**Mean absolute percentage error**

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The **mean absolute percentage error** (**MAPE**), also known as **mean absolute percentage deviation** (**MAPD**), is a measure of prediction accuracy of a forecasting method in [statistics](https://en.wikipedia.org/wiki/Statistics), for example in [trend estimation](https://en.wikipedia.org/wiki/Trend_estimation). It usually expresses accuracy as a percentage, and is defined by the formula:

M = 1 n ∑ t = 1 n | A t − F t A t | , {\displaystyle {\mbox{M}}={\frac {1}{n}}\sum \_{t=1}^{n}\left|{\frac {A\_{t}-F\_{t}}{A\_{t}}}\right|,}

where *At* is the actual value and *Ft* is the forecast value.

The difference between *At* and *Ft* is divided by the Actual value *At* again. The absolute value in this calculation is summed for every forecasted point in time and divided by the number of fitted points *n*. Multiplying by 100 makes it a percentage error.

Although the concept of MAPE sounds very simple and convincing, it has major drawbacks in practical application [[1]](https://en.wikipedia.org/wiki/Mean_absolute_percentage_error#cite_note-tofallis2015-1)

* It cannot be used if there are zero values (which sometimes happens for example in demand data) because there would be a division by zero.
* For forecasts which are too low the percentage error cannot exceed 100%, but for forecasts which are too high there is no upper limit to the percentage error.
* When MAPE is used to compare the accuracy of prediction methods it is biased in that it will systematically select a method whose forecasts are too low. This little-known but serious issue can be overcome by using an accuracy measure based on the ratio of the predicted to actual value (called the Accuracy Ratio), this approach leads to superior statistical properties and leads to predictions which can be interpreted in terms of the geometric mean.[[1]](https://en.wikipedia.org/wiki/Mean_absolute_percentage_error#cite_note-tofallis2015-1)

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**Alternative MAPE definitions**

Problems can occur when calculating the MAPE value with a series of small denominators. A singularity problem of the form 'one divided by zero' and/or the creation of very large changes in the Absolute Percentage Error, caused by a small deviation in error, can occur.

The difference with the original formula is that each Actual Value (At) of the series is replaced by the average Actual Value (Āt) of that series. Hence, the distortions are smoothed out. This alternative is still being used for measuring the performance of models that forecast spot electricity prices.[[2]](https://en.wikipedia.org/wiki/Mean_absolute_percentage_error#cite_note-2)

Another variant is the sum of absolute differences is divided by sum of actual values. Sometimes, it is referred as WAPE.

**Issues**

While MAPE is one of the most popular measures for forecasting error, there are many studies on shortcomings and misleading results from MAPE.[[3]](https://en.wikipedia.org/wiki/Mean_absolute_percentage_error#cite_note-3) First the measure is not defined when the actual value is zero, A t = 0 {\displaystyle A\_{t}=0} . Moreover, MAPE puts a heavier penalty on negative errors, A t < F t {\displaystyle A\_{t}<F\_{t}} than on positive errors.[[4]](https://en.wikipedia.org/wiki/Mean_absolute_percentage_error#cite_note-4) To overcome these issues with MAPE, there are some other measures proposed in literature:

* [Mean Absolute Scaled Error](https://en.wikipedia.org/wiki/Mean_Absolute_Scaled_Error) (MASE)
* [Symmetric Mean Absolute Percentage Error](https://en.wikipedia.org/wiki/Symmetric_Mean_Absolute_Percentage_Error) (sMAPE)

**See also**

* [Least absolute deviations](https://en.wikipedia.org/wiki/Least_absolute_deviations)
* [Mean absolute error](https://en.wikipedia.org/wiki/Mean_absolute_error)
* [Mean percentage error](https://en.wikipedia.org/wiki/Mean_percentage_error)
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**External links**

* [Mean Absolute Percentage Error (MAPE)](http://www.gestiondeoperaciones.net/proyeccion-de-demanda/error-porcentual-absoluto-medio-mape-en-un-pronostico-de-demanda/)
* [Errors on percentage errors](http://robjhyndman.com/hyndsight/smape) - variants of MAPE

**References**

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  Jorrit Vander Mynsbrugge (2010). "Bidding Strategies Using Price Based Unit Commitment in a Deregulated Power Market", K.U.Leuven

  Hyndman, Rob J., and Anne B. Koehler. "Another look at measures of forecast accuracy." International journal of forecasting 22.4 (2006): 679-688.

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