors *i* at time *t*, fc_{1nt} stands for the value of firm characteristics *j* of firm *n* at time *t*, and $\bar{\eta}_{int}$ is an error term.In this respect, we implicitly assume $\partial\bar{b}_{int} / \partial fcjnt = \gamma_{ji}$ i.e.,γ_{ji} is the marginal changing influence of the firm's characteristic fc_{jnt} on the sensitivity $\bar{b}_{int}$. Note also that we implicitly assume that all differences in sensitivities amongst firms can be explained by the firm's characteristics. Substitution of expression (1.1) into (1.2) leads to:

$$\bar{R}nt = E(\bar{R}nt) + \sum_{i=1}^{k} \left(\gamma_{0i} + \sum fc_{jnt}\cdot\gamma_{1i} \right)\cdot\Delta\bar{f}_{1t} + \bar{v}_{int} \quad n = 1, \ldots, N, t = 1, \ldots, T. \quad (1.3)$$

In the expression above, K denotes the number of factors and *m* the number of firm characteristics. Note that $\bar{v}_{int} = \bar{\epsilon}_{nt} + \sum_{i=1}^{k} \bar{\eta}\,\text{int}\cdot\Delta\bar{f}_{1t}$ and hence the stochastic structure of $\bar{v}_{int}$ depends on the stochastic structure of $\bar{\epsilon}_{nt}$ and $\bar{\eta}int$.

5.2. Operationalization of the Model

Given model (1.3), which is a theoretical model, it is essential to have regard to the fact that in such an application, data usually comprise firm characteristics using annual measures rather than the marginal changes that equation (1.3) is based upon. Accordingly, it is necessary to use annual changes to approximate marginal changes. Furthermore, it is important to understand that one is not observing the expected value of the performance measure nor the exogenous factors and that one is only observing realized yearly changes. As a result, it is necessary to adapt expression (1.3). It is assumed that an expected change in the factor value's sensitivity ($(E(\bar{f}_{it}) - f_{i,t-1})$) is identical to an unexpected change in factor value ($(\bar{f}_{it} - E(\bar{f}_{it}))$ so that:

$$E(\bar{R}_{nt}) = R_{n,t-1} + \sum_{i=1}^{k} b_{int}\cdot(E(\bar{f}_{it}) - f_{i,t-1}) \quad (1.4)$$

Next, given that a sudden variation in factor value is just the same as the realized factor value with the expected change subtracted from it ($\Delta\bar{f}_{it} \equiv \bar{f}_{it} - E(\bar{f}_{it})$) and then substituting (1.4) into (1.2), we have:

$$\bar{R}_{nt} - R_{n,t-1} = \sum_{i=1}^{k}(\gamma 0i + \sum fc_{jnt}\cdot\gamma_{ji})\cdot(\bar{f}_{it} - f_{i,t-1}) + \bar{v}_{int} \quad n = 1, \ldots, N, t = 1, \ldots, T \quad (1.5)$$

The corresponding *ex post* empirical relationship is:

$$\bar{R}_{nt} - R_{n,t-1} = \sum_{i=1}^{k}(\gamma 0i + \sum fc_{jnt}\cdot\gamma_{ji})\cdot(f_{it} - f_{it-1}) + \bar{v}_{int} \quad n = 1, \ldots, N, t = 1, \ldots, T. \quad (1.6)$$

Where: $\bar{v}_{nt} = \bar{\epsilon}_{nt} + \sum_{i=1}^{k} \bar{\eta}\,\text{int}\cdot(f_{it} - f_{it-1})$

In the expression above, $(R_{nt} - R_{n,t-1})$ represents the realized change in firm *n*'s value of the performance measure from $t-1$ to t. Also, fc_{jnt} represents the *j*th firm's characteristic of firm *n* at the time t. $(f_{it} - f_{it-1})$ is the realized change in factor *i* from time $t-1$ to time t. Among other things, the estimated procedure is dependent upon the assumptions that are made about $\bar{\epsilon}$and $\bar{\eta}$and also how valid are such assumptions. It is assumed that $\bar{\epsilon}$ is distributed normally. It is also assumed that its specification is the same to the linear regression model's specification (that is, that there is independence between the residual term and the independent variable, that there is no autocorrelation in the residuals, that there is a constant variance, and that the expected value is zero). In regards to $\bar{\eta}$, it is assumed, as done in Van Gresbergen (1980) that $\bar{\eta}int = 0$. Consequently, it is possible to use OLS to estimate the parameters of expression (1.6). The estimated parameters of γ_{ji} are able to be interpreted as just the annual change in sensitivity brought about by an annual variation in firm characteristics. It is possible to calculate the sensitivity to an exogenous factor of a firm by using expression (1.2).

$$\hat{b}_{int} = \hat{\gamma}_{0i} + fc_{1nt}\hat{\gamma}_{1i} + \ldots + fc_{mnt}\,\hat{\gamma}_{mi} \qquad (1.7)$$

Expression (1.7) shows that sensitivity is obtained by summing up the products of each firm's characteristics and the sensitivities of varying influences of such characteristics. It is possible to compute the covariance matrix of $\hat{b}_{int}$ as:

$$\text{COV}(\hat{b}_{int}) = \bar{f}c^{T}\ \text{COV}\ (\hat{\gamma})\bar{f}c$$

In the above, the covariance matrix is COV. Further, $\bar{f}c$ is vector $(1, fc_{1nt}, \ldots fc_{mnt})$.

The most frequently used method to capture a system's dynamics and interrelated time series when the system has two or more equations is vector autoregression (VAR). Ciccarelli and Rebucci (2003) show that if a set of variables have true simultaneity, no difference between exogenous and endogenous variables should occur and also that it is a measurement of the dynamic relationship that exists among jointly endogenous variables, without the need to impose *priori* restrictions. In a VAR model, it is posited that each of the system's endogeneous variables is a function of the system's endogeneous variables' lagged values. It is possible to express the connotations of VAR of (n) variables as:

$$\mathbf{Y_t} = \boldsymbol{A_0} + \sum_{m=1}^{p} \boldsymbol{A_m Y_{t-m}} + \boldsymbol{\varepsilon_t}$$

An empirical analysis is done by making use of the generalized variance decomposition technique, the vector error correction model, and the Johansen-Juselius multivariate cointegration test. This is done to ensure the results are more effective and accurate.

An exponential generalized autoregressive conditional heteroscedastic (E-GARCH) model without the imposition of non-negativity constraints was developed by Nelson (1991). Compared to the GARCH model, this model is more general. With such a framework, as in the GARCH model, it is possible for the E-GARCH model to account for a shock's direction due to its corresponding mean equation. The difference is that the conditional variance is an asymmetric function of the lag residuals. Accordingly, this model is helpful in identifying asymmetric effects. It is possible to express the E-GARCH model as:

$$\log(h_t) = w_0 + \sum_{i=1}^{q} \alpha_1 g(z_{t-1}) + \sum_{j=1}^{p} \gamma_j \log(h_{t-1})$$

given $R_t = \mu + \varepsilon, \varepsilon_t|\Omega_{t-1} \sim N(0,h_t)$

where w and μ are constant

$g(z_t) = \theta_{zt} + \gamma[|zt| - E|zt|]$ and

$$z_t = \frac{\varepsilon t}{\sqrt{hj}}$$

$$\log h_t^2 = w + \sum_{i=1}^{p} \beta_I \log(h_{t-1}^2) + \sum_{j=1}^{q} (\gamma \left[\frac{\varepsilon t - j}{ht - j}\right] + \alpha \frac{\varepsilon t - j}{ht - j})$$

In the above, (h_t^2) stands for the conditional variance. There is an exponential leverage effect and there are non-negative forecasts of the conditional variance. Asymmetry is indicated by $\alpha \neq 0$.

Leverage is indicated by $\alpha < 0$ and returns have a negative correlation with the volatility of the previous period. The order of the AR process is P. The order of the MA process is q.

Next, as in Dewaelheyns and Van Hulle (2008), Vlieghe (2001), and Altman (1983) a distributed lag empirical econometric model is used. Also used, as in Dewaelheyns and Van Hulle (2007), Gaffeo and Santoro (2006) Liu (2004), and Liu and Wilson (2002), is a vector error correction model. Here, all the variables are substituted and the model is extended to introduce new variables like catastrophe theory concepts, characteristics of firms, linear and non-linear exchange rate exposure, and the financial crisis.

$$CRPV_{it} = \alpha_{it} + \sum_{i=0}^{k} \beta_{1,t-i} X_{1,t-i} + \sum_{i=0}^{k} \beta_{2,t-i} X_{2,t-i} + ... + \varepsilon_t \ \ldots\ldots \quad (1)$$

where:
CPRV= corporate value
k = maximum lag length
X = macroeconomic variables
ε = error term

The direct estimation of such model results in multicollinearity problems between different lagged variables and is costly in terms of degrees of freedom. Both issues can be addressed by an Almon polynomial distributed lag (PDL) specification, which can be shown that any β_i in equation1 bove can be approximated by a polynomial of order m

$\beta_i = b_0 + b_1 + b_{2i}^2 + \ldots + b_n i^n \quad \ldots (2)$

Substituting (2) into (1) leads to:

$$CRPV_{it} = \alpha_{it} + \sum_{i=0}^{k} b_{j,0t} Z_{j,0t} + \sum_{j=1}^{l} b_{j,1t} Z_{j,1t} + \sum_{i=0}^{k} b_{j,mt} Z_{j,mt} + \varepsilon_t \ \ldots\ldots\ldots\ldots (3)$$

where*l* = the set of macroeconomic variables

$$Z_{j,0t} = \sum_{i=0}^{k} X_{j,t-1}$$

$$Z_{j,1t} = \sum_{j=1}^{l} iX_{j,t-1}$$

$$Z_{j,mt} = \sum_{i=0}^{k} i^m X_{j,t-1}$$

In equation (3) there will be best linear unbiased estimator insofar as the OLS assumptions are fulfilled by ε. It is then possible to compute, from the polynomials, individual β coefficients from equation (1). The sum of such $\hat{\beta}_s$ are a reflection of the long-run relationship that exists between the macroeconomic variable on one hand and the bankruptcy rate on the other.

Vector Error Correction Models (VECM)

It is possible to argue that first differencing occurs at a cost, which is to lose information that could be found in the data's levels; further, if there is cointegration among a number of variables, if the association is first differenced, there will be, as noted by Enders (1995), a misspecification error. If there is cointegration in a number of the non-stationary series, it is possible to find a stationary linear combination of this series. Basically, this means that the different series have a long-run equilibrium, which can be estimated as a static model (i.e., the cointegrating equation) as follows:

$$\beta_1 CRPV_{it} = \sum_{i=0}^{k} \beta X_{it} + \varepsilon_t = 0 \ldots\ldots\ldots\ldots\ldots\ldots\ldots 4$$

where:
l=aggregate variables selected
X = macroeconomic variables
e= equilibrating error term

An error correction model is based on the fact that deviations from the long-run equilibrium should be reduced through time. The short-run dynamics of the relationships between the cointegrated variables can be expressed as a system of equations:

$$\begin{bmatrix} \Delta BRT_t \\ \Delta X_{1,t} \\ \vdots \\ \Delta X_{t,t} \end{bmatrix} = \begin{bmatrix} \gamma_{0,0} \\ \gamma_{0,1} \\ \vdots \\ \gamma_{0,1} \end{bmatrix} + \begin{bmatrix} a_0 \\ a_1 \\ \vdots \\ a_1 \end{bmatrix} [EC_{t-i}] + \sum_{i=1}^{k} \begin{bmatrix} \gamma_{0,0} & \gamma_{1,0}^{i} & \cdots & \gamma_{1,0}^{i} \\ \gamma_{1,0}^{i} & \gamma_{1,1}^{i} & \cdots & \gamma_{1,1}^{i} \\ \vdots & \vdots & \ddots & \vdots \\ \gamma_{0,1}^{i} & \gamma_{1,1}^{i} & \cdots & \gamma_{1,1}^{i} \end{bmatrix} \begin{bmatrix} \Delta BRT_{t-1} \\ \Delta X_{1,t-1} \\ \vdots \\ \Delta X_{1,t-1} \end{bmatrix} + \begin{bmatrix} \varepsilon_{0,t} \\ \varepsilon_{1,t} \\ \vdots \\ \varepsilon_{1,t} \end{bmatrix} .....5$$

where:
ECt-i = the deviation from the long-run equilibrium in the previous period, based on the cointegrating equation estimated in equation (4)
l=the set of macroeconomic variables
X = the macroeconomic variables
K= maximum lag length
α = the speed of adjustment towards long-run equilibrium
ε = the error term

The parameters obtained from the final examination will be used to determine their respective catastrophic influences upon the values of respective corporate entities under investigation in this study. Similarly, in line with the normative and positive theory of bankruptcy, this section will make use of the application of catastrophe theory in order to investigate the magnitude of the effect of mild or abrupt changes on the dependent variables from the independent variable. In this respect, if the transition (change) occurs on the back edge of the surface as described earlier, following the green line, the event is normal and continuous (i.e., the effects of the magnitude of change are mild). If, on the other hand, the transition (change) occurred along the front edge, following the red line, then the event is a sudden and abrupt change, which is a catastrophe. This will enable us to know if the respective influences of independent variables on the dependent variable agree with Walter's theory of corporate bankruptcy.

Basic characteristics	**Cusp catastrophe**	**Butterfly catastrophe**
Dimension of state space	1	1
Dimension of control space	2	4
Representation	f: R^2 x $R^1 \rightarrow R$	f : R^4 x $R^1 \rightarrow R$
Potential function	$f(a,b,x) = 1/4x^4 + 1/2bx^2 + ax$	$f(a,b,c,d,x) = 1/6x^6 - 1/4dx^4 - 1/3cx^3 - 1/2bx^2 - ax$
Manifold	$M_3 = ((a,b,x): df/dx = 0, df/dx = x^3 + bx + a=0)$	$M_5 = ((a,b,c,d, x,): df/dx = 0 df/dx = x^5 - dx^3 - cx^2 - bx - a=0)$
Singularity set	$S_3 = ((a,b,x): d^2f/dx^2=0, d^2 f/d^2x/dx^2 = 3x^2 + b = 0)$	$S_5 = ((a,b,c,d,x): d^2f/dx^2=0, d^2 f/d^2x/dx^2 = 5x^4 - 3dx^2 - 2cx - b=0)$
Bifurcation set	$B_3 = ((a,b): 4b^3 + 27a^2 = 0)$	$B_5 = ((a,b,c,d): F (a,b,c,d) = 0)$

From the parameters:

$$CR\hat{P}V_{it} = \alpha_{it} + \sum_{i=0}^{k} \hat{\beta}_{1,t-i} X_{1,t-i} + \sum_{i=0}^{k} \hat{\beta}_{2,t-i} X_{2,t-i} + ... + \varepsilon_t$$

Depending on the catastrophic yield of the respective variables on corporate value, the Artificial Neural Network (ANN) should be used to calibrate and model *ex-ante* corporate failure predictive possibilities before an incoming financial crisis.

According to Li (1994), an ANN is a sophisticated form of computer technology which provides support for complex mechanical abilities to achieve reasonable precision in the processing and

conversion of data or information. Another feature of an ANN is that has creative and innovative intelligence capable of predicting representations through data or information processing into a form that is logical and with a modeling process that is meaningful. An ANN's basic intellectual transformation mechanism and structure are that it simulates various features of the physical structure and information processing of its complex mechanical intelligence that is constructed with a strong network of neural connectivities that are known as a 'white-box' or 'microscopic' system. It also simulates an expert system as a 'black-box' or 'macroscopic' system. Both of these types of systems are some of the predictive modeling's most powerful tools. Additionally, an ANN's complex and intellectual mechanical brain comprises a high number of ordinary but layered and interconnected processing elements.

A large number of neural networks have been proven to be highly efficient and effective as ways of handling and solving very complicated financial modeling problems. They also have been demonstrated to be highly effective in the recognition and handling of structured modeling processes. This occurs because there is a learning process from the sensitive and interconnected neurons which shows the real situation's potential influx and pictorial ideas. Ideas are understood by identifying a well-architectured form's interconnectivity which operate on the basis of simulations, calibrations, designs, and inputs that are deliberately built into the system and that proceed using an ethical and objective manner of data or information processing.

6. Conclusion

The conceptual analysis of this paper indicates that modern corporate failure prediction in the 21st century is far from the workings and efficacies of ordinary financial ratios. As a result of this, we conclude that the pattern of corporate failure in the Asian region is quite dynamic and beyond the explanatory power of ordinary ratios. This is inconsideration of the pervasive influence of exchange rate exposure, exchange rate misalignment, and macroeconomic volatility in some countries, which manifests as crises. One crucial factor that needs to be reckoned with is that the proximity of most Asian countries and their similarities in terms of economic fundamentals and growth prospects and their closely linked trading relationships has made it possible for crises to balloon and affect other Asian countries, thereby causing spillovers and contagions from one locus to the other. In such circumstances, financial ratios alone cannot reveal the true picture of corporations as ongoing concerns, particularly of giant corporate entities with enormous capital bases and businesses all over the Asian region. Finally, the chicken and egg relationship of corporate failure revolves more around the potency of macro-financial indicators than any other means considering their strong and pervasive influence in causing corporate failure in the 21st century, particularly in the Asian setting, and considering the report of the vagaries of exchange rate misalignment presented by the ADB. Finally, inconsistent policies could, among other things, stir up macro-financial variables to create economic dysfunctionalities that in turn breed unprecedented economic downturns, regardless of how benign the environment may be. In general, the magnitude of risk emission during crisis era is quite impossible to be adjudged by the old-age ratios of 1966.

7. Interim Recommendations

From the theoretical and conceptual analysis of literature and the conclusions made, we make interim recommendations pending the birth of the new model of corporate failure for the Asian region. These palliative recommendations are : There should be regional economic integration with (a) a common currency throughout the region; (b) free market economies in the entire region (c); reductions in the cost of doing business in the region; (d) adoption of the culture and spirit of 'Green Entrepreneurship'; and (e) elimination of all factors that can cause production and investment shocks (this can be done through the elimination of factors that constrain capital movement, which in turn inhibits the influx of foreign investors).

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