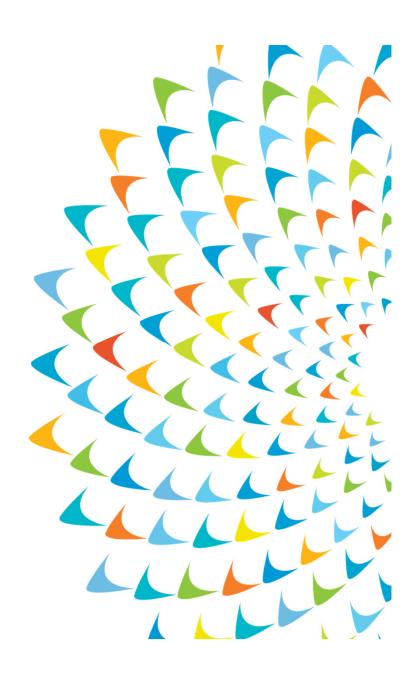


CALL PROBABILITY FORECASTING TOOL

Jonathan Vincent-Viry

Treasury Specialist, Quantitative Analysis Unit Treasury Department

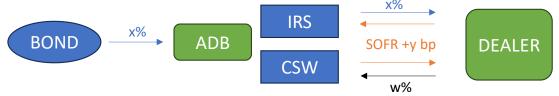
October 2023





BACKGROUND

- Trade idea from our Investment Division
 - Objective: generate a better yield than investing in a callable bond
 - Buy US Treasury, fixed-coupon bond (x%)
 - Enter an Interest Rate Swap (IRS) where ADB:
 - pays fixed-coupon (x%)
 - receives SOFR (+y bp)
 - Enter a Cancellable Swap (CSW) where ADB:
 - receives fixed-coupon (w%)
 - pays SOFR (+y bp)

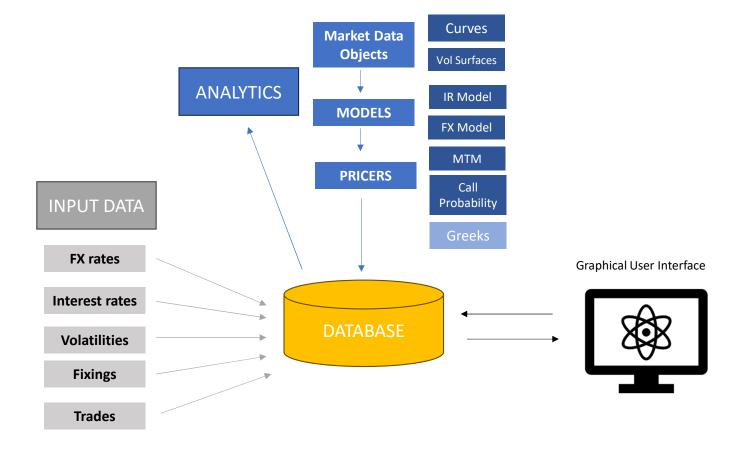


- Risk management
 - Proactively manages cash inflows (dealer calling the CSW)
 - Monitors the call probabilities of the CSW trades





REQUIRED INPUTS AND TOOLS







POTENTIAL SOLUTIONS



- PROS
- Customizable
- Skill in-house
- Not expensive
- <u>SUPPORT</u>
- In-house
- <u>CONS</u>
- No version control
- Limited features
- Not scalable



- PROS
- Pre-built
- Advanced Features
- Version control by vendor
- Scalable
- **SUPPORT**
- Vendor
- CONS
 - Hard to customize
- License costs
- Additional implementation costs

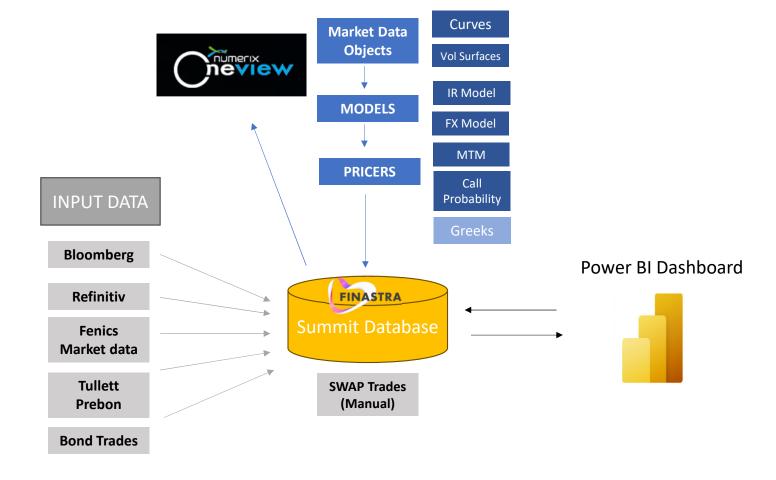


- PROS
- Customizable
- Skill in-house
- Not expensive
- Scalable
- SUPPORT
- In-house
- CONS
- Hard to version control Power BI





OUR SELECTED SOLUTION







KEY FEATURES – CALL MONITORING (1)

MAX Call probability per option type

| Option Type | LPC | MPC | HPC | Total | Trade Count |
|-------------|-------|-------|-----|--------|-------------|
| CALLABLE | 1,372 | 8,780 | 270 | 10,422 | 174 |
| KNOCK-OUT | - | - | - | - | - |
| TARN | - | - | - | - | - |
| Grand Total | 1,372 | 8,780 | 270 | 10,422 | 174 |
| | | | | | |

LPC, MPC and HPC is based on the maximum call probability in the call dates of the trade during the selected projection period. **LPC:** "Low Probability of Call" where maximum call probability is less than 0.01 **MPC:** Refers to "Medium Probability of Call" where maximum call probability is >=0.5 and <=1.





KEY FEATURES – CALL MONITORING (2)

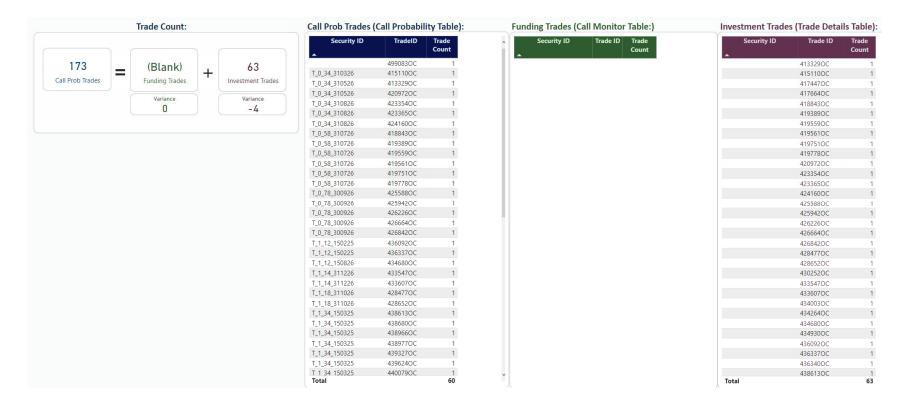
MAX Call probability per call dates

| Year-Month | Option Type | LPC | MPC | HPC | Total | Trade Count |
|------------|-------------|-------|-------|-----|--------|-------------|
| 2023-10 | CALLABLE | 200 | 0 | 0 | 200 | 1 |
| 2023-11 | CALLABLE | 100 | 0 | 0 | 100 | 1 |
| 2024-01 | CALLABLE | 225 | 0 | 0 | 225 | 2 |
| 2024-02 | CALLABLE | 200 | 0 | 0 | 200 | 3 |
| 2024-03 | CALLABLE | 300 | 230 | 0 | 530 | 11 |
| 2024-04 | CALLABLE | 50 | 150 | 0 | 200 | 4 |
| 2024-05 | CALLABLE | 0 | 100 | 0 | 100 | 2 |
| 2024-08 | CALLABLE | 200 | 0 | 0 | 200 | 2 |
| 2024-09 | CALLABLE | 0 | 100 | 0 | 100 | 2 |
| 2024-10 | CALLABLE | 0 | 150 | 0 | 150 | 1 |
| 2024-11 | CALLABLE | 0 | 162 | 0 | 162 | 4 |
| 2024-12 | CALLABLE | 50 | 50 | 50 | 150 | 3 |
| 2025-01 | CALLABLE | 0 | 50 | 0 | 50 | 1 |
| 2025-02 | CALLABLE | 0 | 325 | 0 | 325 | 3 |
| 2025-03 | CALLABLE | 0 | 100 | 0 | 100 | 2 |
| 2025-04 | CALLABLE | 0 | 50 | 0 | 50 | 1 |
| 2025-05 | CALLABLE | 0 | 435 | 0 | 435 | 6 |
| 2025-06 | CALLABLE | 0 | 200 | 0 | 200 | 3 |
| 2025-08 | CALLABLE | 0 | 209 | 0 | 209 | 2 |
| 2025-09 | CALLABLE | 0 | 200 | 0 | 200 | 3 |
| 2025-10 | CALLABLE | 0 | 216 | 50 | 266 | 7 |
| 2025-11 | CALLABLE | 0 | 100 | 0 | 100 | 2 |
| 2025-12 | CALLABLE | 0 | 50 | 0 | 50 | 1 |
| 2026-01 | CALLABLE | 0 | 300 | 0 | 300 | 6 |
| 2026-02 | CALLABLE | 0 | 200 | 0 | 200 | 3 |
| 2026-03 | CALLABLE | 0 | 437 | 40 | 477 | 10 |
| 2026-06 | CALLABLE | 0 | 202 | 0 | 202 | 5 |
| 2026-09 | CALLABLE | 0 | 505 | 0 | 505 | 2 |
| 2026-10 | CALLABLE | 0 | 60 | 0 | 60 | 2 |
| 2027-03 | CALLABLE | 0 | 110 | 0 | 110 | 2 |
| 2027-06 | CALLABLE | 0 | 32 | 0 | 32 | 2 |
| Total | | 1,372 | 8,780 | 270 | 10,422 | 174 |





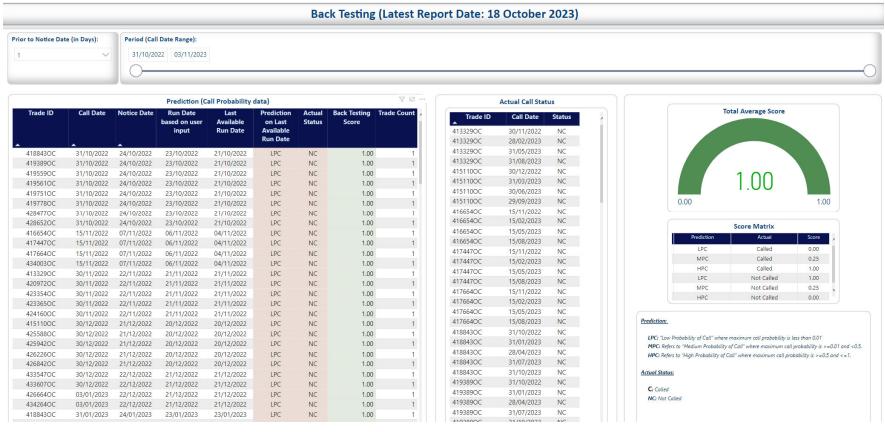
KEY FEATURES – POPULATION CHECK







KEY FEATURES – BACKTESTING (1)







KEY FEATURES – BACKTESTING (2)

HPC Backtesting

| | | | Prediction (C | all Probability | data) | | | 7 E |
|------------------|------------|-------------|------------------------------------|-------------------------------|--|------------------|-----------------------|-------------|
| Trade ID | Call Date | Notice Date | Run Date based on user input | Last Available Run Date | Prediction on Last Available Run Date | Actual Status | Back Testing Score | Trade Count |
| 344226AD | 27/12/2022 | 28/11/2022 | 27/11/2022 | 25/11/2022 | HPC | NC | 0.00 | 1 |
| 344226AD | 27/06/2023 | 25/05/2023 | 24/05/2023 | 24/05/2023 | HPC | С | 1.00 | 1 |
| Total Ave. Score | | | | | | | 0.50 | 2 |

MPC Backtesting

| | | | Prediction (C | all Probability | data) | | | A E. |
|------------------|------------|-------------|------------------------------------|-------------------------------|--|------------------|-----------------------|-------------|
| Trade ID | Call Date | Notice Date | Run Date based on user input | Last Available Run Date | Prediction on Last Available Run Date | Actual Status | Back Testing Score | Trade Count |
| 379455AD | 19/06/2023 | 19/05/2023 | 18/05/2023 | 18/05/2023 | MPC | NC | 0.25 | 1 |
| 347464AD | 01/08/2023 | 03/07/2023 | 02/07/2023 | 30/06/2023 | MPC | NC | 0.25 | 1 |
| Total Ave. Score | | | | | | | 0.25 | 2 |





Project Summary

- Developers:
 - 1 Backend developer (Database)
 - 1 Frontend developer (PowerBI)
 - 2 Financial engineers (Analytics validation)
- Timeframe: 5 months
- Next steps:
 - Feed Duration from Numerix OneView (Currently MSCI)



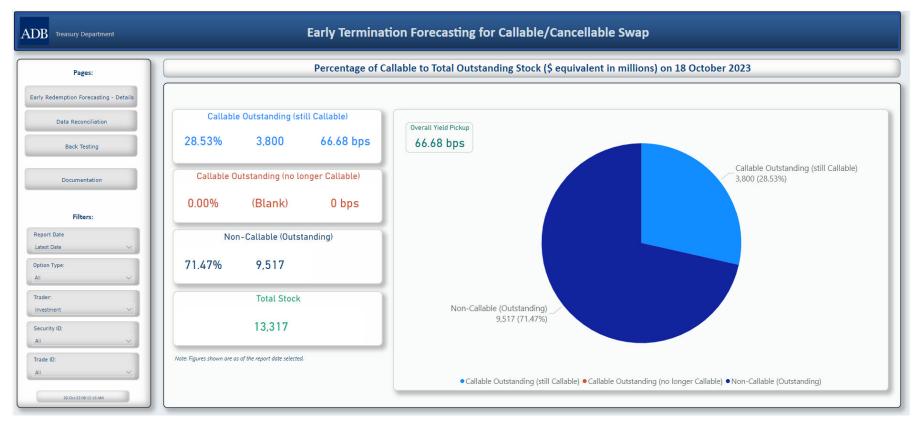


Appendix





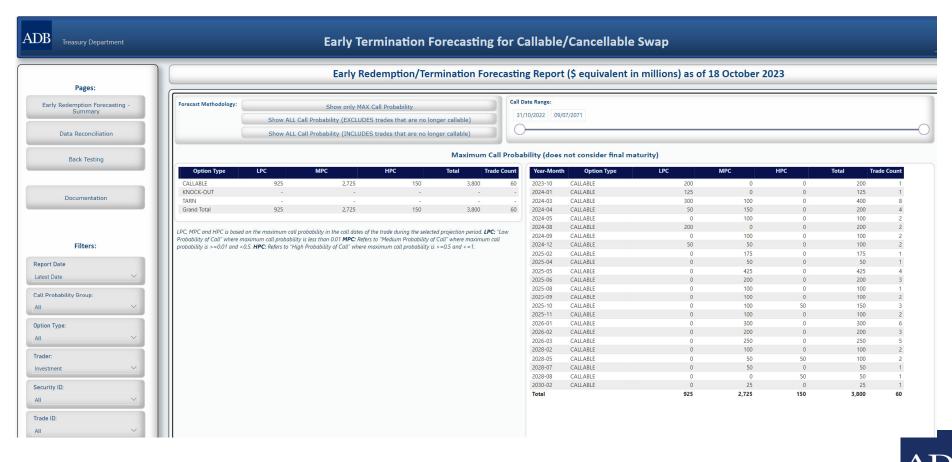
LANDING PAGE







EARLY TERMINATION FORECASTING (1)





EARLY TERMINATION FORECASTING (2)

Maximum Call Probability (does not consider final maturity)

| Year-Month | Call Date | Security ID | Trade ID | Pool | Trader | Maturity Date | Coupon Rate | Yield Pick- Up (bps) | Duration Option Ty | pe Group Type | LPC | MPC | HPC | Call Probability | Duplicate? | Trade Count |
|-------------------------|----------------|-------------|----------|---------|------------|------------------|----------------|-------------------------|--------------------|------------------|-----|-------|-----|---------------------|------------|----------------|
| 2023-10 | 31/10/2023 T_2 | _38_300426 | 430252OC | PLP_USD | Investment | 30/04/2026 | 2.22 | 24.66 | 2.27 CALLABLE | LPC | 200 | 0 | 0 | 0.00 | No | - 1 |
| 2024-01 | 31/01/2024 T_2 | _58_310126 | 434930OC | PLP_USD | Investment | 31/01/2026 | 2.19 | 14.76 | 2.08 CALLABLE | LPC | 125 | 0 | 0 | 0.00 | No | 1 |
| 2024-03 | 15/03/2024 T_1 | _34_150325 | 438613OC | PLP_USD | Investment | 15/03/2025 | 2.00 | 25.00 | 1.60 CALLABLE | LPC | 50 | 0 | 0 | 0.00 | No | 1 |
| 2024-03 | 15/03/2024 T_1 | _34_150325 | 438680OC | PLP_USD | Investment | 15/03/2025 | 2.04 | 28.50 | 1.60 CALLABLE | LPC | 50 | 0 | 0 | 0.00 | No | |
| 2024-03 | 15/03/2024 T_1 | _34_150325 | 438966OC | PLP_USD | Investment | 15/03/2025 | 2.25 | 49.50 | 1.60 CALLABLE | LPC | 50 | 0 | 0 | 0.00 | No | |
| 2024-03 | 15/03/2024 T_1 | _34_150325 | 439327OC | PLP_USD | Investment | 15/03/2025 | 2.31 | 56.20 | 1.60 CALLABLE | LPC | 50 | 0 | 0 | 0.00 | No | |
| 2024-03 | 15/03/2024 T_1 | _34_150325 | 439624OC | PLP_USD | Investment | 15/03/2025 | 2.54 | 79.00 | 1.61 CALLABLE | LPC | 50 | 0 | 0 | 0.00 | No | |
| 2024-03 | 15/03/2024 T_1 | _34_150325 | 440079OC | PLP_USD | Investment | 15/03/2025 | 2.80 | 105.00 | 1.61 CALLABLE | LPC | 50 | 0 | 0 | 0.00 | No | |
| 2024-03 | 29/03/2024 T_2 | _12_310327 | 457312OC | PLP_USD | Investment | 31/03/2027 | 3.97 | 147.00 | 2.81 CALLABLE | MPC | 0 | 50 | 0 | 0.24 | No | |
| 2024-03 | 29/03/2024 T_2 | _12_310327 | 457686OC | PLP_USD | Investment | 31/03/2027 | 4.05 | 154.50 | 2.72 CALLABLE | MPC | 0 | 50 | 0 | 0.27 | No | |
| 2024-04 | 01/04/2024 T_2 | _12_310327 | 457314OC | PLP_USD | Investment | 31/03/2027 | 3.97 | 147.00 | 2.81 CALLABLE | MPC | 0 | 50 | 0 | 0.11 | No | |
| 2024-04 | 01/04/2024 T_2 | _12_310327 | 457689OC | PLP_USD | Investment | 31/03/2027 | 4.05 | 154.50 | 2.44 CALLABLE | MPC | 0 | 50 | 0 | 0.12 | No | |
| 2024-04 | 15/04/2024 T_2 | _58_150425 | 442515OC | PLP_USD | Investment | 15/04/2025 | 3.00 | 37.50 | 1.68 CALLABLE | LPC | 50 | 0 | 0 | 0.01 | No | |
| 2024-04 | 15/04/2024 T_2 | _58_150425 | 442608OC | PLP_USD | Investment | 15/04/2025 | 3.03 | 40.90 | 1.66 CALLABLE | MPC | 0 | 50 | 0 | 0.05 | No | |
| 2024-05 | 31/05/2024 T_2 | _58_310527 | 448208OC | PLP_USD | Investment | 31/05/2027 | 3.55 | 92.00 | 2.70 CALLABLE | MPC | 0 | 50 | 0 | 0.13 | No | |
| 2024-05 | 31/05/2024 T_2 | _58_310527 | 448812OC | PLP_USD | Investment | 31/05/2027 | 4.29 | 166.00 | 2.30 CALLABLE | MPC | 0 | 50 | 0 | 0.28 | No | |
| 2024-08 | 15/08/2024 T_1 | _12_150225 | 436092OC | PLP_USD | Investment | 15/02/2025 | 1.85 | 35.00 | 1.33 CALLABLE | LPC | 100 | 0 | 0 | 0.00 | No | |
| 2024-08 | 15/08/2024 T_1 | _12_150225 | 436337OC | PLP_USD | Investment | 15/02/2025 | 2.09 | 58.80 | 1.30 CALLABLE | LPC | 100 | 0 | 0 | 0.01 | No | |
| 2024-09 | 03/09/2024 T_3 | _18_310827 | 458823OC | PLP_USD | Investment | 31/08/2027 | 4.22 | 109.00 | 2.25 CALLABLE | MPC | 0 | 50 | 0 | 0.25 | No | |
| 2024-09 | 03/09/2024 T_3 | _18_310827 | 460393OC | PLP_USD | Investment | 31/08/2027 | 4.53 | 140.50 | 1.94 CALLABLE | MPC | 0 | 50 | 0 | 0.30 | No | |
| 2024-12 | 16/12/2024 T_1 | _34_150325 | 438977OC | PLP_USD | Investment | 15/03/2025 | 2.40 | 65.00 | 1.48 CALLABLE | LPC | 50 | 0 | 0 | 0.00 | No | |
| 2024-12 | 31/12/2024 T_3 | _14_300627 | 452889OC | PLP_USD | Investment | 30/06/2027 | 4.39 | 113.80 | 2.33 CALLABLE | MPC | 0 | 50 | 0 | 0.17 | No | |
| 2025-02 | 28/02/2025 T_2 | _34_310825 | 436340OC | PLP_USD | Investment | 31/08/2025 | 2.85 | 10.00 | 1.75 CALLABLE | MPC | 0 | 175 | 0 | 0.03 | No | |
| 2025-04 | 30/04/2025 T_2 | _34_300427 | 444118OC | PLP_USD | Investment | 30/04/2027 | 3.45 | 70.00 | 2.54 CALLABLE | MPC | 0 | 50 | 0 | 0.25 | No | |
| 2025-05 | 15/05/2025 T_1 | _58_150526 | 416654OC | PLP_USD | Investment | 15/05/2026 | 2.41 | 78.00 | 2.28 CALLABLE | MPC | 0 | 125 | 0 | 0.04 | No | |
| 2025-05 | 15/05/2025 T_1 | _58_150526 | 417447OC | PLP_USD | Investment | 15/05/2026 | 2.27 | 64.50 | 2.34 CALLABLE | MPC | 0 | 175 | 0 | 0.04 | No | |
| 2025-05 | 15/05/2025 T_1 | _58_150526 | 417664OC | PLP_USD | Investment | 15/05/2026 | 2.42 | 79.50 | 2.29 CALLABLE | MPC | 0 | 50 | 0 | 0.04 | No | |
| 2025-05 | 15/05/2025 T_2 | _14_151125 | 434003OC | PLP_USD | Investment | 15/11/2025 | 1.89 | 41.27 | 1.91 CALLABLE | MPC | 0 | 75 | 0 | 0.04 | No | |
| 2025-06 | 30/06/2025 T_1 | _14_311226 | 433547OC | PLP_USD | Investment | 31/12/2026 | 1.91 | 66.00 | 2.76 CALLABLE | MPC | 0 | 50 | 0 | 0.05 | No | |
| 2025-06 | 30/06/2025 T_1 | _14_311226 | 433607OC | PLP_USD | Investment | 31/12/2026 | 1.93 | 68.00 | 2.76 CALLABLE | MPC | 0 | 50 | 0 | 0.05 | No | |
| 2025-06 | 30/06/2025 T_2 | _58_311225 | 434264OC | PLP_USD | Investment | 31/12/2025 | 2.01 | 31.86 | 2.12 CALLABLE | MPC | 0 | 100 | 0 | 0.04 | No | |
| 2025-08 | 15/08/2025 T_1 | _12_150826 | 434680OC | PLP_USD | Investment | 15/08/2026 | 2.17 | 67.00 | 2.47 CALLABLE | MPC | 0 | 100 | 0 | 0.07 | No | |
| I/Ave. Call Probability | | | | | | | | 4,435.06 | | | 925 | 2,725 | 150 | 0.10 | | 6 |

^{* &#}x27;All Call Probability' with 'NO' provides 'Next Call Date (depending on the notice date) and 'Call probability on the next call date. If these notice dates are earlier than the report date, then the next call date will be displayed (it assumes that it will not be called on the current call date).



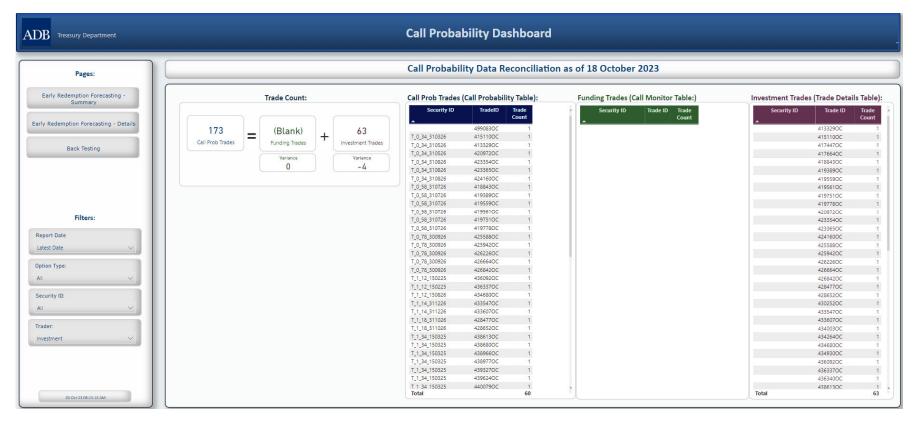
Yield Pick-Up (bps) column is applicable to Cancellable Swaps (Trader=Investment) only. Negative yield pick-up value will be highlighted in red text.

For trades with HPC (High Probability of Call), the entire row is highlighted in orange.

[•] Duration figures is sourced from MSCI starting 04-May-2023 onwards. Prior to this date, it is sourced from ORM's OAM data.



TRADE POPULATION CHECK







BACKTESTING

