### **Detailed Prompt**

#### **Objective**

* **Primary Goal**: Develop 20 distinct monthly rebalancing timing strategies that aim to outperform the buy-and-hold version of the cad\_ig\_er\_index in terms of both total return and risk-adjusted performance metrics.
* **Secondary Goals**:
  + Utilize logical interpretations of the column names and their economic meanings.
  + Ensure strategies are based on patterns identified within the dataset.

#### **Dataset Details**

* **Frequency**: Monthly data.
* **Time Range**: Determine the start and end dates from the dataset (since data includes 289 monthly observations, this likely spans over 24 years).
* **Data Quality**:
  + Verify data cleanliness.
  + Check for missing values or anomalies and address them appropriately.
* **Data Columns**:

| **#** | **Column** | **Description** |
| --- | --- | --- |
| 0 | cad\_ig\_er\_index | Canadian Investment Grade Excess Return Index (Target) |
| 1 | cad\_ig\_sprds | Canadian Investment Grade Credit Spreads |
| 2 | vix | CBOE Volatility Index (Market Volatility Indicator) |
| 3 | us\_hy\_er\_index | US High Yield Excess Return Index |
| 4 | us\_ig\_er\_index | US Investment Grade Excess Return Index |
| 5 | tsx\_index | S&P/TSX Composite Index (Canadian Equity Market) |
| 6 | us\_eco\_suprise | US Economic Surprise Index |
| 7 | lei\_yoy\_index | Leading Economic Index Year-over-Year |
| 8 | us\_recession\_odds | US Recession Odds |
| 9 | cad\_recession\_odds | Canadian Recession Odds |
| 10 | atlanta\_fed | Atlanta Fed GDPNow Forecast |
| 11 | growth\_surpise | Growth Surprise Index |
| 12 | hard\_data | Economic Hard Data Indicators |
| 13 | equity\_revisions | Equity Earnings Revisions |
| 14 | fed\_credit\_model | Federal Reserve Credit Model Indicator |

#### **Constraints**

* **Trading Rules**:
  + **Long-Only**: No leverage or short selling is permitted.
  + **Rebalancing Frequency**: Monthly, aligned with the data frequency.
  + **Transaction Costs**: Ignore transaction costs, taxes, and slippage for this analysis unless specified otherwise.
* **Tools and Environment**:
  + **Backtesting Framework**: Use vectorbt library.
    - **Note**: vectorbt has known issues with monthly frequency data. Address these issues by adjusting date indices or using custom resampling techniques.
  + **Programming Environment**: Jupyter Notebook with Python.

#### **Performance Metrics**

* **Absolute Performance**:
  + Total Return
  + Annualized Return
* **Risk-Adjusted Performance**:
  + Sharpe Ratio
  + Sortino Ratio
  + Maximum Drawdown
  + Volatility (Standard Deviation of Returns)
* **Benchmarking**:
  + Compare each strategy's performance against the buy-and-hold strategy of the cad\_ig\_er\_index.

#### **Strategy Development Guidelines**

Develop 20 unique strategies based on logical interpretations of the dataset's columns. Consider the economic meaning behind each indicator and how it might impact the cad\_ig\_er\_index. Below are suggestions to guide the development:

1. **Credit Spread Strategy**:
   * **Indicator**: cad\_ig\_sprds
   * **Logic**: When credit spreads tighten (decrease), it indicates improving credit conditions; go long on cad\_ig\_er\_index.
2. **Volatility Strategy**:
   * **Indicator**: vix
   * **Logic**: High vix values indicate market stress; reduce exposure when vix exceeds a certain threshold.
3. **Economic Surprise Strategy**:
   * **Indicator**: us\_eco\_suprise
   * **Logic**: Positive surprises suggest economic strength; increase exposure when the index is positive.
4. **Leading Economic Indicators Strategy**:
   * **Indicator**: lei\_yoy\_index
   * **Logic**: An upward trend suggests future economic growth; invest more heavily during upward trends.
5. **Recession Odds Strategy**:
   * **Indicator**: us\_recession\_odds and cad\_recession\_odds
   * **Logic**: Reduce or eliminate exposure when recession odds exceed a specific threshold (e.g., 50%).
6. **GDP Forecast Strategy**:
   * **Indicator**: atlanta\_fed
   * **Logic**: Higher GDP forecasts imply economic strength; increase positions when forecasts improve.
7. **Growth Surprise Strategy**:
   * **Indicator**: growth\_surpise
   * **Logic**: Positive growth surprises lead to better market performance; adjust exposure accordingly.
8. **Hard Data Strategy**:
   * **Indicator**: hard\_data
   * **Logic**: Focus on actual economic data rather than expectations; increase exposure when hard data is strong.
9. **Equity Revisions Strategy**:
   * **Indicator**: equity\_revisions
   * **Logic**: Positive earnings revisions signal corporate health; increase investment when revisions are positive.
10. **Federal Reserve Credit Model Strategy**:
    * **Indicator**: fed\_credit\_model
    * **Logic**: Use the model to anticipate credit market conditions; adjust exposure based on signals.
11. **High Yield Spread Strategy**:
    * **Indicator**: us\_hy\_er\_index vs. us\_ig\_er\_index
    * **Logic**: The spread between high yield and investment grade returns can signal risk appetite; adjust positions based on the spread's widening or tightening.
12. **Equity Market Trend Strategy**:
    * **Indicator**: tsx\_index
    * **Logic**: Positive trends in the equity market can lead to better performance in credit markets; increase exposure when tsx\_index is trending upwards.
13. **Composite Indicator Strategy**:
    * **Indicators**: Combination of multiple indicators (e.g., vix, us\_eco\_suprise, cad\_ig\_sprds)
    * **Logic**: Create a composite score to generate signals.
14. **Momentum Strategy**:
    * **Indicator**: cad\_ig\_er\_index historical returns
    * **Logic**: Use past performance to predict future trends; invest more when momentum is positive.
15. **Mean Reversion Strategy**:
    * **Indicator**: Deviation from moving averages
    * **Logic**: When cad\_ig\_er\_index deviates significantly from its moving average, expect a reversion.
16. **Economic Cycle Strategy**:
    * **Indicator**: lei\_yoy\_index and hard\_data
    * **Logic**: Adjust exposure based on the phase of the economic cycle.
17. **Sentiment Strategy**:
    * **Indicator**: Implied via vix and us\_eco\_suprise
    * **Logic**: Use market sentiment indicators to time entries and exits.
18. **Yield Curve Strategy**:
    * **Indicator**: Proxy via fed\_credit\_model
    * **Logic**: An inverted yield curve predicts economic downturns; reduce exposure accordingly.
19. **Seasonality Strategy**:
    * **Indicator**: Time of the year
    * **Logic**: Invest based on seasonal patterns in the market.
20. **Machine Learning Strategy**:
    * **Indicator**: All available indicators
    * **Logic**: Use a simple machine learning model (e.g., logistic regression) to predict positive or negative returns.

#### **Implementation Steps**

1. **Data Preparation**:
   * Load the dataset into the Jupyter Notebook.
   * Verify the data range and ensure all columns align correctly on a monthly basis.
   * Handle missing values appropriately (e.g., forward-fill or interpolate).
   * Convert date indices to a format compatible with vectorbt.
2. **Handling Monthly Frequency in VectorBT**:
   * **Issue Resolution**:
     + Modify vectorbt settings to handle custom frequencies.
     + If necessary, resample data to a frequency compatible with vectorbt and adjust strategy logic accordingly.
3. **Strategy Coding**:
   * For each of the 20 strategies:
     + **Define**: Clearly outline the strategy logic and the economic rationale behind it.
     + **Implement**: Code the strategy using vectorbt, ensuring rebalancing occurs monthly.
     + **Document**: Include comments and explanations within the code for clarity.
4. **Backtesting**:
   * Run backtests for each strategy over the entire available data period.
   * Ensure that all strategies are backtested under the same conditions for fair comparison.
5. **Performance Evaluation**:
   * Calculate the specified performance metrics for each strategy.
   * Use vectorbt's built-in functions or custom calculations as needed.
   * Compare each strategy's performance to the buy-and-hold benchmark.
6. **Result Visualization**:
   * Generate comprehensive visualizations:
     + **Equity Curves**: Plot cumulative returns over time.
     + **Drawdowns**: Visualize maximum drawdowns and recovery periods.
     + **Performance Metrics**: Create tables or charts summarizing key metrics.
     + **Signal Charts**: Show when buy/sell signals were generated.
7. **Comprehensive Reporting**:
   * Compile findings in the Jupyter Notebook:
     + **Introduction**: Briefly describe each strategy.
     + **Methodology**: Explain how each strategy was implemented.
     + **Results**: Present performance metrics and visualizations.
     + **Analysis**: Interpret the results, noting which strategies outperformed and potential reasons why.
     + **Conclusion**: Summarize key insights and suggest possible next steps.
8. **Challenges and Resolutions**:
   * Document any issues encountered, especially with handling monthly data in vectorbt.
   * Explain how these issues were resolved to ensure reproducibility.

#### **Additional Considerations**

* **Risk Management**:
  + Even though leverage and short selling are not used, consider implementing basic risk management techniques like position sizing or stop-loss mechanisms.
* **Interpretability**:
  + Emphasize strategies that are interpretable and based on sound economic reasoning.
* **Extensibility**:
  + Structure the code to allow for easy modification and extension of strategies.
* **Performance Optimization**:
  + Ensure that code execution is efficient, possibly by vectorizing operations or using optimized libraries.

#### **Deliverables**

* **Jupyter Notebook** containing:
  + Data loading and preprocessing steps.
  + Implementation code for all 20 strategies.
  + Backtesting results and performance evaluations.
  + Visualizations for each strategy.
  + Comprehensive analysis and conclusions.
* **Supporting Documentation**:
  + Any auxiliary scripts or functions used.
  + Detailed explanations of any custom methods or adjustments made.

#### **Summary**

By following this prompt, you will:

* **Develop** 20 diverse and economically sound timing strategies using your dataset.
* **Backtest** these strategies effectively, overcoming any technical challenges with vectorbt.
* **Evaluate** each strategy comprehensively, comparing them against the buy-and-hold benchmark.
* **Gain Insights** into which indicators and strategies may offer an edge in timing the cad\_ig\_er\_index.