Seasonal adjustment

with application to quarterly national accounts

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Bulgarian National Bank

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The views expressed in the presentation are those of the author and do not necessarily reflect those of the BNB
Structure of the talk

• What is seasonality?
• How to seasonally adjust in general?
• What is specific about national accounts?
• Options for seasonal adjustment of the national accounts data
• Conclusion
What is seasonality?

- Factors of non-economic nature affect the economic activity and act each year during each of the seasons of the year.
- Thus it is very difficult to assess the economic developments compared to the previous period and we must rely on data further back in the past.
- Economic indicators are also affected by calendar effects and working day effects.
- It may be expected that these factors will continue to act in the same way in the future if the circumstances remain unchanged.
Why seasonally adjust?

• Seasonally adjusted series provide timely information
• Useful for policy making
• Modeling and Forecasting
• Finding turning points in economic developments
How to seasonally adjust?

- The simplest method would be the calculation of a yearly growth rate.
- Works when the seasonal movements are regular with respect to both the *time profile* and the *magnitude* of the seasonal pattern.
Annual growth rate

The following time series exhibit the same yearly growth rate
More advanced methods are needed

• “Naïve” models use moving averages to smooth the data and eliminate the residuals as seasonal factors

• Structural or component models assume that the data generating process can be decomposed into different components which have their specific characteristics
Component models

Additive model
\[ X_t = T_t + C_t + S_t + I_t \]

Multiplicative model
\[ X_t = T_t \times C_t \times S_t \times I_t \]
Component models decomposition
Component models decomposition

Seasonal factors

Trend-cycle
Component models decomposition

The final seasonally adjusted series are the combination of the trend-cycle and the irregular component.
Component models estimation

• Both the additive and multiplicative model assume that the observed series can be split into a number of unobserved components
• Unobserved components can only be indirectly observed by being estimated
• Several statistical packages exist for that purpose:
  • Tramo/Seats – generally used in Europe
  • X-12-Arima – mostly used in North America
• Both packages consist of a number of procedures aimed at estimating the model’s components optimally
• They also provide the possibility of calendar adjustments and outlier detection
Seasonally adjusted GDP - Bulgaria

Source: NSI
Quarterly growth rates

Source: NSI
What is specific about national accounts?

• GDP is specific because it is an aggregate series
• Furthermore, it can be obtained from three different approaches
• It is published on a quarterly and on an annual basis
• Quarterly estimates sum up to annual figures

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Coherence in time
Seasonal adjustment of aggregate series

- Seasonal adjustment of aggregate series can be performed using different approaches
- The *direct method* consists in a *separate* seasonal treatment for each series
- The *indirect method* consists in obtaining the GDP through *summing up* the seasonally adjusted components
- The *multivariate* seasonal adjustment consists in adjusting the series *simultaneously*, thus respecting their *covariance*
Issues

- Economic analysis
- Modeling and Forecasting
Economic analysis

• The seasonally adjusted GDP is informative in itself
• Nevertheless one would normally want to know how much each component contributed to the change in GDP
• We typically analyze GDP through its components
• Final Expenditure Approach, the Production Approach and the Income Approach
Contributions to annual growth – Final Expenditure

Source: NSI, BNB
Contributions to annual growth – Production Approach

% percentage points

Source: NSI, BNB

- Gross domestic product at market prices
- Agriculture, forestry and fishing
- Industry
- Services
- Taxes less subsidies on products
Direct vs Indirect method (1)

Billion BGN, chain-linked volumes

Source: NSI, BNB

GDP - Direct Seasonal Adjustment

Direct vs Indirect method (2)
Direct vs Indirect method (3)

Source: NSI, BNB
Indirect seasonal adjustment and quarterly growth rates

Source: NSI, BNB
Contributions to quarterly growth – Final Expenditure

- Net exports
- Gross capital formation
- Final consumption expenditure of general government
- Household and NPISH final consumption expenditure
- Gross domestic product - Direct Seasonal Adjustment
- Gross domestic product - Indirect seasonal adjustment

Source: NSI, BNB
Contributions to quarterly growth – Final Expenditure

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Contributions to quarterly growth – Production Approach

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- Taxes less subsidies on products
- Services
- Industry
- Agriculture, forestry and fishing

- Gross domestic product - Direct seasonal adjustment
- Gross domestic product - Indirect seasonal adjustment
Contributions to quarterly growth – Production Approach

Source: NSI, BNB
Types of solutions

• *Benchmarking* the components in order to sum up to the direct seasonal adjustment

• *Multivariate seasonal adjustment* in order to stop treating each series separately and obtain GDP series coherent with the dynamics with its components
Benchmarking seasonally adjusted data

- The *direct* seasonal adjustment *breaks up* the accounting coherence in national accounts because of the separate treatment for each series.
- Benchmarking is an ad-hoc method used to *restore* those identities.
- In BNB we developed an algorithm which distributes the discrepancies throughout the components.
- It is constrained to keep the same quarterly growth rates for the GDP series as published by NSI.
- And minimizes the deviation from the originally published quarterly growth rates for the components.
Restoring the Accounting coherence

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Benchmarking

Coherence in time
Multivariate seasonal adjustment

• The true source of the discrepancies is the *univariate* seasonal adjustment performed by TRAMO/SEATS and X-12-ARIMA
• Solution: Use *multivariate* seasonal adjustment
• The multivariate seasonal adjustment consists in adjusting the series *simultaneously*, thus respecting their *covariance*
• Few available user-friendly software packages exist
• One is a module called STAMP (*STructural Time Series Analyser, Modeller and Predictor*) found in OxMetrics developed by Siem Jan Koopman, Andrew Harvey, Jurgen A Doornik and Neil Shephard
• It uses Kalman filter techniques to extract the unobserved components (trend, cycle, seasonal and irregular)
## Multivariate seasonal adjustment

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**Coherence in time**
Contributions to quarterly growth – Final Expenditure

% percentage points

Source: BNB

- Net exports
- Gross capital formation
- Final consumption expenditure of general government
- Household and NPISH final consumption expenditure
- Gross domestic product - Multivariate Seasonal Adjustment
Contributions to quarterly growth – Final Expenditure

Source: BNB
Contributions to quarterly growth – Production Approach

Source: BNB

- Taxes less subsidies on products
- Services
- Industry
- Agriculture, forestry and fishing
- Gross domestic product - Multivariate Seasonal Adjustment
Contributions to quarterly growth – Production Approach

%, percentage points

Source: BNB
Contributions to quarterly growth – Final Expenditure

Source: BNB, NSI
Contributions to quarterly growth – Final Expenditure

Source: BNB, NSI
Conditional multivariate seasonal adjustment

• Once multivariate seasonally adjusted series are obtained, they can be (re)used for additional seasonal adjustments of other series

• Seasonal adjustment of the Income Approach series by preserving the already obtained GDP and Taxes less subsidies on products seasonally adjusted series
Contributions to quarterly growth – Income Approach
*(Conditional multivariate seasonal adjustment)*

**Taxes less subsidies on products**

**Other taxes and subsidies on production**

**Gross operating surplus**

**Compensations of employees**

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**Gross domestic product - Multivariate Seasonal Adjustment**

*Source: BNB*
Contributions to quarterly growth – Income Approach

*(Conditional multivariate seasonal adjustment)*

![Graph showing contributions to quarterly growth](image)

- **Taxes less subsidies on products**
- **Other taxes and subsidies on production**
- **Gross operating surplus**
- **Compensations of employees**
- **Gross domestic product - Multivariate Seasonal Adjustment**

Source: BNB
Modeling and forecasting

- Multivariate seasonal adjustment may produce seasonally adjusted series inconsistent with the officially published series.
- Because official figures are used as a starting point for forecasting from many organizations and institutions, data input consistency is desirable.
- *Conditional* multivariate seasonal adjustment approximates as much as possible the officially published series but keeps the accounting constraints.
Contributions to quarterly growth – Final Expenditure
*(Conditional multivariate seasonal adjustment)*

Source: BNB, NSI
Contributions to quarterly growth – Production Approach

(Conditional multivariate seasonal adjustment)

Source: BNB, NSI
Future work

• Multivariate seasonal adjustment with respect to both the Accounting coherence and the Time coherence

• In other words: matching the sum of the seasonally adjusted quarterly estimates to the annual officially published figures
Conclusion

• The seasonal adjustment is first of all a procedure which is aimed at providing *timely information*

• There are different methods which can improve certain characteristics of the seasonally adjusted series *depending on the needs of the final users*

• Multivariate seasonal adjustment by STAMP can provide seasonally adjusted series which *respect the Accounting coherence and probably the Timely coherence*