Dear Editors and Reviewers,

Thank you for your comments and the opportunity to revise our manuscript. This document contains our point-by-point responses (in blue) to your comments (in black). We believe the manuscript has improved significantly and hope that it addresses the review team's concerns. The major changes to the manuscript are as follows:

Major Changes to the Manuscript

1. **Improving Writing Efficiency and Quality.**
    a. We have edited our writing to improve its efficiency and quality and have reduced the length of the main manuscript to 26 pages (excluding the references and appendix material).
2. **Improving Figure Quality**
    a. We edited all figures to improve quality and clarity. Additional changes to specific figures were made as requested by the reviewers.
3. **Incorporating Multivariate Time Series Features**
    a. As suggested by the second reviewer, we have included features designed for multivariate time series, namely, the first five eigenvectors of the cross-series correlation matrix. We recomputed all results for the M3 data with these features included in the feature selection process. We found that these new features were almost never selected for swapping, and that our results remain consistent with what we presented in our previous version of the manuscript.

Associate Editor Comments:

The authors have done a good job overall in accommodating the reviewers' comments as well as their feedback. I believe there should be a route for publication of that paper. However, as also mentioned by one of the reviewers, the paper is very long. The authors should look into potential ways to shorten it. The message can certainly be conveyed as efficiently by cutting and rephrasing some parts of the paper.

Thank you for your feedback and helpful comments. As mentioned in Major Changes to the Manuscript #1, we have significantly reduced the length of the paper to more efficiently convey our findings.

In addition, please make sure you place emphasis on the quality of the figures, to make sure they are not too small, easily readable, etc.

Thank you. We have addressed this comment, as mentioned in Major Changes to the Manuscript #2.

Reviewer 1 Comments:

The authors have very satisfactorily addressed all my concerns, and the new version of the paper is very much improved. Some minor suggestions would be the following:

Thank you for your feedback. We hope the following changes are satisfactory and we appreciate your enhancements of our manuscript.

I am worried that the changes of MAE are dominated by time series of larger magnitude. How did the author calculate the percentage?

We report the percentage change in mean forecast error (MAE) across all series and forecasting models for each privacy method. Suppose we have J time series and M forecasting models, giving us $J \times M$ forecasts for both the unprotected and protected versions of the time series data. Letting MAE^o and MAE^p denote the mean absolute error of the forecasts from the original and protected versions of the time series, respectively, we calculated

$$\%\ Change\ MAE = (MAE^p - MAE^o)/MAE^o \times 100.$$

Per your comment, we performed this calculation for the time series with large vs. small magnitudes (defined using the median of the actual values from the forecasted time period $T + 1$). These results are shown in the table below, which is included in the appendix and is mentioned in the footnote on page 15 of the main text. While the small magnitude time series tend to have smaller increases in forecast error, none of the privacy methods consistently maintain forecast accuracy at acceptable levels of privacy risk, regardless of time series magnitude, which is consistent with the conclusion based on our previous results.

Privacy Method	Parameter	Magnitude	Accuracy (% Change MAE)
Unprotected	-	Small	0%
	-	Large	0%
Additive Noise	$s = 2$	Small	239.4%
		Large	338.5%
Differential Privacy	$\epsilon = 1$	Small	622.9%
		Large	761.5%
k-nTS	$k = 3$	Small	160.1%
		Large	165.0%
k-nTS+	$k = 3$	Small	126.5%
		Large	128.8%
k-nTS+ (k = 3)	$M = 1.5$	Small	81.1%
		Large	99.9%

Table 13: Percentage change in MAE for small and large magnitude time series (defined using the median of the actual values from the forecasted time period $T + 1$).

Figure 2: The presentation should be improved, for example, letter capitalization, typography...

We have carefully adjusted Figure 2 to improve its presentation. Notable changes are as follows:

- Adjusted placement of all lines and polygons to improve typography and reduce figure size.
- Center aligned text in all polygons.
- Capitalized the first word of all text descriptions.
- Removed the "Original Data Set" polygons immediately following both the "YES" and "NO" branches since this object was already referenced in the first "X = Time series to forecast" polygon.

Figure 12: The authors should focus on the computation time of k-nTS+ process, and the forecasting models such as RNN, ARIMA should be omitted.

Thank you for the suggestion, we have adjusted Figure 9 (previously Figure 12) to focus on the computation time of the *k*-nTS+ process.

A little proof-reading would be beneficial.

Thank you. We have carefully proof-read the paper, and we hope that you find our changes to be satisfactory.

Reviewer 2 Comments:

Reviewer 2: The reviewer appreciates the effort of the authors to improve their paper. However, there are still a few issues.

Thank you for your helpful comments. We hope the changes described below have addressed your concerns. Thank you for helping us improve our manuscript.

The paper is long, and the presentation/analysis of results should be more concise.

Thank you for this suggestion. As per Major Changes to the Manuscript #1, we have improved the writing efficiency and quality, reducing the length of the main text to 26 pages.

The swapping method swaps data to maintain features like mean, kurtosis, etc. None of these metrics is designed for multivariate time series data. For example, are the cross-correlations considered/maintained?

Thank you for pointing this out. As per Major Changes to the Manuscript #3, we included the first five eigenvectors of the cross-series correlation matrix as additional features and re-performed the protection process for the M3 data sets. This is mentioned in Section 4.2.1 on page 14. Overall, our results did not change substantively and our conclusions remain the same (the cross-correlation features were rarely selected for swapping by *k*-nTS+).

We also include an analysis in Section 8 of the appendix showing the mean absolute change in cross-correlation coefficients going from the unprotected to protected M3 data sets. The results are shown in the table below.

Privacy Method	Parameter	Mean Absolute Change
Additive Noise	$s = 1.5$	0.45
	$s = 2.0$	0.50
Differential Privacy	$\epsilon = 4.6$	0.39
	$\epsilon = 1.0$	0.57
k-nTS	$k = 3$	0.32
	$k = 5$	0.34
k-nTS+	$k = 3$	0.28
	$k = 5$	0.29
k-nTS+ (k = 3)	$M = 1.0$	0.16
	$M = 1.5$	0.21
VAR Simulated	-	0.45

Table 18: Mean absolute change in cross-series correlation coefficients between protected and unprotected original M3 series.

Of the protected series with acceptable privacy, the bounded *k*-nTS+ ($k = 3, M = 1.5$) protected series produced the smallest mean absolute difference in cross-series correlations (approximately 0.21). By comparison, the VAR-simulated series had a mean absolute difference of 0.45. The distributions of the cross-correlations for the unprotected, AN ($s = 1.5$), DP ($\epsilon = 4.6$), *k*-nTS+ ($k = 3, M = 1.5$), *k*-nTS ($k = 3$), and VAR-simulated protected series are shown in the Figure below which is found in Section 8 of the appendix. The VAR-simulated series produced the largest

distortion in the distribution of cross-correlations with 50% of the correlations being approximately equal to one. The other privacy methods reduced the strength of cross-correlations towards zero, with the k-nTS+ ($k = 3, M = 1.5$) cross-correlation distribution being most similar to that of the unprotected series.

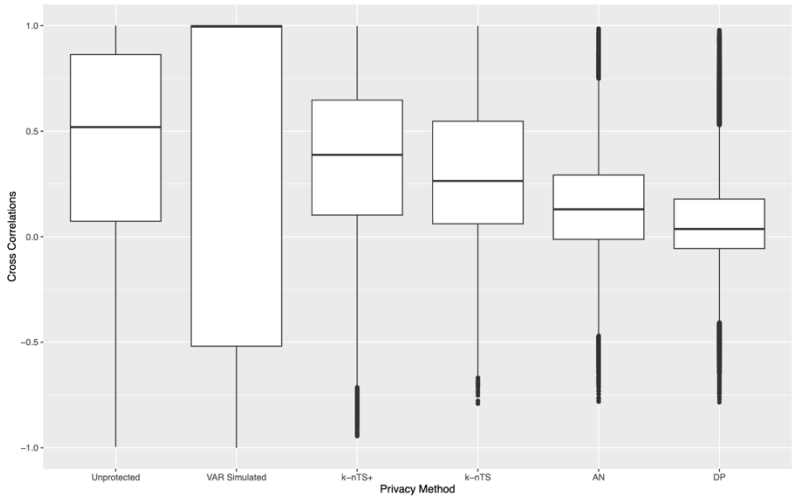

Figure 13: Distributions of cross correlations for the original unprotected and protected M3 series. Values shown are for AN ($s = 1.5$), DP ($\epsilon = 4.6$), k-nTS+ ($k = 3, M = 1.5$), k-nTS ($k = 3$), and the VAR-simulated series.

Detailed comments:
- Page 3: I would represent both time series in the same plot, e.g., using different point types and colors. The same for Fig. 6, Fig.8.

Thank you, we have made the suggested changes. The new plots are Figure 1 (pg. 2) and Figure 6 (pg. 21).

- Page 4: Please clarify the contributions: authors wrote their proposal is the "[...] first to produce protected time series data with both acceptable privacy and usable forecast accuracy." This sentence should be more precise because, e.g., the "Privacy-preserving distributed learning for renewable energy forecasting" method also protects time series data, while maintaining the accuracy of the VAR model. However, their method cannot be applied to nonlinear models like neural networks.

We appreciate the suggestion and apologize for the initial ambiguity. We have revised the statement (found in the last paragraph on pg. 2) to reflect that our method enables sharing of an entire protected data set, rather than just model parameters or lagged values, and is not restricted to specific forecasting models. It now reads:

"To the best of our knowledge, this paper is the first to produce a protected time series data set with acceptable reidentification levels and usable forecast accuracy. Importantly, our method enables

entire protected time series to be shared with forecasters, rather than model weights or forecasts only, and can accommodate any forecast horizon, accuracy metric, or forecasting model."

- Page 6: "Luo et al. (2018) simulated data integrity attacks and found that multiplicative noise". Revise this sentence; their noise is additive.

Thank you, we have changed our statement (first paragraph, pg. 4) to reflect this.

- Page 22: Table 3 measures % Change MAE, compared to what?

Table 3 measured the % change in MAE (averaged across the SES and DES forecasting models and across all time series) when forecasting using the protected data relative to forecasting using the unprotected data. This table is now found in Section 3.1 of the appendix, and we added details of the MAE calculation to the table description. We also made sure to mention how the % MAE was calculated in the text when relevant for other tables.

- Tables 8 and 9: I would merge these two tables; for each column, the authors could have the value for original and rate data.

Thank you for the idea, we have merged the tables as suggested (shown below) which can be found on page 16 in the manuscript.

Privacy Method	**Parameter**	$\bar{P}$		$\bar{P}^f$		**Accuracy (% Change MAE)**		**Accuracy (% Change MAE) Original Scale**
		Original	*Rate*	*Original*	*Rate*	*Original*	*Rate*	*Rate*
Unprotected	-	98.4%	98.4%	18.4%	2.5%	0%	0%	0%
Additive Noise	$s = 1.5$	11.1%	7.3%	5.9%	1.9%	218.7%	23.7%	80.0%
	$s = 2$	8.0%	3.4%	4.8%	1.7%	298.7%	35.6%	131.3%
Differential Privacy	$\epsilon = 4.6$	15.7%	10.3%	6.9%	2.0%	209.4%	29.6%	826.1%
	$\epsilon = 1$	3.7%	1.4%	2.6%	1.7%	705.9%	186.5%	-
k-nTS	$k = 3$	3.5%	4.5%	2.6%	1.4%	163.0%	8.1%	21.4%
	$k = 5$	3.7%	4.2%	2.3%	1.5%	178.5%	8.8%	23.5%
k-nTS+	$k = 3$	5.2%	7.8%	3.0%	1.5%	127.9%	6.1%	19.3%
	$k = 5$	4.7%	6.5%	2.9%	1.4%	143.6%	6.7%	21.3%
k-nTS+ ($k = 3$)	$M = 1$	14.3%	30.6%	5.2%	1.6%	74.4%	6.5%	17.4%
	$M = 1.5$	8.2%	15.1%	4.3%	1.6%	92.3%	7.4%	18.2%

Table 4: Identification disclosure risk and forecast accuracy for the unprotected and protected original and rate M3 data sets.

- Table 9: "s" parameters for additive noise are not the same as in Table 8.

Thank you for pointing this out, this has been addressed in the table shown above.

- Section 5: a sentence is missing to explain the organization of the content

Since we have restructured most of the paper, our section numbering (and content) has changed significantly. We have included descriptions at the beginning of the major sections 3 (methods) and 4 (simulation and empirical application) to explain the content organization.

- Section 5.2 is about time series features, and Section 5.7 is also about time series features. I recommend merging both sections.

Thank you for the recommendation. As we mentioned above, the section numbering and content has changed significantly. We now include a brief mention of the features used in the protection process in Sections 4.1 (the implementation details for the Simulation analysis) and 4.2.1 (the implementation details for the M3 and M4 analysis). Section 4.2.5 contains a significantly shorter description of the results of the feature selection process and Section 4.2.6 specifically examines how time series features change after privacy protection.

- Page 5: typo "error (MASE) values of the error" remove "of the errors"
- Page 6: typo "MASE on the M, M3, and M4" > M should be M1
- Page 16: typo "subsections 4.4 and 4.4"
- Equations (10) and (11): the metrics defined are represented with the same nomenclature (bar(P))

Thank you for catching these mistakes. We have either corrected or deleted these statements in the revised manuscript.