



DESTABILIZED GLOBAL SECURITY-MARKETS: COPING WITH THEIR FORECASTING CONSEQUENCES

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Abstract

Context As Forecasters, we are interested in: The **Destabilization** of the **Global Security-Markets** caused by **Events**, noted as: {DGSM[E]}. The question that motivates this research report is:

What are the Nature of the systemic-longitudinal effects on key Forecasting Y-Variates of Market Traded Firms produced by the following two “life-cycle” Phases of a {DGSM[E]}:

*Pre[The{DGSM[E]}] then **During**[The{DGSM[E]}] then **Post**[The{DGSM[E]}]?*

At Issue If there is inferential-evidence that these **two** “life-cycle” Phases of a {DGSM[E]} align with the generating processes of the firm, and so create Ergodic Forecasting Model [FM]Y-Variates, *then and only then*, these *longitudinal* datasets **could and should** be used in the creation of forecasts for planning. If, alternatively, the Phases of a {DGSM[E]} act on the [FM]Y-Variates in a chaotic, illogical, or unexpected manner and so create **Non-Ergodic Data Panels**, then prudence would require that forecasters avoid using such {DGSM[E]}-data in the creation of forecasts. Inferential testing of Ergodicity requires the selection of an {DGSM[E]}. We

selected The *Lehman Brothers IncTM* -debacle; it is an ideal example of a **Destabilizing-Event** {DE} to *test and validate* our Data-Analytic *inferential*-protocol: The [iDA] Model.

Specifics To parametrize our iDA Model for testing, we selected a random sample of Firms traded on the S&P₅₀₀ and used selected Income Statement [IS]- & Balance Sheet [BS]-Variables to form profiles of their Pearson Product Moment Correlations [PPMC] over the Three Phases of the DGSM[Lehman]-datasets.

Results We found that: (i) There was discernable, systemic, and logical inferential-intel that rationalized **excluding** certain **Income Statement**[Y-Variates] and **Balance Sheet**[Y-Variates] from use in forecasting.

Keywords: *Forecasting Model Data Inputs, Ergodic Data, PPMC-Screening, Lehman-Debacle*

INTRODUCTION

Overview

The purpose of this research report is to: Offer a Data Analytic inferential-{set of protocols}: [The iDA Model] to create [False Positive Error] $FPE[Null[H_0]]$: *p-value*-profiles that can address the following:

*If, in the past, there has been an **Event** that likely caused a **Destabilization** of the **Global Security-Markets** for some period of time: Noted as An {DGSM[E]}, is there inferential evidence to Reject the overall judgmental $FPE[Null[H_0]]$ of No Effect, where No Effect indicates that: The{DGSM[E]} has NOT destabilized the selected Forecasting Model [FM] Y-Variates of the Firm. **Simply** Rejecting H_0 indicates acceptance of the alternative: H_a that: The {DGSM[E]} has created [FM]Y-Variates during the Phases of the **Destabilization** that are **NOT** aligned with the usual Firm generating process(es). Further, as clarification, **Failing to Reject** H_0 tacitly indicates that the [FM]Y-Variates were **not** affected in such a manner that they are judged to be **Non-Ergodic** with respect to the other variable Panels usually used in creating forecasts.*

To create the iDA Model-profiles, needed for this decision-making, we will:

- I. Suggest an **Event** that effected a **Destabilization** of the **Global Security-Markets**. After a compressive evaluation, we have decided that there is none better than the: *Lehman Brothers Inc.*-sub-prime debacle hereafter noted as: The {DGSM[**Lehman**]},
- II. Select a Random Sample of: Firms from the S&P₅₀₀ and [FM]Y-Variates for the following three *Lehman* Event-Phases:

Pre-[The{DGSM[Lehman]}] **then**,

During-[The{DGSM[Lehman]}] **then**,

Post{The{DGSM[Lehman]},

III. Discuss and Justify the Pearson Product Moment Correlation [PPMC] as ***an ideal***

Judgmental Triage-measure used to classify [FM]Y-Variates as: ***Ergodic*** or ***Non-Ergodic***, and

IV. Present the *i*DA Model {DGSM[Lehman]}-***Ergodicity*** results for the [FM]Y-Variates of the S&P₅₀₀ Firms.

Caveat We are only using The{DGSM[Lehman]} as an example for our *i*DA Model-testing protocol. The theoretical basis of our investigation is:

In Forecasting, one believes that the past datasets have information that Forecasting Models will usually transform/project into reliable insights of future indications. In this case, a key-screening-protocol, often *overlooked*—a *euphuism* for “*intentionally ignored*”, is:

The Data Screening Phase

The most detailed and extensive version of this phase is offered by Collopy & Armstrong (1992) [C&A], the authors of the Rule Based Forecasting [RBF] Expert System, detailed as follows:

C&A’s General Advice: Macro-Recommendation [Paraphrased: Any *italics* are our additions to the C&A-text.]:

If Past-Activity is to be used to Project Activity likely to be the State of Nature in the future, then the Analyst must scrutinize the Past Data to determine IF observations are judged to be irregular based upon domain knowledge [—i.e., Non-Ergodic in the parlance of our study], THEN adjust the observations prior to analysis to remove their short-term effects. [The transitory effects of unusual events should not have an impact on the forecast; thus, the observations should be adjusted.] C&A[The Rule Base[3:[p.1409]]].

Following is a C&A **Micro-Recommendations** of an RBF-action to be taken:

“IF the functional form is multiplicative, THEN use a log transformation of the original series”.

C&A[The Rule Base[2:[p.1409]]. We will be following this recommendation.

Summary

We are referencing the C&A RBF Model’s **Macro-Recommendation** suggestions for data modification as this has been used for decades to enhance the quality of the Forecasting Intel. Indeed, we offer our *i*DA Model as an additional possibility for inclusion in the C&A Rule-Set.

Caveat However, there are those forecasters, many of whom are valued colleagues, who reject the logic of the C&A-modification-recommendation. They point out that:

If the analyst, in any manner, changes the datasets as inputted into the Forecasting Models, they are NO LONGER solving the problem as it exists as the ACTUAL State of Nature.

Caveat Duly Noted!!!

THE *i*DA MODEL : OUR ERGODICITY PROFILER

Overview

We selected the Lehman Destabilization Event as it is well known*, extensively detailed, and speaks to most of the issues that are part of the Ackoffian *Mess* [Ackoff(1970) that Destabilization precipitates in the global milieu. For example, Shavshukov (2018) discusses the role of the BRICS [**B**razil, **R**ussia, **I**ndia, **C**hina and **S**outh Africa]-countries as strong players in the global economy and is aimed at identifying major obstacles to their economic growth. Further, it is noted that:

- - -, *the analysis also revealed some fundamental economic weaknesses, originating in the global economic crisis. The most serious of these are increasing financial risks and the destabilization of the money markets. The post-crisis period is characterized by the struggle for stability and the creation of new infrastructure (New Development Bank and Pool of Contingent Reserve Arrangement).*

Also, the treatment of Komorowski (2018) is an excellent complement to the Shavshukov research report.

*See: <https://www.investopedia.com/articles/economics/09/lehman-brothers-collapse.asp> an excellent treatment of the *Lehman Bros, Inc* debacle.

The Operational Aspects of The *i*DA

Following, we will present the components of our *i*DA Model that will be used in the Ergodic-profiling of the [FM]Y-Variates as impacted by The{DGSM[Lehman]}. We will detail and illustrate these *i*DA: components in stand-alone Sections. Then, after their presentations, we will move to execution of the *i*DA Model using The{DGSM[Lehman]}-example. We find this to be the best way to communicate our theoretical suggestions and practical assumptions.

Critical Alert To facilitate the exposition, we are assuming the Role of Forecasters of a Firm— i.e., we are *The Analysts*. In this context, we need to suggest a set of Sensitive and Specific Accounting Information System [AIS]-Accounts that we will use to generate the forecasts used by the Firm's Planning Committee to plan the future expectations of the Firm. To this end, we randomly selected firms from the S&P₅₀₀ and then selected Key-AIS-Variables [[FM]Y-Variates] from these firms. We are tacitly assuming that these S&P₅₀₀ [FM]Y-Variates are the data used in the Forecasting Model of OUR FIRM. This is a logical necessity as we do NOT have *actual firm datasets* to test our *i*DA Model. Finally, the output of the *i*DA Model will address the **Question of Ergodicity** with recommendations as to which Y-Variate-datasets should be Excluded [*or Modified*] following C&A's **Macro-Recommendation**. However, for this research communication, we will not offer Panel Modifications as this is the subject for future research;

rather, we have opted for only **noting** the Ergodic Nature of the [FM]Y-Variates. Following are the **Stand-Alone Sections** where we detail and illustrate the elements of the iDA Model.

The Time Periods Selected for Profiling the Data

As we are using the Lehman-debacle as our DGSM{E[]} which was a destabilization-event identified *Circa The 4th Quarter of 2007*, we selected the following Data-Phases for our testing protocol:

Pre-{DGSM[Lehman: **2000 through 2006**]}, our *Benchmark-Profile*, then

During-{DGSM[Lehman: **2007 through 20013**]}, then

Post-{DGSM[Lehman: **2014 through 2020**]}

These phases seemed to be ideal for our testing of: The {DGSM[**Lehman**]}-effects on the S&P₅₀₀ datasets as they are the **Event-Space in between** the creation of the **PCAOB Circa 2000**, as the US Federal Government's reaction to the Destabilization of the Markets in the 1990s and the **"COVID-19 outbreak" Circa 2021**.

The S&P₅₀₀ Data Set: Our Surrogate for an Actual Firm Dataset

We used the *Market Screener*TM Market Profiler to select our test firms. Specifically, we randomly selected from the *Bloomberg*TM Market Trading Platform: The following three Groups of Firms Ranked by the *Market Screen** : {The **Top** 20[Firms: [1through 20], The **Middle** 20: [We selected a random number from 100 to 400 as the accrual-starting-point. Thus, we selected Firms [141 through 160]] and finally, The **Bottom** 20: Firms [481 through 500]]. From these 60-Firm-Candidates, we randomly selected 13 firms from the Top-Rated 100, 13 firms from the Middle-Rated 100 firms, and 13 firms from the Trailing 100. There were seven Firms that failed to have contagious-Panel-values that started at: 2000 and/or ended at: 2020. Thus, giving overall 32 S&P₅₀₀ firms for our iDA Model-testing-frame. These firms are noted in Appendix A.

*See[<https://www.marketscreener.com/quote/index/S-P-500-4985/components/>]

The S&P₅₀₀ Y-Variates Selected

Given the three Time-Frames: [2000 through 2020], we used the Fraser & Ormiston (2013) text as guidance in selecting the following Sensitive & Specific [FM]Y-Variates:

(i) Balance Sheet[Std] BS Y-Variates

[Cash, Cash Equivalents and STI[BBT_[7]]] & [Current Assets[BBT_[24]]] & [Current Liabilities[BBT_[58]]] & [Total Equity[BBT_[83]]] & [Current Ratio[BBT_[98]]]

(ii) Income Statement[GAAP]: IS Y-Variates

[Revenue[BBT_[4]]] & [Gross Profit[BBT_[11]]] & [Operating Income Loss[BBT_[17]]] & [Net Income Avail to Common, Adj[BBT_[39]]] & [Profit Margin[BBT_[63]]]

Note: We have noted the Line Number of the BBT[Account] as: BBT_[n].

We selected the Current Ratio as a **vetting** measure. For each Firm, we computed Current Ratio as:

Current Ratio = [Current Assets[BBT_[24]]] / [Current Liabilities[BBT_[58]]]

If the Current Ratio[BBT_[98]]*—i.e., as reported by Bloomberg, was not equal to our computation, then we did not use that Firm in our sample. There were no instances where was the case.*

Our Definition of Ergodicity & Its Inferential Application to Profiling the [FM]Y-Variates

Recall, we are testing the Ergodic Nature of IS & BS Y-Variates of 32 randomly selected S&P₅₀₀ Firms during the three DGSM[{**Lehman**}]*-Time Periods*. We are using our *iDA* Model that will produce the *FPE[Null][H₀]*: *p-value*-profiles to aid in creating intel re:

The Nature of the Ergodicity of the selected BS & IS Y-Variates over the Lehman{Pre-During- & Post-} Time Periods.

A typical **Sampling-Frame definition** of Ergodicity for **A Panel of Y-Variate Firm-data** is:

*IF the Statistical profile of a collection of random Sub-sets of a Data-Panel of a Key-Variable of a Firm actively traded on a Stock Exchange were to have a *FPE[Null][H₀]*: *p-value* for a particular Statistical Measure, usually one of the first four moments, vis-à-vis that of the Full Panel, excluding the collection of random Sub-sets, that would likely suggest: **Fail to Reject H₀**, this would imply that the Profile of: {The Random Subsets} is not different from the Profile of: {The adjusted Whole Panel}. **This would be the definition of an Ergodic-collection of random Sub-sets of the Data-Panel.** Interestingly, this definition is valid if the collection is only ONE-Subset of the entire Panel; however, in this case, there is usually a diminished likelihood of Rejection of the *FPE[Null][H₀]*. Given this definition, and our research agenda, following we will discuss the Measure that we will use in the *iDA* Model to arrive at an understanding of the decision-intel to be derived re: Ergodicity.*

This Sampling-Frame definition pertains only to **A Panel of Data**. We considered using this context for detecting Ergodicity. This led us to revise the definitional context for our study; we will be using a **Judgmental** focus for the analysis of a Collections of Panels where we are relying on the expertise of an informed and motivated Analyst for the identification of **Ergodic**- or **Non-Ergodic**-Panels. In this regard, we are using a simple correlation measure as the detection-variable for deconstructing the collection of Panels re: Ergodicity.

The Measure of Ergodicity & “Le Mode d’Emploi”

If one is using Ergodicity as a Measure for decision-making, the *onus* is on the research Analyst to: Define & Rationalize the selected measure of Ergodicity in the decision-context—**Simply** The Nature of Ergodicity is a judgmental definition that for the decision-making collective is accepted as pertinent re: The “*Problématique*” under consideration. Our Mantra, for this research report, is:

“Ergodicity is in the Eye of the Beholder”

It is for this reason that we have elected to use a Judgmental-Analysis for profiling Ergodicity. In the next section, we will develop the conceptual structure needed to form the inferential-intel to use our associational measure of Ergodicity in a decision-making context. Recall the decision of interest is:

- I. If there are *iDA*-indications that the BS or IS Y-Variates **as groups** are **likely-Ergodic**, then the Firm-Data in these Lehman-temporal windows will likely qualify to be used in forecasting, or
- II. If this is not the case—i.e., the Firm-data in the Lehman-temporal windows are likely **Non-Ergodic**, then the Data in these Lehman-temporal windows will likely **not** qualify to be used in forecasting.

THE SCRIPTING THE ERGODIC-CONTEXT OF OUR STUDY

The Assumptions

As is the usual case, there are a series of assumptions underlying creating a Variable Measure that will be used to form an inferential test. For our *iDA* Model, the *Defining* Assumptions are presented and illustrated following:

- I. *Assumption: [Experiential Vetted Y-Variates]* The Time Series [TS] forecasting-datasets of the Firm are the Past: Y-BS & -IS Variates [*noted above*] that have been used in making TS-forecasts that over time and, based upon *ex-post* evaluations, have experiential-validity as useful in guiding the firm, and
- II. *Assumption: [Strength & Trajectory Integrity]* For Ergodicity-testing in a **Time-Series** [TS] forecasting context, it would be beneficial to have a Measure of: (i) **The Strength &** (ii) **The Relative Direction of the Dynamic Motion** of the Y-Variate Panel with the TS-Index. The Critical-Measure is clearly the **Strength Measure. Rationale** If there is not a meaningful dynamic association of the Y-Variate’s movement for CHANGES in the TS-Index, then there is NO possibility for a TS-FM to produce useful projections of the future from such Y-Variates. Thus, if one screens-out the Y-Variates that **fail** the Strength-Test, then the *Directional-* or *Trajectory-intel* is likely meaningful for the remaining set of Y-

Variates. This being the case, for Ergodic-screening, we suggest the following Y-Variate **Qualification**-Screening Protocol. The Screening-Measure selected is the Coefficient of Determination which is usually referred to as R^2 . **Rationale** The Coefficient of Determination [CoD], in the *OLSR TS FM-context*, is:

The proportion of the variation of the Y-Response-Variate accounted for by its regression on: The X-Projection-Variate.[Tamhane & Dunlop (2000, p.354)]

Thus, the CoD is a measure of the **Non-Directional Strength** of association of the Y-variate with the Time Index for the OLSR-TS FM.

Further, The Pearson Product Moment Correlation [PPMC] in *Excel* is:

=CORREL(The Y-Variate Panel used to fit the OLSR TS FM , The TS: Time Index)

Thus, the PPMC is a measure of the **Direction or Trajectory** of linear movement of the Y-variate with the Time Index for the OLSR-FM.

Fortuitously, in the OLSR TS-context, **The CoD[or R^2] is Defined as: PPMC²**. Thus, for the OLSR-FM, after the Regression is effected, the reported [R] is the PPMC & The [R^2] is the CoD. Further, the Range of: [The R^2 or The CoD] is [0 : 1.0]; whereas. the Range of the PPMC is [-1.0 : + 1.0]. **Simply**, we can derive {{The CoD & The R^2 }} from The PPMC; however, the directional property of the PPMC cannot be derived from the {CoD **or** R^2 }.

Critical Assumption For our *iDA* Model, which addresses Forecasting Panel Ergodicity, there is no conditional restriction on the Nature of the FM used by the Firm!—**Simply** We are proffering, based upon our experience, that:

The expectations for the OLSR TS FM generalize to most of the FMs in the practical-panoply of the Forecasting Division.

Rationale As support for this assertion, we used Table[5_[a]]: *Median APE All Data [1,001]* of the M-Study[See Makridakis *et al*, (1982)] to correlate the reported APE[Median]-Profiles for **first eight** of the FMs noted in Table[5_[a]] one of which was the OLSR TS FM. We collected this information over the first six Extrapolations. **Results** The PPMC-Profile of the OLSR TS FM APEs *v.* The Other Seven FMs was Mean[96.4%] Range[91.5% : 99.2%] **and** these PPMC[p-values[H_0]] were all <0.005 for the seven comparisons. Also, the standard vetting test for using the PPMC as the association measure is the test of the Variance Differences over the test-Panels. The three standard vetting tests had the following FPE[p-value]-Profile re: H_0 :*The Null of No Difference*: [Mean[0.655] Range[0.4701 : 0.937]]. This is **strong** confirmation of the suitability of the vetting-intel created by the PPMC-comparative analysis.

Detailing Our Measure of Forecasting Acuity

Having presented the underlying assumptions of the *iDA* Model, we now delve into the operational details that create the inference structure that rationalizes the information to be garnered by examining the $FPE[Null[H_o]]$: *p-value* produced by the *iDA* Model.

The Foundation of the Inference Intel: The Strength Dimension

First we will Screen the collections of IS and BS Y-Variates to identify those Y-Variate-collections for the *Pre-Lehman*:Phases that have **High CoD[Means]**. The calculation of the **High** CoD[Mean] Toggle-Point is detailed in Appendix B. The proposed **High**: CoD-Toggle-Point is: CoD[45.0%]. The Mean[CoDs] for the *Pre-Lehman*-Events for the IS- & BS-accruals from the S&P500 are: [59.4% & 63.0%] respectively. Thus, these *Pre*-CoD[Means] are certainly indicative of the CoD-Panels that are vetted as **High**.

Parsing of the Longitudinal {DE}-Effects: The Trajectory Dimension

We will use as the Inferential Measure for the *iDA* Model, the **Mean** of the number of Y-Variates in a particular collection that have [PPMC-values<0]. **The *iDA*-Specifics** In this context, we will benchmark **the expectation of the** Mean[PPMC<0]s of the ***During*- & *Post***-Y-Variate Data by that of the *Pre* Y-Variates. This is **an ideal measure** of Forecasting Acuity because, as noted above, the CoD is the R^2 of the OLSR TS FM and The CoD $\equiv [PPMC]^2$. Given these relationships, the *iDA*-Model will use the **Analyst's judgment** as to what would be the Mean frequency of the [PPMC that are <0] that would be the $FPE[Null[H_o]]$: **Inferential-Toggle-Point [ITP]** for the Ergodicity Decision. These *ITPs* are presented & profiled in Table 4. If this PPMC[Inferential-Toggle-Point], noted as: $\tilde{\pi}_{ITP}$, compared to the Actual Mean[PPMC that are <0], noted as: $[\bar{\pi}_k$ where: k is {*During* or *Post*}] has a $FPE[Null[H_o]]$: *p-value* where: H_o is *Not Rejected*, then the Panel-set under examination will likely be noted as: **Ergodic**; otherwise, the likely judgment will be **Non-Ergodic**.

Point of Clarification We selected the *Pre-Lehman*-Phase as the Benchmark, as it is expected that for the ***During*- & *Post***-Lehman Phases, their CoDs-would be lower than that of the *Pre*[CoD], if there were to be a Lehman-Effect for the ***During*- & *Post***-Datasets. In this regard, we will also **vet** the logic of the selection of the *Pre*-Phase to benchmark the IS- & BS-Y-Variates, by testing the *Pre*-CoD-Profiles *against* those of the ***During*- & *Post***-Event-Effects. **This, as a capsule, will be our *iDA* Model Protocol.** At this point, an illustration is in order to reinforce these *iDA* Model-elements and inferential computations.

Illustration of the Inferential Aspects of the *iDA*

Let us examine ONLY the ***During***-Phase of The{DGSM[Lehman]} for the **Balance Sheet**[Std] for their **PPMC**[<0]-Profile: Noted as: ***During***-[$Y_{<0}^{BS}$]. For this ***During*** Phase, the Analyst will use the ***Benchmarking*** Information from the ***Pre***-{DGSM[Lehman]}-Phase to create the PPMC[***Inferential-Toggle-Point***]: $\tilde{\pi}_{ITP}$ for the ***During***-[$Y_{<0}^{BS}$] inferential *iDA*-testing. The reason for this is that the ***Pre***-Phase is very likely the realistic State of Nature for the Firm unfettered by Destabilization-Events. Thus, the ***Pre***-[$Y_{<0}^{BS}$] will be an *ideal* dataset to use in creating the ***Analyst's Judgmental-Projections-Expected*** for the ***During***-Phase that will be the: $\tilde{\pi}_{ITP}$ for the ***During-Panel*** dataset. For inferential testing, the judgmental $\tilde{\pi}_{ITP}$ for the ***During***-[$Y_{<0}^{BS}$] profile can then be tested against the ***Actual During***-[$Y_{<0}^{BS}$] as: [$\tilde{\pi}_{During}$]. ***Simply*** This is the Nature of the *iDA* Model. Consider now the details of the computations that will be made by the *iDA* VBA Model.

Forming the Initial Parameters: [*iDA* Phase I]

Create the 95%CIs for the ***Pre***-[$Y_{<0}^{BS}$]; then, select their whole numbers for the Limits of the 95%CI as:

$$\begin{aligned} &= \text{ROUND}(\text{Lower Limit of the 95\%CI}, 2) \\ &= \text{ROUND}(\text{Upper Limit of the 95\%CI}, 2) \end{aligned}$$

These will be used as input to create the [FPE[Null[p-value]]]: ***Test Against***: $\tilde{\pi}_{ITP}$ for the decision re: Ergodicity for the ***During***-Phase. ***Justification*** These values are reasonable estimates under the random-sampling of the Central Limit Theorem [CLT] for the limits of the ***Pre***-[$Y_{<0}^{BS}$] ***Population*** Mean for which The Analyst can be 95% Confident.

Probing The{DGSM[Lehman]}-Phases the [*iDA* Phase II]

The Analyst uses these ***Pre***-Population[$Y_{<0}^{BS}$]Values to suggest ***During***-[$Y_{<0}^{BS}$] inferential [FPE[Null[p-value[Test-Against-Values]]]]: $\tilde{\pi}_{ITP}$ that is the Analysts' ***reasoned conjecture*** as to ***During***-[$Y_{<0}^{BS}$]-value: (i) likely to have resulted from the Lehman-Event, but (ii) is ***just*** at the ***cusp-point*** or ***Toggle-Point*** where one would likely evaluate the action to be taken re: H_0 . As this is a rather complicated set of computations and decisions, an illustration is needed!

Computational Illustrations: The FPE[Test] of: The{DGSM[Lehman]} *During*-Phase

This is the actual information from our S&P₅₀₀ Datasets.

For the ***Pre***-[$Y_{<0}^{BS}$]-profile is: The ***Pre-Mean***[6.25%[8/128]] and

The 95% CIs are: [2.0% : 10.5%]. Thus, the values used in the *iDA* will be:

$$2.0\% = \text{ROUNDDOWN}(2.0\%, 2)$$

$$11.0\% = \text{ROUNDUP}(10.5\%, 2)$$

As these are the likely State of Nature values before: The {DGSM[Lehman]}—i.e., **Pre**-[$Y_{<0}^{BS}$], we can be 95% Confident for Benchmarking purposes that:

The Mean[**Pre**-[$Y_{<0}^{BS}$]] could be as **Low** as 2%, and

The Mean[**Pre**-[$Y_{<0}^{BS}$]] could be as **High** as 11%,

With this intel, the next step is to render our judgment as to the Test-Against value to make the decision as to the likely Nature of the Ergodicity of the **During-DGSM[Lehman]}**-Panels: $\tilde{\pi}_{ITP}$.

Our Mindset regarding the Parametrization of the *iDA*

Given these Mean[**Pre**-[$Y_{<0}^{BS}$]] Population-ranges, experientially, we *proffer* that the Lehman-event will likely *increase* the percentage of Mean[**During**-[$Y_{<0}^{BS}$]-value] from **11%**. We conjecture that **if** the Lehman-Event increased the 128 BS Y-Variates *from* the Mean[**Pre**-[$Y_{<0}^{BS}$]] of **11% to 15%, then** we will use this difference to make the **Ergodicity Decision**:

ABS[$\tilde{\pi}_{\text{During}} - [\tilde{\pi}_{ITP} = 15\%]$] to form the FPE[Null[H_o]]: p-value

The attendant-computations offer clarifications:

The Actual Mean [**During**-[$Y_{<0}^{BS}$]]:[$\tilde{\pi}_{\text{During}}$ was 17.2% [**22/128**]. Our conjectural-Test-Against [*ITP*] for the **During**-[$Y_{<0}^{BS}$]] was: $\tilde{\pi}_{ITP} = 15\%$].

The FPE[Null[H_o]]: p-value as computed by the *iDA* using the Excel-Data[Platform] is:

$$t_{df=127} = \text{ABS}[22/128 - 15\%] / [0.03348] = 0.653$$

$$\text{p-value} = \text{T.DIST.RT}(0.653, 128 - 1) = 0.257$$

Using Table 4, as **0.257** is > **0.25**, the decision that we made was:

There is not sufficient inferential evidence to suggest Rejecting: H_o of No Inferential Effect.

Thus, this suggests that the Dataset under examination is not likely to be non-Ergodic and thus may be used in the Firm's Forecasting Model.

In other words, if the sampled **During-Population** were to have had a Mean[PPMC<0] of **15%**, a random sample from this **During-Population** could have arrived at a Mean of **17.1%** or greater **25.7%** of the time. Using Table 4, as our inferential calibration, as our Computed FPE[p-value] is **0.257** which is > 0.25, the likelihood is **that**:

*The DGSM[E{Lehman}] did **not** perturb the **During**-Dataset to the extent that it would be **Non-Ergodic**. This inferential information would rationalize that the Firm's **During**-Dataset could be used in forecasting.*

THE CONDITIONAL SUGGESTIONS AND RESULTS OF THIS RESEARCH

Overview

Above we have presented the context of the tests for Ergodicity. In this context, there are a multiplicity of Parameters that need to be set so as to arrive at the intel to inform Decision Makers regarding the actions that need to be considered for particular datasets in the DGSM[E{}]-Time Periods regarding **Ergodicity**. Following we will address our comments to indicating the testing decisions that **we have made** for: The DGSM[E{Lehman}]-Event. These were **our** decisions from Sampled Data of the S&P₅₀₀. Appreciate that this data is NOT likely to be representative of “*Real AIS Y-Variates*” of a Firm for which there has been a Destabilizing Event. Thus, our analysis is **Quasi-Normative**; however, it will be useful as guidelines for realistic applications as well as academic presentations. Finally, the $\bar{D}A$ is a simple VBA-open-source platform that we recommend for actual consulting engagements and also for academic instruction. As a final note. We repeat our *Mantra* for this research report:

“Ergodicity is in the Eye of the Beholder”

In this judgement context, we offer our suggestions that should govern the application of our $\bar{D}A$ -protocol of Testing for Ergodicity. It is critical for the Analyst that will be offering judgmental opinions as to the PPMC- [H_o]:[Test Against Profiles[$\tilde{\pi}_{TP}$]] to have the following **mind-set**:

Over the years, there have been numerous Events that have altered, to some extent, the datasets that we have used in forecasting. I have, from time to time, eliminated or modified certain of these datasets that based my opinion have likely failed to align with the Panels that we have used over the years for forecasting. Experientially, I feel that by using the “Totality” of these Datasets that we have used in forecasting as my analytic-context, I can offer a useful opinion as to Test-Against Toggle-Point: $\tilde{\pi}_{TP}$ to be used in making the decision on the Ergodicity of particular Datasets.

Testing the S&P₅₀₀ Datasets Y-Variates for Ergodicity

Initially, we will offer the vetting profiles of: The [$Y_{n=128}^{IS}$]- & [$Y_{n=164}^{BS}$]-Panels. Recall, we have selected the **CoD**-measure as our surrogate for the **Strength** of Panels in the forecasting domain. Thus, tacitly, we expect that for Panels that have **High**-CoD[Means] their PPMC-behavior can be expected to be a rational Measure of Ergodicity for the collection of the Y-Variates that form the Panel. We have detailed in Appendix B that the **Strength**-indication **Toggle-Point** for our proposed **High**-CoD[Means] was: [CoD[**45.0%**]]. Further, the CoD[Mean]-Profiles of the [$Y_{n=128}^{IS}$]- & [$Y_{n=164}^{BS}$]-Panels were respectively: [**59.4%** & **63.0%**]; thus, these Y-Variate Panels are **Strength**-vetted as: **High** Mean[CoD].

Vetting the Expectations of the Ergodicity Probing

We strongly suggest that the Analyst create vetting-screens for the expected ***During- & Post-***{DE}-effects. This sort of vetting is a means to calibrate the Level of Confidence that the Analyst has in the evidence derived from the Screening for Ergodicity. As for ***our*** vetting-screening, we have elected to examine the ***directional/trajectory nature*** of the longitudinal-profiles of: The $[Y_{n=128}^{IS}]$ & $[Y_{n=164}^{BS}]$ for the Lehman-Phases: ***During- & Post-***. ***Rationale*** We will be examining the PPMC from the *Pre*-context over: The ***During-*** & The ***Post-*** for the Panels: $[Y_{n=128}^{IS}]$ & $[Y_{n=164}^{BS}]$. If the PPMC was a wise selection of the Measure of Ergodicity, then logically one would expect that the *Pre*-[CoD]-profile, as the benchmark, would be inferentially ***higher*** than those of: ***The During-[CoD] & The Post-[CoD]*** for the Lehman-Phases. Additionally, as a second-trajectory vetting test, we have discussed the longitudinal-sensitivity of our AIS-Y-Variates with colleagues. The majority of whom offered that one should expect that: The $[Y_{n=128}^{IS}]$ should be more sensitive to the Lehman-Effect than: The $[Y_{n=164}^{BS}]$. For these vetting-screens we offer the following inferential Profiles in Table 1.

Table 1 Vetting Screens used for the Supporting the Logic of the Selection of High[CoD] Y-Variate Panels for the Ergodicity Testing

CoD Profiles	$[Y_{n=128}^{IS}]$	$[Y_{n=164}^{BS}]$
<i>Pre</i> -{Lehman}	59.4%	63.0%
<i>During-</i> {Lehman}	41.3%	60.9%
<i>Post-</i> {Lehman}	44.5%	53.1%
Welch[ANOVA]	<0.0001	0.044
T-K HSD* Pairwise p-values		
<i>Pre</i> v. <i>During-</i>	<0.0001	0.866
<i>Pre</i> v. <i>Post-</i>	<0.0001	0.038

*These *p*-values are produced by SAS®[JMP®_{v.13}]-software that uses the Tukey-Kramer Honestly Significant Differences [HSD] pairwise-comparisons of the LSMeans.

Discussion

These results are a very strong vetting-indication of the logic of selecting the CoD & PPMC as the ***Strength & Ergodicity Screening Measure***. The $[Y_{n=128}^{IS}]$: *Pre*[CoD] dominates over the ***During-*** & The ***Post-*** as all three *p*-values are <0.0001. Further, in the $[Y_{n=164}^{BS}]$ -context, the *Pre*[CoD] begins its domination after the ***During-***Phase. Thus, all of the longitudinal-vetting-aspects that we proffered as expectations are inferentially in evidence.

The {DGSM[Lehman]}-Event Profiled

Following, the Ergodicity Screening Profiles are presented in Table 2

Table 2 Scoring the Ergodic Nature of: {The DGSM[Lehman]}

Pre-Lehman Dataset	IS[GAAP] Y-Variates	BSheet Y-Variates
Mean[<i>PPMC</i> <0]	11.0% [18/164]	6.25% [8/128]
95%CI[Test-Against]	LL= [6%] : UL= [16%]	LL= [2%] : UL= [11%]
During-}{The DGSM[Lehman]}-Event		
The [ITP] Judgment	$\tilde{\pi}_{ITP} = 25\%$	$\tilde{\pi}_{ITP} = 15\%$
Actual Mean: $\bar{\pi}_{During}$	31.1% [51/164]	17.2% [22/128]
p-value[iDA]	FPE[31.1% v. 25%]: 0.047	FPE[17.1% v. 15%]: 0.257
Implication	Likely Non-Ergodic*	Likely Ergodic*
Post-}{The DGSM[Lehman]}}-Event		
The [ITP] Judgment	$\tilde{\pi}_{ITP} = 30\%$	$\tilde{\pi}_{ITP} = 25\%$
Actual Mean: $\bar{\pi}_{Post}$	32.9% [54/164]	32.0% [41/128]
p-value[iDA]	FPE[32.9% v. 30%]: 0.214	FPE[32.0% v. 25%]: 0.046
Implication	Likely Indeterminant*	Likely Non-Ergodic*

*These summary inferential indications are derived from the Inferential Codex for the *iDA* model as profiled in Table 4.

Discussion

Recall, the basis of the *iDA* Model is the creation of judgmental benchmarking-intel from the *Pre*-Phase to be used in inferential testing the severity of the effect of the {DE} on the ***During***- & ***Post***- Datasets. ***It may be an excellent idea to review the During-Analysis presented in [Section 3.3.4], in preparation for your analysis of the iDA-intel of Table 2.***

Recasting the Profiles of Table 2

Our results are very interesting. However, Table 2 is relatively *densely-packed* with information. Thus, we wish to offer a slight re-organization of these profiles in Table 3 that better support our decision regarding Coding the Ergodic Nature of {The DGSM[Lehman]}-Event.

Table 3. Impact Profile for the Ergodic Nature of: {The DGSM[Lehman]}

Ratios	IS[GAAP] Y-Variates	BS[Std] Y-Variates
During/Pre	+283%[31.1%/11.0%]: Likely Non-Ergodic	+274%[17.1%/6.25%]: Likely Ergodic
Post/Pre	+300%[32.9%/11.0%]: Likely Indeterminant	+512%[32.0%/6.25%]: Likely Non-Ergodic

We suggest that these Impact Profiles offer a more intuitive understanding as to the logic of the inferential testing of the Changes in the PPMC Profiles of the various Y-Variate groupings created by the iDA Model. For example, the *Actual* Mean[PPMC<0] profile of the IS[Y-Variates] from the *Pre* to the ***During*** increased as a ratio **to** 283%; and, the *Actual* Mean[PPMC<0] profile of the BS[Y-Variates] from the *Pre* to the ***During*** increased as a ratio **to** 274%. These are basically **not** inferentially different. However, The IS[Variate-***During***] was found to be: [Likely Non-Ergodic]; whereas, the BS[Variate-***During***] was found to be: [Likely Ergodic]. This highlights the nature of the iDA-inferential logic as follows: The reason that the inferential indication of the IS[Y-Variates] was that this ***During***-dataset was **not** likely an Ergodic Panel was due to **our** conjectural-Test-Against for the ***During***-[$Y_{<0}^{IS}$] that was: $\tilde{\pi}_{ITP}=25\%$. Thus, the iDA inference calculation was: {**31.1%** v. **25%**} and this inferential test p-value was: [**0.047** < 0.1] and so tested to: **Reject H_0** : Thus, this suggesting that the likely State of Nature of the ***During***-IS Panel-set is **Non-Ergodic**. Contrast this with the ***During***-BS Panels. The ***Actual*** [PPMC<0] profile of the BS[Y-Variates] from the *Pre* to the ***During*** had our conjectural-Test-Against for the ***During***-[$Y_{<0}^{BS}$] of: $\tilde{\pi}_{ITP}=15\%$. Thus, the iDA inference calculation was: **17.1%** v. **15%** and this inferential test p-value was: [**0.257** > 0.25] and so tested to **Fail to reject H_0** : Thus, suggesting that the likely State of Nature of the ***During***-BS Panel-set is **Ergodic**. This underscores that the nature of the iDA-inferential test is sensitive to the test of: {**The Actual** v. **The Analyst's Informed Judgment**[$\tilde{\pi}_{ITP}$]}. **Simply** The iDA is a: ***Judgment Inferential Model***.

Final Summary

Our iDA profiles, as presented in Tables 2 &3, indicate:

- I. *There likely needs to be Modifications to the ***During***-DGSM{E[Lehman]}-Data sets of the Income Statement, if they are to be used in the forecasting model, and*
- II. *There likely needs to be Modifications to the ***Post***-DGSM{E[Lehman]}-Data sets of the Balance Sheet, if they are to be used in the forecasting model.*

Panel-Modifications are the likely action to be taken as **Eliminations** are usually not a practical solution as this drastically reduces the Sample Size of the Past Data that can be used to forecast the future indications that are needed by the Planning Committee. The reduction in the sample size usually compromises the precision of the forecasting Confidence and Prediction Intervals. **As noted above, we will take up the issue of Panel-Modifications in the extension of this research report.**

THE *iDA* MODEL : OUR CONTRIBUTION TO THE AI-WORLD

The Operational Aspects of the *iDA* Model

We have created a VBA-Platform for producing the inference-intel for profiles that are presented in Table 4. The *iDA* Model is an open-access VBA-Module and is available at no cost from the authors as a download. Following, we detail aspects of the *iDA* Model.

iDA*: Functions** As the *iDA* is an open-access Standard VBA-Excel Modular Platform, we will only discuss the: (i) Purpose of the various *iDA*-inputs, and (ii) The outputs so generated. Let us examine ONLY the ***During-Phase of: The{DGSM[Lehman]}for the Balance Sheet[Std] for the collection of the Y-Variates selected that have a [PPMC <0]:

***iDA*₁ : Forming the Test-Data-Panel**

There is Launch Button: [Number of Panel Points]. This launches the following Input Box:

InputBox("Enter the Number of Panel Values that are to be Analyzed.")

This creates the Vector [$n \times 1$] where: n is the number of PPMCs in the Panel. **We enter [128].**

***iDA*₁ : Populating the Test-Data-Panel**

Then, the following Input Code is launched:

InputBox("Enter the Number of Y-Variates having PPMC < 0 [Less than Zero].")

This creates the Vector [$k \times 1$] where: k is the number of PPMCs < 0 in the Panel of size [$n \times 1$].

We enter [22].

***iDA*₂ Creating the Computations & Intel**

There is a Launch Button [Launch the Descriptive Stat Platform] that launches the following Input Box:

InputBox("Indicate the Population Test-Against Value:[$\tilde{\pi}_{ITP}$] that YOU are Offering") **We enter [15%].** This is Posted in E2: as **15%**.

Sampling from the *iDA*: Profile

At this point, we have **created the vector: *During*-[$Y_{<0}^{BS}$]] and our Test-Against: [$\tilde{\pi}_{ITP}$]. The *iDA* Model will now access the Excel[Data[Descriptive Statistics]-Platform and inputs the *During*-Vector ($n \times 1$). This creates the Descriptive Statistics Platform that is Pasted in the Excel Worksheet produces all the information that is needed to form the Inferential Profile.**

Specifically, the Descriptive Statistics Platform is Pasted in: [D3:E18]. Then the *i*DA collects the following data:

- E2: [15%] is our judgmental Test-Against: [$\tilde{\pi}_{ITP}$],
- E5: [0.17188] is the Mean of the ***During***-Panel: [$\tilde{\pi}_{During}$],
- E6: [0.03348] is the Standard Error of the ***During***-Panel, and
- E17: [128] is the number of elements in the Vector for analysis.

This information is formed into the t_{cat} as follows:

$$t_{cat} = [ABS[E5 - E2] / E6] = G6:[0.65342]$$

$$FPE[p\text{-value}] = =T.DIST.RT(G6,E17-1) = H6:[0.25733]$$

In addition, the *i*DA has a *Linguistic Codex*, following, to suggest the evaluation of H6 that has been scored for the ***During***-BS[H6] as: ***Likely Ergodic***. The *Linguistic Codex* is ***our*** experiential codex for the *i*DA Model and was used to indicate the Nature of the Ergodicity of the various tests profiled in Table 4. In this regard, for the *i*DA Model, we used the following Experiential Taxonomy to guide our assessment of the decision re: ***Ergodicity***:

Table 4 Our Suggested Linguistic Codex for The Likely Nature of Ergodicity

FPE[[Null]p-value]	<i>i</i> DA- [<0.1]	<i>i</i> DA- [≥ 0.1 : ≤0.25]	<i>i</i> DA- [>0.25]
<i>“En Bref” Codex</i>	<i>Likely Non-Ergodic</i>	<i>Indeterminate</i>	<i>Likely Ergodic</i>
Experiential indications of the inferential Triage that <i>usually</i> made the correct decision re: forming useful forecasting datasets	<i>Do not use this data for forecasting.</i>	Reflective Consideration of the <i>possible use</i> of the data for forecasting—i.e., <i>collect more vetting-intel.</i>	<i>Use of the data</i> for forecasting is <i>usually</i> warranted.
<i>Experientially</i>	<i>30%</i> of the Cases	<i>50%</i> of the Cases	<i>20%</i> of the Cases

Table 4 is, of course, offered as a guideline from the Experiential-Base of the authors. Others will have other Experiential-history and -Insights. These suggestive indications are also part of the *i*DA-VBA Platform and so will be displayed.

Summary Reflection

Our {DGSM[E]}-Protocol and the suggested *i*DA Model analyses—including to be sure—***the various vetting-tests***, offer intel to encourage a ***lively*** discussion of the forecasters to address the Core Forecasting Question Interest:

How confident are we, as forecasters, that our Past Data produces Meaningful Future expectations?

SUMMARY & OUTLOOK

Summary

The iDA Model We have selected the **Pearson Product Moment Correlation [PPMC]** as the Measure that is: *Specific* as well as *Sensitive* to probing and detecting the effects of Destabilizing Events {DEs} in Data Panels used in creating forecasts to be used by the Planning Committee. **Rationale** The **PPMC** is:

- I. Aligned with the R^2 of the OLSR TS Forecasting Model [FM] and, thus is *usually reasonably* homomorphic with the Nature of the Forecasting Acuity of the OLSR and *most other TS-FMs*,
- II. Instructed in most Undergraduate Statistics Courses in the World, and so is universally familiar to most all decision-makers in the Forecasting *milieu*,
- III. Likely to be sensitive to changes in the directional trajectory that are often created by {DEs}, and thus

We offer that the PPMC **is an ideal Measure** to probe and identify **Ergodic-Issues** re: Forecasting Datasets.

The Rule Based Forecasting Connection

We have used the Rule Based Forecasting EXPERT System-set of protocols for many years. Along the way, we have developed a sensitivity for Events that can have short-term effects on longitudinal-data that would call into question of using such data as *Qualified Past Data* that can be expected to provide reliable and useful forecasts. This is the reason why we associated our DGSM{[E]}-analyses with **C&A's General Advice re: Macro-Recommendation. With due respect**, we suggest that our DGSM{[E]} *iDA Model fits in* C&A's RBF-Protocol as it addresses the following important, but often *overlooked*, aspect of forecasting:

*How much confidence do we have that the Firm's AIS-Variables are **Ergodic** and so are qualified to be used in forecasting so as to create reliable and useful **Future Projections** from this **Past Data**?*

We hope that our *iDA Model* will be used in conjunction with the RBF Model.

Outlook

In musing about the interesting aspects of the *iDA Model* that can be addressed in a vetting-context, we offer the following:

We have used the OLSR TS FM as our frame-of-reference. There are two other FMs that are part of the standard-fare of the forecasting-milieu: The Naïve 1 and the ARIMA(0,2,2) or Holt FMs. See [Makridakis et al, (1982) [Appendix 2]]. In addition, in the presence of

multiplicative-generating processes, usually ubiquitous, the In-transformation is uniformly recommended. This offers an interesting collective-vetting-mix: The standard {OLSR TS & Naïve 1 & Holt} using the Y-Variates as downloaded; and also, the same FMs where the In-transformation is applied to the Y-Variates. The question of interest is: IS Ergodically identification affected by the Nature of the FMs AND/OR The transformations?

Caveats

Following are three “*en bref*” caveats that are necessary to mention pertaining to this research report. These caveats offer insights into other logical extensions of other testing possibilities:

- I. The $\bar{I}DA$ Model uses a judgment-based inferential context, i.e., the FPE-Test is: $\{ \text{The computed Mean}[PPMC < 0] \bar{\pi}_k \}$ v. $\{ \text{The Judgmental Expectations of the Analyst}[\bar{\pi}_{ITP}] \}$. These Judgmental Expectations of the Analyst **could also be vetted** before the $\bar{I}DA$ Model is parameterized as we have suggested in [Section 4.2.1], and
- II. In defining Ergodicity [Section 2.2.4], we have used inferential concepts that would suggest a sampling-frame focused on *A Longitudinal Panel of the Past Firm Data*. We then created a very different version that was focused on the **veracity of the judgments of an Analyst**. Both are reasonable but have a very different assumptions upon which to base the decisions re: **Ergodicity**. We have **not** examined if: The Sampling Model and our Judgement Model are “Homomorphic”.

APPENDICES

Appendix A

S&P500 Randomly Selected Tickers for the Y-Variates

AJG	AMZN	APH	APPL	BBWI	BRK	DVA	ECL	EMR	GD	HAS
HD	JCI	JNJ	LLY	MAR	MCHP	MHK	MRK	MSFT	MSI	NVDA
PG	PH	PXD	ROP	SEE	UNH	VFC	WHR	WRK	XOM	██████████

Appendix B [Toggle Point for the CoD]

Clarification As the CoD is the $PPMC^2$, we will use the inferential test of the PPMC to reverse-engineer the CoD-**Toggle-Point** used to qualify the CoD of the accrual panels as **High CoD** and so useful in the forecasting context. Computationally, assuming that sample Mean[CoD] is a valid surrogate for the Population Mean, μ_{Pop}^{CoD} , and T&D[p.381] note that the t_{Cal}^{PPMC} is: $[PPMC \times \sqrt{n-2}] / \sqrt{1-PPMC^2}$, we can form a reasonable estimate of the PPMC as follows: Assume that the Panel size is seven (7) and the FPE(NullPPMC[H_o]) is the test set at 0.099. The ratio of:

$k \equiv [t_{Cal}^{PPMC} / (\sqrt{5})]$ or $[2.022927/2.236068] = [k=0.90468]$. solving for the PPMC we have: PPMC = $[[k^2 / [k^2 + 1]]^{.5}] = 0.67088$. This gives the **CoD Toggle-Point** as: $0.4501[0.67088^2] = 45.0\%$.

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