Provisional Application for United States Patent

TITLE: Unified deconvolution approach to compute financial systemic risk scores

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USPTO PATENT APPLICATION NUMBER: 62134667

BACKGROUND

In the financial world, home loans are usually organized, optimized by groups and structured into mortgage backed securities (MBS). These MBS are bought and sold on the bond market. Determining the market value of these securities in a highly transparent and efficient manner is important to all the entities involved in creating, buying, selling, servicing, and holding these securities. Originators, underwriters, issuers, trustees, investment bankers, fund managers, broker-dealers, servicers, investors all need tools to determine the implied value the securities they are trading or holding.

There are many approaches to modeling the financial behavior of securities based on mortgages. Most have shortcomings for a variety of reasons. Earlier option pricing models such as the 1973 Black Scholes approach with brownian motion and diffusion process as described by the second law of thermodynamics are sufficient for near-the-money or at-the-money trades but not for out-the money trades.

The understanding that financial systems interactions can be modeled in the same manner as physical systems leads to the use of the laws of physics and mathematics to create financial models that are analogs of physical interactions in our universe.

This modeling invention addresses the shortcomings of earlier models by the separation, by deconvolution, of the various space time dimensional factors and then recombining them taking into account the individually weighted, sometimes nonlinear interactions of each factor with each of the other factors**.** It uses aspects and concepts from the unified field theory of mathematical physics including:

The weak interaction

The strong interaction

Electromagnetism

Gravitation

Differentiable manifold

Deconvolution

General relativity

Black hole dark matter

Quantum electrodynamics

In the financial world, there are similarities to the above mentioned fields causing interactions among factors, for example the incentive to refinance is strongly influenced in a non-linear way by several factors: interest rate, house prices, jobless rate, credit score, etc

BRIEF SUMMARY OF THE INVENTION

A forecasting model for MBS analytics using agency Prepayment P-score and Default D-score and associated loan-level or pool-level analytics for Fannie Mae, Freddie Mac, and Ginnie Mae MBS. The P-score ranks the voluntary prepayment behavior, while the D-score ranks the involuntary prepayment behavior. The model uses a host of the associated loan-level or pool-level analytics including interest rate, home price index, credit cycle, turnover, refinance, cash-out, buyout, and curtailment. The model also includes forecasting four speed vectors for pricing agency bonds: (1) the voluntary prepayment rate, (2) the involuntary prepayment rate, (3) the 60+ days delinquent rate, and (4) the loss severity factor. The key innovation in the model is the deconvolution of the macro-economic cycles of credit and market risks from the interacting characteristics of individual loan profiles, agency and servicer treatments, underwriting at different period of time, and government monetary and housing polices.

The data used to develop the scores consist of all agency loans originated from January 1991 to January 2015. The scores include thirty-one factors, eight key interaction terms, and twenty-one sub-components. Both P-scores and D-scores are calibrated across all sub-components and refreshed on a monthly basis. The model uses an innovative non-linear calibration to map all scores in between 100 and 999

DETAILED DESCRIPTION AND BEST MODE OF IMPLEMENTATION

The model is implemented as a set of computer programs running on a massively parallel, memory based, ubiquitous computing system that use a large heterogeneous data base of securities data going back several decades along with other inputs such as interest rate, home price index, etc.

The model can also be used for other types of financial or other modeling using the appropriate data and factors.

MODEL

The model include eleven vectors

$$\boldsymbol{v} = \left(\boldsymbol{u}_{crr}, \boldsymbol{m}_{crr}, \boldsymbol{a}_{crr}, \boldsymbol{u}_{cdr}, \boldsymbol{m}_{cdr}, \boldsymbol{a}_{cdr}, \boldsymbol{u}_{deq}, \boldsymbol{m}_{deq}, \boldsymbol{a}_{deq}, \boldsymbol{r}_{sev}, \boldsymbol{r}_{cur}\right)$$

Each vector is the sum of individual factors and interaction terms

$$\boldsymbol{v} = \boldsymbol{v}_o + \sum_{i=1}^{n} \boldsymbol{v}_i + \sum_{i,j,\dots,k}^{n} \boldsymbol{f}_{ij\dots k}\boldsymbol{s}_i\boldsymbol{s}_j \dots \boldsymbol{s}_k$$

Each factor is given by, depending on the number $\boldsymbol{n}$ of available factors,

$$\boldsymbol{v}_i = \boldsymbol{x}_i + \boldsymbol{a}_i(\boldsymbol{1} - \boldsymbol{n}/\boldsymbol{m})$$
$$\boldsymbol{s}_i = \boldsymbol{s}(\boldsymbol{x}_i)$$

The parameter $\boldsymbol{x}_i$ specifies the complete-factor $(\boldsymbol{n} = \boldsymbol{m})$ model, while the parameter $\boldsymbol{a}_i$ specifies adjustment for the partial-factor $(\boldsymbol{1} \leq \boldsymbol{n} < m)$ model. The parameter $\boldsymbol{s}_i$ specifies the interaction terms, with the interaction strength given by the coefficient $\boldsymbol{f}_{ij\dots k}$.

SCORES

The P-score is based on the average of the model vector $\boldsymbol{u}_{crr}$ over the next twelve months

$$\boldsymbol{P} = \begin{cases} \boldsymbol{P}_s\langle \boldsymbol{u}_{crr}\rangle \dfrac{\boldsymbol{1} - \boldsymbol{P}_l}{\boldsymbol{1} - \langle \boldsymbol{u}_{crr}\rangle} + \boldsymbol{P}_o & \langle \boldsymbol{u}_{crr}\rangle < \boldsymbol{P}_l \\ \boldsymbol{P}_s\langle \boldsymbol{u}_{crr}\rangle + \boldsymbol{P}_o & \boldsymbol{P}_l \leq \langle \boldsymbol{u}_{crr}\rangle \leq \boldsymbol{P}_h \\ \boldsymbol{P}_s\langle \boldsymbol{u}_{crr}\rangle \dfrac{\boldsymbol{1} + \boldsymbol{P}_h}{\boldsymbol{1} + \langle \boldsymbol{u}_{crr}\rangle} + \boldsymbol{P}_o & \langle \boldsymbol{u}_{crr}\rangle > \boldsymbol{P}_h \end{cases}$$

The D-score is based on the average of the model vector $\boldsymbol{u_{cdr}}$ over the next twelve months

$$\boldsymbol{D} = \begin{cases} \boldsymbol{D_s \langle u_{cdr} \rangle \frac{1 - D_l}{1 - \langle u_{cdr} \rangle} + D_o} & \boldsymbol{\langle u_{cdr} \rangle < D_l} \\ \boldsymbol{D_s \langle u_{cdr} \rangle + D_o} & \boldsymbol{D_l \le \langle u_{cdr} \rangle \le D_h} \\ \boldsymbol{D_s \langle u_{cdr} \rangle \frac{1 + D_h}{1 + \langle u_{cdr} \rangle} + D_o} & \boldsymbol{\langle u_{cdr} \rangle > D_h} \end{cases}$$

SPEED VECTORS

The monthly voluntary prepayment rate is given by

$$\boldsymbol{p_{crr} = \frac{e^{-u_{crr}}}{1 + e^{-u_{crr}} + e^{-u_{cdr}}} \left(\frac{e^{m_{crr}}}{e^{a_{crr}}} \right) + \left(1 - e^{r_{cur}} \right)}$$

The monthly involuntary prepayment rate is given by

$$\boldsymbol{p_{cdr} = \frac{e^{-u_{cdr}}}{1 + e^{-u_{crr}} + e^{-u_{cdr}}} \left(\frac{e^{m_{cdr}}}{e^{a_{cdr}}} \right)}$$

The 60+ day delinquent rate is given by

$$\boldsymbol{p_{deq} = \frac{e^{-u_{deq}}}{1 + e^{-u_{deq}}} \left(\frac{e^{m_{deq}}}{e^{a_{deq}}} \right)}$$

The loss severity factor is given by

$$\boldsymbol{f_{sev} = e^{r_{sev}}}$$

CLAIMS

A model for forecasting the financial system performance of mortgage backed securities.

A model for forecasting the financial system performance of tradable financial asset instruments.

A method using deconvolution of space-time dimensions to allow the interaction of dimensions to be included in an individually weighted and for some cases non-linear weighted manner.

A method to calculate the model vectors as the sum of dimensions and interaction terms.

A method to calculate the P-score based on the average of a model vector over months

A method to calculate the D-score based on the average of a model vector over months

A method to calculate the speed vectors uses in the model

ABSTRACT

The unified deconvolution approach is used to compute financial systemic risk scores.

This approach uses very large heterogeneous historical loan-level and pool-level data bases to calibrate the model. It utilizes innovative unified deconvolution computing of the various space-time dimensional factors so that individual factor interactions can be included in an individually weighted non-linear manner. The model uses an innovative non-linear calibration to map all scores in between 100 and 999 to address 10^{27} combinatorial permutations of interactions.