Provisional Application for United States Patent

TITLE: RISK-ADJUSTED YIELD (RAY) MBS PRICING

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BACKGROUND

Traditional pricing of Mortgage Backed Securities utilizes collateral level data as well as prepayment and default projections to derive cash flows, which are then discounted at a prevailing market rate that is often opaque across buyers and sellers.

BRIEF SUMMARY OF THE INVENTION

Our advent of Risk Adjusted Yield based MBS pricing allows the ability to price MBS based on simply R-Score and D-Score, paired with collateral-level data without the need for prepayment or default cash flow projections. Furthermore, the Risk Adjusted Yield (RAY™) algorithm itself establishes an execution-based return which is calibrated daily and therefore completely transparent to both the buyers and sellers of MBS.

DETAILED DESCRIPTION AND BEST MODE OF IMPLEMENTATION

The RAY algorithm is based on both short-term and long-term forces, which are similar to waves which use the security (e.g. MBS) as the medium. As such, we formalize both the short range and long range RAY equations with a Wave Equation basis, as characterized by the following equations:

<u>Equation 1:</u>
Short-Range RAY (*SWL*: Short Wave Length)

$$\frac{\partial^2 q(x,t)}{\partial t^2} = \tilde{\omega}^2 d^2 \frac{\partial q^2(x,t)}{\partial x^2}$$

<u>Equation 2:</u>
Long-Range RAY (*LWL*: Long Wave Length)

$$\frac{\partial^2 q(x,t)}{\partial t^2} = c^2 \frac{\partial q^2(x,t)}{\partial x^2}.$$

From Eqs 1 and 2, we note the function *SWL*(w,d) while *LWL*(c), which is explained by the fact that w and d in the *SWL* represent both the short-term views of the buyers and sellers, magnified (squared) so that both can achieve a short-term minimum return, while the *c* in the *LWL* is the buyer's converted (e.g. rational) return for the same product however over the long-term.

With integration of the function in Equation 1 relating to the short-range RAY, we establish a total return that is representative of market execution pricing. The reason such claim is possible is because the Short-range function pairs the dynamics of both buyers and sellers, which try to optimize their buying/selling ability within a short-term (e.g. less than 3 months) horizon. What we must realize is that in the financial universe, we must formulize components discretely before then transforming into a continuous topology which can then be integrated. As such, we first discretize our solution of short term return u as based on both Sellers (A) and Buyers (B).

Equation 3.1

$$u = A(\xi) + B(\eta)$$

We made the observation that, because Sellers (A) already own the MBS position and are pre-meditated in terms of return, our domain becomes (x-at), while Buyers (B) are approached at a later time and therefore the return expectations are slightly lagged as (x+at). Therefore we can rewrite equation 3 into a more specific form:

Equation 3.2:

$$u = A(\xi) + B(\eta) = A(x - at) + B(x + at).$$

Thus, the short-range constraint using equation 3.2 allows for the execution-based RAY characterized as *x*RAY™ which is further explained mathematically based on the differential sensitivities when characterized in continuous form (e.g. the RAY "Greeks"). The long-range return, characterized simply as RAY, is the mean-reverting forward discount curve that establishes the optimal market yield for mortgage-backed pools and securities.

System 1: RAY Field Equations

To begin our "RAY field" in order to arrive at the "RAY Field Equations" we must first establish the Seller (A) return function as follows:

Equation 4.1

$$A(x) = \frac{1}{2}F(x) - \frac{1}{2a}\int_0^x G(s)\ ds$$

Where F and G are the Fear and Greed component.

Because both buyers and sellers are human and operate in similar mental capacities, we use the same logic to derive the Buyer (B) function:

Equation 4.2

$$B(x) = \frac{1}{2}F(x) + \frac{1}{2a}\int_0^x G(s)\ ds.$$

The RAY forward curve is built mathematically using the following components and proprietary Greeks:

- Quantum (intrinsic) factors [Q]: mortgage credit and prepayment behavior as established by the R-Score and D-Score

- Market (systematic) factors: Tracking of global market indices across equity [Beta], fixed-income [Lambda], and commodity markets, using a dynamic correlation matrix [Rho] which itself is parameterized with space and time [Theta].
- Volatility Call & Put surfaces across various credit markets: CDS and equity derivative call and put price movements [Delta] are tracked in real-time, and imply volatility surfaces [Vega] which are essential leading indicators to the RAY calibration. When Call or Put is not available for a given maturity, we use the following formulation to fill in the continuous surface:

$$C(t) = \text{MAX}[\ 0, S(t) - K(t)\ ], \text{ where } t < T$$

- Loan-level (CLC) structural data which captures embedded sensitivities such as duration, convexity, DV01, CS01, and gamma.
- Global yield curves including Treasury, swap curve, LIBOR short- medium- and long-end curve, Eurodollar, and a basket of international yields.
- The Fundamental applications for the RAY include pricing mortgage securities with an Execution Price (real-time market trading level), KDS Implied Price (fundamental long-term price reversion), and a daily Dealer Yield matrix.

The boundary conditions from these constraints force the following expression across the fear and greed domain:

<u>Equation 5:</u>

$$\frac{1}{2}F(-at) - \frac{1}{2a}\int_0^{-at} G(s)\ ds + \frac{1}{2}F(at) + \frac{1}{2a}\int_0^{at} G(s)\ ds$$

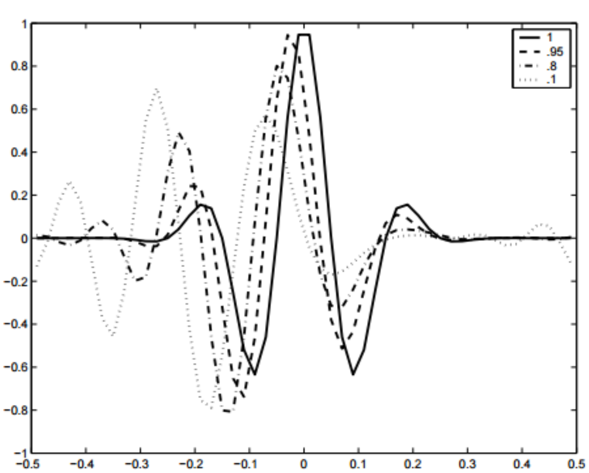
Taking all of these components allows for the long-range RAY field equation:

<u>Equation 6:</u>

$$\textbf{\textit{RAY}}(\textit{R-Score, D-Score}, x, t, F, G) = \frac{1}{2}F(x-at) - \frac{1}{2a}\int_0^{x-at} G(s)\ ds + \frac{1}{2}F(x+at) + \frac{1}{2a}\int_0^{x+at} G(s)\ ds$$
$$= \frac{F(x-at)+F(x+at)}{2} + \frac{1}{2a}\int_{x-at}^{x+at} G(s)\ ds$$

The long-range RAY allows for a total return that converges to the buyer's integral domain. The graph of the RAY solution shows the convergence of the Buyer (left) and Seller (right), over various time intervals as illustrated here:

<u>Long-range RAY convergence</u>



Comparing the return expectations of buyers and sellers based on Equation 6 version Equation 4.2 uncovers a unique property which we have discovered, the long-range "buyer's greed" property. As we converge to the long-range RAY, the mathematical limit approaches the buyer's singularity of greed while the seller's view (e.g. fear force) is minimized to zero.

Therefore, the short-range xRAY optimizes both the buyer and seller view while the long-range RAY converges to the greed view of the buyer. The period which establishes the "short-range" mathematically similar to the differential geometry characterization of the event horizon of black holes, where once the horizon threshold is breached, the limit converges with only one single solution and becomes less and less influenced by the seller's gravitational force. The Horizon (*H*) is characterized by the equation below, which converges away from fear and over to greed during the long terim:

Equation 7:

$$H(x) = \int_0^x G(s)ds,$$

Using this to derive R, which is the short-range RAY, we can use the same equations are the black hole escape velocity:

Equation 8.1:

$$R \leq R_s = 2GM/c^2,$$

As such, by modeling the xRAY we have modeled escape velocity from the Seller's Return expectations, and density of buyer's position *p* is a function of both Greed (*G*) and

Equation 8.2:

$$\rho_{bh} \geq \frac{3}{32\pi} \frac{c^6}{M^2 G^3}.$$

The Greed singularity is described based on differential geometry as shown below (with space measured in polar coordinates (r, Omega), where dOmega = sinθ dθ dφ):

Equation 8.3:

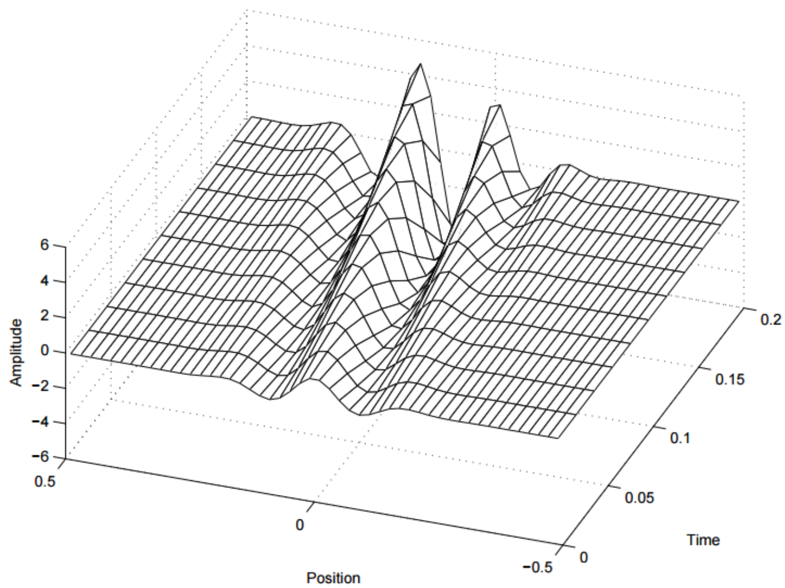
$$\mathrm{d}s^2 = -(1 - R_s/r)c^2\mathrm{d}t^2 + \frac{\mathrm{d}r^2}{1 - R_s/r} + r^2\mathrm{d}\Omega^2.$$

With the advent and explanation of short-range and long-range RAY established, we now explain the mathematical algorithms leading to the execution pricing of MBS.

The RAY, as noted through the system of equations above (the "RAY Field Equations"), is dependent on the R-Score and D-Score of each underlying mortgage. Therefore, without the need for further prepayment nor default projection, we claim to price the MBS at both the market execution (short-range xRAY) level as well as the long-range (ATOMs index) price.

The xRAY as a function of the R-Score and D-score produce the volatility function which is multi-distributed (e.g. far from a normal distribution), as shown below:

xRAY Volatility Smile



With the call and put surface expanding both the short-end and long-end of the volatility smile, the equation above explains why the short-range xRAY function's distribution is heavily weighted towards the near expiration call and put options (with the Position = 0.00 representing an "Expiration Date")

Therefore, given the extremely non-linear surface which is concluded for the xRAY function, numerical integration is necessary to derive the short-range price (execution price, or xPrice) based on this function. As such, with respect to the Execution Pricing, we numerically integrate based on the xPrice equation represented as the general form of Kinetic Energy (KE):

Equation 9.1

$$KE = \frac{1}{2}\int_{-\infty}^{\infty} \rho u_t^2 \, dx.$$

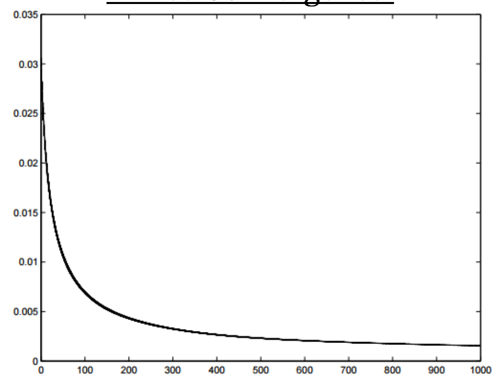
The reason we utilized the Kinetic Energy mathematical form is quite simple: because the execution pricing is the unwinding of the energy captured from the CLC, R & D scores, and Greeks noted above. The price, or execution, is the act of kinetic energy expending. To differentiate KE completely based on both Fear and Greed factors in the Field Equations, we have the xPrice solution, which is shown below:

Equation 9.2

$$\frac{d}{dt}KE = \frac{1}{2}\rho\int_{-\infty}^{\infty} 2u_t u_{tt} \, dx = \int_{-\infty}^{\infty} \rho u_t u_{tt} \, dx.$$

The convergence happens quite quickly, with less than 1000 Monte Carlo simulations to converge to a solution within $0.005 dollar price accuracy. The convergence chart is shown below:

xPrice Convergence:



For long-range pricing, we must move to the mathematical formulation of Potential Energy (instead of Kinetic Energy). We note that Potential Energy, or PE, will then represent a non-executed (or long-term) price which is based on physical principles most simplistically as:

Equation 10

$$\frac{d}{dt}(KE + PE) = 0.$$

Therefore, in the simplest form, the long-term price represented by Potential Energy is based on the solution below:

Equation 11

$$PE = \frac{1}{2}T\int_{-\infty}^{\infty} u_x^2\,dx,$$

CLAIMS

Our claim is that Risk Adjusted Yield (RAY) which has both a short-range and long-range return allows for the pricing of MBS using R-Score and D-Score, without the need for cash flow projections (e.g. prepayment or default projections), because the RAY utilizes the MBS's "DNA" of prepayment and default by relying on R-Score and D-Score as the MBS's genetic make-up.

ABSTRACT:

Risk Adjusted Yield (RAY) based MBS pricing allows the ability to price MBS based on simply R-Score and D-Score, paired with collateral-level data without the need for prepayment or default cash flow projections. Furthermore, the Risk Adjusted Yield (RAY) algorithm itself establishes an execution-based return which is calibrated daily and therefore completely transparent to both the buyers and sellers of MBS.