Foundational idea of forecasting :

Robust accurate forecasts are made when future conditions are like past conditions

The heART of forecasting

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dd/mm/yyyy

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Agenda

Some lectures about the time series

The basics, forecast and error

The Zeta CUP case

The Zeta sales model

From yearly to monthly forecasting

The heART of forecasting

Some lectures about the time series

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Some lectures about the time series General considerations

Topic
Formulating Time Series Problems
A Visual Introduction
Data Considerations and Assumptions
The Very Basics. Got the Time?

Some lectures about the time series Measure of the errors

Topic
MAE Forecast Accuracy (mean absolute error)
MASE Forecast Accuracy (mean absolute scaled error)
sMAPE Forecast Accuracy (symetric mean absolute percentage error)
RMSE Forecast Accuracy (root mean square error)

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Some lectures about the time series Measure of the errors

Topic
Basic Concepts and the Naïve Forecast
Introduction to Moving Averages (3MA), A Visual Guide
Weighted Moving Averages, A Visual Guide
Exponential Moving Average, A Visual Guide
Linear Trend Projection, A Visual Guide
Quadratic Trend Projection, A Visual Guide
Holt Double Exponential Smoothing, A Visual Guide with Excel Solver

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The heART of forecasting

The basics, forecast and error

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The basics

What do we need for the forecast ?

- You have monthly national data, IQVIA and Internal, I recommend to use internal month BE
  - The ratio IQVIA / Internal is not always constant, a brutal change in the ratio needs to be clarified
- If we have the sales per hospital :
  - KAMs to perform a forecast per hospital : **Σ forecast(hospitals) >< your forecast ?**
- Follow the activity of the competitors
  - Data presentation at congresses, Market access development, Samples, CUP, …
- The silent knowledge
  - Stimulate the FF to gain competitive insights, HCP's are sensitive to visits from management…

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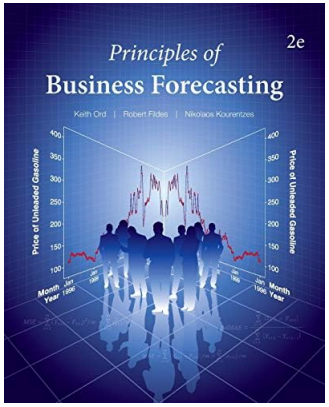
The basics

The PHIVE concept
(Ord, Fildes, Kourentzes 2017)



- Purpose : what is the reason or purpose for generating the forecast ?
  - Business decision, supply chain, investments ? …
- Horizon : how far in the future do we wish to forecast and why ? Tolerance for uncertainty ?
  - Do we need 10y data or 3y ? Weekly, monthly or yearly data ?
- Information : what is available and what are its characteristic's ?
  - Public ? Proprietary ? Accurate ? Automatic ? Manual ? Clean ? Dirty ? Gaps ?
- Value : what are the challenges of an accurate forecast ?
  - Weather forecast to mow the lawn >< health models for vaccine production
- Evaluation : is the forecast effective and what do we have to adapt in our model ?
  - Iterative reviews and adjustments make the forecast more accurate >< fiddling around

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The basics

Other data considerations

- Domain knowledge is crucial ! And the context too !
  - What data to collect ? how to collect it ? How to interpret it ? What to do with the findings ?
  - What kind of forecast was already done, with which outcome ?
  - Are there lagged indicators (a harbinger) that can be used to significantly improve the forecast ?
- Data quality
  - Missing values ? Corrupt values ? Measures inconsistent from period to period ? Data source ? Cross-check possibility ?
- Time frequency
  - Month ➔ weeks ↗ noise
    weeks ➔ month ↘ resolution !
- Specificity
  - Too specific ➔ zero counts
    not enough specific ➔ erase distinctions

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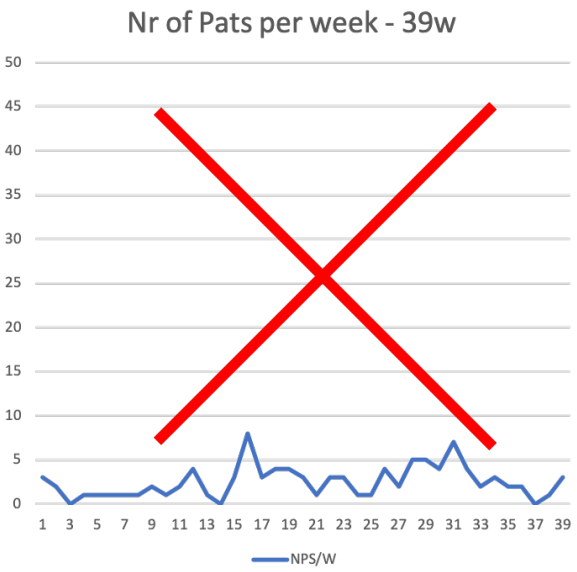
The basics

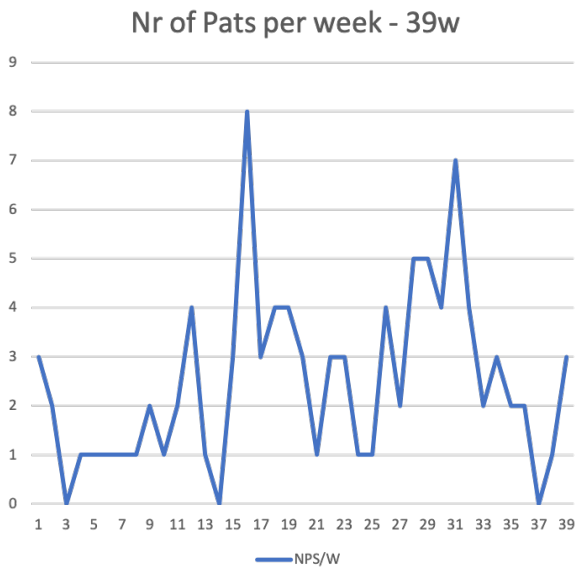
Don't look at the data as is

	NPS/W
14/10/2022	3
21/10/2022	2
28/10/2022	0
04/11/2022	1
11/11/2022	1
18/11/2022	1
25/11/2022	1
02/12/2022	1
09/12/2022	2
16/12/2022	1
23/12/2022	2
30/12/2022	4
06/01/2023	1
[illegible]	[illegible]
[illegible]	[illegible]
27/01/2023	8
03/02/2023	3
10/02/2023	4
17/02/2023	4
24/02/2023	3
03/03/2023	1
[illegible]	[illegible]
17/03/2023	3
24/03/2023	1
31/03/2023	1
07/04/2023	4
14/04/2023	2
21/04/2023	5
28/04/2023	5
05/05/2023	4
12/05/2023	7
19/05/2023	4
26/05/2023	2
02/06/2023	3
09/06/2023	2
16/06/2023	2
23/06/2023	0
30/06/2023	1
07/07/2023	3

Look at the data with a graph …



…with the right scale



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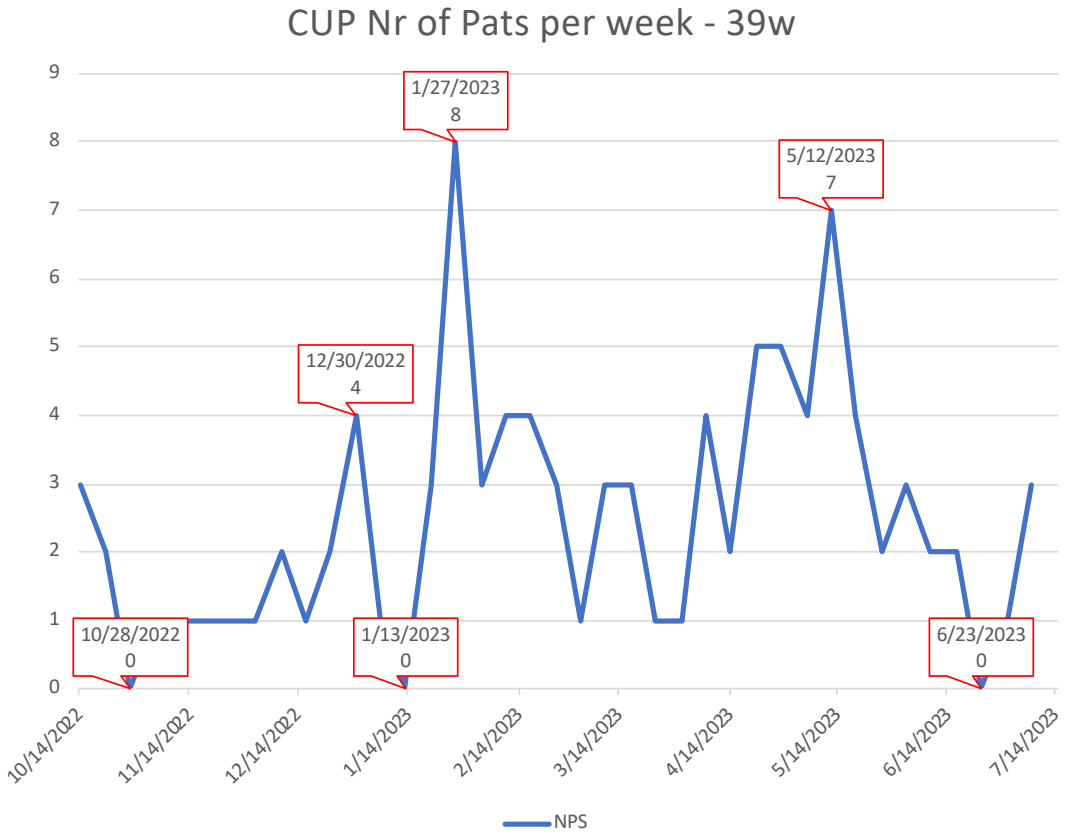
The basics

Do we have an explanation for the peaks ? Holidays ? Congress ? Examination period ?



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The basics
Different forecast methods

Naïve forecast : the forecast t+1 F(t+1) will be the value t V(t) and so on

- F(t+1) = V(t)…F(t+2) = V(t+1) …
- With that, you assume that nothing will change and that the best forecast for the next period is just what you achieved at the last period

Moving average forecast : the forecast at the time t+3 will be the average of the 3 last known values

- F(t+3) = [V(t) + V(t+1) + V(t+2)]/3
- With that calculation, you take into account a little bit more the historical values
- BUT this method cannot correctly reflect a trend as it is always minimizing the ↗ or ↘ on the 3 values

Weighted moving average forecast : instead of giving the same weight to the 3 previous values, WMA will give different weights – you can adapt yourself - to the 3 previous values to better reflect the trend

- From
- 1/3 x V(t) + 1/3 x V(t+1) + 1/3 x V(t+2) to
- 1/6 x V(t) + 2/6 x V(t+1) + 3/6 x V(t+2), if trend ↗
- 3/6 x V(t) + 2/6 x V(t+1) + 1/6 x V(t+2), if trend ↘

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The basics
Different forecast methods

- **Exponential smoothing** : the forecast t+1 will be the value t. The forecast t+2 will be a mix of the forecast t+1 and the value t+1
  - You take into account the historical values AND the recent ones
  - $F(t+2) = \alpha \times V(t+1) + (1-\alpha) \times F(t+1)$
    - The greater α, the greater the importance of the recent value
    - The greater $1-\alpha$, the greater the importance of the historical values
  - If $\alpha = 1$ then $F(t+2) = V(t+1)$ (naïve forecast)
    If $\alpha = 0$ then $F(t+2) = F(t+1)$ … is a constant value equal to V(t)
  - The art of this forecast is to find the best α : the one that will minimize the errors… coming soon
  - This method suits best for STATIONARY time series

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The basics
Different forecast methods

- **Holt exponential smoothing** : This is double exponential smoothing when the time series is not stationary
  - There will be a parameter α to take into account the LEVEL
  - There will be a parameter β to take into account the TREND
- **Winters exponential smoothing** : this a triple exponential smoothing when the time series is not stationary and shows seasonality
  - On top of α and β, there will be a parameter γ for the SEASONALITY
  - This method is accessible in Excel → *Data* → *Forecast sheet* (PC)
  - In the options of the sheet → *include the forecast statistics*
  - This will return the 3 values α, β, γ
    AND of crucial importance the errors

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The basics
Different forecast methods

- **Linear regression** : the forecast is a function of 1st degree that best represents all the values at once
  - LR(t) = a x t + b : a is the slope and b a constant (the level when t=0)
  - That model tries to find the best straight line minimizing the distance between the line and the values
  - You can easily extrapolate for future values, this is the Linear extrapolation (LE)
  - This methods suits best for time series with a trend
  - This method does not work well when there is a change of trend (↗ then ↘)

The basics
Different forecast methods

- **Polynomial regression** : the forecast is a function of 2nd degree or higher degree that best represents all the values at once
  - $PR(t) = a \times t^2 + b \times t + c \ldots$
  - That model tries to find the best curve minimizing the distance between the curve and the values
  - There exist a risk of overfitting the values by selecting a curve of 2nd or 3rd degree … that can lead afterwards to aberrant values when extrapolating

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The basics
Different error calculation methods

MAE : Mean Absolute Error

- E(t) = abs(V(t) – F(t)) and so on. Take the average of the sum of all E's
- Easy to interpretate as expressed in the same unit as the data, the smaller the better
- Always calculate the MAE of the naïve forecast …

MASE : Mean Absolute Scaled Error

- MASE = MAE (the forecast method you use) / MAE (naïve forecast)
- The MASE of the naïve forecast is 1 by definition : MAE (naïve forecast) / MAE (naïve forecast)
- If the MASE of your method is >< 1, then your method brings more/less errors than the naïve forecast

SMAPE : Symetric Mean Absolute % error

- Measures what percentage of the « [forecast + value] average » is represented by the MAE
- E(t) = abs(V(t) – F(t)) / (V(t) + F(t))/2 and so on.

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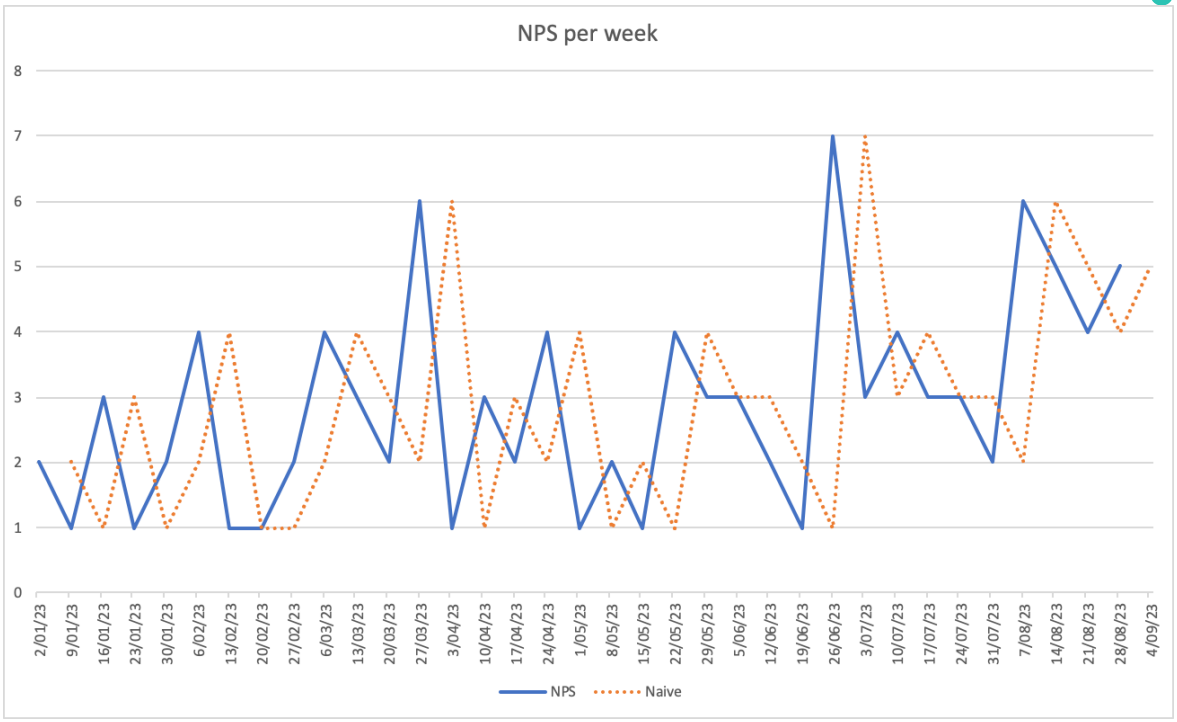
How many patients in the week 04/09 ?

Naïve forecast : 5

MAE = 1,79

MASE = 1

SMAPE = 64%



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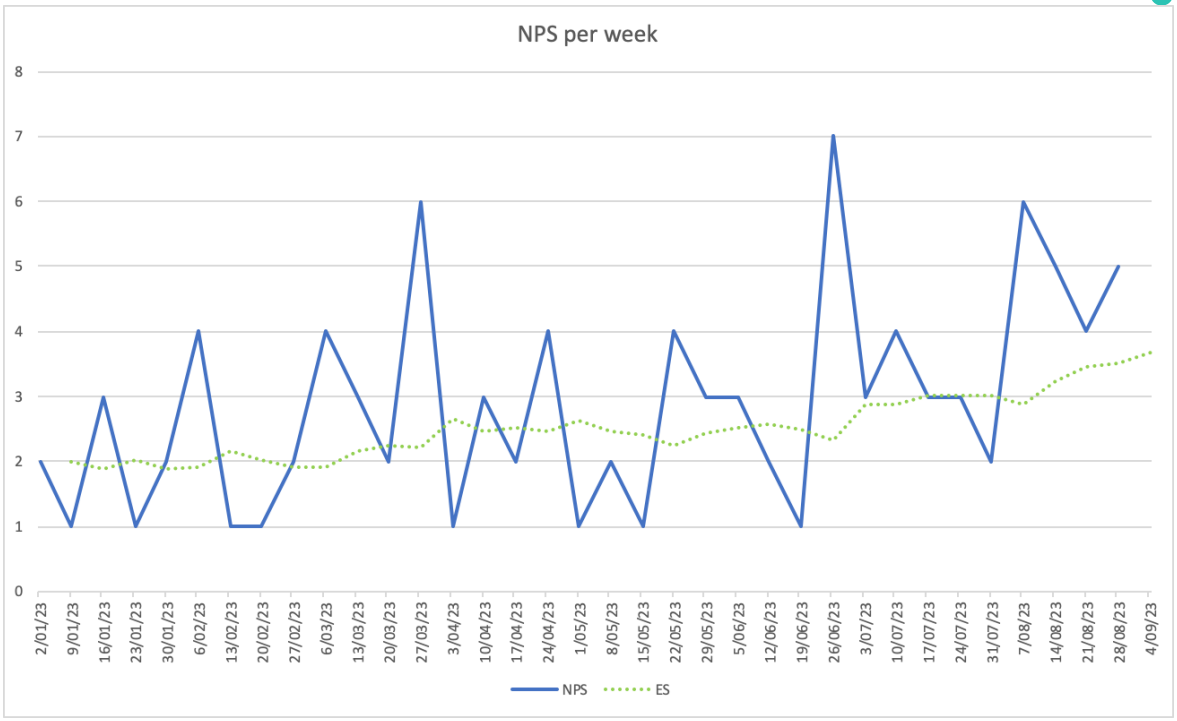
How many patients in the week 04/09 ?

Exponential : 3,7

MAE = 1,21

MASE = 0,67

SMAPE = 45%



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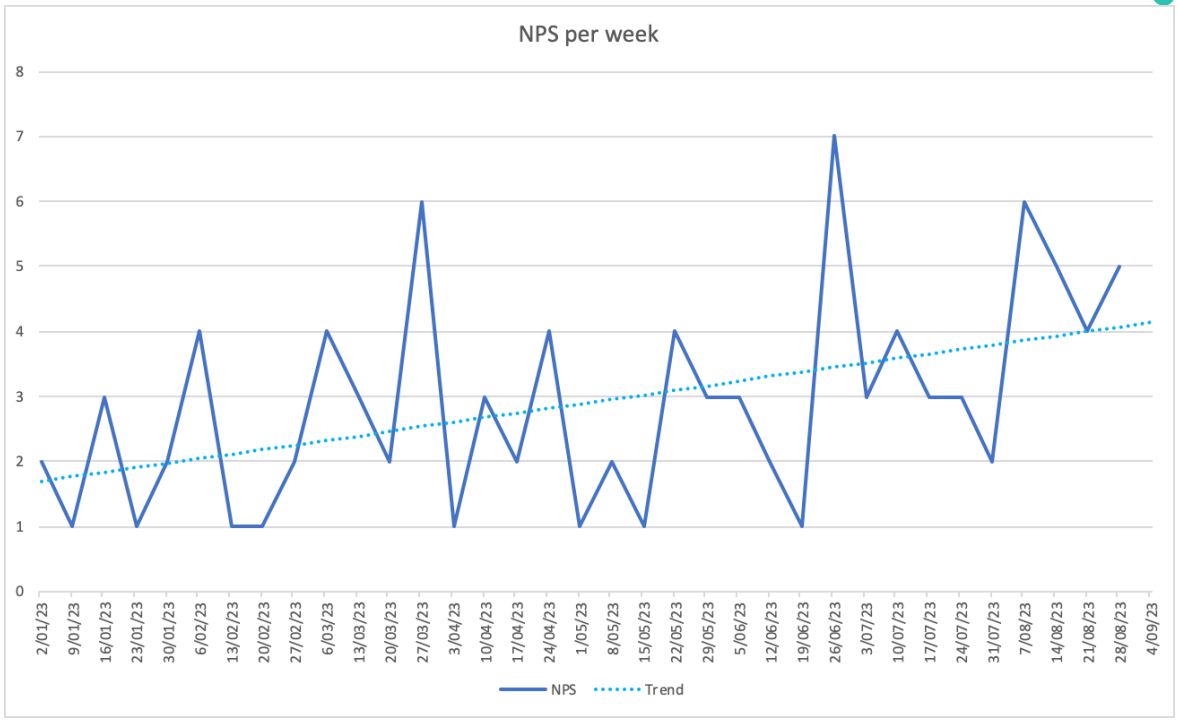
How many patients in the week 04/09 ?

Trend : 4,5

MAE = 1,13

MASE = 0,63

SMAPE = 43%



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The Zeta CUP Case 😉

We planned 150 patients for the Zeta CUP, from 01/23 to 12/23.

After 6 months, we recruited 66 patients

The following question arises to secure the supply of the Zeta boxes :

- How many patients are we going to recruit in our CUP based on the statistics we have until 26/06 ?

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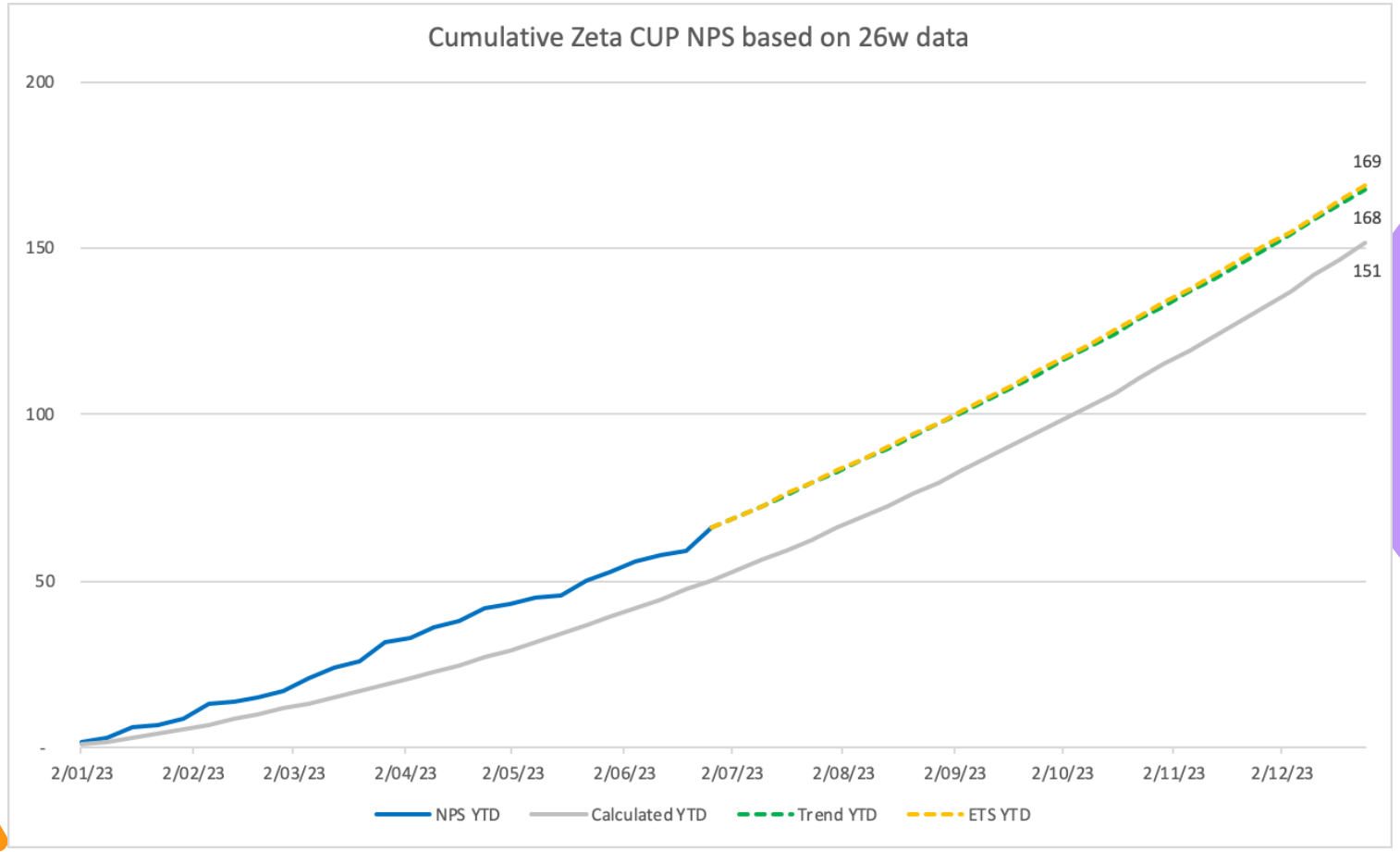
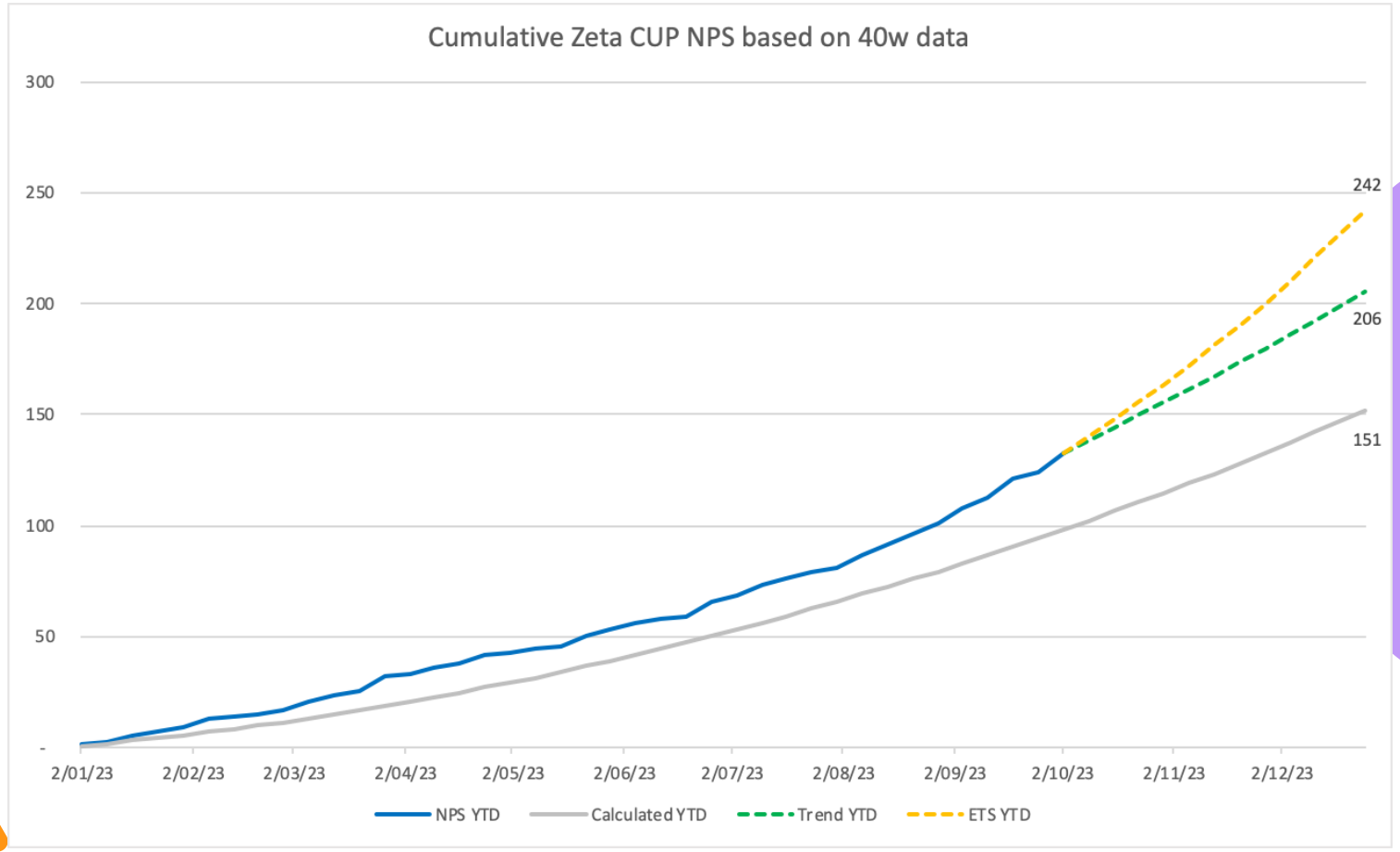


There is no big gap between the 2 estimations (1 units) and the initial forecast of 150 has to be revised upwards.



The 14 new values show an acceleration of the recruitment. The gap between Trend and ETS increases as ETS is more influenced by the most recent data whereas Trend considers the wole dataset

The heART of forecasting

The Zeta SALES CASE

The sales have been excellent since the launch but the 2 last months, the trend is unclear as we face a sudden decrease. We ended at 1837 units vs 1950 planned

- Are we going to reach in 2023 the ambitious objective of 3250 units!

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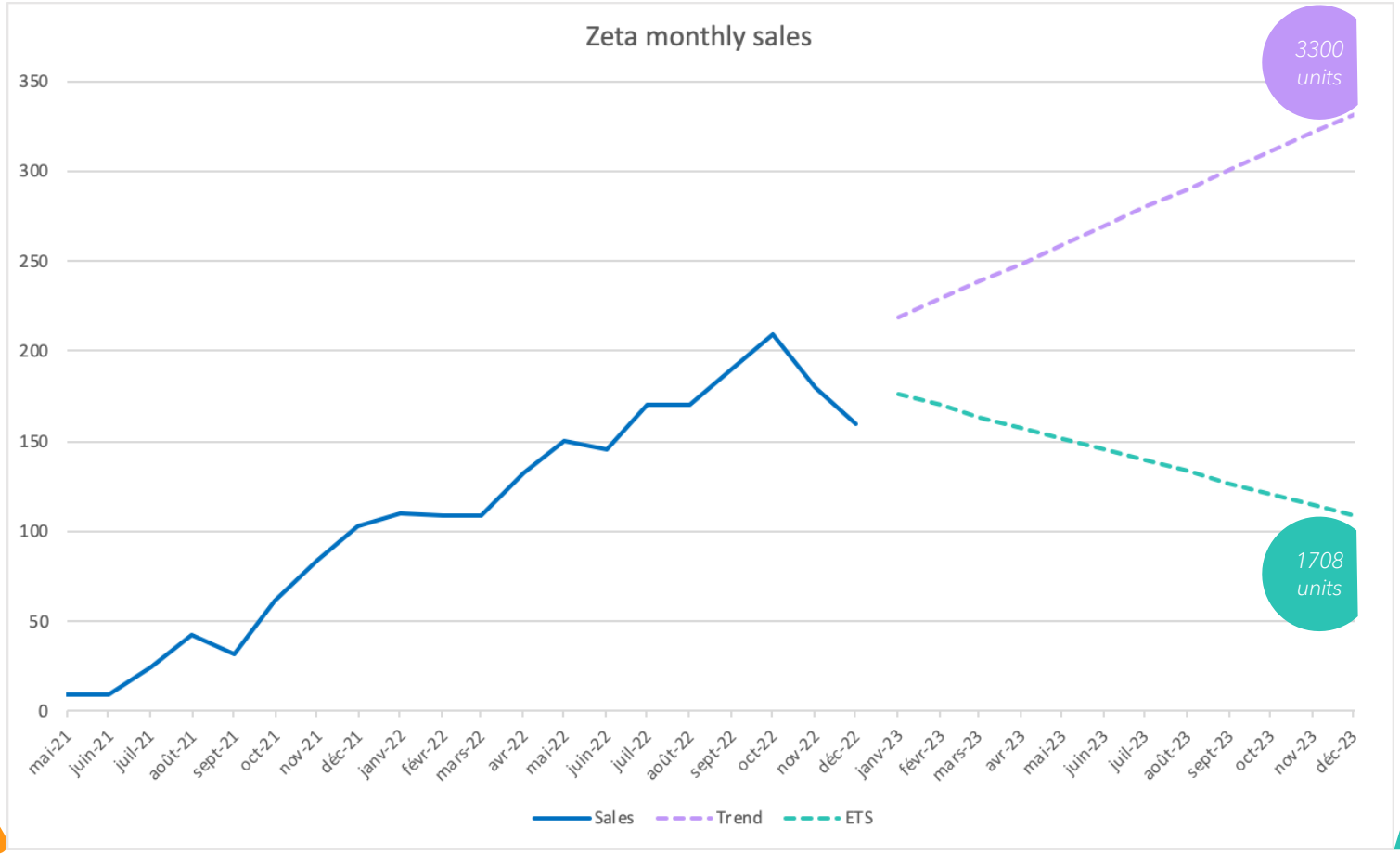


Big gap between both estimations. Again Trend considers the whole dataset and ETS focuses more on the most recent data.

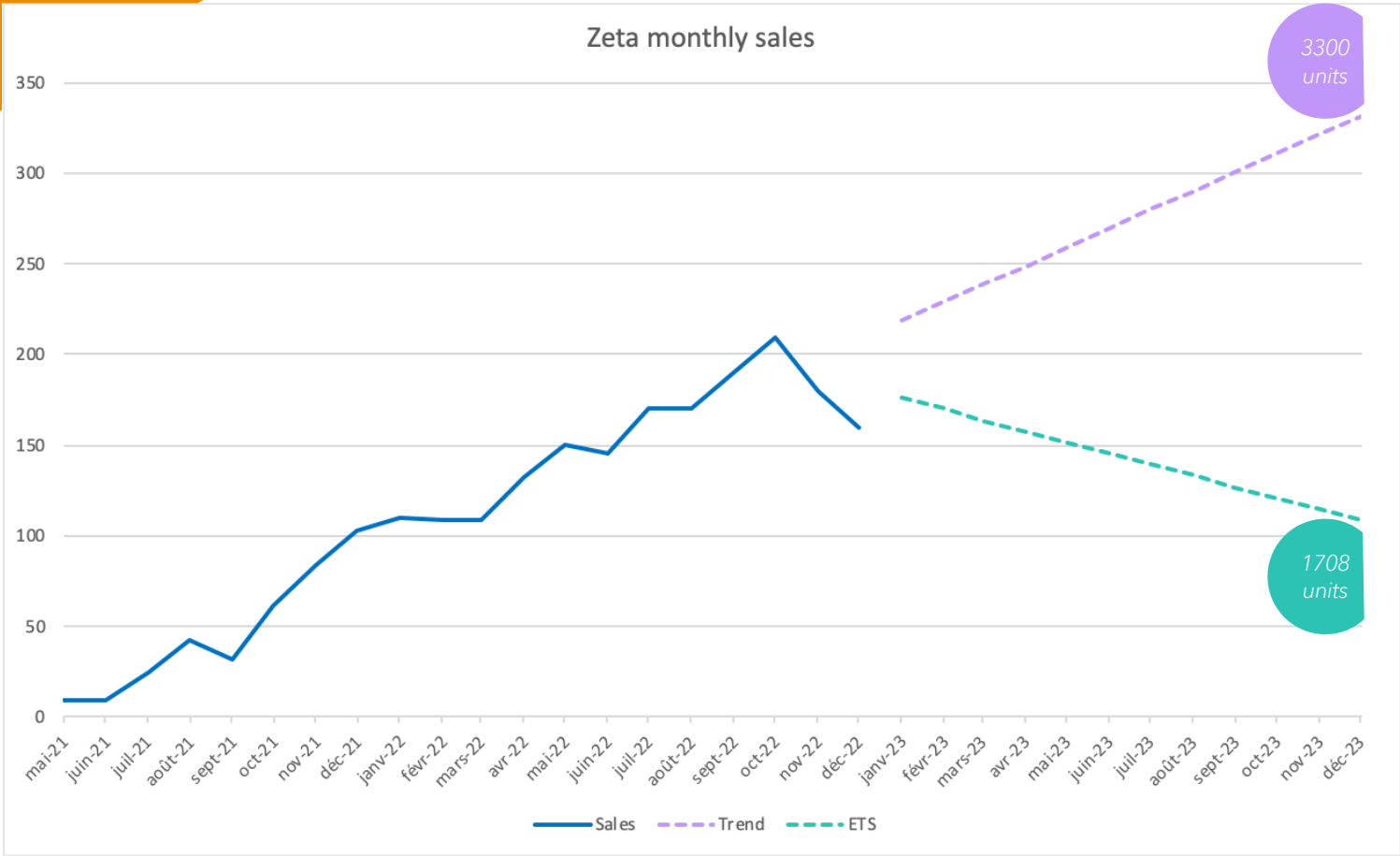
What to decide ?

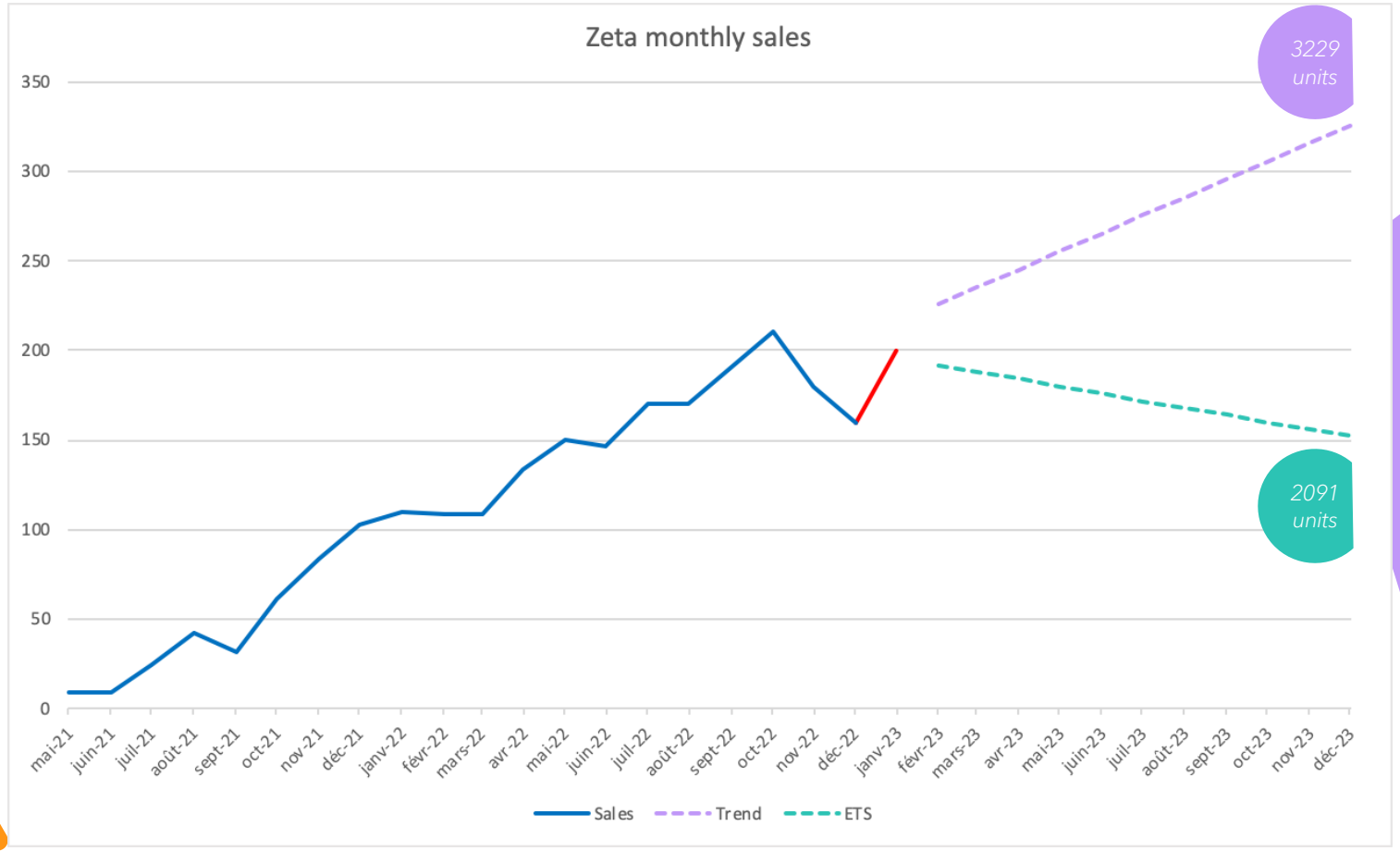
Explanation for the trend of the last 2 months ?

Late ordering in December
with invoicing in January ?

Competitive intelligence ?

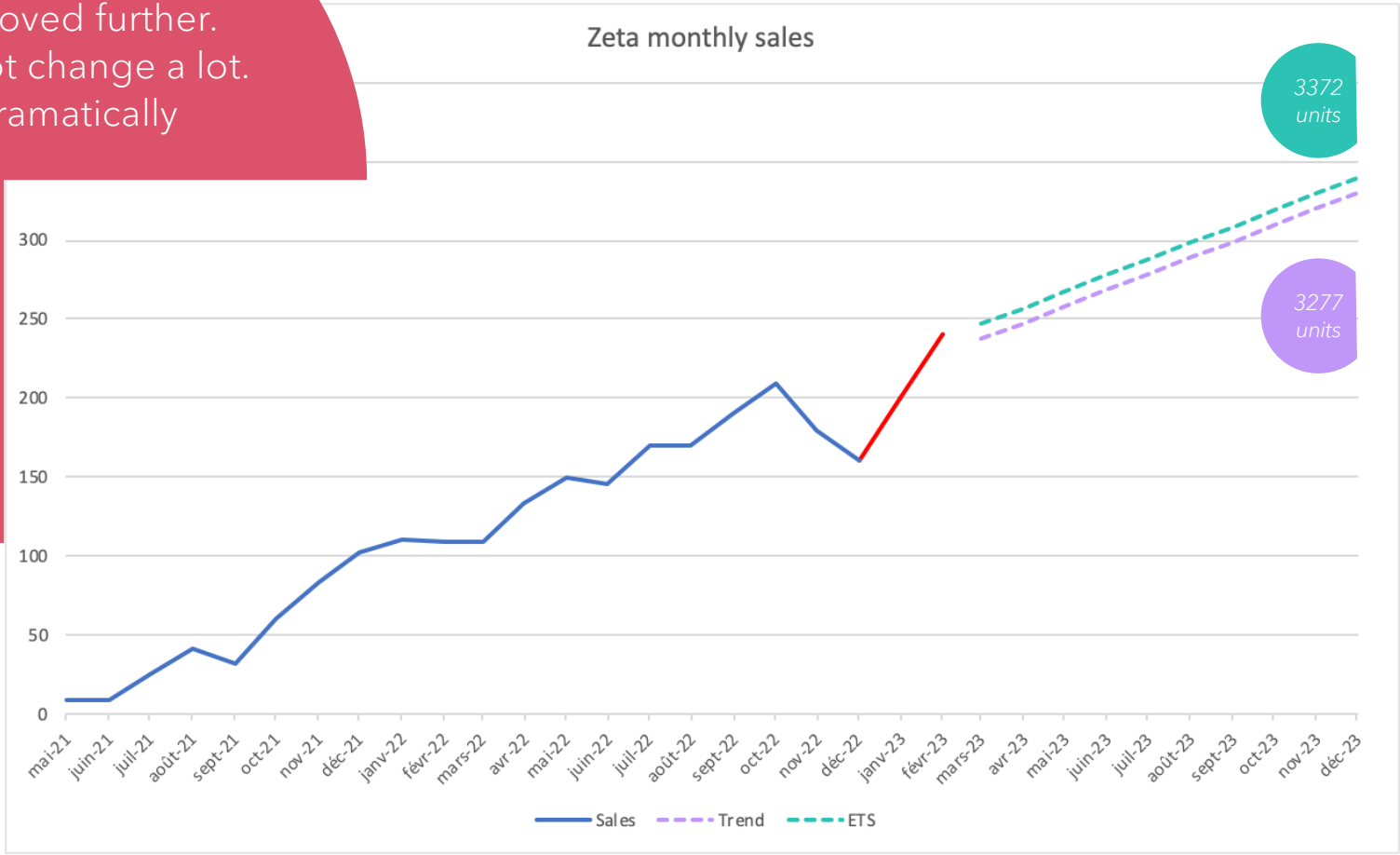
Let us see what happens
1 month later
before deciding !



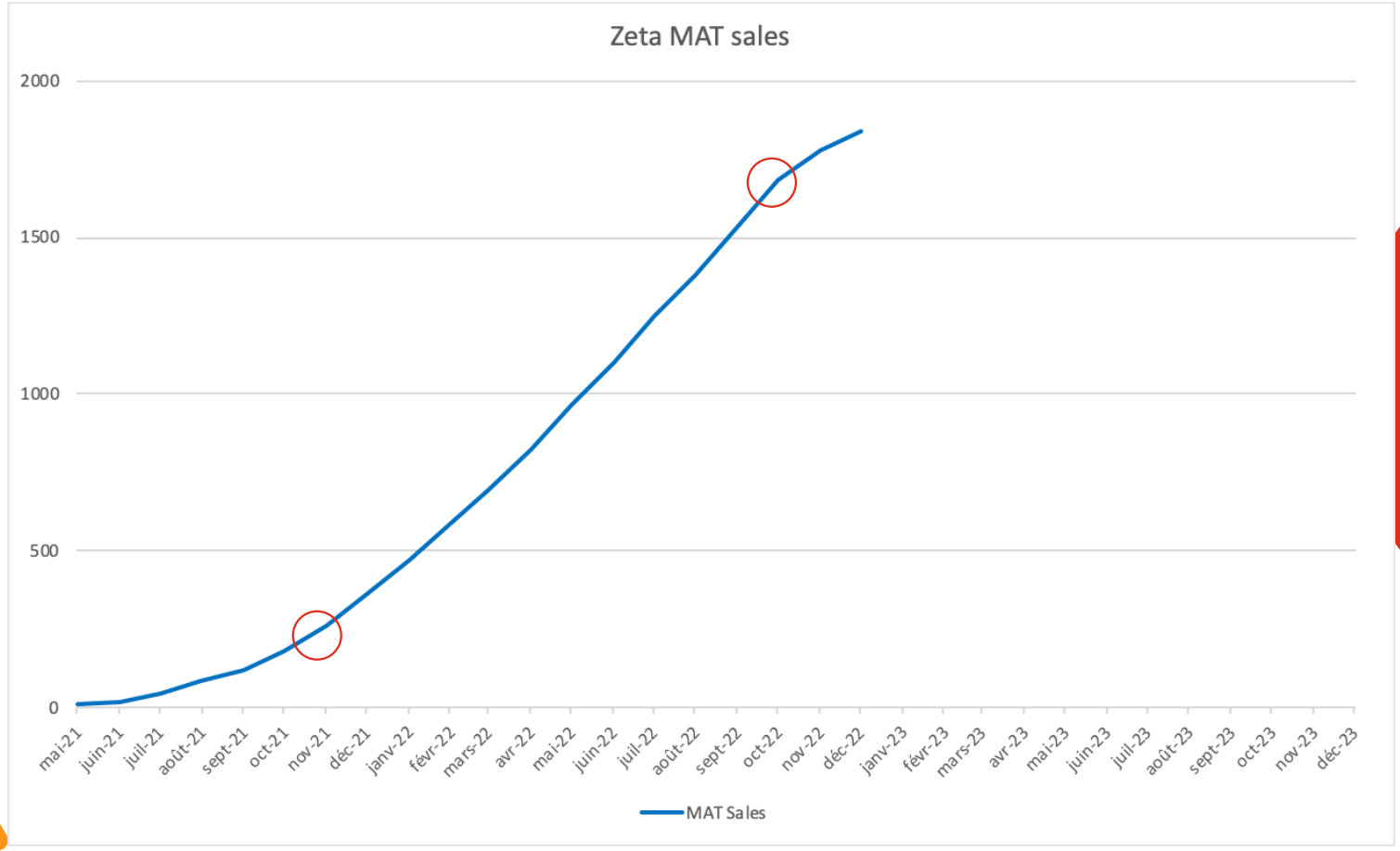


We are 1 month later and January improved. Trend does not evolve much (-71 units). ETS evolves much more due to the improvement in last month (+383 units)

We are 2 months later and February improved further. Trend does not change a lot. ETS evolves dramatically due to improvement in last month (+383 units)

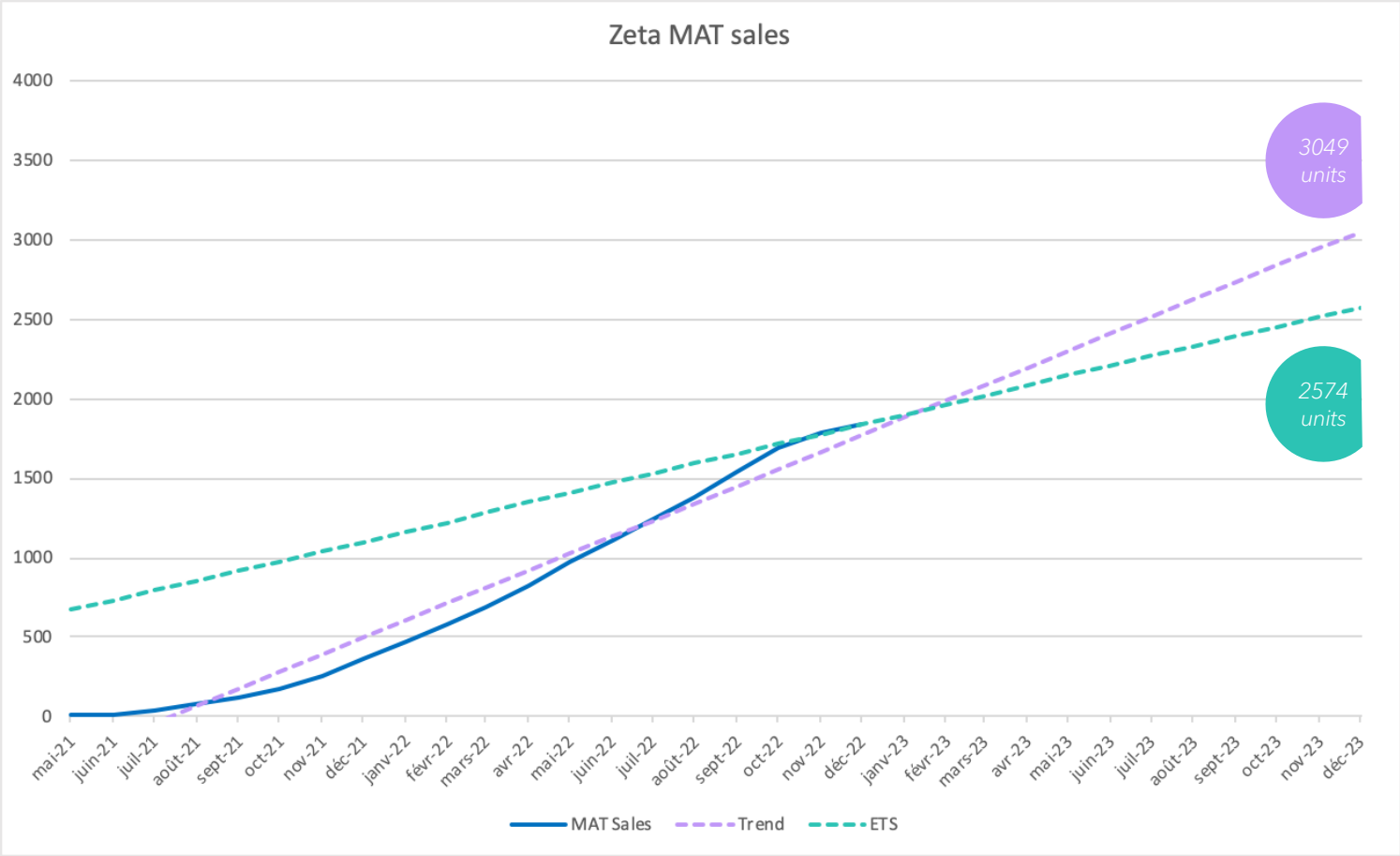


How about trying a different approach ?

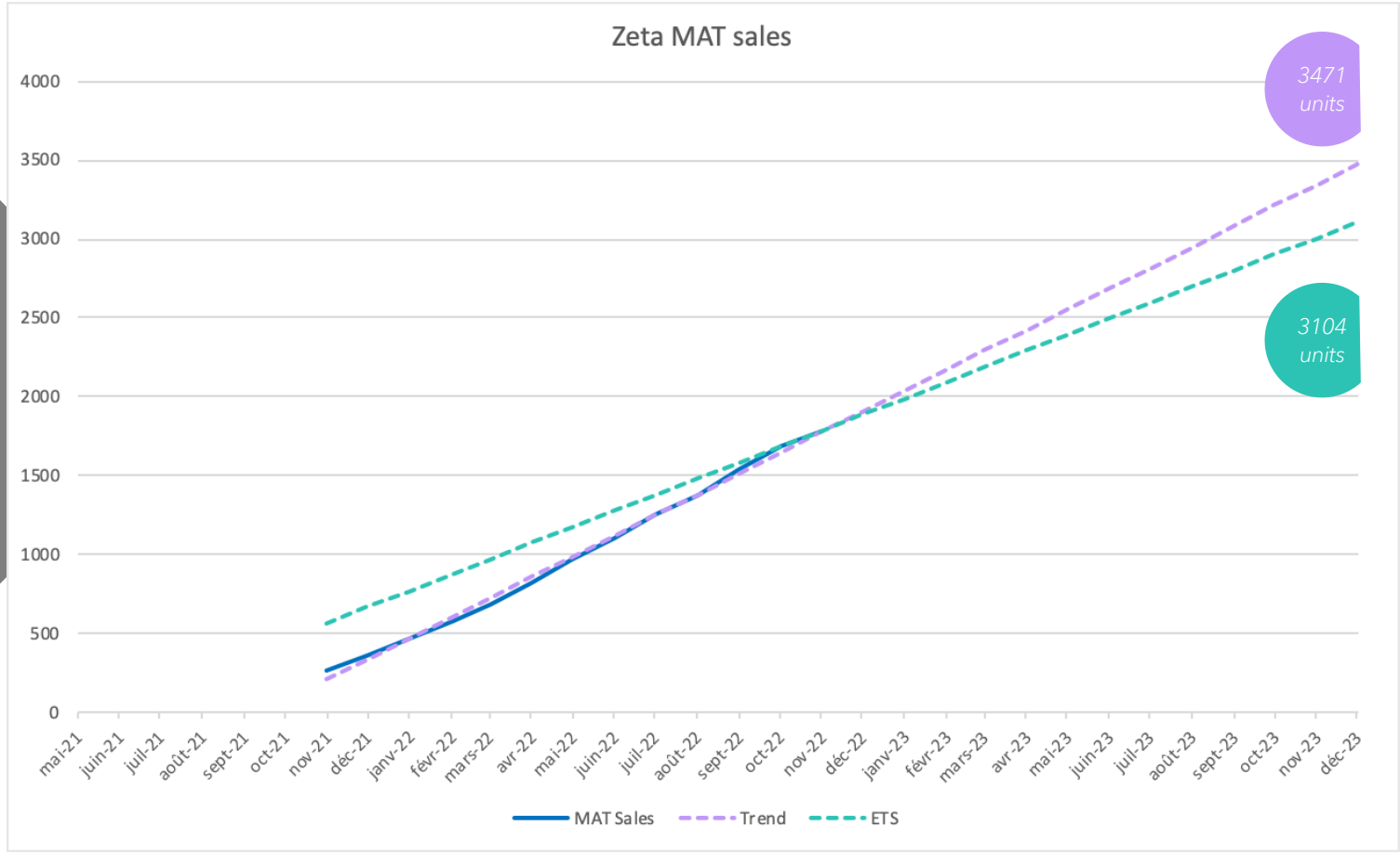


How about trying with the MAT ? Remember, Trend does not like changes of slope and ETS is very sensitive to the last values

Trend ignores the 2 changes of the slope.
ETS considers too much the last values
What to do ?



Eliminate from the calculation the data that looks aberrant, the launch time and 12/22 that is probably linked to a problem of invoicing



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How to go from the yearly forecasting to monthly split ?

This question will frequently arise, when you launch a product or if you anticipate a significant evolution and will most often come from Supply Chain but might come from Business Intelligence to prepare the bonus plan of the fieldforces or from Market Access to prepare a MEA

- How do you proceed ?

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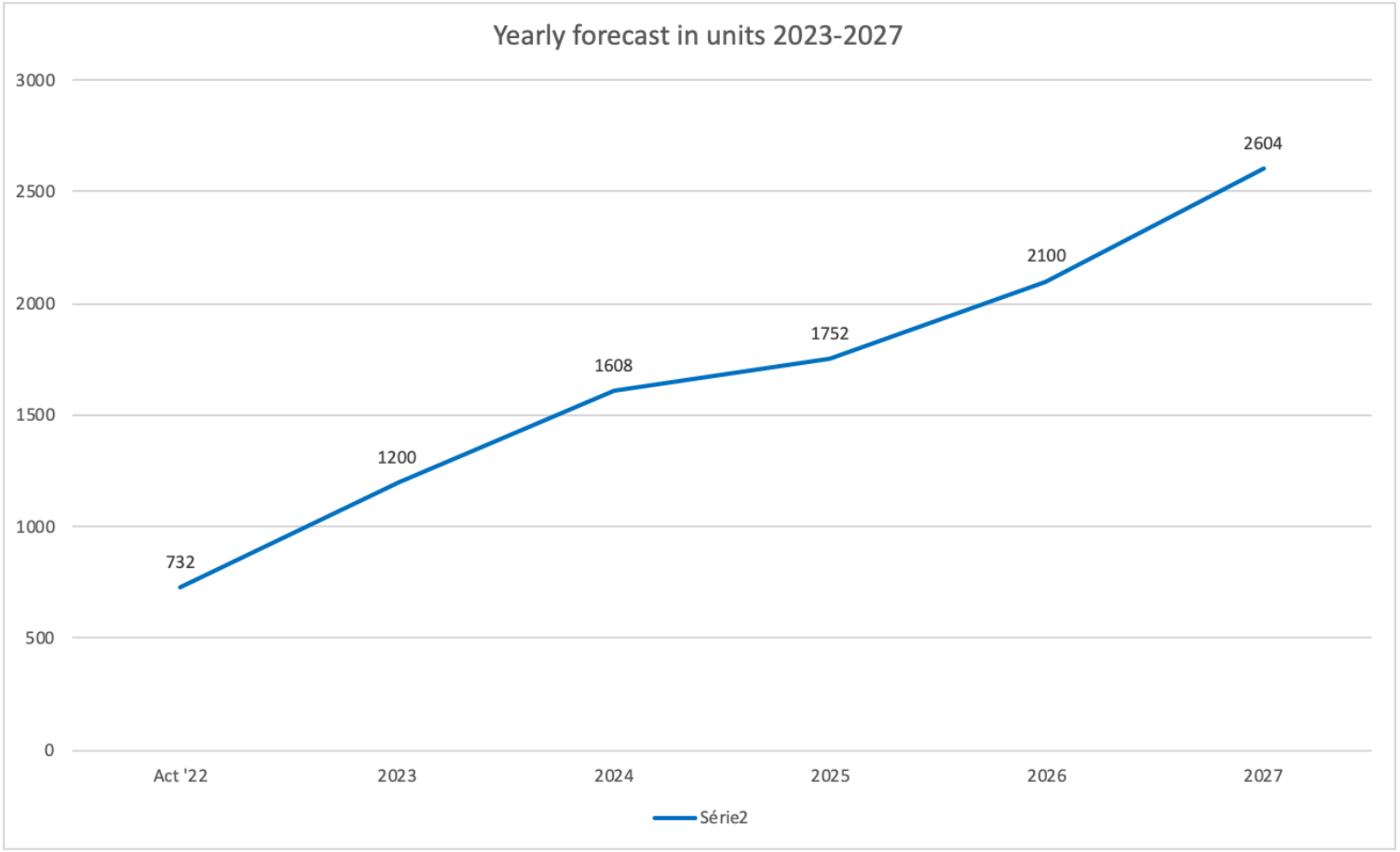
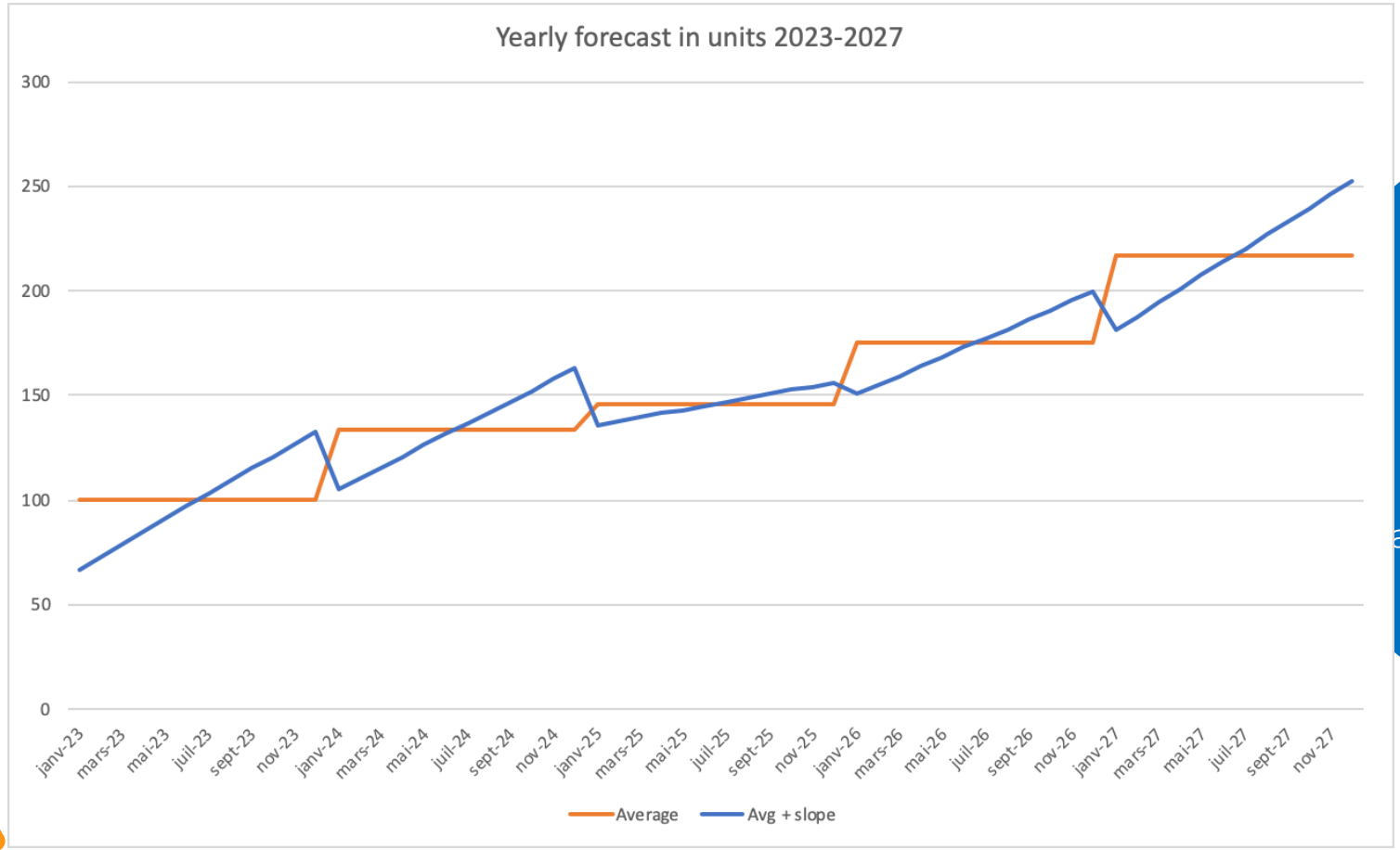
Imagine you have to provide the monthly forecast for this yearly forecast

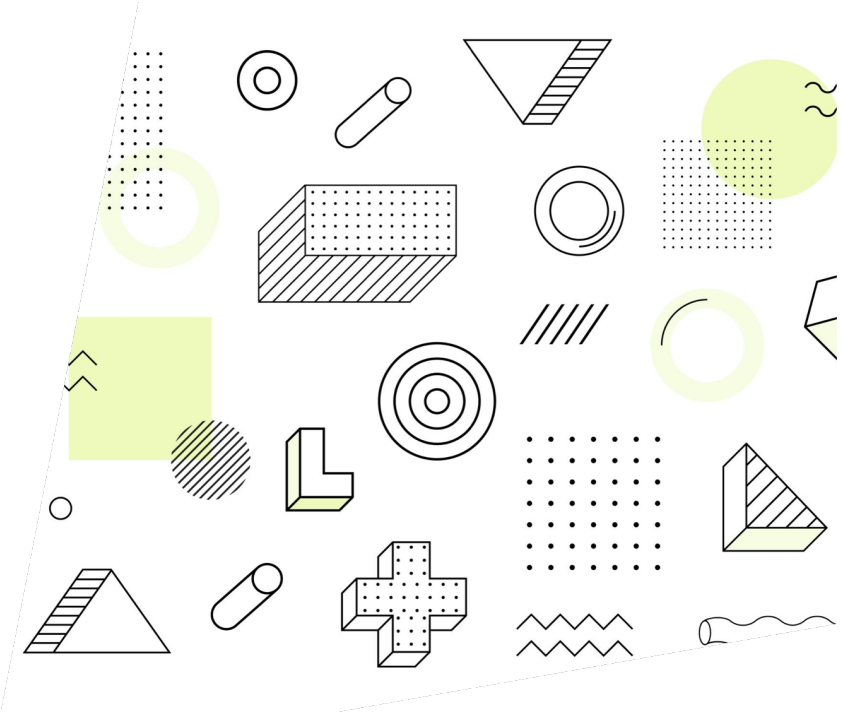


No time, you divide by 12 !
SC produces too much in the beginning and too little at the end of the year.
BI proposes a bonus plan that is not Motivating as Disconnected from the reality



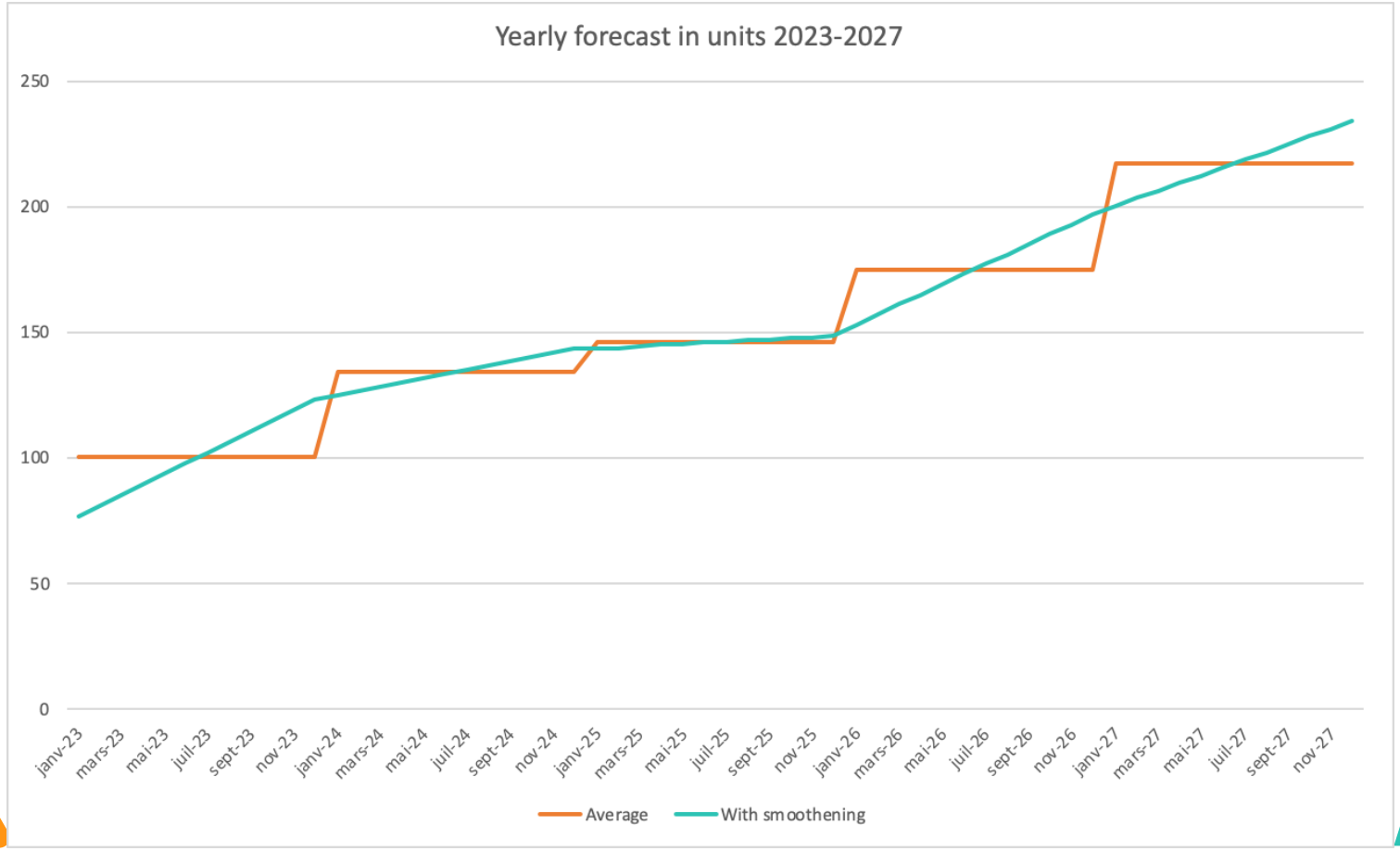
You need to add a slope
It is already a step forward in the good direction.
What kind of slope to avoid irrealistic gaps at year's transition ?

How to smoothen the curve, the recipe of Chef Simon 😉



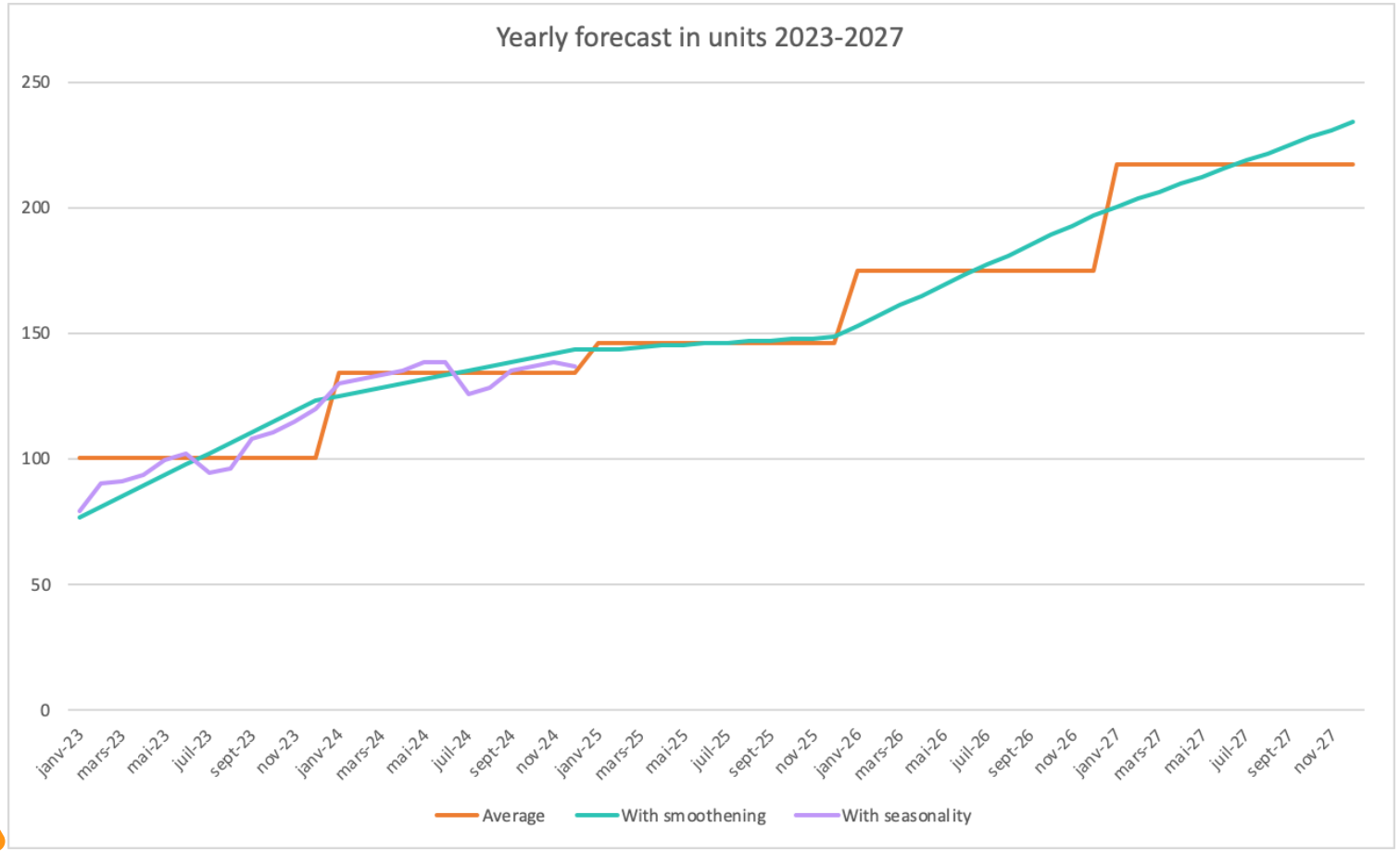
How to smoothen the curve, the recipe of Chef Simon 😉

- Assume that you know the sales of 12/22 : 73 units
- The sales of 2023, w/o any grow vs 12/22 would be 73x12=876 units and you planned 1200 units
- The delta is 1200–876=324 units
- As you grow, you gain new patients (NP) every month, the ones of January will generate 12 units/y. The ones of February will generate 11 units/y and so on
- Finally, 12 NP starting in 2023, 1 per month, will generate 78 units (12+11+10+9+8+7+6+5+4+3+2+1) or 6,5 units per patient per year on the average.
- In 2023, you will gain 324/6,5 NP=49,85
- Assume that you gain the same number of NP/m, you come to 49,85/12=4,15
- For 01/23, add to the value of 12/22, the number of NP/m 73+4,15=77,15
- In 02/23 you gain 4,15 NP on top of what you did in 01/23 77,15+4,15=81,30
- ...
- In 12/23 you gain 4,15 NP on top of what you did in 11/23 118,69+4,15=122,85
- Use this value of 12/23 to restart the same exercise for 2024 and so on



Smoothen the curve according to the model explained above

Add seasonality as needed



Thank you
Questions ?

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