

# Back-testing on the Revenue Cash Flow Forecasting Model for Daily Revenue Obligations (DROs) and Daily Revenue Portfolios (DRPs)

## Contents

Summary .....	1
Back-testing Metrics .....	2
Back-testing Results .....	2
Conclusion .....	4

## Summary

This report analyzes the predictive accuracy of CSPI Ratings' Revenue Cash Flow Forecasting Model through out-of-sample and out-of-time back-testing across five months. The back-testing evaluation focuses on key metrics such as bias, Root Mean Square Error (RMSE), out-of-sample R<sup>2</sup>, and portfolio predicted error to measure the models' predictive accuracy.

### Key Metrics and Findings

- Bias:** This metric measures the deviation of the model's predictions from the actual values. Throughout the assessment period, the model shows instances of both underestimation and overestimation. However, the bias values consistently reflect high predictive accuracy.
- Root Mean Square Error (RMSE):** The RMSE metric, which quantifies the average magnitude of prediction errors with an emphasis on larger discrepancies, provides valuable insights into the model's overall precision. For the model, the RMSE values remain relatively low throughout the evaluation period, indicating strong predictive accuracy.
- Out-of-Sample R<sup>2</sup>:** The out-of-sample R<sup>2</sup> values, which measure the proportion of variance in the actual data explained by the model's predictions, consistently indicate strong predictive power. The values range from 82.98% to 92.53%, demonstrating that the model effectively captures the underlying patterns in the revenue cash flows and performs well on data that are not used during the model training phase.
- Portfolio Prediction Error:** The low discrepancy between the predicted results and the actual realized returns of the DRO portfolio signifies a high level of accuracy in the model's forecasts. The values of portfolio prediction error for the assessment period range from -2.85% to 1.12%. Specifically, for the month of April, the portfolio prediction error was observed to be 0.8%.

Overall, CSPI Ratings' Revenue Cash Flow Forecasting Model exhibits robust and reliable forecasting capabilities. The model's performance across various metrics confirms its ability to provide accurate predictions and adapt to changing market dynamics. The consistently high out-of-sample R<sup>2</sup> values underscore the model's strong explanatory power, while the low portfolio prediction errors demonstrate its significant out-of-sample predictive power. These back-testing results solidify the model's value as a tool for predicting the revenue cash flows of DRO portfolios.

Additionally, the accurate out-of-sample prediction of revenue cash flows for DRO portfolios by CSPI Ratings' model provides compelling evidence that the revenue cash flows of small businesses and their associated DROs can be forecasted with a notable degree of precision when aggregated at the portfolio level. Despite the inherent uncertainties and volatility associated with individual small businesses, their collective revenue streams exhibit predictable patterns that can be effectively captured by a well-designed forecasting model. This

## Contact

**Name** Ke Chen Ph.D.  
**Title** Chief Analytics Officer  
**Direct** +852 3615 8316  
**Email** ke.chen@cspi-ratings.com

**Name** Bining Cai, FRM  
**Title** Analyst  
**Direct** +86 755 8321 0225  
**Email** bining.cai@cspi-ratings.com

finding has significant implications for investors, financial institutions, and risk management strategies, as it enables more informed decision-making, efficient pricing, and effective diversification techniques.

## Back-testing Metrics

Before diving into the analysis, it is essential to understand the definitions of the back testing metrics used and what they represent:

1. **Bias:** The average of the differences between the model's predicted and actual values. It indicates whether the model tends to over- or under-estimate and the extent of this tendency. A positive bias suggests underestimation, while a negative bias indicates overestimation.

$$Bias = \frac{\sum(Actual\ values - Predicted\ values)}{Number\ of\ Observations} \quad (1)$$

2. **Root Mean Square Error (RMSE):** The square root of the mean of the squares of the prediction error. It measures the prediction accuracy and reflects the magnitude of the difference between the predicted and actual values. A lower RMSE indicates higher prediction accuracy.

$$RMSE = \sqrt{\frac{\sum(Predicted\ values - Actual\ values)^2}{Number\ of\ Observations}} \quad (2)$$

3. **Out-of-sample R<sup>2</sup>:** A measure of the model's predictive power on out-of-sample data. A higher value indicates better performance in predicting unknown data.

$$Out - of - sample\ R^2 = 1 - \frac{\sum(Predicted\ values - Actual\ values)^2}{\sum(Actual\ values - Mean\ of\ Actual\ values)^2} \quad (3)$$

4. **Portfolio Predicted Errors:** This term refers to the discrepancies between the forecasted returns of a model and the actual returns that a portfolio realizes over a specific period. These errors are critical for assessing the accuracy and reliability of financial models used in investment management and financial forecasting.

$$Portfolio\ Predicted\ Error = \left( \frac{\sum(Actual\ values - Predicted\ values)}{\sum Actual\ values} \right) \quad (4)$$

## Back-testing Results

In this section, we present a comprehensive analysis of the back-testing results for five distinct months, leveraging the previously described back-testing methodologies and performance metrics. The data used for this evaluation comprise the outstanding DROs in Micro Connect's portfolio, spanning from February 13, 2023, to April 30, 2024. For each month under examination, we conduct a thorough comparison between the predicted returns, which are based on the data available up to the end of the previous month, and the actual realized returns during the month in question. This rigorous approach allows us to assess the accuracy, reliability, and predictive power of our forecasting models, providing valuable insights into their performance over time and under various market conditions.

### Back-testing Results for November 2023

Out-of-sample Back-testing Results (November 2023)				
	Bias	RMSE	Out of sample R <sup>2</sup>	Portfolio Predicted Error
CSPI Ratings' Model	-129.54	7643.37	87.36%	-1.01%

- The bias of -129.54 suggests a slight overestimation by the model.
- An RMSE of 7643.37 indicates relatively high prediction accuracy.
- The out-of-sample R<sup>2</sup> of 87.36% signifies excellent performance in predicting unknown data.

- The portfolio predicted error of -1.01% shows a slight optimistic forecast of future trends.

In November, the CSPI Ratings' model appears sensitive to year-end market activity, reflecting awareness of cyclical events, particularly anticipating a surge during the holiday sales period. The optimistic bias suggests a positive outlook on upcoming business activities.

### Back-testing Results for December 2023

Out-of-sample Back-testing Results (December 2023)				
	Bias	RMSE	Out of sample R <sup>2</sup>	Portfolio Predicted Error
<b>CSPI Ratings' Model</b>	149.99	10165.11	83.19%	1.12%

- A bias of 149.99 indicates slight underestimation.
- The RMSE remains relatively low, indicating good predictive accuracy.
- The out-of-sample R<sup>2</sup> slightly decreased to 83.19%, yet it still indicates strong predictive performance.
- The predicted change percentage of 1.12% suggests a relatively conservative forecast for December.

Entering December, the CSPI Ratings' model shows some reversal in its predictions, reflecting flexibility in adjusting to market changes. It seems to adopt a more cautious prediction strategy, considering the potential market fluctuations due to holiday season and year-end settlements.

### Back-testing Results for January 2024

Out-of-sample Back-testing Results (January 2024)				
	Bias	RMSE	Out of sample R <sup>2</sup>	Portfolio Predicted Error
<b>CSPI Ratings' Model</b>	-427.67	10941.03	84.77%	-2.85%

- A bias of -427.67 shows overestimation, but the accuracy remains relatively high given the RMSE.
- The RMSE of 10941.03 demonstrates the model's continued accuracy.
- An out-of-sample R<sup>2</sup> of 84.77% confirms strong predictive capability.
- The predicted change percentage of -2.85% indicates an optimistic trend.

The January analysis reveals that the CSPI Ratings' model faces challenges at the beginning of the new year, showing an overly optimistic trend. This may result from not adequately considering post-holiday market adjustments or reflecting positive expectations for post-holiday market recovery.

### Back-testing Results for March 2024

Out-of-sample Back-testing Results (March 2024)				
	Bias	RMSE	Out of sample R <sup>2</sup>	Portfolio Predicted Error
<b>CSPI Ratings' Model</b>	-311.77	12995	82.98%	-2.07%

- The bias of -311.77 indicates systemic overestimation, albeit less severe than in January.
- An RMSE of 12995 suggests increased discrepancies, leading to a slight decline in prediction accuracy.
- The out-of-sample R<sup>2</sup> of 82.98% remains strong in explaining unknown data.
- The predicted change percentage of -2.07% indicates a slight optimistic trend.

In March, the CSPI Ratings' model appears to balance its predictions better, possibly correcting the overly optimistic forecast of January. The model's adaptability shows effective absorption and learning from previous fluctuations.

#### Back-testing Results for April 2024

Out-of-sample Back-testing Results (April 2024)				
	Bias	RMSE	Out of sample R <sup>2</sup>	Portfolio Predicted Error
CSPI Ratings' Model	122.39	13335	92.53%	0.80%

- A bias of 122.39 indicates slight underestimation.
- An RMSE of 13335 remains relatively low, indicating high predictive accuracy.
- An out-of-sample R<sup>2</sup> of 92.53% shows excellent performance in predicting unknown data, significantly improved from previous months.
- The predicted change percentage of 0.80% suggests accurate forecasting of future trends with minimal error.

In April, the CSPI Ratings' model continues to show high adaptability to market changes. The back-testing results indicate that despite the slight underestimation, the model maintains low bias and RMSE, reflecting high predictive accuracy. The consistently high out-of-sample R<sup>2</sup> demonstrates strong explanatory power for unknown data. The April predictions further indicate improved accuracy, showcasing the model's robustness and reliability in various economic environments.

#### Forecasting Revenue Cash flows of the DRO Portfolio for May 2024

The table presented below contains the forecasted revenue cash flows for the DRO portfolio, for the month of May 2024. The out-of-sample forecast provides valuable insights into both the effectiveness of the forecasting model and the behavior of the asset class.

Out-of-sample Forecasting Revenue Cash Flows of the DRO Portfolio for May 2024		
	Number of DROs	Forecasting Revenue Cash Flows of the DRO Portfolio (RMB)
CSPI Ratings' Model	10,703	144,487,414

## Conclusion

The back-testing analysis of CSPI Ratings' Revenue Cash Flow Forecasting Model demonstrates its robust predictive capabilities and reliability in forecasting the revenue cash flows of DRO portfolios. The model's performance, as evidenced by key metrics such as bias, RMSE, out-of-sample R<sup>2</sup>, and portfolio prediction error, highlights its ability to provide accurate predictions and adapt to changing market dynamics. The consistently high out-of-sample R<sup>2</sup> values and low portfolio prediction errors underscore the model's strong explanatory power and significant out-of-sample predictive accuracy. Moreover, the model's ability to accurately forecast the revenue cash flows of DRO portfolios suggests that, despite the inherent uncertainties associated with individual small businesses, their collective revenue streams exhibit predictable patterns that can be effectively captured by a well-designed forecasting model. These findings have important implications for investors, financial institutions, and risk management strategies, enabling more informed decision-making, efficient pricing, and effective diversification techniques in the realm of small business finance.

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