

Research Global

The hidden seasonal layers of PMI

- The PMI index released by S&P has a large effect on financial markets as it gives an early indication of the direction of economic activity. Recently, the correlation to growth has declined, and we analyse whether this is due to the seasonal adjustment method used by the S&P. Further, we show what market participants can learn from the seasonal adjustment method in predicting PMIs and thus markets.
- S&P use both the Census Bureau X12-ARIMA model and a discretionary adjustment to seasonally adjust PMI data (see appendix). The discretionary adjustments tend to be positive in the first half of the year (thereby increasing PMIs) and be negative in the second half for both eurozone and US manufacturing, while eurozone service PMIs are adjusted up in Q2 and Q3 and down in Q1 and Q4.
- In the US, we find that PMIs adjusted by solely an X12-ARIMA model outperforms the combined S&P inhouse discretionary and X12-ARIMA model (the official data) in predicting GDP growth. The difference is largest in the post-pandemic years, where the X12 adjusted PMIs have a 11-percentage point higher correlation to growth.

Using solely the X12 model (i.e. excluding the discretionary factors) for adjustments makes recent service PMIs look weaker and manufacturing PMIs stronger compared to the official data.

Discretionary adjustments does not improve GDP correlation

We first examine whether the PMIs adjusted by both the in-house discretionary model and the X12-ARIMA (i.e. the official data) are better predictors of GDP growth compared to the PMIs adjusted solely by an X12-ARIMA model, in the same quarter. We take quarterly averages of the monthly PMIs and compute the correlation coefficient to quarterly GDP growth. Results are shown in table 1.

Table 1. Correlation coefficients of composite PMIs to quarterly GDP growth

Eurozone	X12	X12+discretionary (official)
Whole sample	54%	53%
Post-2020	81%	85%
Pre-2020	82%	80%
US	X12	X12+discretionary (official)
Whole sample	50%	49%
Post-2020	48%	37%
Pre-2020	29%	23%

Past performance is not a reliable indicator of current or future results.

Source: Danske Bank, Macrobond Financial

Note: Sample is from Q1 2000 to Q2 2024 for the eurozone and from Q3 2009 to Q2 2024 for the US.

In the US, the discretionary adjustments made have worsened the correlation to GDP growth. In the post-2020 years the correlation to GDP of the X12 adjusted data is 11

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percentage points higher, while the difference is 6 percentage points pre-2020. Looking at the whole sample, however, there is not a significant difference in the correlation coefficients. Note also, that the correlation is remarkably low when we evaluate the years prior to 2020.

In the eurozone, the two models have a similar performance. Post-2020 the X12 model combined with discretionary adjustments (the official data) performs slightly better, and vice versa in the years prior to 2020. However, given the statistical uncertainty there is not a compelling case for outperformance of either model. Excluding 2020 altogether significantly improves the correlation between PMIs and GDP growth, however.

In the appendix, we present correlation coefficients split up in service and manufacturing PMIs. The pattern across the two areas is the same, and X12-adjusted US services has a strong outperformance compared to X12-adjusted US manufacturing in the post-2020 period.

Sizable discretionary adjustments in PMIs

Given that the X12-adjusted series in some periods outperforms the X12+inhouse-adjusted series, we now examine how this has affected the reported PMIs. Charts 1-4 present the average in-house-model seasonal components for each month, based on all available data. We conduct separate analyses for services and manufacturing PMIs. It is clear from all four charts that the X12-ARIMA model does most of the adjustment in both regions and for both sectors. However, there are sizable discretionary adjustments made as well.

Eurozone service PMIs are adjusted up in Q2 and Q3, and down in Q1 and Q4, while US service PMIs are adjusted down in H2

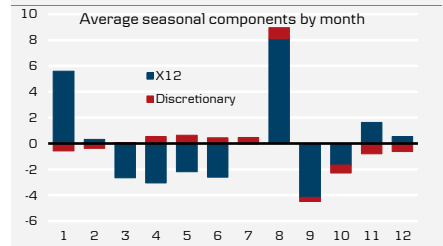
Starting in services, we see that in the eurozone the discretionary adjustments are generally positive in Q2 and Q3, and negative in Q1 and Q4. This means that the inhouse model tends to moderate the seasonality identified by X12. January and August stand out with very large adjustments, and in the latter case the raw data has been increased by, on average, almost 9 units with the majority of the adjustment coming from the X12 model. This is likely due to the EU holiday season. Otherwise, the discretionary adjustments are in the range of -0.5 to 0.5 index points.

In the United States we see that there are positive discretionary adjustments in Q1 and negative adjustments in Q3 and Q4, while Q2 is mixed. In September, the average discretionary adjustment is almost 1-1 disproportionate to the X12 adjustment and is fairly large, at almost -1.5. This suggests that the X12-model is judged to overestimate the drag of seasonality in the latter half of the year, and thus the discretionary adjustments pull the opposite way, lowering US service PMI in September and the second half of the year. Other than in September, the discretionary adjustments are roughly similar to the eurozone in terms of magnitude.

Manufacturing PMIs are adjusted up in H1 and down in H2

In manufacturing, the discretionary adjustments tend to be positive in the first half of the year and negative in the latter half of the year in both regions. They are also slightly smaller – in both directions – than in services. In the eurozone, the discretionary adjustments almost always have a different sign than the X12 adjustments. Thus, in manufacturing the inhouse model also moderates the X12-identified seasonality. The largest discretionary adjustments are made in the latter half of the year, the PMIs are dragged down compared to the X12-adjusted series.

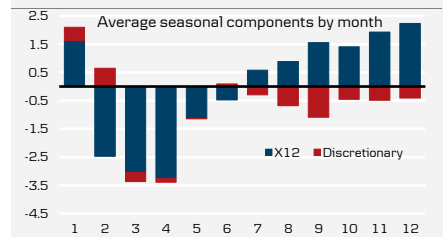
Chart 1. Eurozone services



Source: Danske Bank, Macrobond Financial.

Note: Sample is from 06/1997 to 08/2024

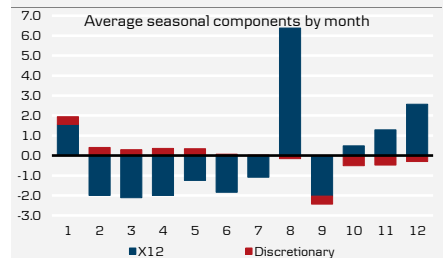
Chart 2. US services



Source: Danske Bank, Macrobond Financial.

Note: Sample is from 10/2009 to 08/2024

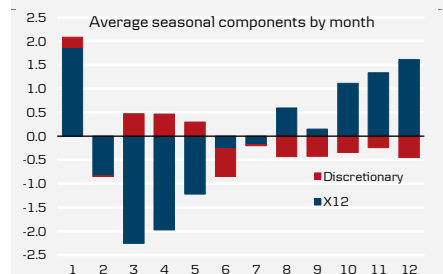
Chart 3. Eurozone manufacturing



Source: Danske Bank, Macrobond Financial.

Note: Sample is from 03/2000 to 08/2024

Chart 4. US manufacturing



Source: Danske Bank, Macrobond Financial.

Note: Sample is from 05/2007 to 08/2024

The magnitudes of discretionary adjustments are more uniform across the year in the United States, but we see the same pattern where the in-house model moderates the seasonality identified by the X12-model. In August the discretionary adjustment almost cancels out the X12 adjustment and in September it has on average had a larger impact than the X12 adjustment – in both cases to make the manufacturing PMI weaker than the raw data suggests.

What would it have meant for the reported PMIs from the last 2 years if there had been no discretionary adjustment?

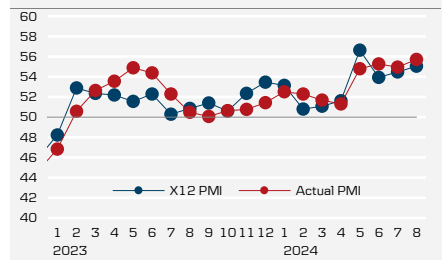
In the US, services have by far the biggest share of GVA (about 70%), and chart 5 suggests that services activity in 2023 would have looked much smoother if it were not for the discretionary adjustments, which made the sector look very strong in the first half of the year and weaker in the second half of the year – in contrast to national accounts data on GVA. There is a particularly large difference in May 2023 where the official print shows 54.8 while the X12 adjusted figure shows 51.5, and vice-versa in December 2023 with the official print at 51.4 versus X12’s 53.4. The latest two prints look slightly weaker when using only the X12 model to adjust for seasonality, at 54.5 for July and 55.1 for August versus the reported 54.9 and 55.7, respectively.

Doing the same comparison but for eurozone manufacturing, in chart 6, reveals that the X12 adjusted data shows a manufacturing sector which is weaker in the first half of 2023 and 2024, and stronger in the second halves, than the official PMIs. The alternative seasonal adjustment does not significantly change the overall picture of a weak manufacturing sector in the eurozone, however. Conversely, in the chart 7 we see how using just the X12-ARIMA model to adjust eurozone service PMIs shows a eurozone service sector that was not contracting in the last half of 2023, and with a generally smoother trajectory over the last 2 years. This is in line with national accounts data showing positive growth in service sector GVA in 2023H2.

Conclusion: keeping an eye on the discretionary adjustments is worth it, particularly in the US

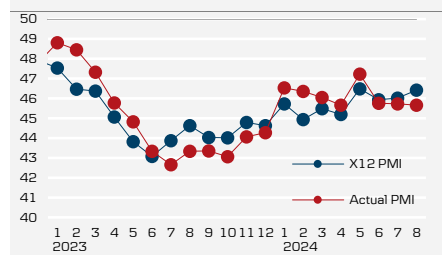
In conclusion, this analysis has found that the S&P’s discretionary adjustments made to raw PMIs do not necessarily improve their correlation to GDP growth. This is most clear in the US in the post-pandemic period, where the composite PMI adjusted by X12 beat the composite PMI adjusted by X12 and the S&P inhouse model in predicting GDP growth. Using just the X12 model reveals a US service sector with a smoother trajectory in the past 2 years, and which is somewhat weaker than reported by the official numbers in recent months. While there is not a stark difference in the X12-adjusted eurozone PMIs and the X12+inhouse-model adjusted eurozone PMIs in predicting GDP growth, using the former model reveals a manufacturing sector that is slightly stronger than recently reported, and a service sector which did not contract in the last half of 2023, in line with national accounts data. We do not argue what seasonal adjustment method is the most correct, but simply highlight that if you want to have an early indicator of GDP, we find a higher correlation by using an X-12 model in the US. Moreover, we the seasonal patterns of the discretionary adjustments can be useful when forecasting and interpreting the numbers.

Chart 5. US services



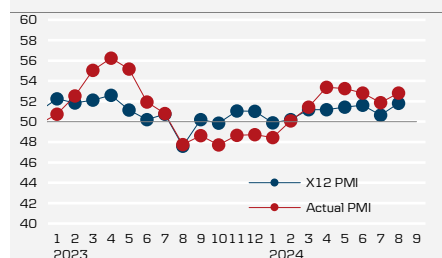
Source: Danske Bank, Macrobond Financial

Chart 6. Eurozone manufacturing



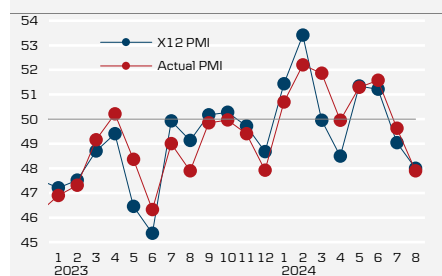
Source: Danske Bank, Macrobond Financial

Chart 7. Eurozone services



Source: Danske Bank, Macrobond Financial

Chart 8. US manufacturing



Source: Danske Bank, Macrobond Financial

Appendix

A methodology

Methodology: Seasonal adjustment of PMIs

The Purchasing Manager's Index (PMI) is a popular tool used by analysts to gauge the direction of economic activity across regions and sectors. PMIs are published for both services and manufacturing, and for a slew of countries and regions such as the United States, the UK and the eurozone. It is a diffusion index based on a survey, meaning that it measures what most participants are reporting. An index above 50 thus means that a majority are reporting improving conditions, and vice-versa. The indices are reported on a monthly basis, and as business conditions are subject to patterns of seasonality, the final indices are seasonally adjusted. In this analysis, we aim to assess how the seasonal adjustment has affected the prints and their correlation to GDP growth, the 'ultimate' measure of economic activity.

In their documentation paper, S&P Global state that the raw indices are seasonally adjusted using a "combination of the Census Bureau X12 ARIMA method and an in-house model...". The Census Bureau X12 ARIMA method was developed by the US Census Bureau and is widely used in statistical bureaus around the world, though has to some extent been replaced by the X-13 ARIMA-SEATS recently. The model adjusts a data series by first adjusting for calendar-, trading day-, and outlier effects using an ARIMA framework for model selection, then decomposing the series into a trend-cycle, seasonal, and irregular component (see Census Bureau, 1998).

The precise model specification and sample period used in both the X12 method and in-house model by S&P are not explicitly mentioned. To gauge the size of the discretionary adjustments made by the in-house model, we have adjusted the raw series using Census Bureau X12-ARIMA method, using all data available. We have then computed the difference between the adjusted series released by S&P Global and the series adjusted by us. The result is then our estimate of the adjustment performed by S&P's in-house model. We will refer to this as the discretionary component of the seasonal adjustment. The difference between the raw PMI data and the series adjusted by just an X12 model is what we refer to as the X12 seasonal component.

We refer to the data adjusted by just the X12 model as X12-adjusted data, and the series adjusted by both X12 and the in-house model as X12+discretionary (official) model-adjusted data. The latter is the data, which is reported in the official PMI releases and shown on Bloomberg and Reuters etc.

B Correlation coefficients

Table B1. Correlation coefficients of PMIs to quarterly GDP growth

Eurozone	Services		Manufacturing	
	X12	X12+inhouse	X12	X12+inhouse
Whole sample	0.60	0.58	0.45	0.43
Post-2020	0.62	0.64	0.80	0.81
Pre-2020	0.70	0.68	0.80	0.78
United States	Services		Manufacturing	
	X12	X12+inhouse	X12	X12+inhouse
Whole sample	0.51	0.49	0.40	0.39
Post-2020	0.53	0.40	0.28	0.21
Pre-2020	0.29	0.23	0.63	0.62

Past performance is not a reliable indicator of current or future results.

Source: Danske Bank, Macrobond Financial

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Report completed: 30 September 2024, 12:30 CET

Report first disseminated: 30 September 2024, 13:00 CET