MBS P&L Analytics - Formula Documentation

Overview

This document provides detailed documentation of all P&L calculation formulas used in the MBS (Mortgage-Backed Securities) trading system, including data sources, calculations, and business logic.

Data Sources

1. Instrument Data (`instrument_data`)

Contains static and dynamic characteristics of MBS instruments:

- **CUSIP**: Unique security identifier
- **Coupon**: Annual coupon rate (%)
- **WAM**: Weighted Average Maturity (months)
- **CurrentUPB**: Current Unpaid Principal Balance
- **CPR**: Current Prepayment Rate (%)
- **CurrentPrice**: Latest market price
- **AccruedInterest**: Current accrued interest

2. Position Data (`position_data`)

Contains trading position information:

- **PositionId**: Unique position identifier
- **CurrentFace**: Current face value of position

- **CostBasis**: Purchase price (clean)
- **AverageCost**: Purchase price (dirty, including accrued)
- **AccruedInterestAtPurchase**: Accrued interest at time of purchase
- **UnrealizedPnL**: System-calculated unrealized P&L

3. Price Data (`price_data`)

Contains daily pricing information:

- **CleanPrice**: Price without accrued interest
- **DirtyPrice**: Price including accrued interest
- **OpenPrice**: Opening price for the day
- **ClosePrice**: Closing price for the day
- **AccruedInterest**: Current accrued interest amount

4. Trade Data (`trade_data`)

Contains individual trade transactions:

- **TradeQuantity**: Face value traded
- **TradePriceClean**: Trade execution price (clean)
- **TradePriceDirty**: Trade execution price (dirty)
- **Commission**: Trading commission costs
- **OtherFees**: Additional trading fees
- **RealizedPnL**: Realized profit/loss on trade

P&L Calculation Formulas

1. Price P&L (Clean)

Formula: `(CurrentCleanPrice - CostBasisClean) × CurrentFace ÷ 100`

Data Sources:

- `CurrentCleanPrice`: From `price_data.CleanPrice` (latest record)
- `CostBasisClean`: From `position_data.CostBasis`
- `CurrentFace`: From `position_data.CurrentFace`

Business Logic: Calculates profit/loss based on price movement excluding accrued interest changes.

2. Price P&L (Dirty)

Formula: `(CurrentDirtyPrice - CostBasisDirty) × CurrentFace ÷ 100`

Data Sources:

- `CurrentDirtyPrice`: From `price_data.DirtyPrice` (latest record)
- `CostBasisDirty`: From `position_data.AverageCost`
- `CurrentFace`: From `position_data.CurrentFace`

Business Logic: Calculates total price P&L including accrued interest impact.

3. Accrued Interest P&L

Formula: `(CurrentAccrued - AccruedAtPurchase) × CurrentFace ÷ 100`

Data Sources:

- `CurrentAccrued`: From `price_data.AccruedInterest` (latest record)
- `AccruedAtPurchase`: From `position_data.AccruedInterestAtPurchase`

- `CurrentFace`: From `position_data.CurrentFace`

Business Logic: Captures profit/loss from changes in accrued interest since purchase.

4. Total Unrealized P&L

Formula: `PricePnL_Clean + AccruedPnL`

Components:

- Price P&L (Clean): Pure price movement impact
- Accrued P&L: Accrued interest change impact

Business Logic: Total unrealized profit/loss on the position.

5. Mark-to-Market Value

Formula: `CurrentDirtyPrice × CurrentFace ÷ 100`

Data Sources:

- `CurrentDirtyPrice`: From `price_data.DirtyPrice` (latest record)
- `CurrentFace`: From `position_data.CurrentFace`

Business Logic: Current market value of the position.

6. Cost Value

Formula: `CostBasisDirty × CurrentFace ÷ 100`

Data Sources:

- `CostBasisDirty`: From `position_data.AverageCost`
- `CurrentFace`: From `position_data.CurrentFace`

Business Logic: Original investment cost of the position.

7. Daily P&L

Formula: `(ClosePrice - OpenPrice) × CurrentFace ÷ 100`

Data Sources:

- `ClosePrice`: From `price_data.ClosePrice`
- `OpenPrice`: From `price_data.OpenPrice`
- `CurrentFace`: From `position_data.CurrentFace`

Business Logic: Intraday profit/loss based on price movement.

8. Trade Costs

Formula: `Sum(Commission) + Sum(OtherFees)`

Data Sources:

- `Commission`: From `trade_data.Commission`
- `OtherFees`: From `trade_data.OtherFees`

Business Logic: Total transaction costs for the position.

9. Duration Risk (Simplified)

Formula: `|PricePnL_Clean| × (DurationYears ÷ 100)`

Data Sources:

- `PricePnL_Clean`: Calculated price P&L
- `DurationYears`: `instrument_data.WAM ÷ 12`

Business Logic: Approximates 1% interest rate move impact on P&L.

10. Monthly Carry

Formula: `(Coupon ÷ 12) × CurrentFace ÷ 100`

Data Sources:

- `Coupon`: From `instrument_data.Coupon`
- `CurrentFace`: From `position_data.CurrentFace`

Business Logic: Monthly interest income from the position.

11. P&L Percentage

Formula: `(TotalUnrealizedPnL ÷ CostValue) × 100`

Components:

- `TotalUnrealizedPnL`: Calculated total unrealized P&L
- `CostValue`: Calculated cost value

Business Logic: Return on investment percentage.

Data Relationships

Primary Keys and Joins

1. **Instruments** ↔ **Positions**: Joined on `CUSIP`
2. **Positions** ↔ **Trades**: Joined on `PositionId`
3. **Instruments** ↔ **Prices**: Joined on `CUSIP`

Data Flow

```
Instrument Data (Static) → Position Data (Transaction) → Price Data (Market) → P&L Calculations
            ↓
Trade Data (Execution) → Realized P&L → Total P&L Analysis
```

Risk Metrics Integration

Duration Risk Calculation

- **Purpose**: Measure interest rate sensitivity
- **Input**: WAM (Weighted Average Maturity)
- **Conversion**: `WAM ÷ 12` = Duration in years
- **Application**: Risk-adjusted P&L analysis

Prepayment Risk Indicators

- **CPR Metrics**: Current, 1-month, 3-month, 6-month, 12-month, 24-month
- **Usage**: Assess prepayment speed impact on returns
- **Integration**: Used in AI-driven risk assessment

Geographic Concentration

- **Primary State**: Dominant geographic exposure
- **State Percentage**: Concentration level
- **Risk Application**: Regional economic impact assessment

Portfolio Aggregation

Book-Level Aggregation

Positions are grouped by trading book (`A101`, `B123`, `R345`) for:

- Book-level P&L summaries
- Risk concentration analysis
- Trading desk performance

Total Portfolio Metrics

- **Total Unrealized P&L**: Sum of all position P&L
- **Total MTM Value**: Sum of all mark-to-market values
- **Average P&L Percentage**: Weighted average return
- **Total Monthly Carry**: Sum of all monthly income
- **Total Duration Risk**: Aggregate interest rate sensitivity

Implementation Notes

Price Data Handling

- **Latest Price Logic**: Uses `iloc[-1]` to get most recent price data per CUSIP
- **Missing Data**: System handles missing price data gracefully
- **Price Types**: Maintains both clean and dirty price calculations

Error Handling

- **Division by Zero**: Protected in percentage calculations
- **Missing Instruments**: Handles cases where position CUSIP not found in instrument data
- **Data Type Conversion**: Ensures numeric calculations with proper rounding

Performance Considerations

- **Vectorized Operations**: Uses pandas operations where possible

- **Memory Efficiency**: Selective column processing
- **Calculation Order**: Optimized for minimal redundant calculations

Usage in Trading Decisions

Key Metrics for Traders

1. **Total Unrealized P&L**: Overall position profitability
2. **P&L Percentage**: Return on investment efficiency
3. **Duration Risk**: Interest rate sensitivity exposure
4. **Monthly Carry**: Income generation capability
5. **Daily P&L**: Short-term performance tracking

AI Integration Points

- **Market Data Input**: Real-time price feeds update calculations
- **Risk Assessment**: Duration and prepayment metrics feed risk models
- **Strategy Recommendations**: P&L trends inform holding period suggestions
- **Portfolio Optimization**: Aggregated metrics guide position sizing

This documentation provides the complete framework for understanding how P&L calculations are performed in the MBS trading system, enabling traders and risk managers to make informed decisions based on comprehensive financial metrics.