Chapter:1 Introduction & Background


Any researchable idea comes from intuitiveness, it self-generate and thus provide the motive to extend it to an empirical process leading to the culmination of documented guide-note for further research. This continuous cycle serves two purposes; it improves the confidence of the individual researchers in the similar field of investigation and simultaneously provides a meaningful contribution to the domain-specific knowledge.

Evermann and Tate (2011) stressed on researcher’s ability to ensure that his/her intellectual intuitiveness correspondingly justify the model specification. But, at no point, using standard statistical model for testing model accuracy hampers authors attempt to contribute in the hypothetic-deductive theoretical perspective. Even Weick (1989) critically argued that not all theoretical development necessarily passes through external validation. With this aspect in mind, the present work will surround around various dimensions of illiquid-assets valuation (limiting to pricing and risk model for human capital) and respective volatility with a sole motive of providing a tool/mechanism for financial institutions to adjudge impact on idiosyncratic illiquid asset volatility on the credit-ratings at the firm-level.

The following content in the introduction and background will thus enlarge the scope or dimensions of present work, which together cumulatively draw a reasonable Research problem and objectives in the end.

The concept of human intervention in the productivity of nation’s economy, industry growth and firm’s sustainability is not new, but, empirically demonstrating the relationships

between shadow-human capital pricing and credit-risk framework is statistically worthwhile and tangibly purposive.

Due to advent of technology, the people acquired skills become more visible and can be linked tangibly with the productivity of firms and its growth. The bigger question arises that why to study firm-level employment costs volatility? This reason stems from the various past studies which sufficiently claim that due to rapid innovation in both technology and financial markets, the firms are more “flexible” (Dias, Marques and Martins, 2013) in providing “incentives” to their employees to ensure they remain productive throughout time. Rapidly using financial derivatives to offset the wage deflation is used by large-cap firms. Such firms also have advantage of take credit easily through banking channels.

But, do we ever wonder, what happen if you make wages stable, how to ensure that firms revive their growth just by manipulating wages by so called external means?

Are such human capital pricing related factors which are at times highly idiosyncratic ever highlighted in determining the riskiness of investment in such companies?

Are these firms (mainly large-cap) stock prices also take into account the relationship of highly inflated wages/employee costs and other productive factors within firms?

This aspect demands a quantitative assessment and therefore to measure time-series based firm-level employment volatility become self-evidential.

The broader reasons of using human capital as illiquid asset stems from the contextual notion that “mispricing” occurs either due to lack of agents efforts of collecting “hidden” information within firms (costly search) or it could be due to disincentive in terms of holding costs and price an agent will receive of revelation of “true” information. while, the former demands welfare mechanisms like firms allowed to share critical illiquid asset information to each other and the later require the markets to recognise and incentivise such “powerful agents” who have capabilities to bring more fundamental and useful information to improve
the markets. However, in both the cases, since mispricing continues, the above topics of forecasting firm level human capital volatility through idiosyncratic information become far more imperative. Hence, we can safely assume that the researcher is acting as the role of “Information agent” who is proposing a new model to fix such anomalies surrounding illiquid asset volatilities. To support Brynjolfsson and Hitt, Yang (2002) rightly explored this idea by stating that firm’s valuations and other productivity measures which are tangible and visible can be highlighted with any human capital investments made by firms.

1.1 Definition, concept and pricing of human capital

According to Kucharčíková² several economists right from Adam Smith proposed to include human capital as collection of individual’s knowledge, skills, education, abilities and other attributes which are important for economic activity. The business and management approach confines human capital to its quantitative and quantitative dimension as an economic resource like machines, plant and equipment and so on. Thus, human capital although “intangible” contribute effectively in the productive and value of the enterprise.

Human capital as a production concept:

As it is evident that various production functions, including one proposed by Solow, Cobb-Douglas introduced a mix of labour and capital. Later endogenous economic growth models builds idea of human capital more distinctively in 1980’s and beyond. Human capital thus considered to be an important source of economic growth, collectively emerging from individual firm-growth.

So conceptually human capital demonstrates through employee costs as tangible factor which can be “longitudinally” related to the “growth factors” of the enterprise, namely, sales, R&D, and other production expenses. If we see a stronger correlations among human capital.

capital variable (i.e. employee costs) and other financial variables, can’t this idea may be used for pricing the non-tradable, illiquid, unhedgeable human capital?

**Human capital risks are measurable:**

The very nature of human capital as economic resource is neglected in the “capitalist idea of tradable markets, since, human capital always act as hidden and idiosyncratic and unlike balance sheets comprising facets of financial complexities, human capital as a relatively unknown part of valuation process. Market prices are traded by seeing the performance of profit per capital, or profit per employee as a employee productivity measure but beyond this a modelling process of describing its benefits of performance of listed companies following the notion of “idiosyncratic risk capital” was not much highlighted in the academic arenas particularly in the Indian context.

**What is contextual significance of studying human capital pricing and its related risks?**

In brief according to Goodwin³ contextual economics strongly condemns the proposition of perfect markets, i.e. it provide room for identifying the “hidden” information which the agent’s tradable prices do not reflect. therefore, firstly understanding the dimensions of literature on human capital pricing needs to be briefly highlighted. Bowlus and Robinson (2012)⁴ rightfully explained that since the quantity and price of wages over a period of time cannot be explicitly ascertained, we keep it implicitly constant for theorising human capital contribution. They used human efficiency factors like age-earnings model which assume that wages prices or quantity remain constant. In the same article, it is rightfully mentioned that single price homogenous human capital pricing framework are conceptually justified in defining the aggregate wage structures.

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In the present research the “empirically matching” approach of using human capital on one side with market-prices of the firm equity and the fundamental financial factors (as internal measures of growth) on the other was developed, thus this attaches the “complementarities” with the pricing framework of homogenous human capital as proposed in the present work. Further for a stronger reason, the present model is also not a contribution to the debate on “Asset-pricing”, purely because the human capital prices are hidden and they are not actively factor-in or traded in the stock markets. According to Thomas et. al (2013)\textsuperscript{5} the human capital has a unique “potential” to improve, this is certainly important postulate. Since, how can we measure that potential in firms growth, we need to specify some factors which are firstly identical across firms and then are easily identifiable and analysed. Additionally it should link to the firm’s competitive advantage (Wright and McMahan,1992).

It is imperative at this stage of research to justify why aggregate single-price human capital model makes empirical sense. firstly, no concrete literature determines use of complementarities in the human capital framework comprising pricing based on financial factors as reported in the financial statements. secondly, for mispricing, wage/employee costs longitudinal movements are not purely govern by macroeconomic movements, they are very much idiosyncratic, and usually therefore do not reflect aptly in the market prices. Such, differences in the human capital prices are worth investigating and needs to be extended to the development of better risk management practices for financial institutions.

1.2 Question of Mispricing!

Mispricing means prices do not reflect the complete information. Financial institutions are source of external capital, profits retained are source of internal capital. There is certainly third capital which is human capital in the very nature of other capital used. measuring capital risks involve models using market-prices of assets, hence, for debt and

equity capital, the asset prices are available, for these assets prices there are credit-risk models which are widely used. Unlike them, for human capital which credit risk models are not converted according to so called “window dressed” to human-asset. Therefore exiting credit risk models tends to pose difficulty in human capital pricing and purely dominated by market-prices of assets traded.

**Some background study on risk capital buffer**

(Panetta and QuagliarIello (2011) explained that excess risk capital buffer may induce banks to lower down the credit dispersal since reducing interest rates remain sticky in short-term. This induces procyclicality.

In terms of fundamental value and price ratio (Vf/p), it seems to remain weak with high idiosyncratic volatility (we,2006). Ali, Hwang, and Tombley (2003) also explained the fundamental value-to-price ratio impact by relating it the concept of mispricing and risk proxies.

The present topic of research also strongly relate to the phenomena of “incomplete asset markets” where the idiosyncratic behaviour of wage volatility can be a vital concern. (Finn, Prescott, Lawrence, Eichenbaum, & Fitzgerald, 1997) their work explains this phenomenon very well, the paper clearly states that all endogenous endowments (labor costs) are not fully insurable. (Belzil & Hansen, 2002) explained the need for using a Correlated random coefficient wage regression model. The paper exposes the limitation of OLS technique where the residual heteroscedasticity may pose serious limitations to confirm the comparative advantage between regressors. The author clearly explained how intercepts and slope coefficients determine the relative absolute and comparative advantages in the regression equation.

1.3 Rationale of using human capital pricing model and bank’s investment risks
Despite of an attempt of limiting to use illiquid asset pricing volatility for mispricing purposes the researcher deep-dived to yet another important dimension i.e. firm-level idiosyncratic assets and their related risks which have strong empirical relationships with internal financial factors in comparison to capital market prices. With this aspect in mind, the researcher tried to link the traditional value-at-risk methods otherwise implement to gauge market-price related risks based credit models. Promising paper on this subject is by (Eiling, 2012) who explained how industry-specific human capital diversity support in cross-sectional stock returns. Several other contributors like (Gomez, Priestley & Zapatero, 2016) indeed spread knowledge on the similar area; they elaborated on the intervention of human capital in the traditional CAPM framework with considering the local effect of labor costs in asset pricing. A profound work by (Krusell & Smith, 2006) suggested that how “curse of dimensionality” in optimizing macroeconomic wage inequalities and how macroeconomic forces bring the wage inequalities. Similarly, work by (Gori, 2014) in identifying unsystematic macroeconomic factor risks are of great importance in building the empirical dimension in this research work. The aspect of heterogeneity associated with the economic agents with reference to rationality in the allocation of resources is not merely a mechanical optimization process. (Fugazza, Guidolin, & Nicodano, 2010) claimed that from firm-level employment volatility perspective this is important since a large correlation between wage shocks in one industry in comparison to the financial shock as a whole denotes lesser protection to the workers.

Traditional CAPM model completely failed to accommodate idiosyncratic risks. Thus, under equilibrium there exist inefficiencies due to mispricing (Pontiff, 2006). As it sounds, like Professor Mark Buchanan “metastability” feature (Buchanan, 2013, Pg. 19) can rightly connote with disequilibrium thinking in this direction. Idiosyncratic exposure is difficult to hedge, because unlike other assets which are actively traded, idiosyncratic risks as asset
classes do not have ready-made substitutes. Thus holding costs of arbitrageurs increases due to non-substitutability and hence they demand a risk-proxy (Pontiff, 2006) and (Tuckman and Vile, 1992).

Idiosyncratic risks cannot be fully diversified unless agents are ready to share the risks, secondly, as Pontiff (2006) further claims that longer the duration of abnormal returns, larger the impact of holding costs and lower the impact of transaction costs. A similar aspect is cited on accrual mispricing and arbitrageurs reluctance due to unhedged risks of such accrual cashflows (Mashruwala, Rajgopal and Shelvin, 2006).

Putting Buchanan (2013) again, as he opines on page 41 in his book that market incompleteness must be removed to make it more “complete”, and therefore more freedom to trade and exchange information like what happens in derivatives must be instituted with little legal barriers. This indeed is the reason that hedge funds strategies are countable and must be evaluated to generate meaningful risk-proxies for safer investments.

As a study topic, my additional conceptual query is that “tail” risks seem much relevant, as it discards the traditional “equilibrium myopia”. And, to measure such risks, we need to delve into more concrete fundamental factors to measure the illiquid pricing framework, which is currently debatable and ignored by banks while ascertaining the risks associated with their investments.

The inquisitiveness arises because currently, Indian banks risk management practices failed to accommodate sufficient idiosyncratic components while measuring the illiquid assets hedged options. This is certainly an area worth exploring, since, it brings some shocking exceptions to the norms, sectors who are sitting with largest defaulting (NPA) components are found significantly lowly on hedging risk (in terms of illiquid asset pricing risk based on idiosyncratic information), while this may be mechanism deeply linked to loan-insurance firms it is also to an extent welfare-governing because such risk-proxies must be adequately
shared among agents dealing in such measures and thus bring more deeper efficiency to the market mechanism. Certainly, a dual price mechanism (as the one used here for human capital prices as complementariness-basis) of investment responses towards such illiquid assets might turn them to lesser liquid in case such “risk proxies” are recognized and dealer-driven demand is induced. Such, empirical combinations are regularly looked microscopically by investors, especially investment banks and large hedge funds to reduce their portfolio risks.

Use of factor investing is picking up, Martellini and Milhau (2015) from EDHEC- Risk institute, explained that under consumption-based pricing models, the factors are macroeconomic aggregates and are difficult to ascertain because they tend to change and are of low frequency, under such circumstances, a suitable proxy of Stochastic discount factor must be looked into.

The BASEL committee holds a view that since banks are exposed to systemic and aggregate economy-wide shocks, they must be safeguarded against any contagion-forming risks, and therefore, since BASEL I and BASEL II, the majority of the banks turned towards BASEL III, which constitute the stress on countercyclical capital buffers (referred hereafter CCCB). There is a growing tendency internationally that such capital risk buffers, must not relevantly put banking machinery to increase the dependency of securing equity exposures. It is also to be pointed out, that it has been evident in the past, that banking industry was not robust in terms of measuring their lending evaluations, rather more willingly surrounded on securitization as safest measures; this in turn put higher costs of insurance which the banks smartly passed to the customer.

Banks usually had investment trends closely linked with the performance of the sectors or industries and/or they mainly remain profitable investing in the emerging or growth industries, or industries where the sustainability of their investment returns are somewhat
guaranteed. Under such scenarios, the loan portfolios performance must be tested against these illiquid firm-specific investments (belonging to particular sectors), and certain “common” risk measures must be devised which can support in additional Countercyclical capital buffer (hereafter CCCB) requirements. The credit exposure of bank’s assets are mostly illiquid, and its pricing must account for idiosyncratic factors, since, various empirical studies confirmed that firm-specific information are important for pricing illiquid securities, one such dimension as mentioned below can be “human capital investment”, classified as alternative investment under hedge fund setup, or sticky assets according to Keynesian theory, and more precisely firm-level employment volatility under the present study.

Additional reason as stated in the very beginning of the Introduction that due to more deregulation and financial and technological innovation, and dramatic decrease in the costs attached to it, it is possible for firms to be able to adjust the volatility of firm-level employment with idiosyncratic micro-data like sales, inventory, energy costs etc. There are pertinent reasons of exhibiting lesser covariance between the economic activities like GDP volatility with the firm-volatility, but higher covariances for firm-factor volatility with the idiosyncratic volatility in the coming times. So, while banks extend such credit, investigating the exposure of this idiosyncratic information on firm-level employment volatility become paramount. 1.3.1. Shadow asset pricing

Shadow banking was used in various ways like hedge funds and similar prevailing sophisticated banking system which although meaningful provide direct competition to the existing banking community and challenges to the regulatory bodies.

Shadow banking is considered welfare oriented. For instance, Hedging the risks emerging from illiquid assets say human capital at a banking level is a challenge since there are no alternatives for pricing “aggregate employee costs” other than estimating them under
regression framework, and working backward to assess if this information (idiosyncratic) are linked to “operational hedging” or are “financial derivatives” available for them.

Several papers were studied in this direction, Xian, Colwell, and Ma (2010) utilized various traditional techniques of human capital pricing mainly the use of regression models were emphasized. The paper also mentioned that although the aggregate employee costs are not relevant since employees do get dividends and another form of incentives which add to their overall compensation. Rangel and Engle(2012) work specified use of correlations using idiosyncratic information for a low-frequency data. Another visible aspect was witnessing a high volatility of low-frequency idiosyncratic information with inter-sectoral employment dispersion index. Hence, the employment information volatility (aggregate employee costs) will be having some impact on firm-specific idiosyncratic information.

Wei (2009) provided justification of how inelastic labor supply reduces the impact of monetary policy shocks in the equity premium. The use of internal persistence in form of inflation inertia, habit formation and interest rate smoothing as calibrating with monetary shocks were also tested.

Huselid (1995) emphasized on HRM practices and its relation with the firm's financial performance. Although, such initial work do not account for relative pricing of human resource with statistical simulations as is conducted in the present work.

Stein (2007) extensively touched the aspects of valuation of human capital and criticized that linking the human capital with financial variables like sales and profits will be only reasonable where these firms’ products are homogenous and workers differentiation is not relevant.

1.3.1.1 **Shadow prices and moral hazard problem**

Isn’t moral hazard among financial institutions in the wake of supporting central bank machinery inviting contagious losses due to closely netted financial networks?

Markets had failed in protecting these big banking institutions in the past, hence, an alternative yet coherent sustainable risk modeling framework is the need of time. Shadow banking including hedge funds industry support risk sharing in terms of identifying latent factors which financial institutions fail to discover and hence support in market incompleteness.

A supporting view is exhibited by Andersen (2015) where it is referred that post-financial crisis with regard to ‘automatic stabilizers’ a micro-policy design with collective risk sharing through diversification of idiosyncratic risk is relevantly essential. The paper certainly talked about optimal generosity in a sense that it is “design” issue of how to ensure that a tradeoff can be set in between insurance and incentives among the agents.

The whole idea is whether at an individual level or at a firm level the moral hazard demands generous collective risk sharing options but with a “tangible and tractable” policy measure to ensure that social insurance work effectively where the agents perform some measures to self-sustain or absorb some part of the risks in the system.

1.3.2 “**Small-cap effect**“

There are several past studies done in order to confirm the limitations of traditional CAPM model in the estimation of unbiased betas particularly the notion of small firms outperforming large capitalization firms (Nathan, 1997). Nathan (1997) described the small firms having less information leads to lowered estimation risk and therefore provided better returns to the investors compared to large firms. Drobetz, Meier, and Seidel (2014) explained that impact of financial leverage as an endogenous variable in the estimation of equity
returns, and critically justified that unbiased systematic risk (beta) must account for other endogenous components for estimating the stock price returns. This is particularly relevant for small-cap firms.

The challenge lies with finding the literature on illiquid, non-tradable asset pricing and the small-cap effect which is rare and scanty. Therefore, stock prices as proxies for administering small-cap effect as the empirical ideas can be looked into. Whited and Wu (2006) utilized the external financial frictions with the shadow prices of investments and created an index of financial constraints. Some evidence on small firm effect with relation to reduction in investments is advocated by Chan and Chen (1991) who were more strongly differentiated marginal characteristics of firms due to their high leveraged capital structure and lower dividend payments. Bernanke and Gertler (1989) also spoke on the similar lines, Gerrlter and Gilchrist (1991) also pushed the idea of the small firm impact on monetary policy. Korinek (2011) also pushed the similar idea in terms of financial crisis and decline in asset prices, including non-traded assets like real estate which led to declining collateral values and thus impacting the lender’s balance sheet severely.

One of the important stepping stone on which my current research outcome correlates very well with the above work is as follows:

Since collateral values are mainly examined with the market (external) factors, nor, the internal, idiosyncratic and illiquid components, such collateral values are bound to depreciate faster in comparison to the large firms in the event an adverse macroeconomic shock, since the risk of default and high premium also heavily affect the small firms in comparison to the large firms. So eventually, as the financial institutions also charge high capital buffer for such marginal characteristics firms, because their collateral is priced through market factors and not account for idiosyncratic illiquid components. Hedge funds, particularly, serve better since they understand the role of relative shadow pricing framework
generated through innovative idiosyncratic information (not usually priced at the stock prices) to maintain or lowering the risks of their investment portfolio.

In terms of small-cap investments, a study on European and American stocks under International portfolio diversification stressed on the inclusion of small-cap for hedging risk purposes (particularly under lower variance risks) (Guidolin and Nicodano, 2009).

1.3.3 Illiquid asset pricing and idiosyncratic risks relationship

There are concrete empirical evidences Mitra (2012), Campbell, Lettau, Malkiel and Xu (2001) and several others mentioned about the disassociated aggregate volatility with the firm-level volatility, statistical relationship between idiosyncratic information further amplified in the work by Comin and Mulani (2009) confirming that sales growth and employment figures shown higher volatility in the recent times. Amador and Nagengast (2015) provided the relationships of aggregate credit supply shocks, bank shocks and firm-level shocks differentiating large firms and small firms in terms of credit supply positions.

One important aspect is that banks which had to maintain stable credit-to-GDP ratio tend to lend to large firms comparing to the small firms. And also the number of financial institutions supplying credit to small firms is found relatively lesser compare to large firms. But shouldn’t the banks be allowed flexibility to manage their loan portfolios, irrespective of aggregate capital adequacy requirements, so that a more reasonable inclusive growth (including small firms) can take place?

There are serious questions on the aggregate capital adequacy models imposition. Deregulating capital adequacy ratio at an aggregate level to more firm-level idiosyncratic capital buffers can help financial institutions to remain more sustainable and banks could freely participate in the overall economic growth. Correa and Suarez (2007) advocate the same concept when they align reduction in idiosyncratic shocks to more flexible and deregulated banking system. The issue of moral hazard at both bank level and firm-level are
self-evidential and must be measured by using the robust risk capital measures. Their findings explained how idiosyncratic volatility reduction due to bank’s deregulation (geographical diversification) assisted in the reduction of stock market volatility. Morgan and Strahan (2003) complemented the above statement by showing the impact of bank deregulation by correlating it with the reduction in the state-level employment volatility. While, Amador and Nagengast (2015) used the large and small firm volatility shock, the paper by Thesmar and Thoenig (2009) used the publicly and privately-held firms idiosyncratic shocks in their study in context to the aggregate banking deregulation measures.

The notion of idiosyncratic risks influencing capital asset pricing is also stated by Shleifer(2000) wherein the order of concept of “limited arbitrage”, the reasons of information in asset pricing seems relevant.
1.4. Research problem

The present research work is on this “methodological context” where the entire empirical understanding and modeling approach will be used to essentially provide a coherent yet meaningful sustainable method for measuring and using firm-level human capital (as proxy for illiquid asset) volatility.

The empirical problem is that in case as mentioned above, there exists a “gap” in terms of the measurement of existing human capital pricing models and underline volatility associated with such illiquid assets.

The human capital risks are hedged by agents with Inter-firm Labour contracts i.e. the reason of why human capital volatility remain Pareto optimal despite of dependence on the capital markets. besides, studies on how consumption led pricing models are important also exhibited some empirical benefits.

The available human capital pricing models take human capital with a notion of its individual characteristics and limit to its use as a resource for equilibrium (sticky prices) definitions. No concrete study existed where the human capital pricing and their volatility was extended with concepts like Value-at-risk models and further into the realm of credit-rating migration framework.

The present work solely identified this opportunity to build a comprehensive empirical model which have all statistical robustness and yet generate a viable alternative for existing credit lending institutions to foresee a better risk implementation.

Thus the Research statement formulated states like this:

“*The volatility of aggregate human capital “prices” derived from stock prices and those derive from internal financial variables should necessarily show significant differences.*"
In case it appears that the “gap” exists in terms of human capital volatility (forecasted aggregate relative employee costs volatility) measure through internal financial information and its measure through stock prices, then, it clearly determines or signals the aspect of “mispricing” in terms of the firm market valuations.

1.5 NEED OF THE STUDY

As can be seen in the previous work done in the broader areas of topics including mispricing, human capital pricing model, shadow asset pricing and moral hazard problem, size effect, hedge fund risk management strategy, the key issues underlying is that “How to make informed decisions?

Agents must be always rational, and if it true then Efficient markets and underline asset price need no further empirical enquiry. Market crashes, crisis happen, banks collapse and few gains and many loose. So the manner in which market works is fundamentally goes like this agents hide information, since they are not sufficiently incentivised, together regulatory mechanism evolve slowly particularly in the country like India.

Another particular aspect is granulated credit-risk management I.e. going to sectors which have deep debt trouble, identifying firms and then looking for information through latent faros which is not “priced”. Taking human capital latent prices is one such case, as we can inevitably understand that large firms can hedge human capital risks by moving to derivative markets (of course with derivatives the value of collaterals under margin trading may be a concern in case agent signal a fire-sale, else it is a viable option), but for small firms these access to hedge labour income risk is minimal. This is one big motivation to identify mispricing associated with human capital prices. Intuitively, as mentioned in the literature earlier, a lower elasticity of intertemporal consumption (substitution) explain that either the human capital resist participating in the capital market (as they are fully insured within the firm’s budget since they are lazy and do not aggressively take advantage of economic gains)
or, the firms are strong enough to compensate or hedge any high labour income risks intertemporally. In both the cases, as understood contextually, there exist a “mispricing” effect due to lower equity risk premium, since consumption component do not remain visible in the capital market in case the human capital is completely hedged (complete private contracts). Particularly, due to limit market participation puzzle surrounding in the literature, these latent pricing models and its derived risks and risk based capital and ratings are important empirical challenges and worth investigating and exploring. The aspect of optimal taxation, welfare gains, collective utility are also important since welfare/wage-inequality in case remain unsettled can reduce mis-pricing to an extent since human capital or labour may have their consumption risks compensated by increase participation in the capital markets.

These all reasons proposes to develop better pricing and risk capital framework. The need of the study is confined to the same reasons to develop a “new” empirically superior model with complex structure to support the aspect of fair valuation of listed firms and remove the anomalies particularly in terms of “size-effect”, and intuitively to an extent limited market participation puzzle through the model development phases.

1.6 SIGNIFICANCE OF THE STUDY :

The rationale of the thesis to the researcher is to extend his empirical reasoning on issues of mispricing and its relationship with firm-level illiquid assets (particularly human capital). This work is extended as analytical modelling process and it can aid credit analysts, rating analysts, and economists in the areas of alternative credit rating methodologies. Researcher also extend the belief that even pension funds, and mutual funds can make use of it to design long term portfolio risk management strategies by taking aspects of regression based pricing models for non-tradable as the one advocated in the present work.
1.7. Aims and Objectives

Thus the following objectives are constructed to complete the present study:

1. Creating Single-factor pricing Model for aggregate employee costs (as a proxy for human capital) using decomposed set of Accounting statement information
2. Creating single-factor pricing Model for aggregate employee costs (as a proxy for human capital) using aggregate equity prices of the sampled companies
3. Analysis of post-resampled human capital relative price volatility and related risk measures at the inter-firm and inter-industry level
1.8 Hypothesis

Purpose of Hypothesis: Model validation (Superiority of Internal Financial information Modeling)

Alternative Hypothesis (H1)- Firm-level information does play a significant role in defining the pricing of aggregate employee costs (proxy for human capital pricing) in comparison to the external market prices of firm’s equity capital.
1.9 Theoretical background

1.9.1 Time series modelling

A time series is a sequence of data points, typically consisting of successive measurements made over a time interval. Examples of time series are ocean tides, counts of sunspots, and the daily closing value of the Dow Jones Industrial Average. Time series are very frequently plotted via line charts. Time series are used in statistics, signal processing, pattern recognition, econometrics, mathematical finance, weather forecasting, earthquake prediction, electroencephalography, control engineering, astronomy, communications engineering, and largely in any domain of applied science and engineering which involves temporal measurements.

Time series analysis comprises methods for analyzing time series data in order to extract meaningful statistics and other characteristics of the data. Time series forecasting is the use of a model to predict future values based on previously observed values. While regression analysis is often employed in such a way as to test theories that the current values of one or more independent time series affect the current value of another time series, this type of analysis of time series is not called "time series analysis", which focuses on comparing values of a single time series or multiple dependent time series at different points in time.

Time series data have a natural temporal ordering. This makes time series analysis distinct from cross-sectional studies, in which there is no natural ordering of the observations (e.g. explaining people's wages by reference to their respective education levels, where the individuals' data could be entered in any order). Time series analysis is also distinct from spatial data analysis where the observations typically relate to geographical locations (e.g. accounting for house prices by the location as well as the intrinsic characteristics of the houses). A stochastic model for a time series will generally reflect the fact that observations
close together in time will be more closely related than observations further apart. In addition, time series models will often make use of the natural one-way ordering of time so that values for a given period will be expressed as deriving in some way from past values, rather than from future values.

Time series analysis can be applied to real-valued, continuous data, discrete numeric data, or discrete symbolic data (i.e. sequences of characters, such as letters and words in the English language.

1.9.1.1 Methods of time series analysis

Methods for time series analyses may be divided into two classes: frequency-domain methods and time-domain methods. The former include spectral analysis and recently wavelet analysis; the latter include auto-correlation and cross-correlation analysis. In the time domain, correlation analyses can be made in a filter-like manner using scaled correlation, thereby mitigating the need to operate in the frequency domain.

Additionally, time series analysis techniques may be divided into parametric and non-parametric methods. The parametric approaches assume that the underlying stationary stochastic process has a certain structure which can be described using a small number of parameters (for example, using an autoregressive or moving average model). In these approaches, the task is to estimate the parameters of the model that describes the stochastic process. By contrast, non-parametric approaches explicitly estimate the covariance or the spectrum of the process without assuming that the process has any particular structure.

Methods of time series analysis may also be divided into linear and non-linear, and SINGLE-FACTOR and multivariate.

1.9.1.2. Autocorrelation analysis

Autocorrelation, also known as serial correlation, is the cross-correlation of a signal with itself. Informally, it is the similarity between observations as a function of the time lag
between them. It is a mathematical tool for finding repeating patterns, such as the presence of a periodic signal obscured by noise, or identifying the missing fundamental frequency in a signal implied by its harmonic frequencies. It is often used in signal processing for analyzing functions or series of values, such as time domain signal

1.9.1.3 Cross-correlation

In signal processing, cross-correlation is a measure of similarity of two series as a function of the lag of one relative to the other. This is also known as a sliding dot product or sliding inner-product. It is commonly used for searching a long signal for a shorter, known feature. It has applications in pattern recognition, single particle analysis, electron tomography, averaging, cryptanalysis, and neurophysiology

1.9.2 Regression analysis:

In statistics, regression analysis is a statistical process for estimating the relationships among variables. It includes many techniques for modeling and analyzing several variables when the focus is on the relationship between a dependent variable and one or more independent variables. More specifically, regression analysis helps one understand how the typical value of the dependent variable (or 'criterion variable') changes when any one of the independent variables is varied, while the other independent variables are held fixed. Most commonly, regression analysis estimates the conditional expectation of the dependent variable given the independent variables – that is, the average value of the dependent variable when the independent variables are fixed. Less commonly, the focus is on a quantile or another location parameter of the conditional distribution of the dependent variable given the independent variables. In all cases, the estimation target is a function of the independent variables called the regression function. In regression analysis, it is also of interest to characterize the variation of the dependent variable around the regression function which can be described by a probability distribution.
Regression analysis is widely used for prediction and forecasting, where its use has substantial overlap with the field of machine learning. Regression analysis is also used to understand which among the independent variables are related to the dependent variable, and to explore the forms of these relationships. In restricted circumstances, regression analysis can be used to infer causal relationships between the independent and dependent variables. However, this can lead to illusions or false relationships, so caution is advisable;[1] for example, correlation does not imply causation.

Many techniques for carrying out regression analysis have been developed. Familiar methods such as linear regression and ordinary least squares regression are parametric, in that the regression function is defined in terms of a finite number of unknown parameters that are estimated from the data. Nonparametric regression refers to techniques that allow the regression function to lie in a specified set of functions, which may be infinite-dimensional.

The performance of regression analysis methods in practice depends on the form of the data-generating process, and how it relates to the regression approach being used. Since the true form of the data-generating process is generally not known, regression analysis often depends to some extent on making assumptions about this process. These assumptions are sometimes testable if a sufficient quantity of data is available. Regression models for prediction are often useful even when the assumptions are moderately violated, although they may not perform optimally. However, in many applications, especially with small effects or questions of causality based on observational data, regression methods can give misleading results.[2][3]

1.9.2.1. (AR) Model

In statistics and signal processing, an autoregressive (AR) model is a representation of a type of random process; as such, it describes certain time-varying processes in nature, economics, etc. The autoregressive model specifies that the output variable depends linearly
on its own previous values. It is a special case of the more general ARMA model of time series

A geometric Brownian motion (GBM) (also known as exponential Brownian motion) is a continuous-time stochastic process in which the logarithm of the randomly varying quantity follows a Brownian motion (also called a Wiener process) with drift.[1] It is an important example of stochastic processes satisfying a stochastic differential equation (SDE); in particular, it is used in mathematical finance to model stock prices in the Black–Scholes model.

Stochastic volatility models are those in which the variance of a stochastic process is itself randomly distributed. They are used in the field of mathematical finance to evaluate derivative securities, such as options. The name derives from the models' treatment of the underlying security's volatility as a random process, governed by state variables such as the price level of the underlying security, the tendency of volatility to revert to some long-run mean value, and the variance of the volatility process itself, among others.

Stochastic volatility models are one approach to resolving a shortcoming of the Black–Scholes model. In particular, models based on Black-Scholes assume that the underlying volatility is constant over the life of the derivative and unaffected by the changes in the price level of the underlying security. However, these models cannot explain long-observed features of the implied volatility surface such as volatility smile and skew, which indicate that implied volatility does tend to vary with respect to strike price and expiry. By assuming that the volatility of the underlying price is a stochastic process rather than a constant, it becomes possible to model derivatives more accurately.

1.9.2.2. Autoregressive conditional heteroskedasticity

In econometrics, autoregressive conditional heteroskedasticity (ARCH) models are used to characterize and model observed time series. They are used whenever there is a
reason to believe that, at any point in a series, the error terms will have a characteristic size or variance. In particular, ARCH models assume the variance of the current error term or innovation to be a function of the actual sizes of the previous time periods’ error terms: often the variance is related to the squares of the previous innovations.

Such models are often called ARCH models (Engle, 1982), although a variety of other acronyms are applied to particular structures of the model which have a similar basis. ARCH models are employed commonly in modeling financial time series that exhibit time-varying volatility clustering, i.e. periods of swings followed by periods of relative calm. ARCH-type models are sometimes considered to be part of the family of stochastic volatility models but strictly this is incorrect since at time t the volatility is completely pre-determined (deterministic) given previous values.

1.9.2.2.1. GARCH

If an autoregressive moving average model (ARMA model) is assumed for the error variance, the model is a generalized autoregressive conditional heteroskedasticity (GARCH, Bollerslev (1986)) model.

Generally, when testing for heteroskedasticity in econometric models, the best test is the White test. However, when dealing with time series data, this means to test for ARCH errors (as described above) and GARCH errors (below).

EQMA is an alternative model in a separate class of exponential smoothing models. It can be an alternative to GARCH modeling as it has some attractive properties such as a greater weight upon more recent observations but also some drawbacks such as an arbitrary decay factor that introduce subjectivity into the estimation.

1.9.2.2.2 NGARCH

Nonlinear GARCH (NGARCH) also known as Nonlinear Asymmetric GARCH(1,1) (NAGARCH) was introduced by Engle and Ng in 1993.
For stock returns, parameter $\theta$ is usually estimated to be positive; in this case, it reflects the leverage effect, signifying that negative returns increase future volatility by a larger amount than positive returns of the same magnitude.

This model shouldn't be confused with the ARCH model, together with the NGARCH extension, introduced by Higgins and Bera in 1992.[clarification needed]

1.9.3 ASSET PRICING THEORIES & MODELS :

1.9.3.1 Capital Asset Pricing model (CAPM)

It is a single factor model and use only market risk premium where a benchmark index is used a proxy for measuring the relative asset price. CAPM model is critiqued on the grounds on being too theoretical since the concept of efficient market as an asumption is strong condemned on empirical standpoint.

$$ER_i = R_f + \beta_i(ER_m - R_f)$$

here,

$ER_i = $ Expected Return

$R_f = $ Risk free rate

$\beta_i = $ Systematic (market-related) risk

$ER_m = $ Historical return of the market index

1.9.3.2 Multifactor pricing models

1.5.3.2.1 Arbitrage pricing models (APT)
Arbitrage pricing model explains that prices are governed by multiple factors and hence it is combination of various factor elasticity which determines the equilibrium state price (a price which is arbitrage-free).

Here, instead of one factor ERm, ERx demonstrates use of multiple factors.

1.5.3.2.2-Fama-French 3 factor model
One widely used multi-factor model is the Fama and French three-factor model. The Fama and French model has three factors: size of firms, book-to-market values and excess return on the market. In other words, the three factors used are SMB (small minus big), HML (high minus low) and the portfolio's return less the risk free rate of return. SMB accounts for publicly traded companies with small market caps that generate higher returns, while HML accounts for value stocks with high book-to-market ratios that generate higher returns in comparison to the market.

\[ R_{it} - R_{ft} = a_i + (R_{Mt} - R_{ft}) + s_iSMB_t + h_iHML_t + e_{it} \text{(3F-FF model)} \]

1.9.3.3 Consumption based pricing models
The consumption based pricing models consider the demand-side of equilibrium. The consumption risks accommodates aspect like labour income risk, household consumption, savings, issues of intertemporal substitution etc.

The consumption capital asset pricing model (CCAPM) is an extension of the capital asset pricing model (CAPM) that uses a consumption beta instead of a market beta to explain expected return premiums over the risk-free rate. The beta component of both the CCAPM
and CAPM formulas represents risk that cannot be diversified away. The consumption beta is based on the volatility of a given stock or portfolio.

The CCAPM predicts that an asset's return premium is proportional to its consumption beta. The model is credited to Douglas Breeden, a finance professor at Fuqua School of Business at Duke University, and Robert Lucas, an economics professor at the University of Chicago who won the Nobel Prize in Economics in 1995.

2.5.4 Behavioural pricing model

1.9.4 CREDIT RISK MODELS

1.9.4.1 Commercial credit models

– Probability of default (PD) models

For a group of borrowers with similar characteristics, predicts the number of borrowers that are likely to default over a specific time horizon, e.g. 1 year. Is based on the characteristics of the borrower

– Loss given default (LGD) models

Attempts to predict the amount of loss in a credit in the. Is based on the characteristics of the facility, i.e. collateral covenants, etc.

– Exposure at default (EAD) models

For unfunded lines of credit, attempts to define the amount of exposure that will exists at the time of default. Is based on the characteristics and the purpose of the facility and the behaviour of the borrower

1.9.4.2 Consumer credit models

– Default models

For a group of borrowers with similar characteristics, predicts the number borrowers that are likely to default over a specific time horizon, e.g. 1 year
Focuses on amount of credit available to borrower, stability of borrower, and history of delinquency

Bankruptcy models

For a group of borrowers with similar characteristics, predicts the number borrowers that are likely to file bankruptcy over a specific time horizon, e.g. 1 year. Focuses on amount and the types of credit used by the borrower

Behavioral models

Focuses on the behavior of an individual customer and the lender’s experience with that customer to focus the bank’s collection and marketing efforts.

Focuses on payment history and spending patterns

1.9.4.3 Structural credit risk models

These models are based on firm’s position of asset, liabilities and equity.

- Merton model: This model was proposed by Merton (1974) which uses black sholes equations to calculate the price or valuation of debt and equity, where debt represents a put and equity represents a call option.

- First passage model: it uses a concept of “default barrier”, and hence uses indirectly a barrier call and put option attached with equity and debt component. It was proposed by Black and Cox (1976).

Structural models may only serve when the distance to default is short, in the large distance to default cases these models fail to provide accurate results

1.9.4.4 Reduced-form credit risk models

These models were offered by Jarrow and Turnbull (1995) and unlike using debt and equity shareholdings, the model uses a default probability (stochastic process) with either

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using a exponential distribution or continuous Markov chain process. This limitation of reduced form models are that they need “observed prices” for valuing credit-sensitive instruments.

1.9.4.5 Hybrid credit risk models

In the Hybrid models (proposed by Duffie and Lando, 2001) both the structural model properties and reduced form properties are combined giving a more robust outlook.

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8 ibid.