

Seasonal adjustment

with application to quarterly national
accounts

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Bulgarian Macroeconomics Association Seminar
17 January 2012

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?

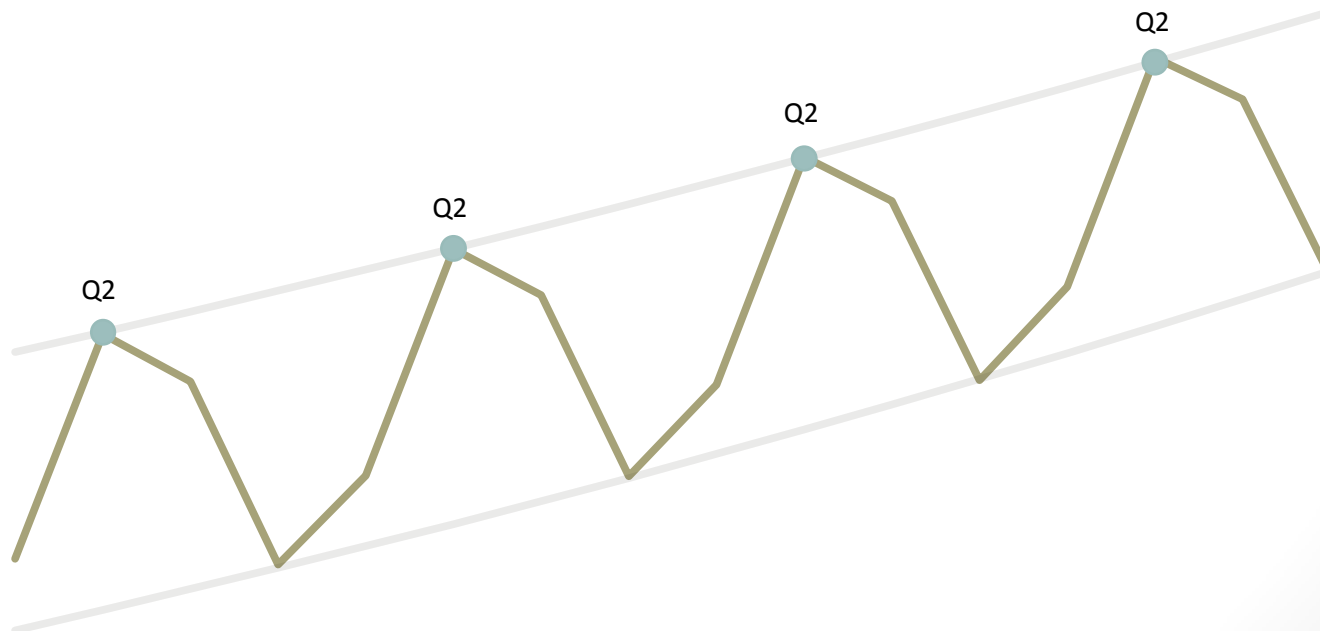
- Factors of non-economic nature affect the economic activity and act each year during each of the seasons of the year
- Thus it is very difficult to assess the economic developments compared to the *previous period* and we must rely on data further back in the past
- Economic indicators are also affected 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

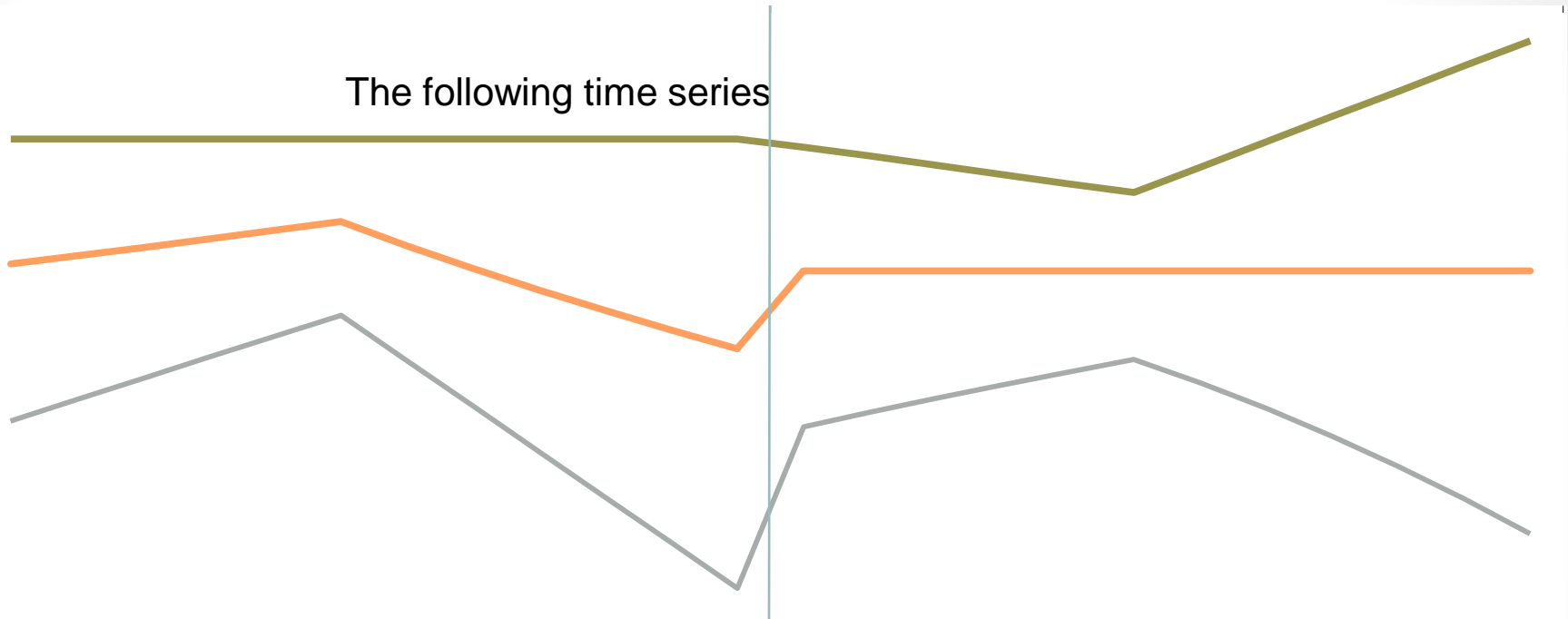
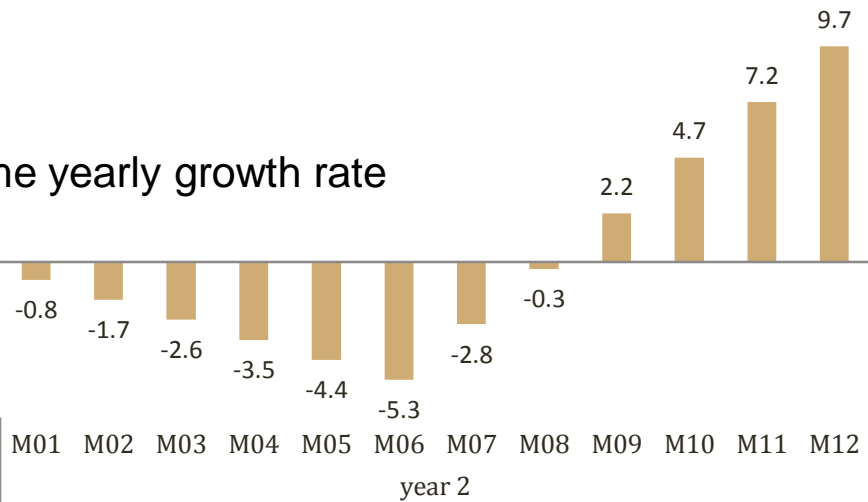


exhibit the same yearly growth rate



M01 M02 M03 M04 M05 M06 M07 M08 M09 M10 M11 M12 year 1
M01 M02 M03 M04 M05 M06 M07 M08 M09 M10 M11 M12 year 2

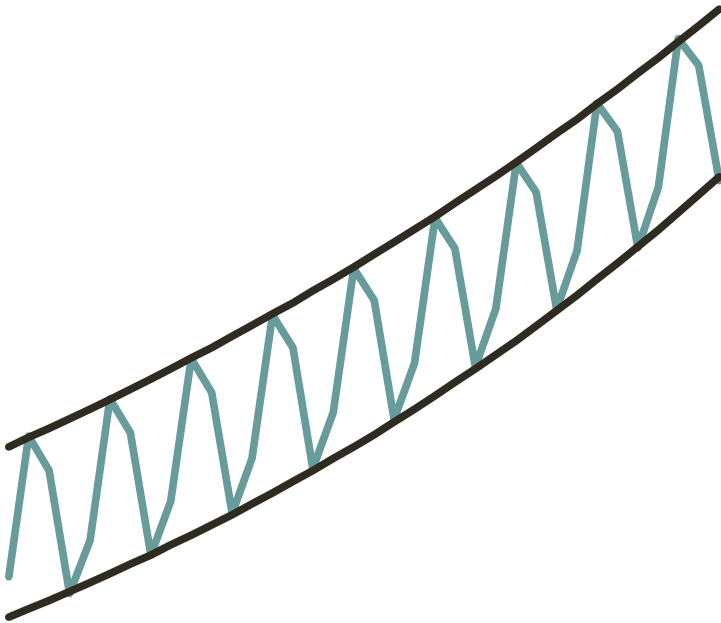
More advanced methods are needed

- “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

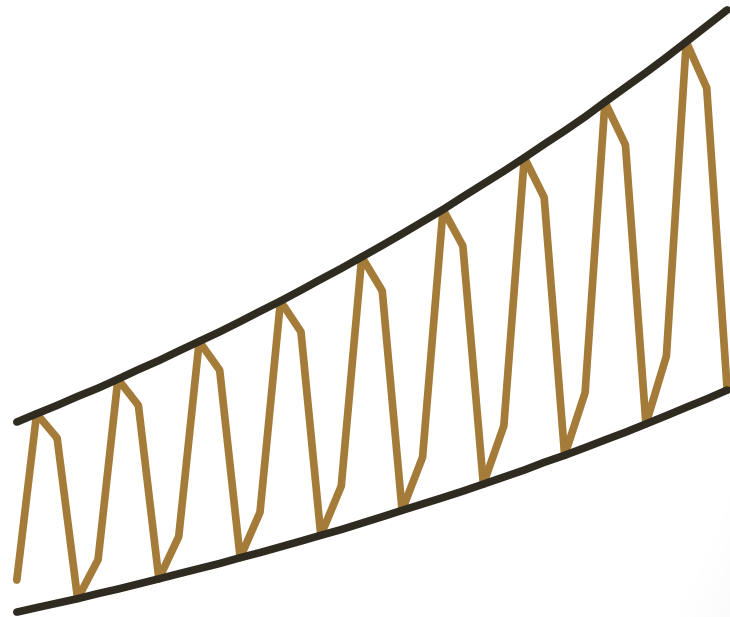
Additive model

$$X_t = T_t + C_t + S_t + I_t$$

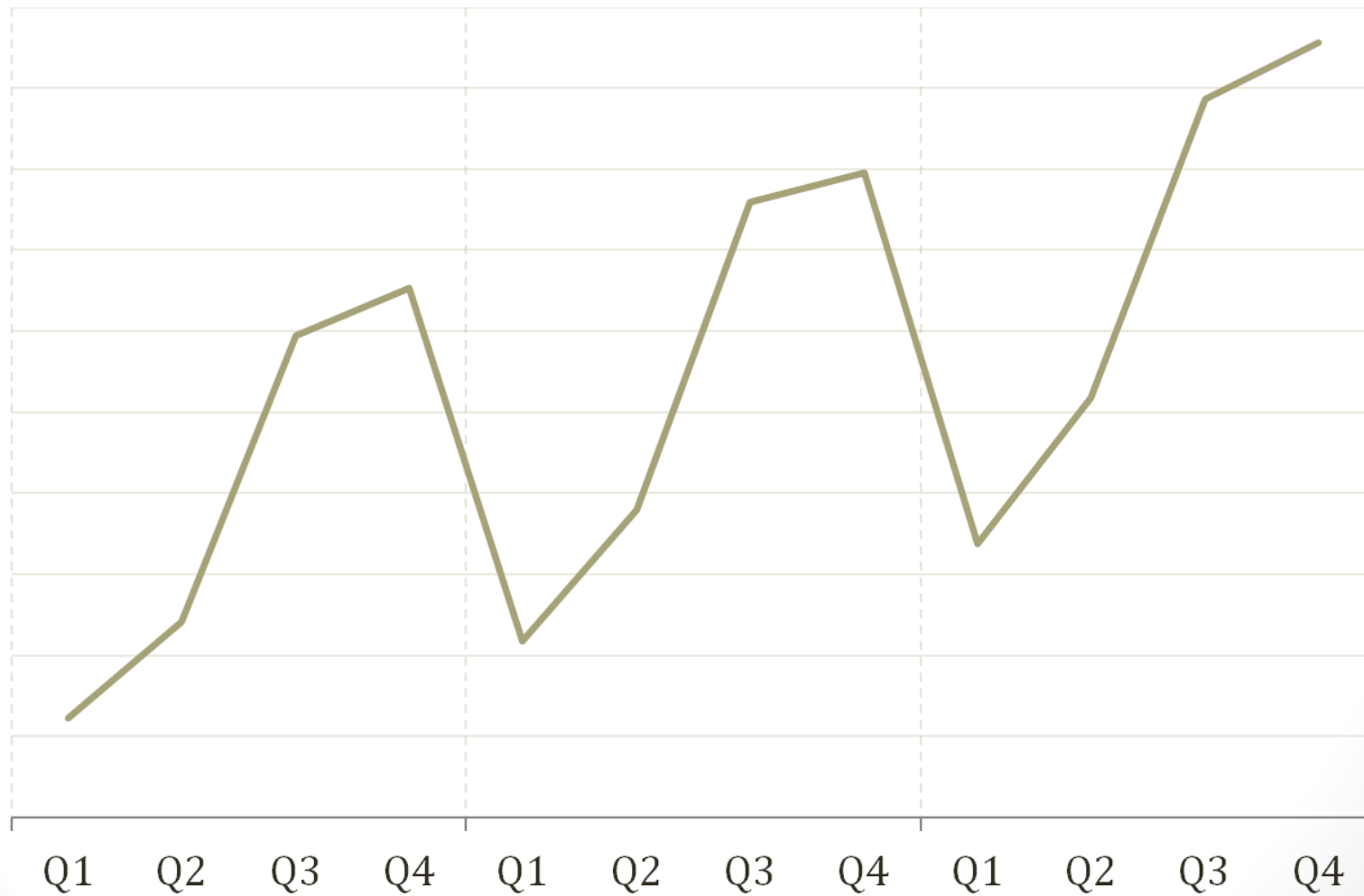


Multiplicative model

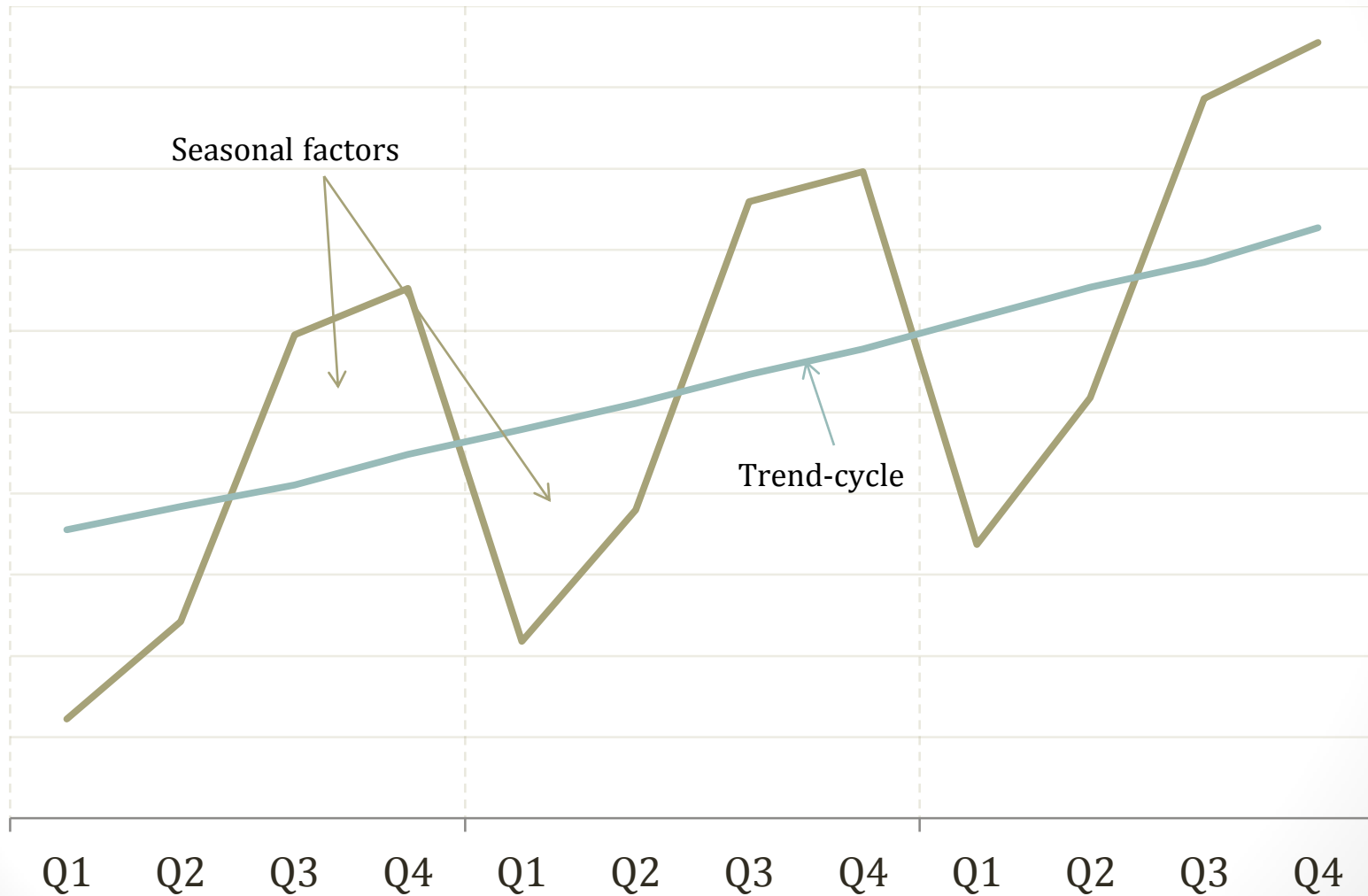
$$X_t = T_t * C_t * S_t * I_t$$



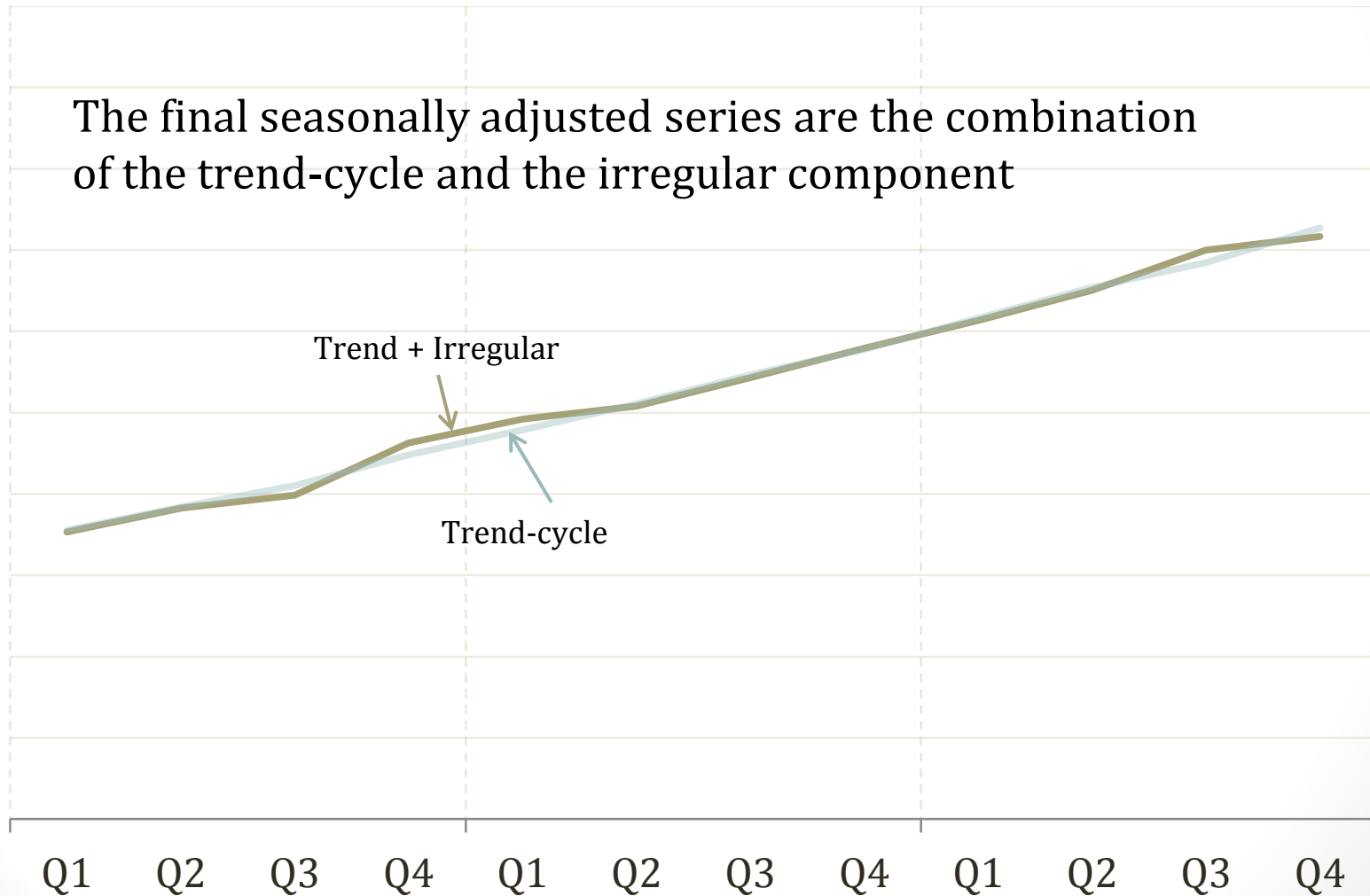
Component models decomposition



Component models decomposition



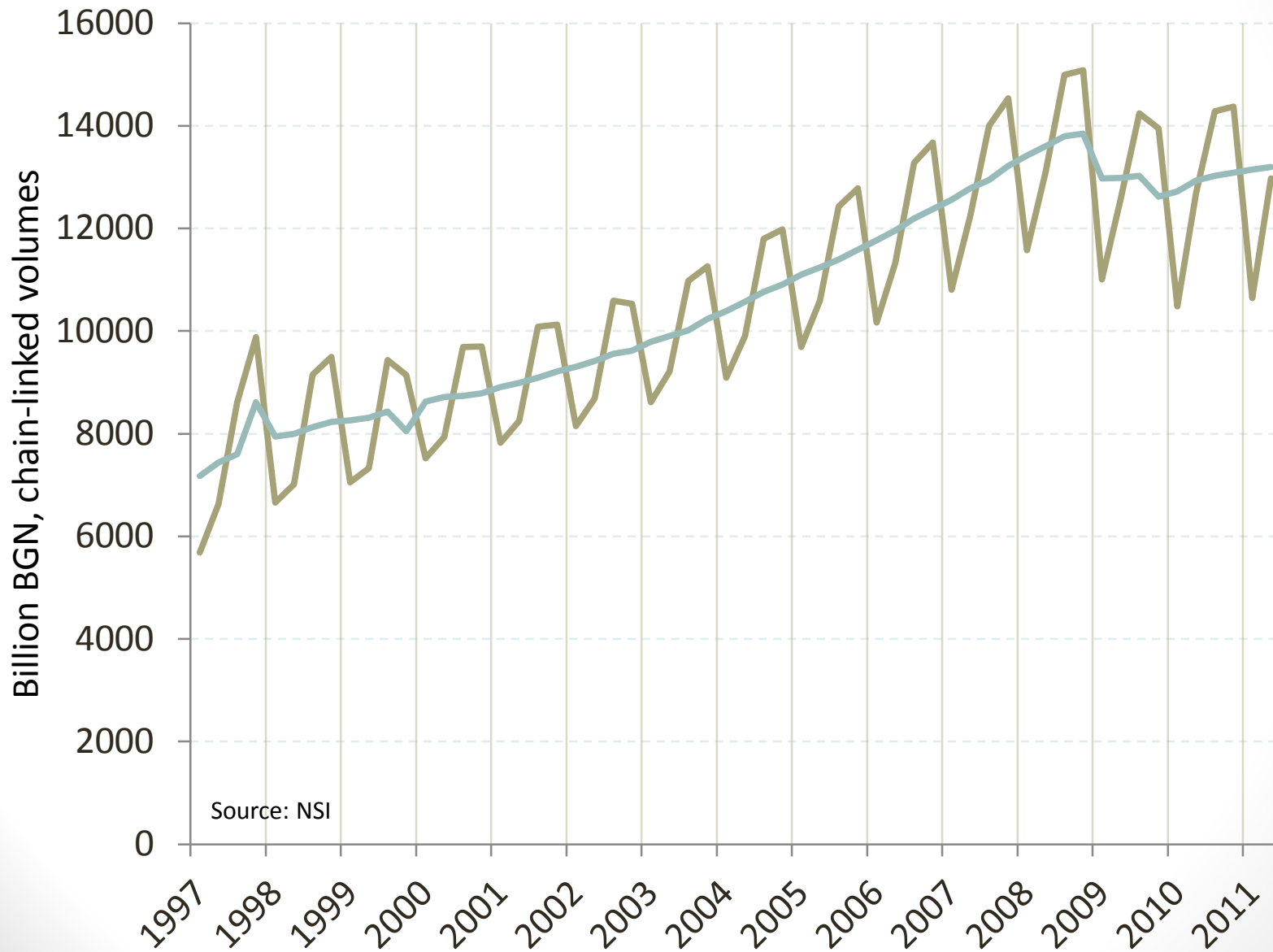
Component models decomposition



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



Quarterly growth rates



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

	Consumption	+ Investment	+ Exports	- Imports	= GDP	Accounting coherence
Q1	65	20	15	10	90	
Q2	70	10	20	20	80	
Q3	75	20	20	25	90	
Q4	80	25	25	20	110	
Year	290	75	80	75	370	

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*

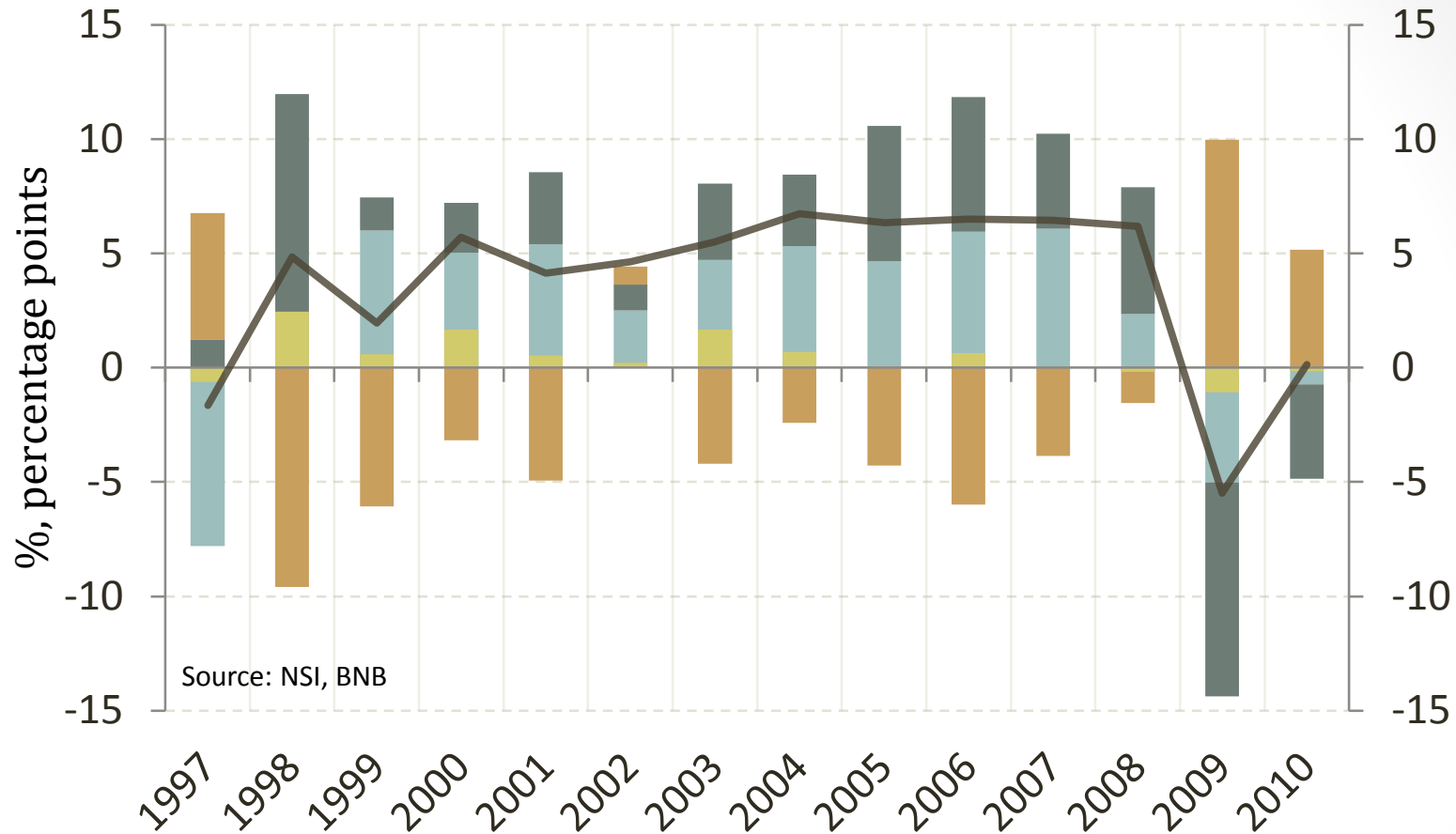
Issues

- Economic analysis
- Modeling and Forecasting

Economic analysis

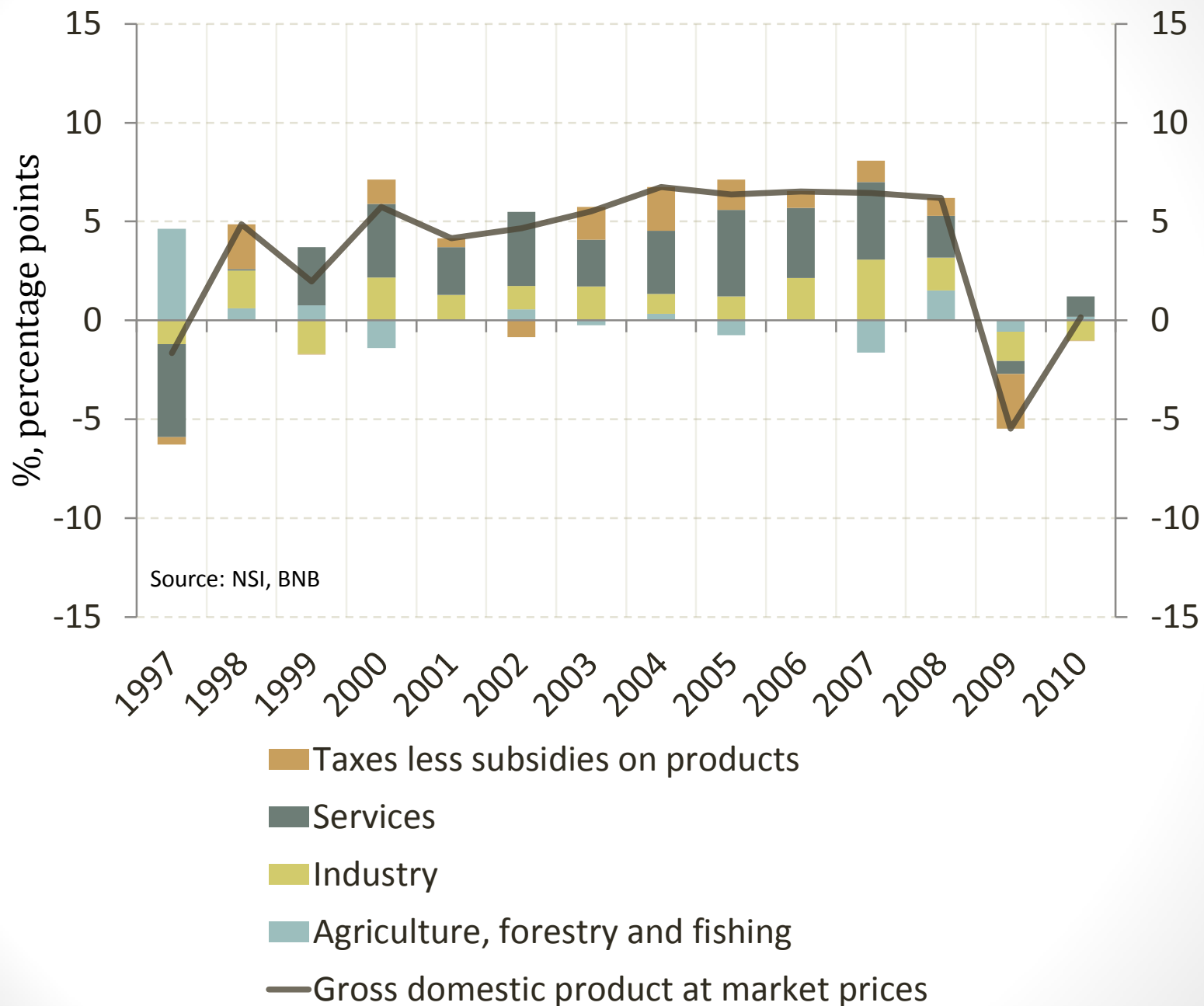
- The seasonally adjusted GDP is informative in itself
- Nevertheless one would normally want to know how much each component contributed to the change in GDP
- We typically analyze GDP through its components
- Final Expenditure Approach, the Production Approach and the Income Approach

Contributions to annual growth – Final Expenditure

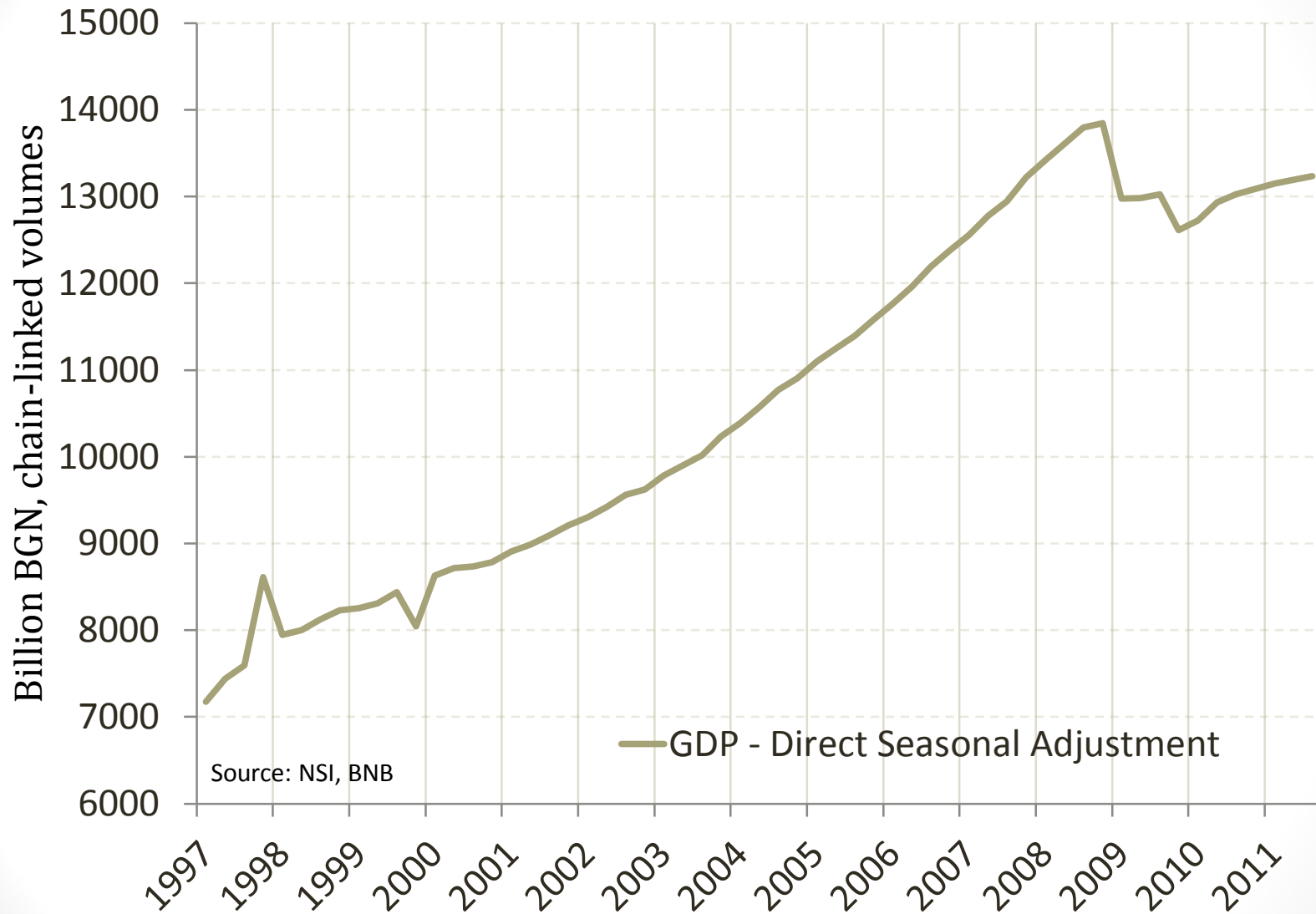


- Net exports
- Gross capital formation
- Household and NPISH final consumption expenditure
- Final consumption expenditure of general government
- Gross domestic product at market prices

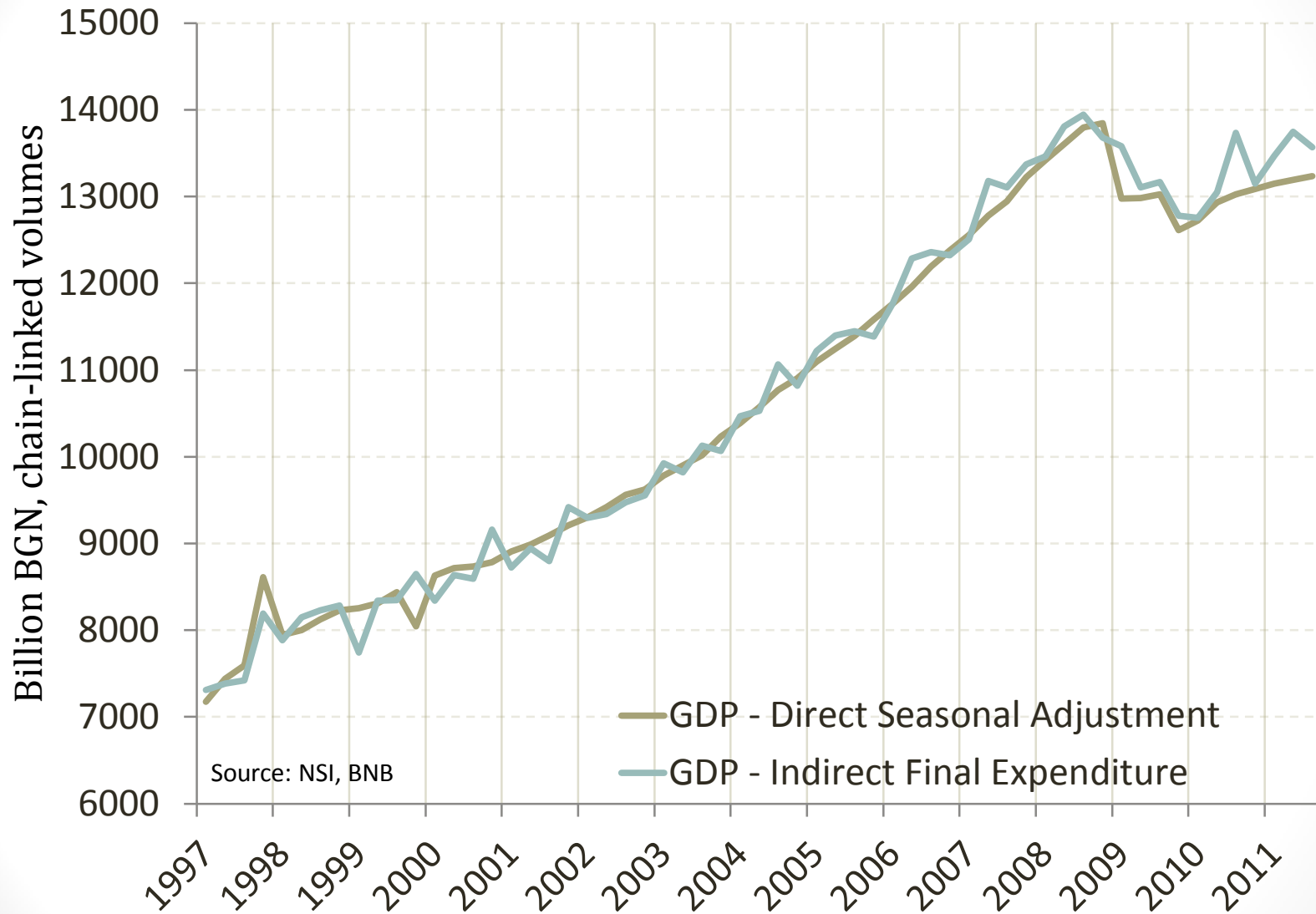
Contributions to annual growth – Production Approach



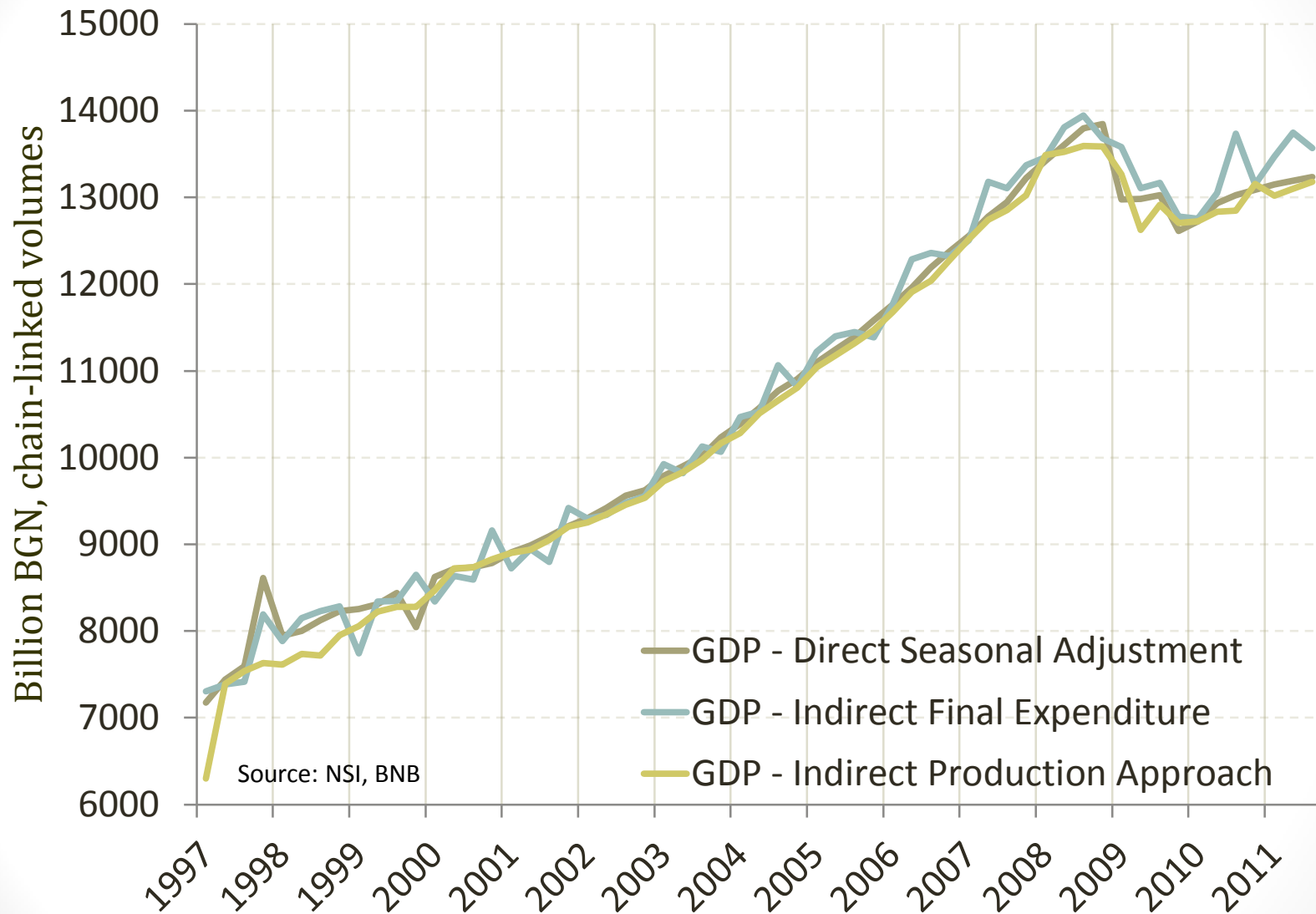
Direct vs Indirect method (1)



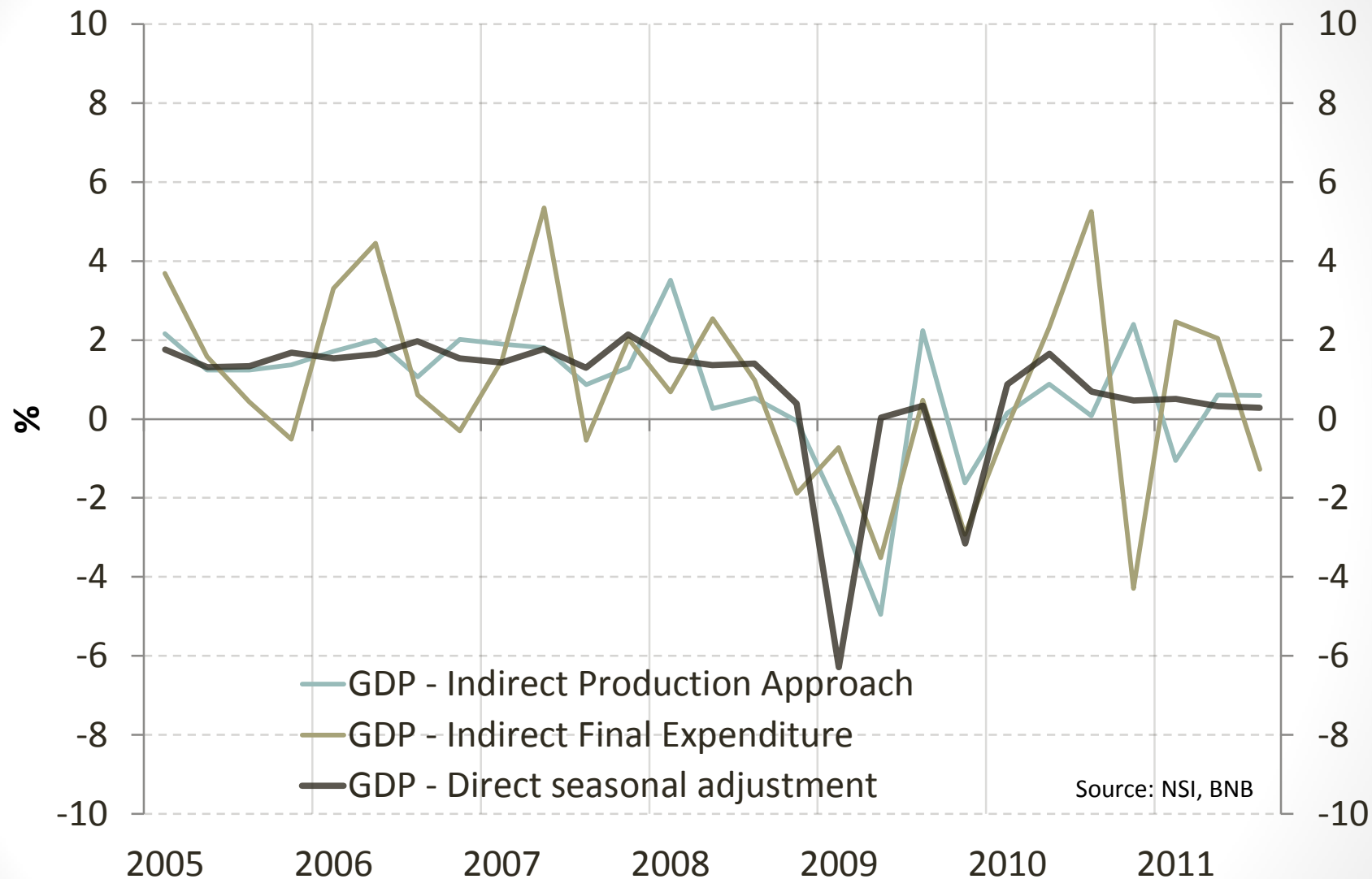
Direct vs Indirect method (2)



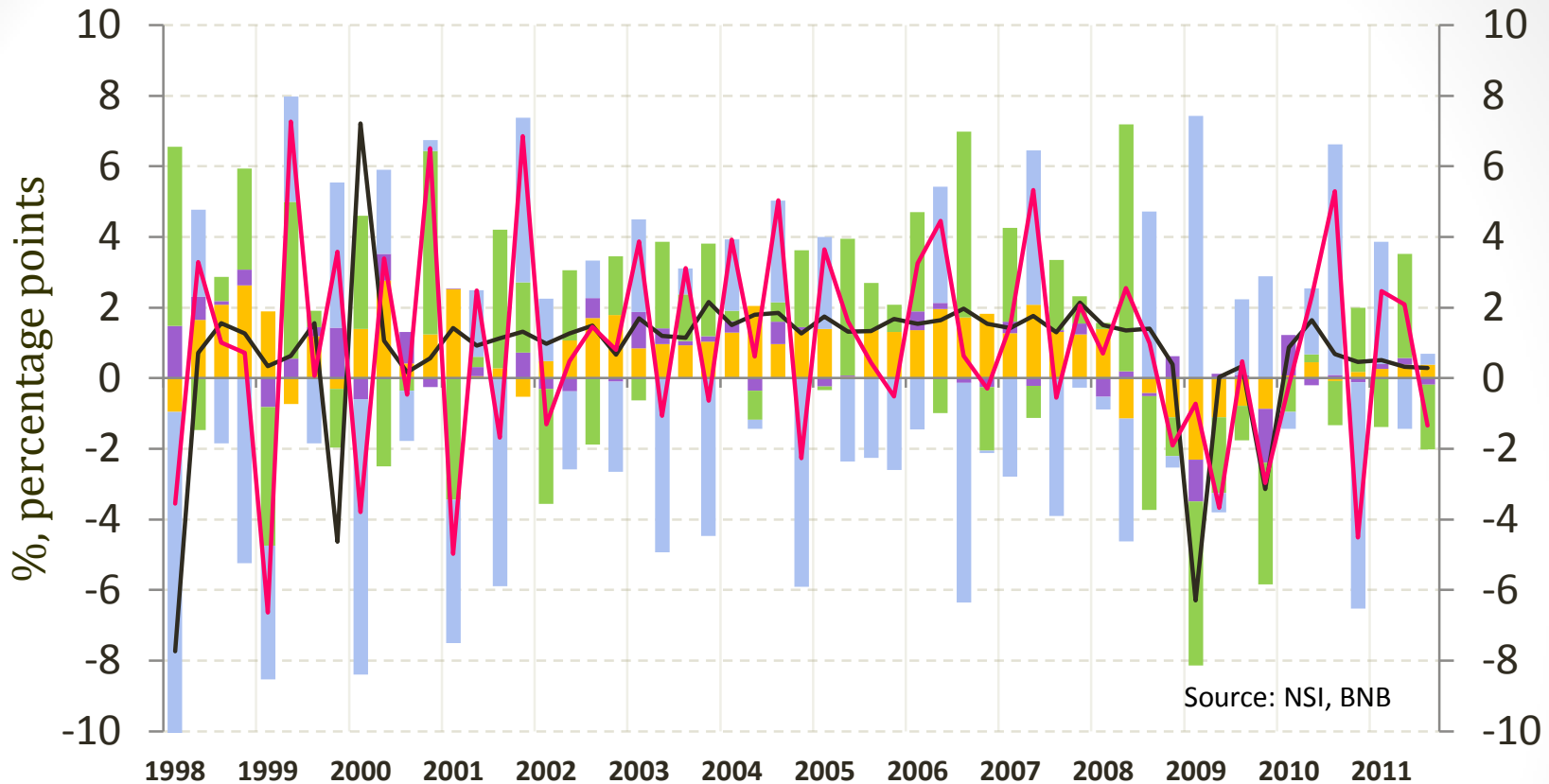
Direct vs Indirect method (3)



Indirect seasonal adjustment and quarterly growth rates

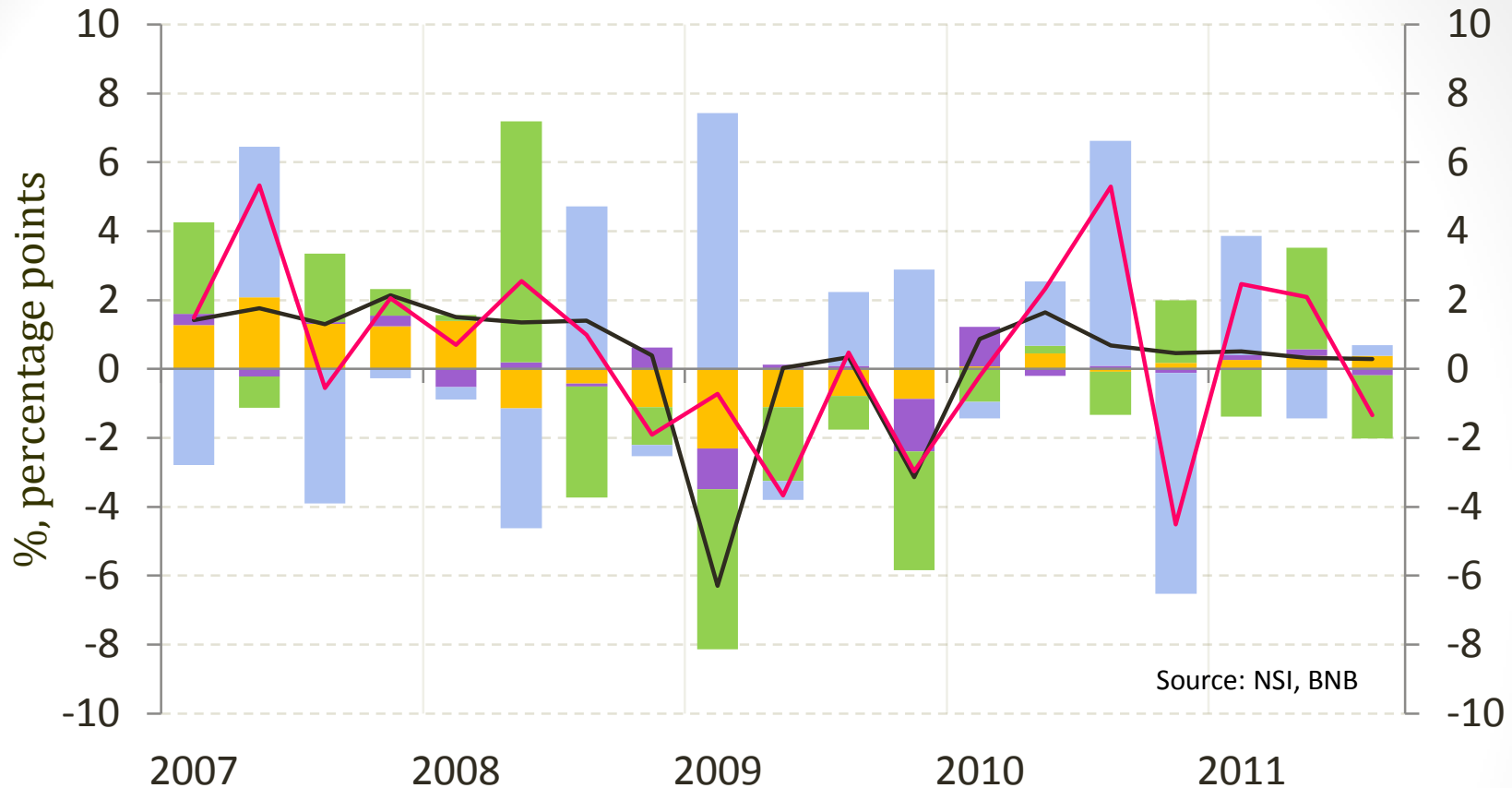


Contributions to quarterly growth – Final Expenditure



- 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

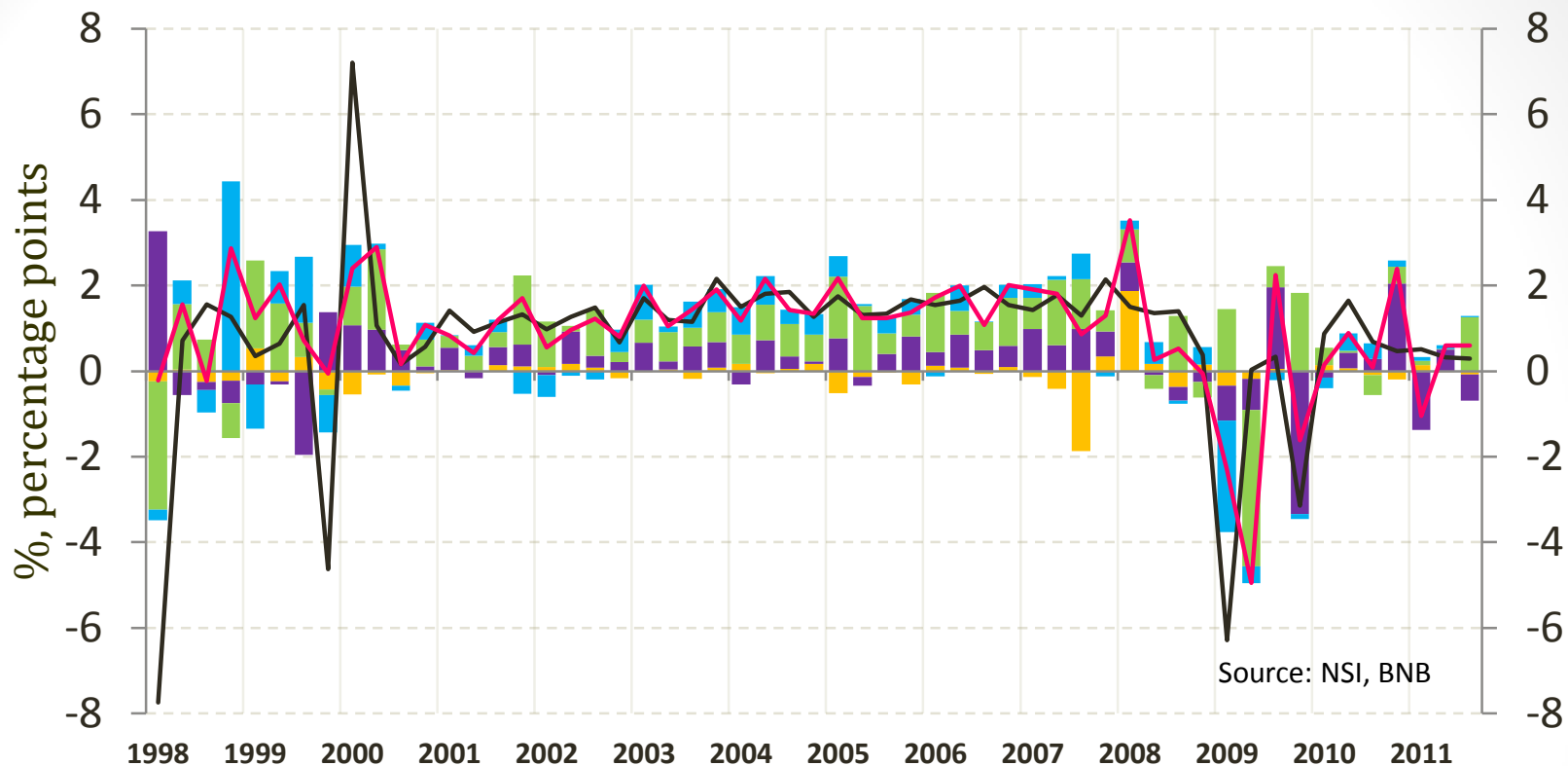
Contributions to quarterly growth – Final Expenditure



Source: NSI, BNB

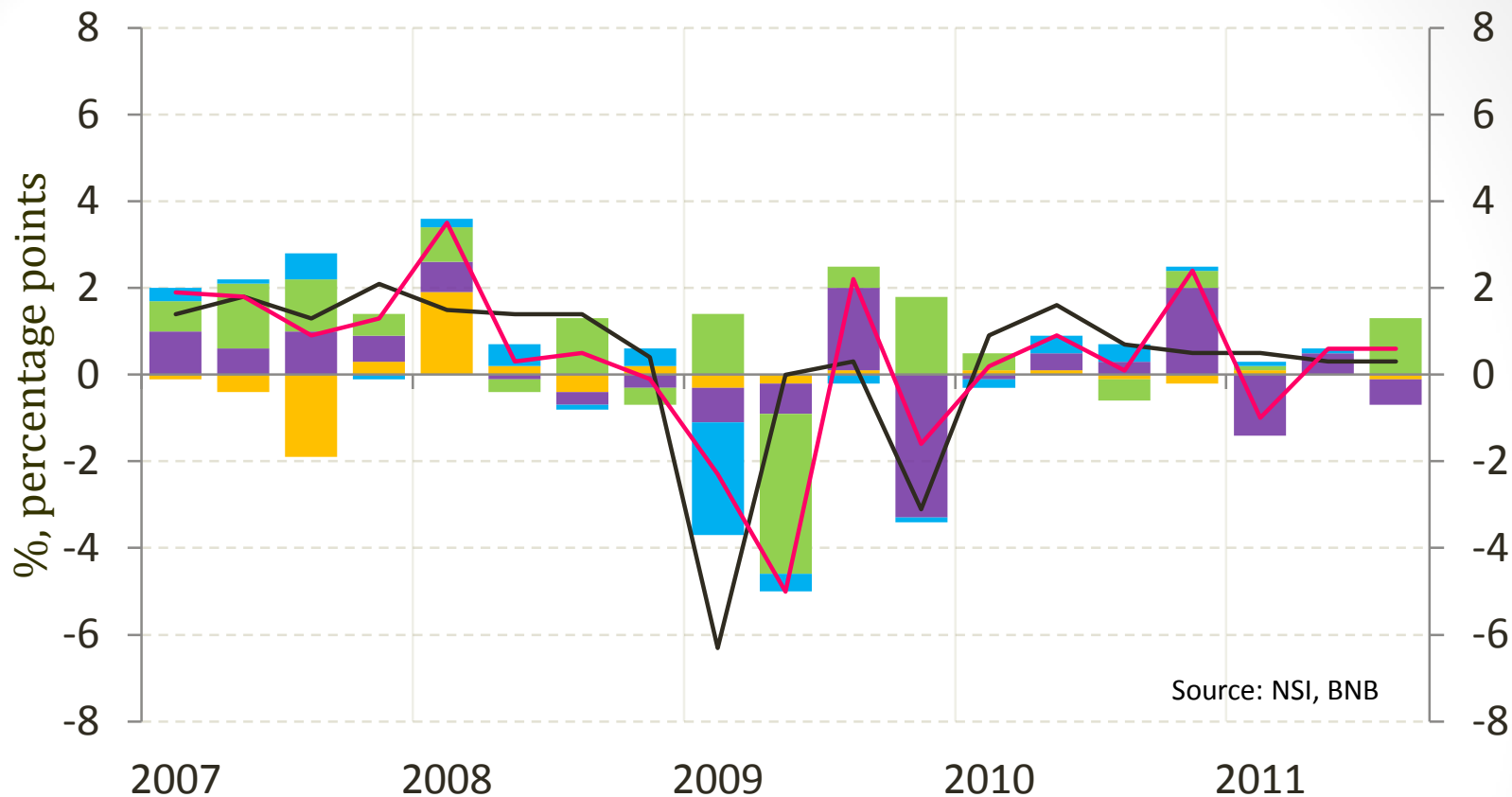
- Net exports
- Gross capital formation
- Final consumption expenditure of general government
- Household and NPISH final consumption expenditure
- Gross domestic product - Direct Seasonal Adjustment
- Gross domestic product - Indirect seasonal adjustment

Contributions to quarterly growth – Production Approach



- 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

- Taxes less subsidies on products
- Services
- Industry
- Agriculture, forestry and fishing
- Gross domestic product - Direct Seas. Adj.
- Gross domestic product - Indirect Method

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

SA	Consumption	+ Investment	+ Exports	- Imports	= GDP	Accounting coherence →	B e n c h m a r k i n g ↓
Q1	65	20	15	10	90		
Q2	70	10	20	20	80		
Q3	75	20	20	25	90		
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Year	290	75	80	75	370		

Coherence in time

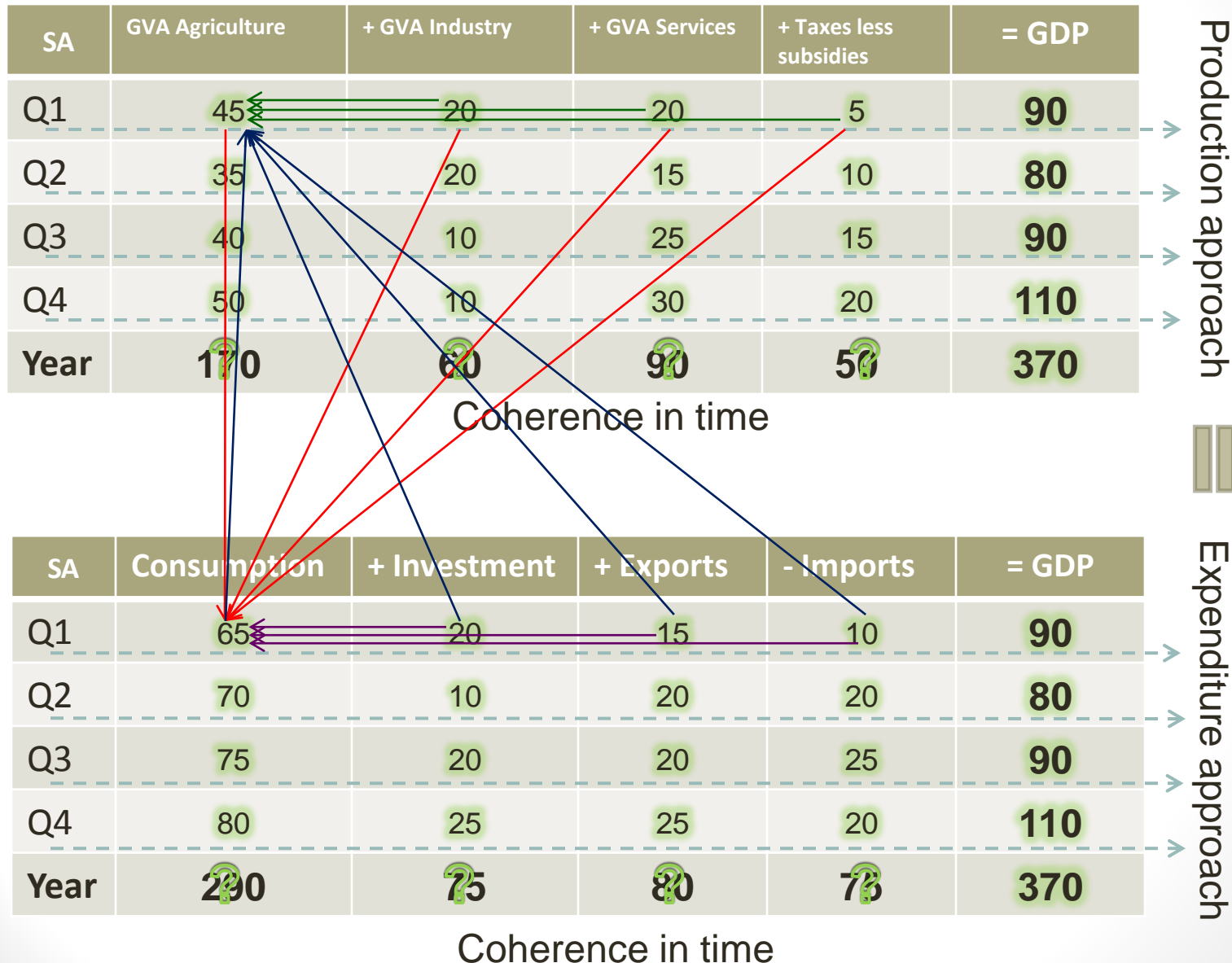
SA	Consumption	+ Investment	+ Exports	- Imports	= GDP	Accounting coherence →	B e n c h m a r k i n g ↓
Q1	60	15	20	5	90		
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Coherence in time

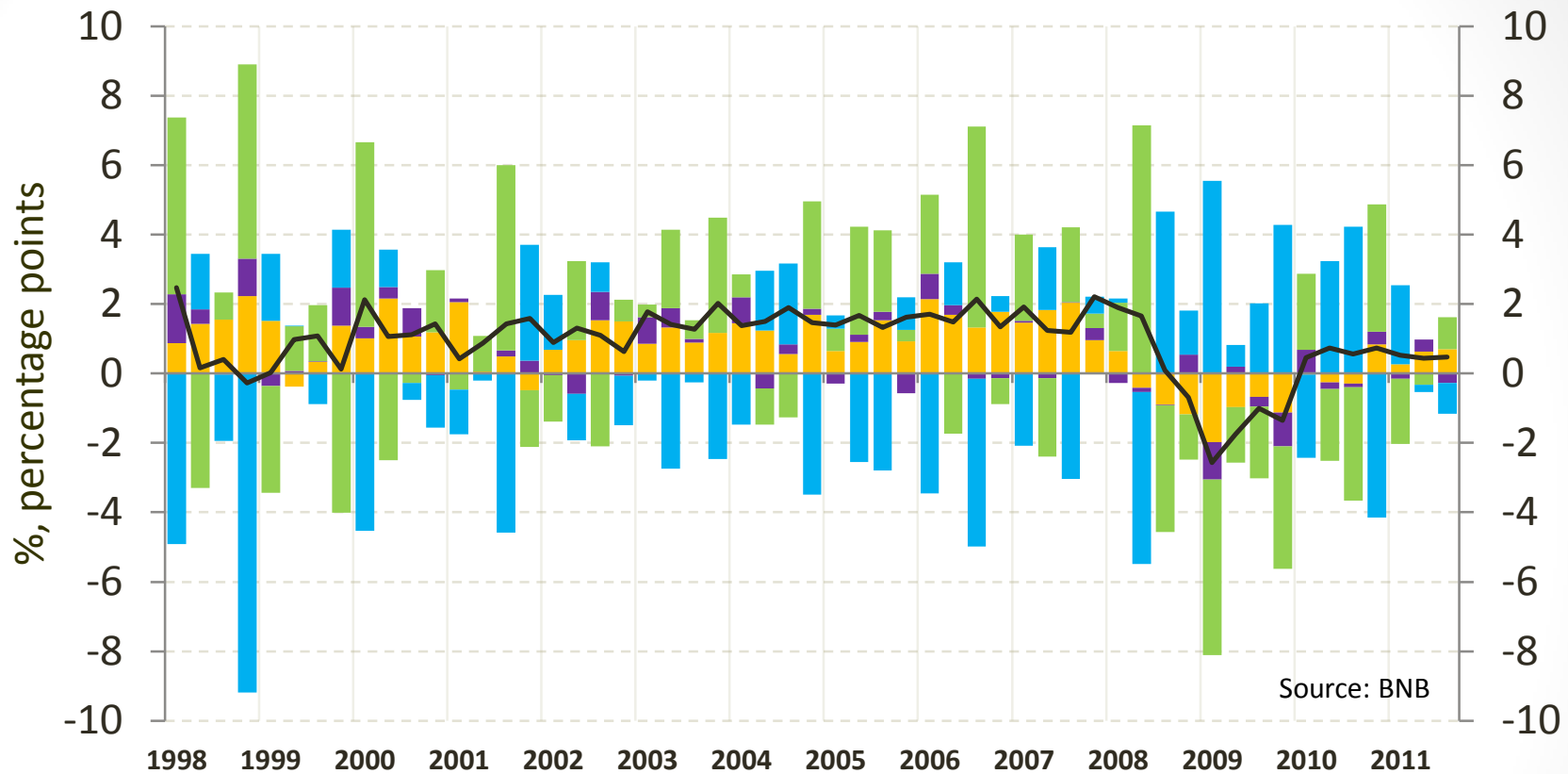
Multivariate seasonal adjustment

- 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 (**S**tructural **T**ime Series **A**nalys(er), **M**odeller and **P**redictor) 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

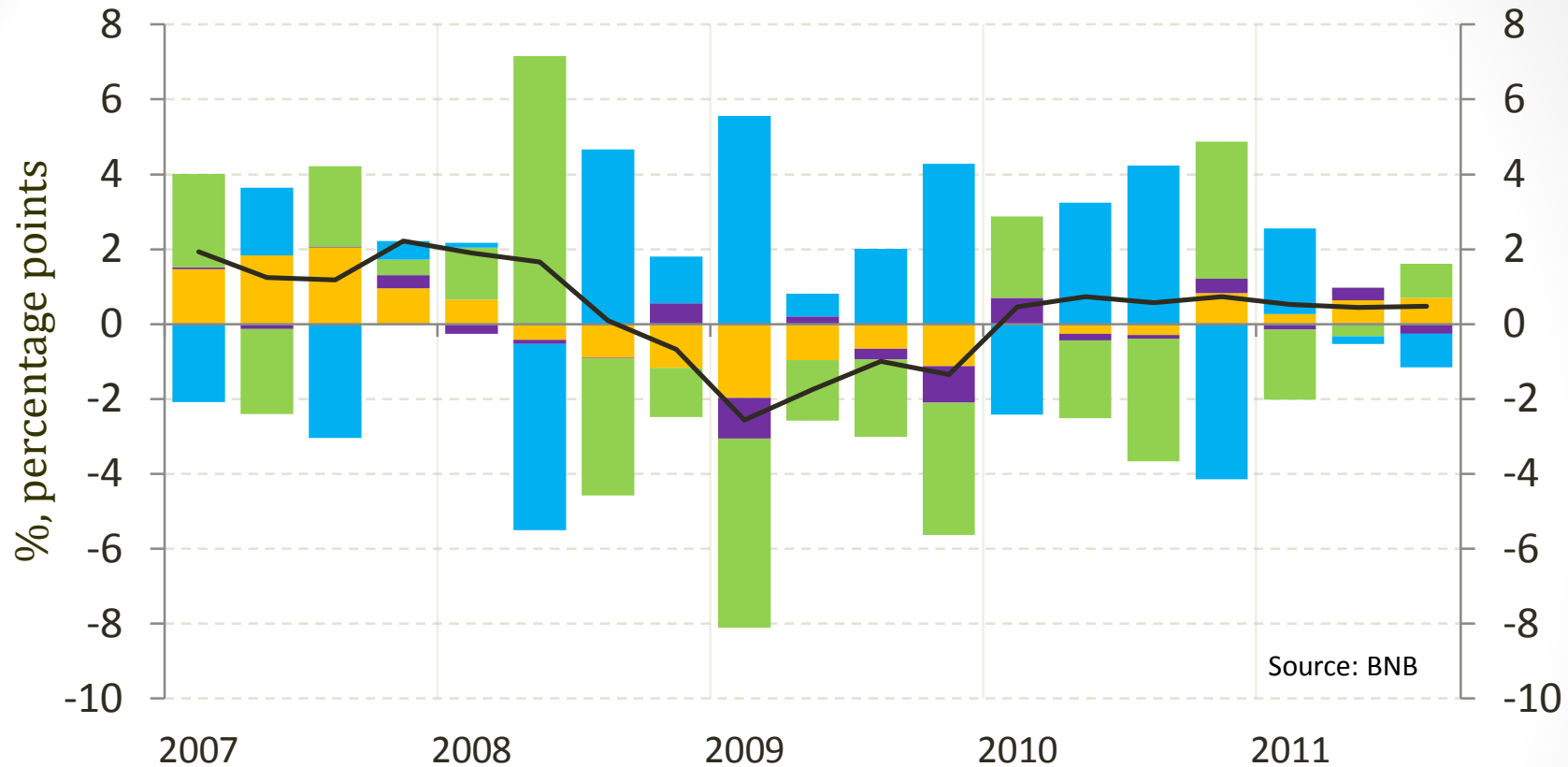


Contributions to quarterly growth – Final Expenditure



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

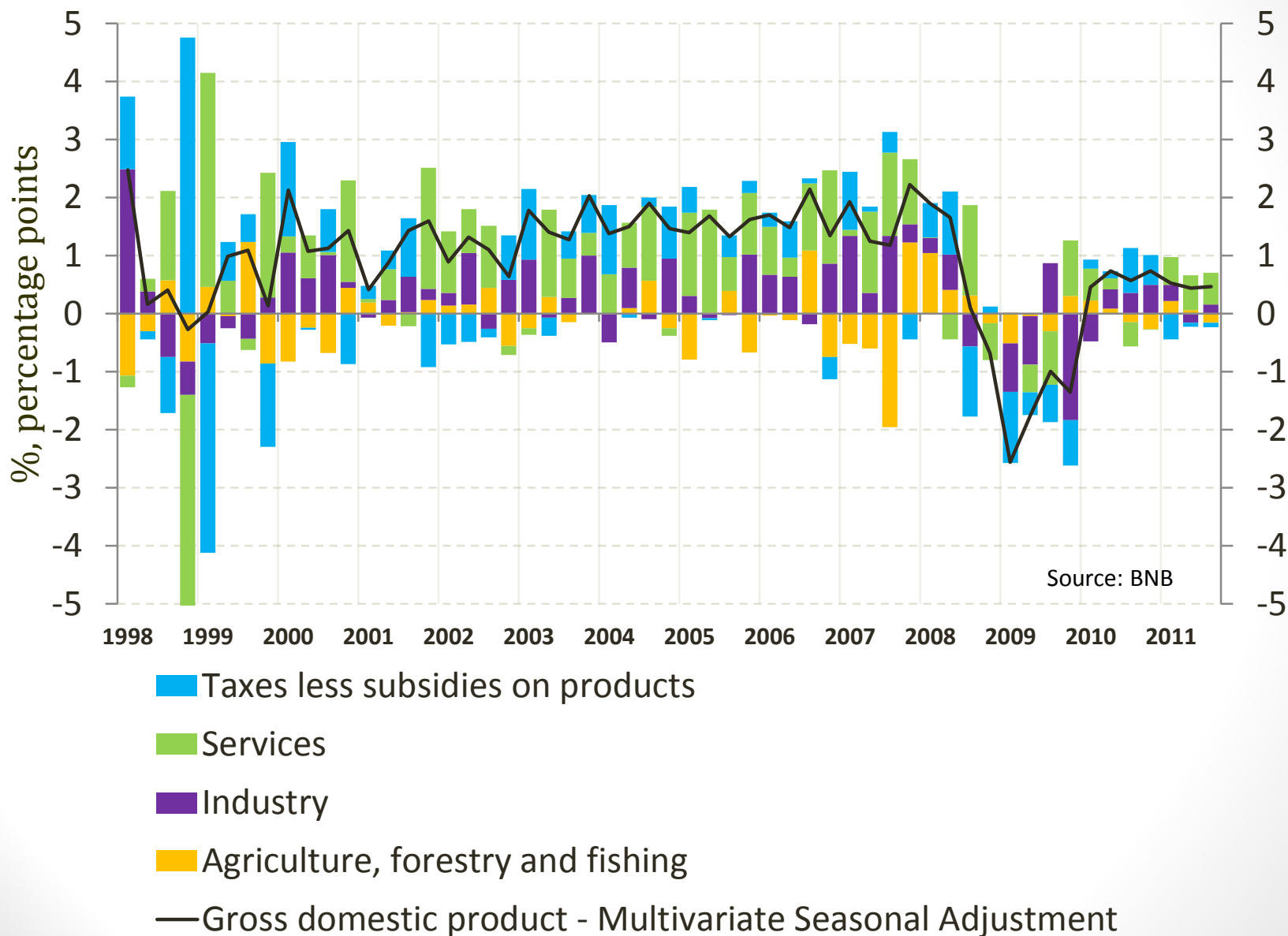
Contributions to quarterly growth – Final Expenditure



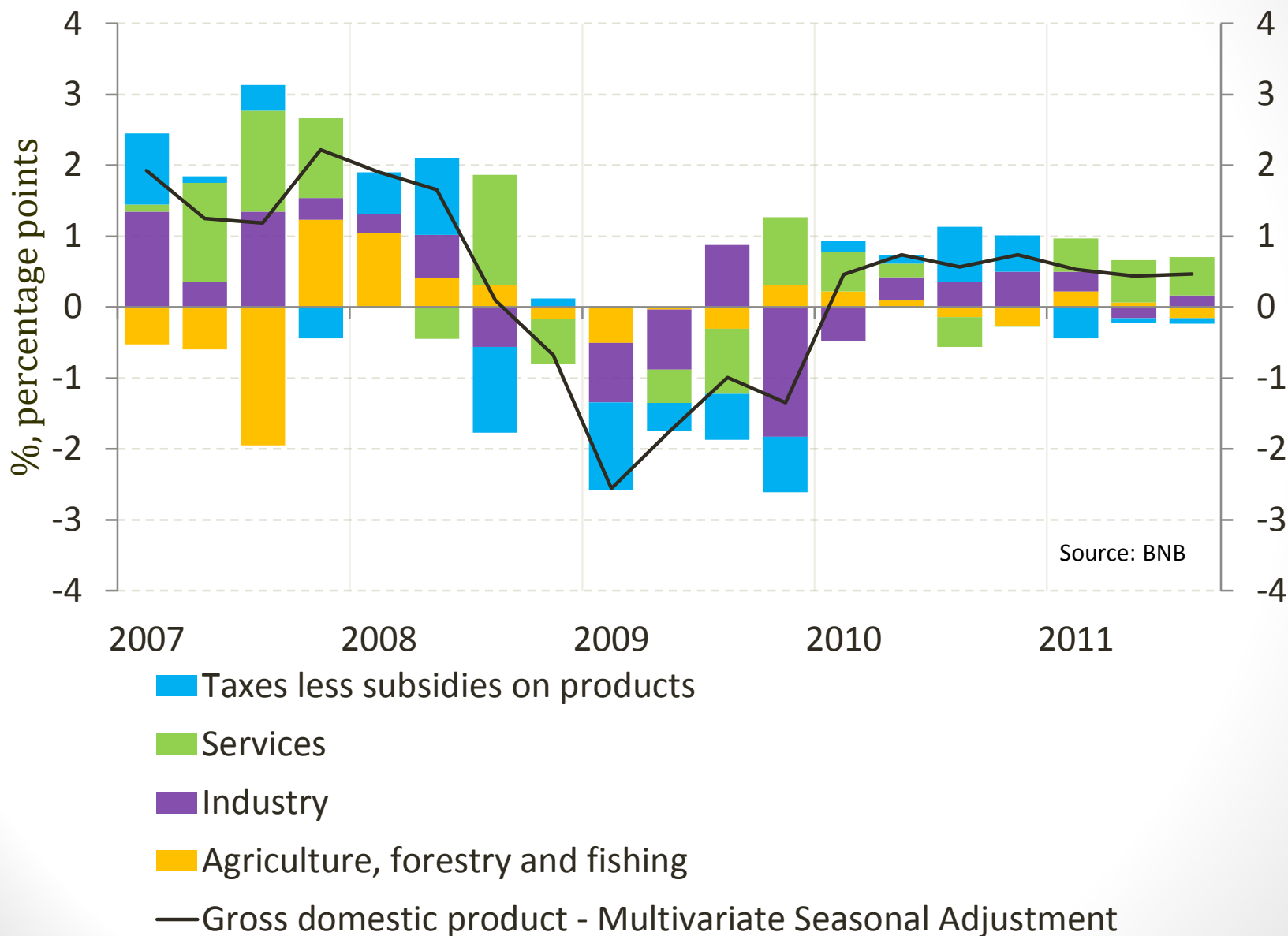
Source: BNB

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

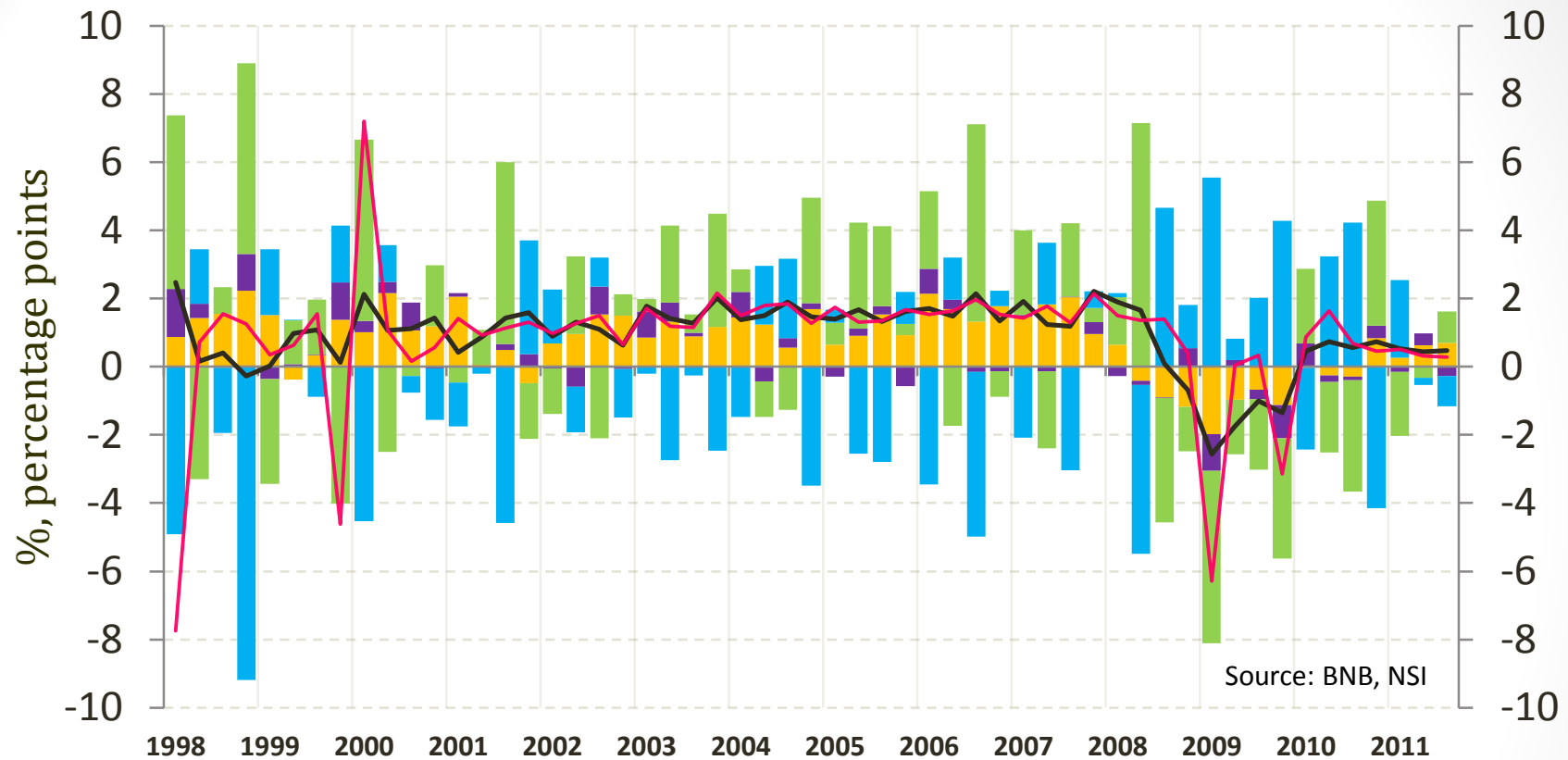
Contributions to quarterly growth – Production Approach



Contributions to quarterly growth – Production Approach

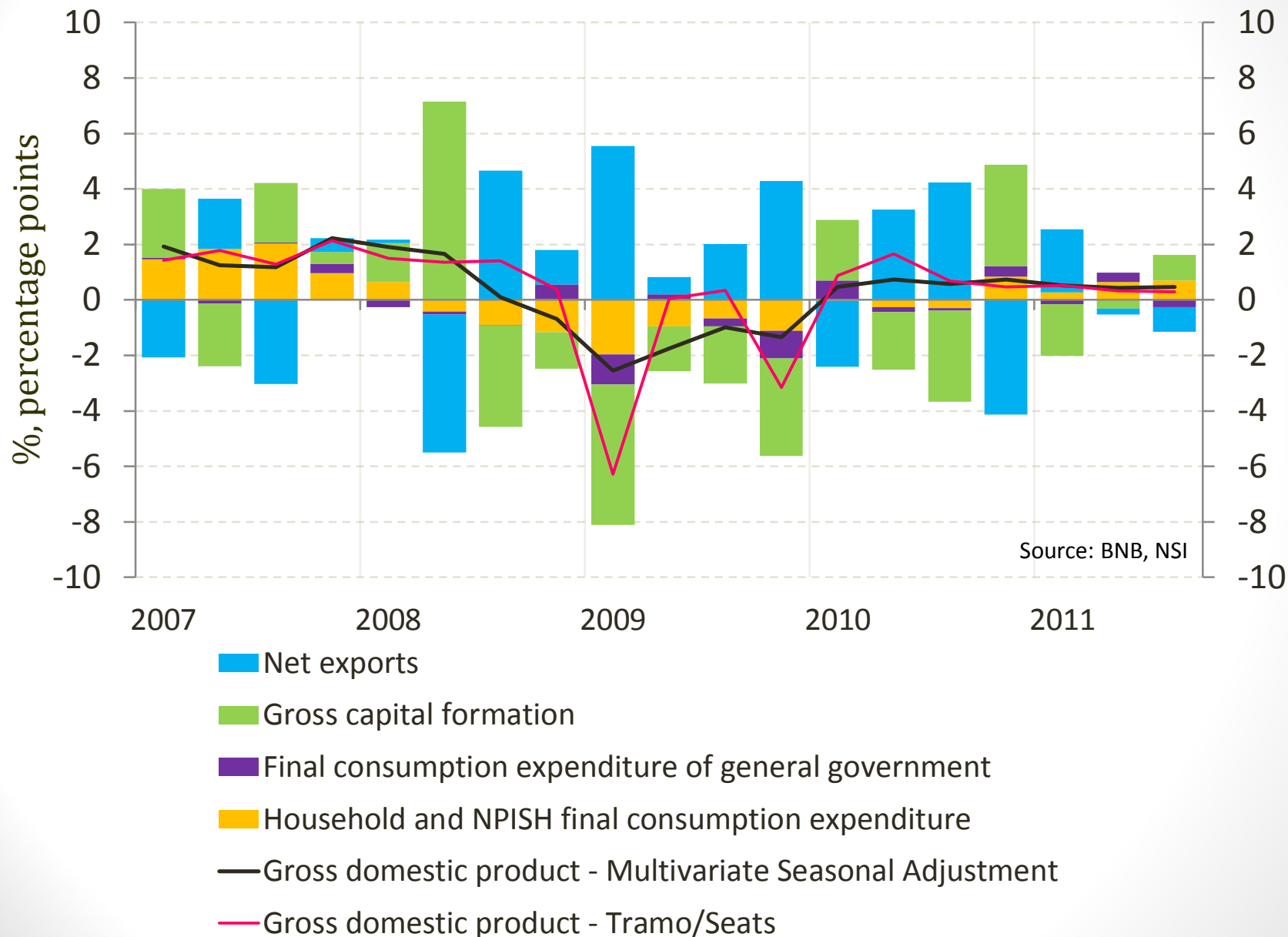


Contributions to quarterly growth – Final Expenditure

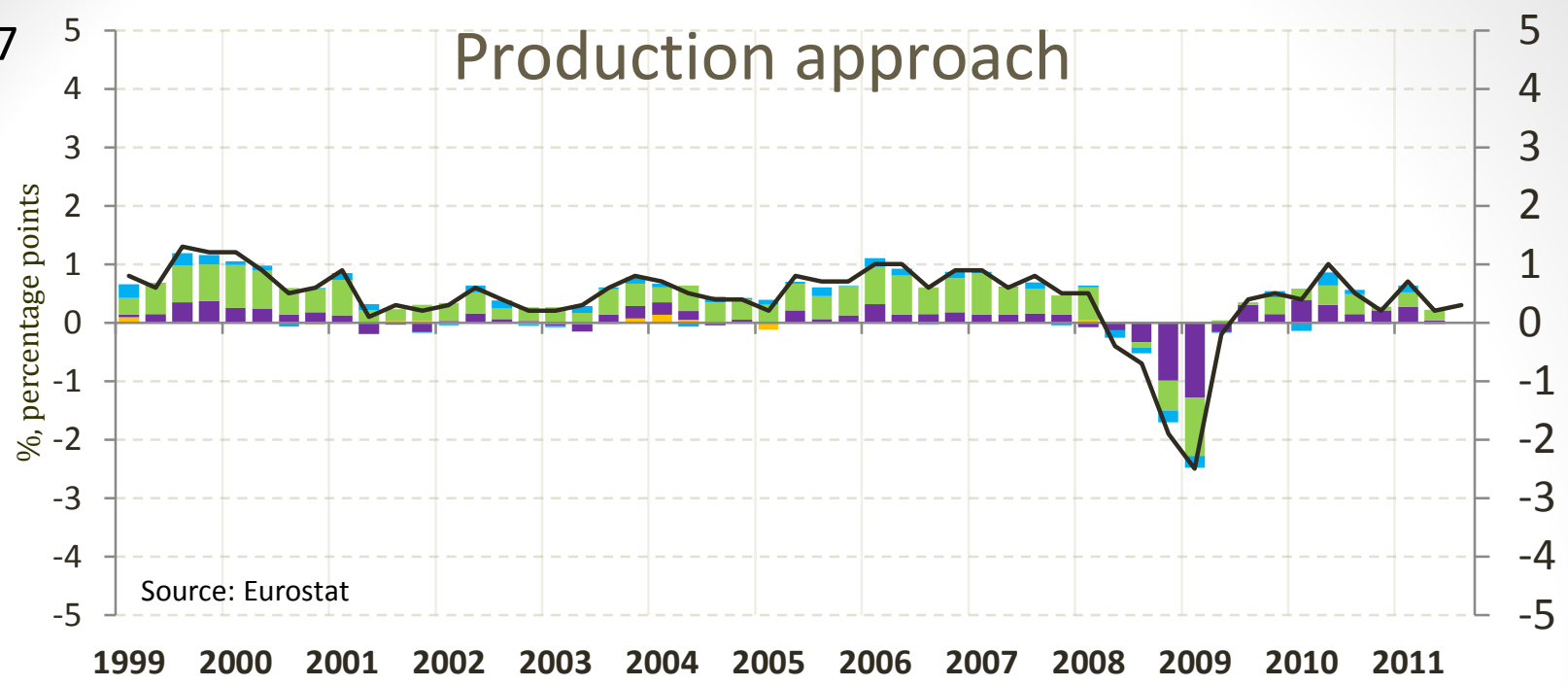


- Net exports
- Gross capital formation
- Final consumption expenditure of general government
- Household and NPISH final consumption expenditure
- Gross domestic product - Multivariate Seasonal Adjustment
- Gross domestic product - Tramo/Seats

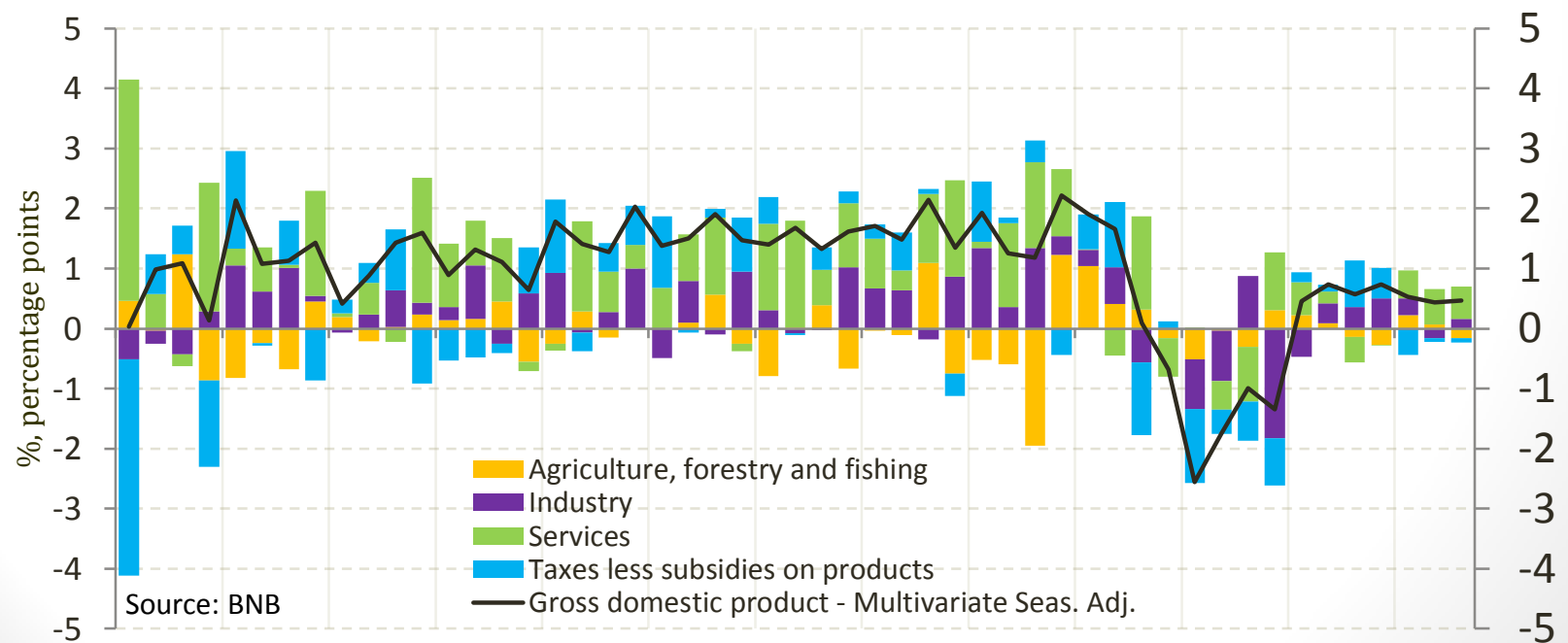
Contributions to quarterly growth – Final Expenditure



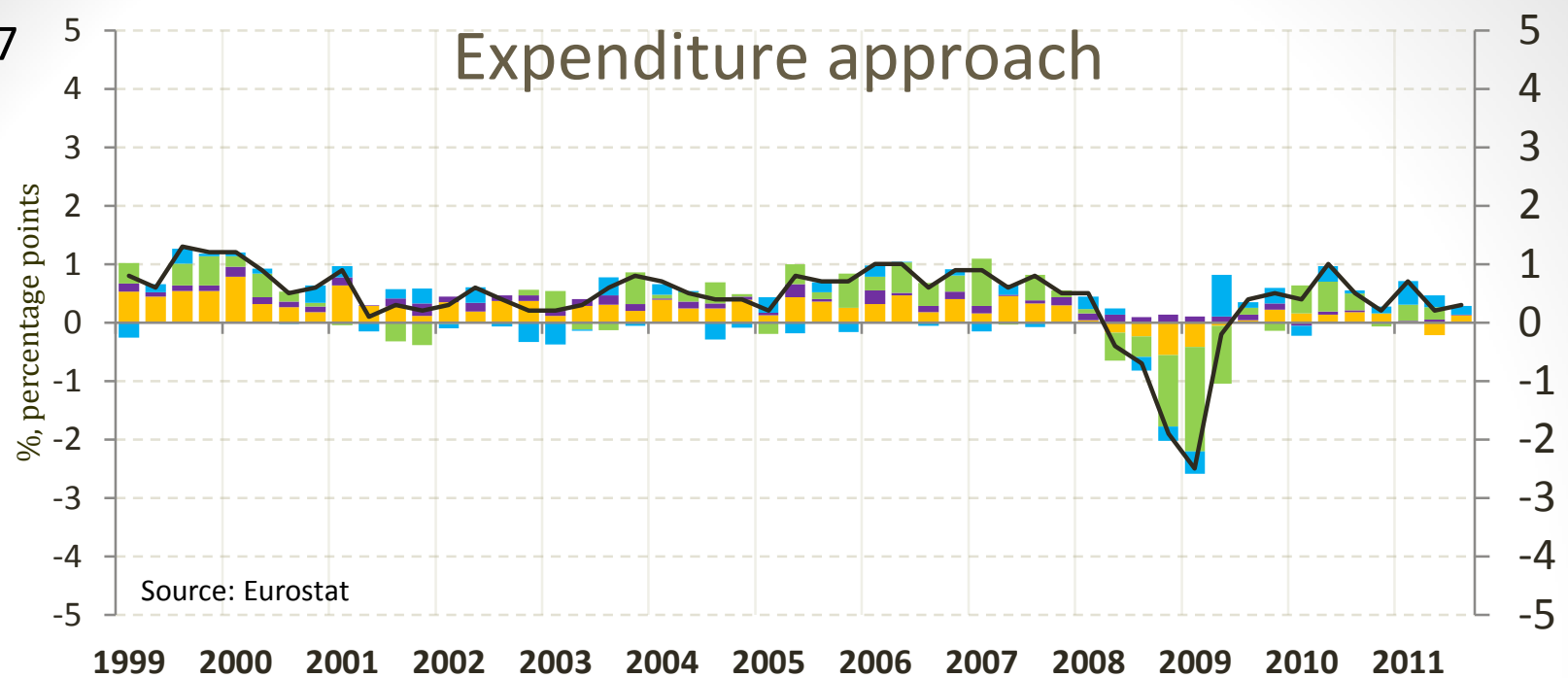
EU27



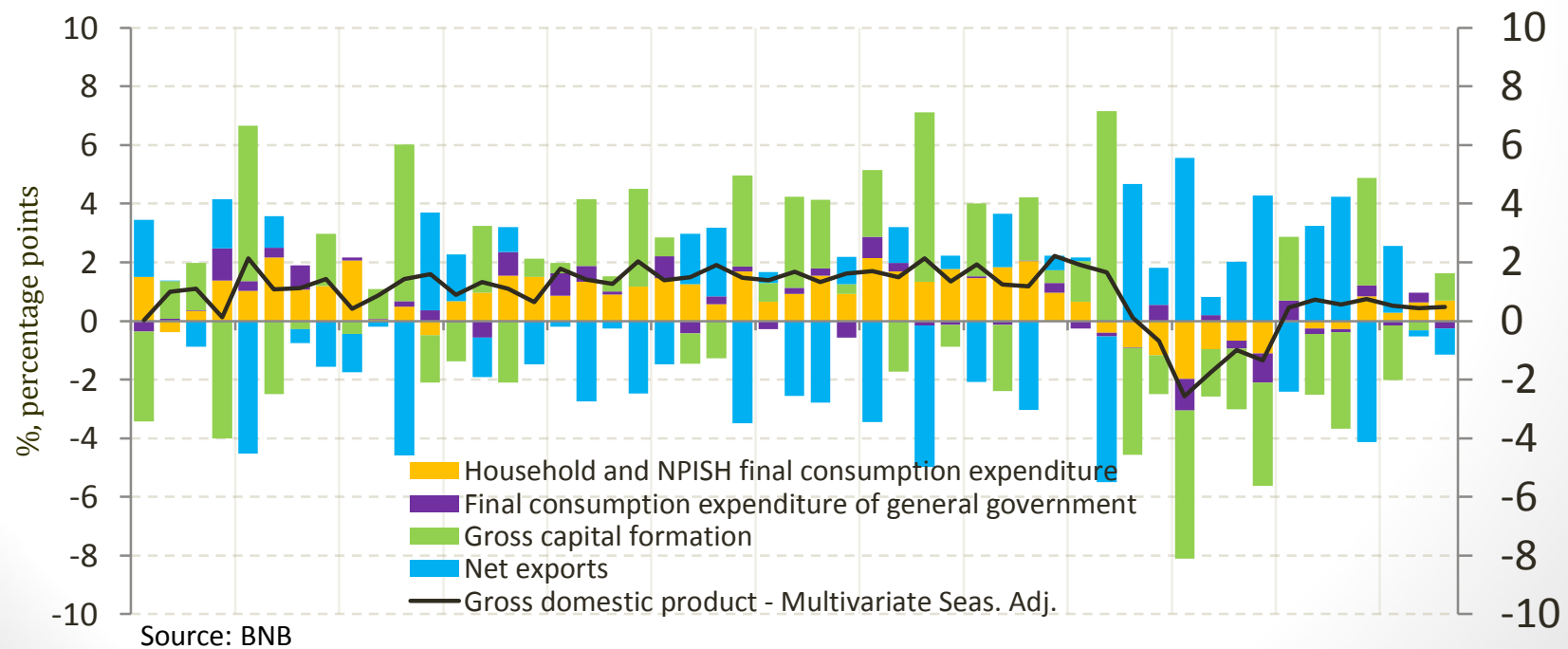
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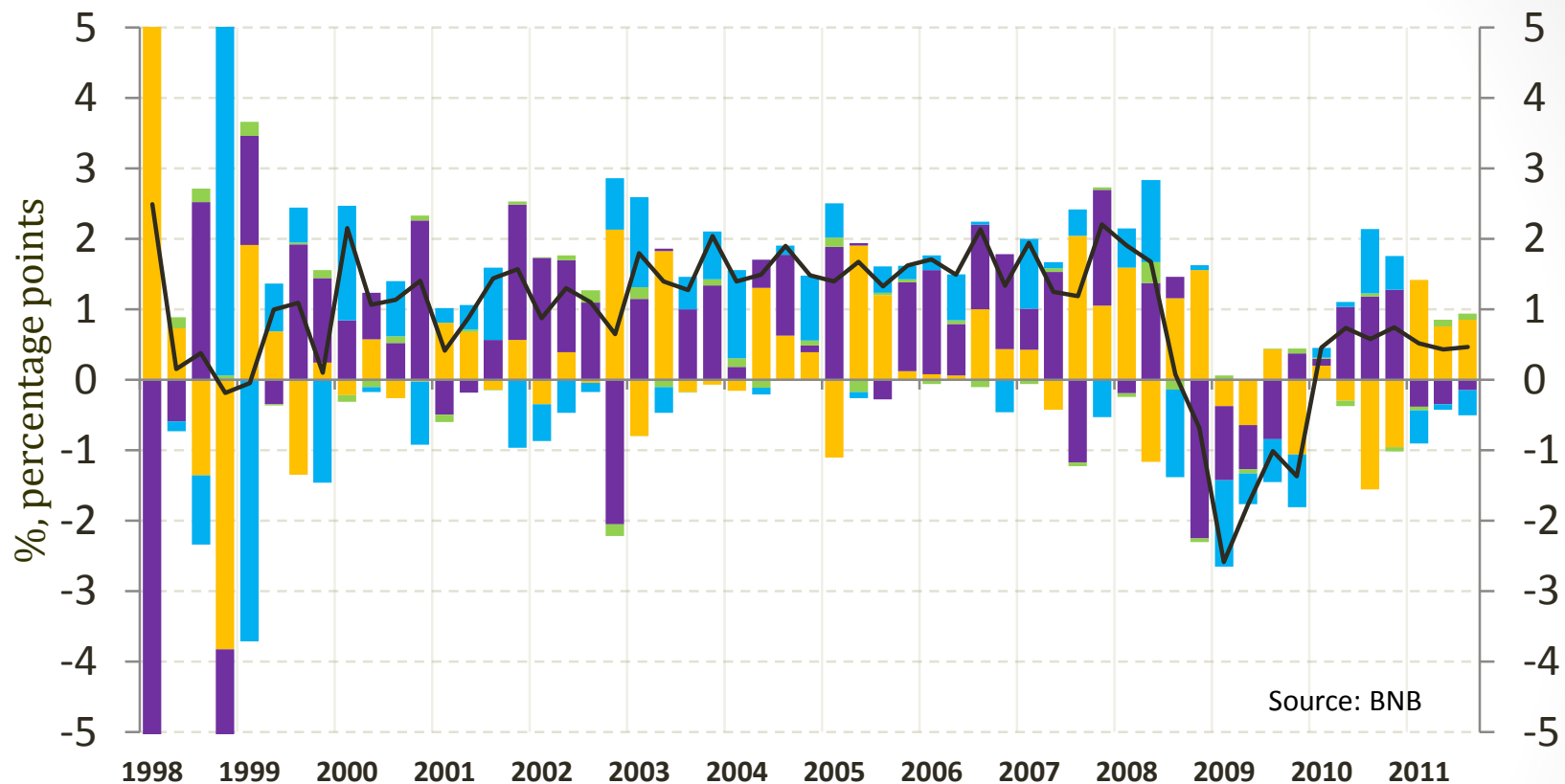


Conditional multivariate seasonal adjustment

- 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)



Source: BNB

■ Taxes less subsidies on products

■ Other taxes and subsidies on production

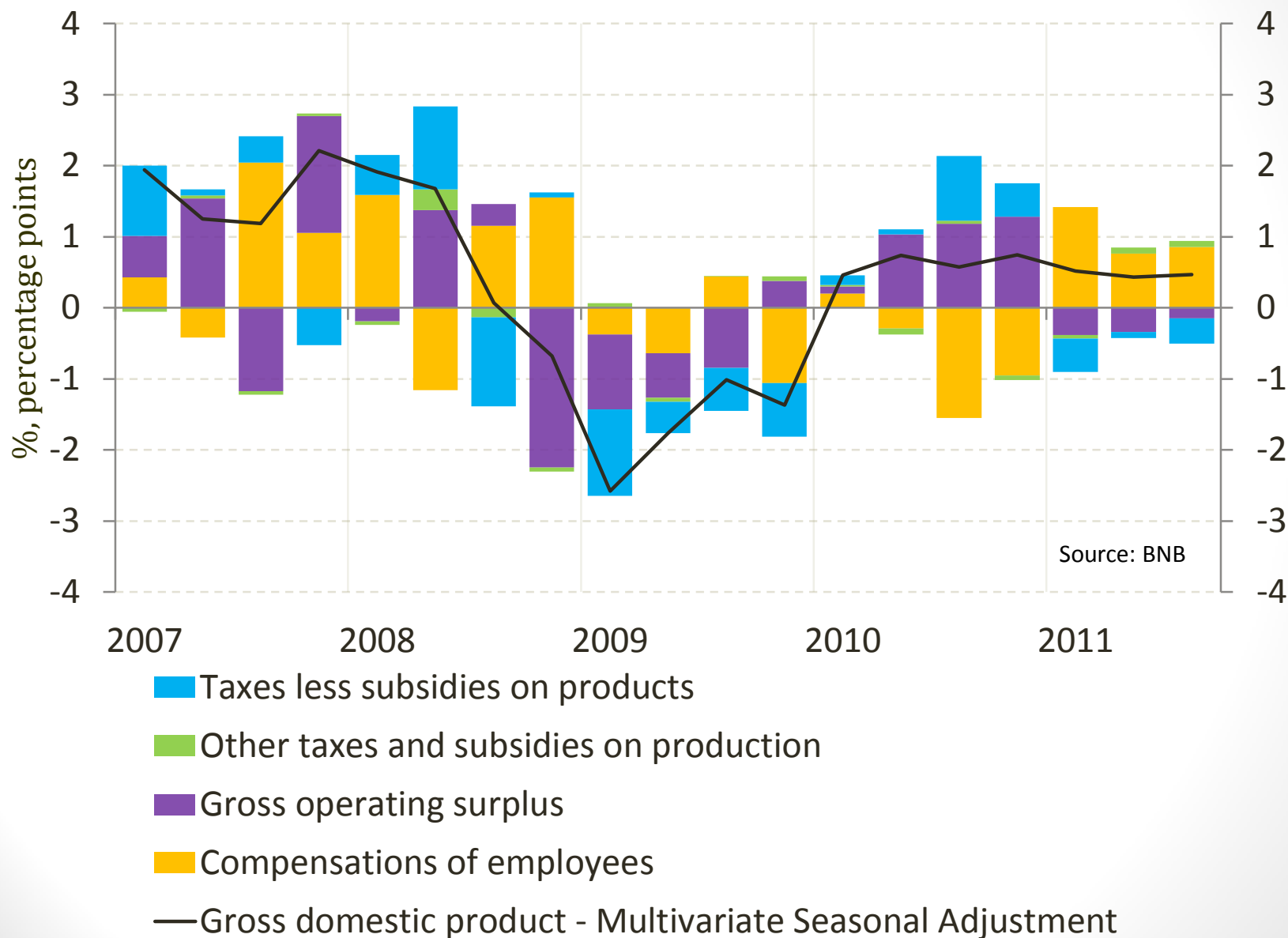
■ Gross operating surplus

■ Compensations of employees

— Gross domestic product - Multivariate Seasonal Adjustment

Contributions to quarterly growth – Income Approach

(Conditional multivariate seasonal adjustment)

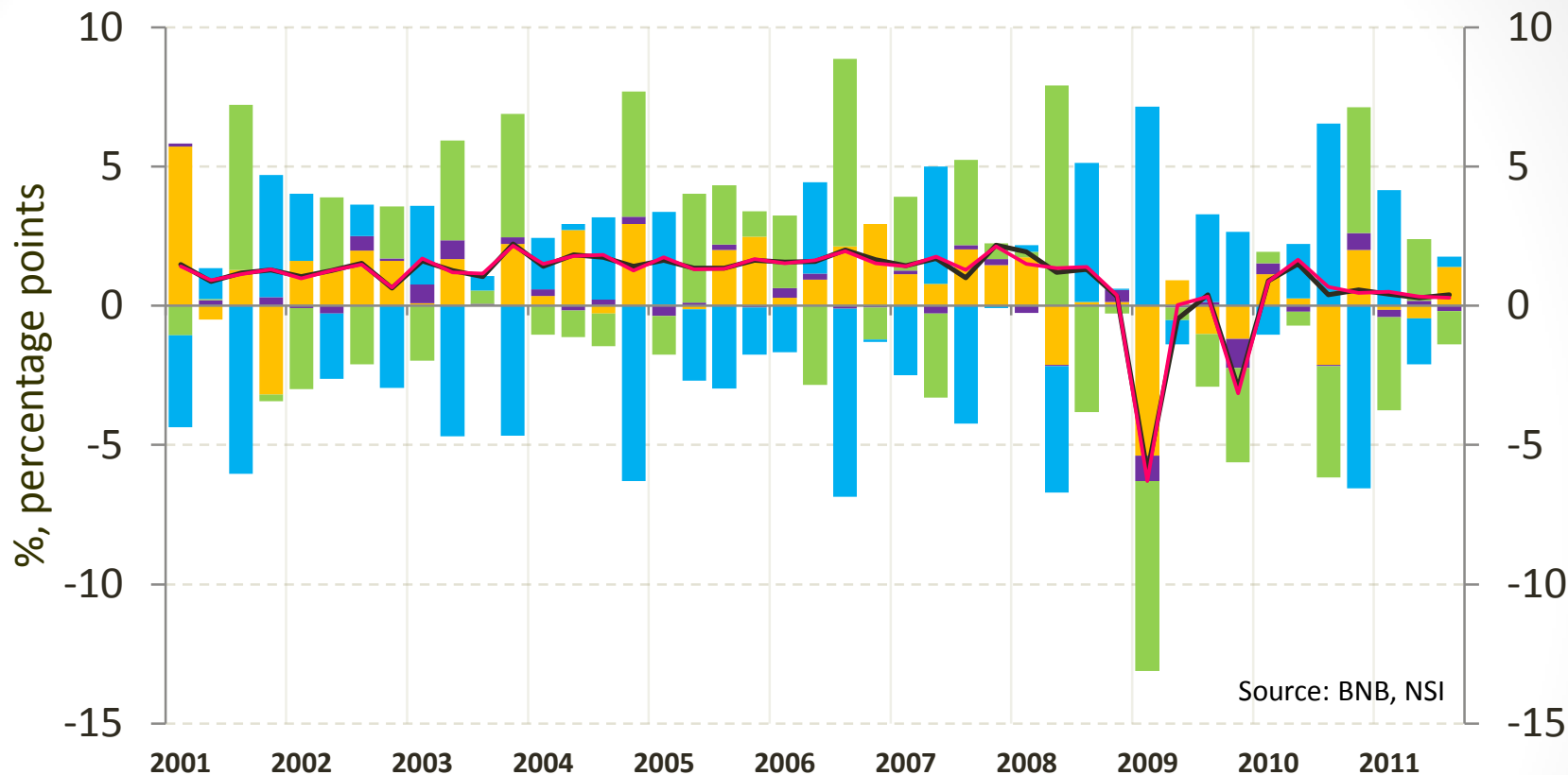


Modeling and forecasting

- 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)

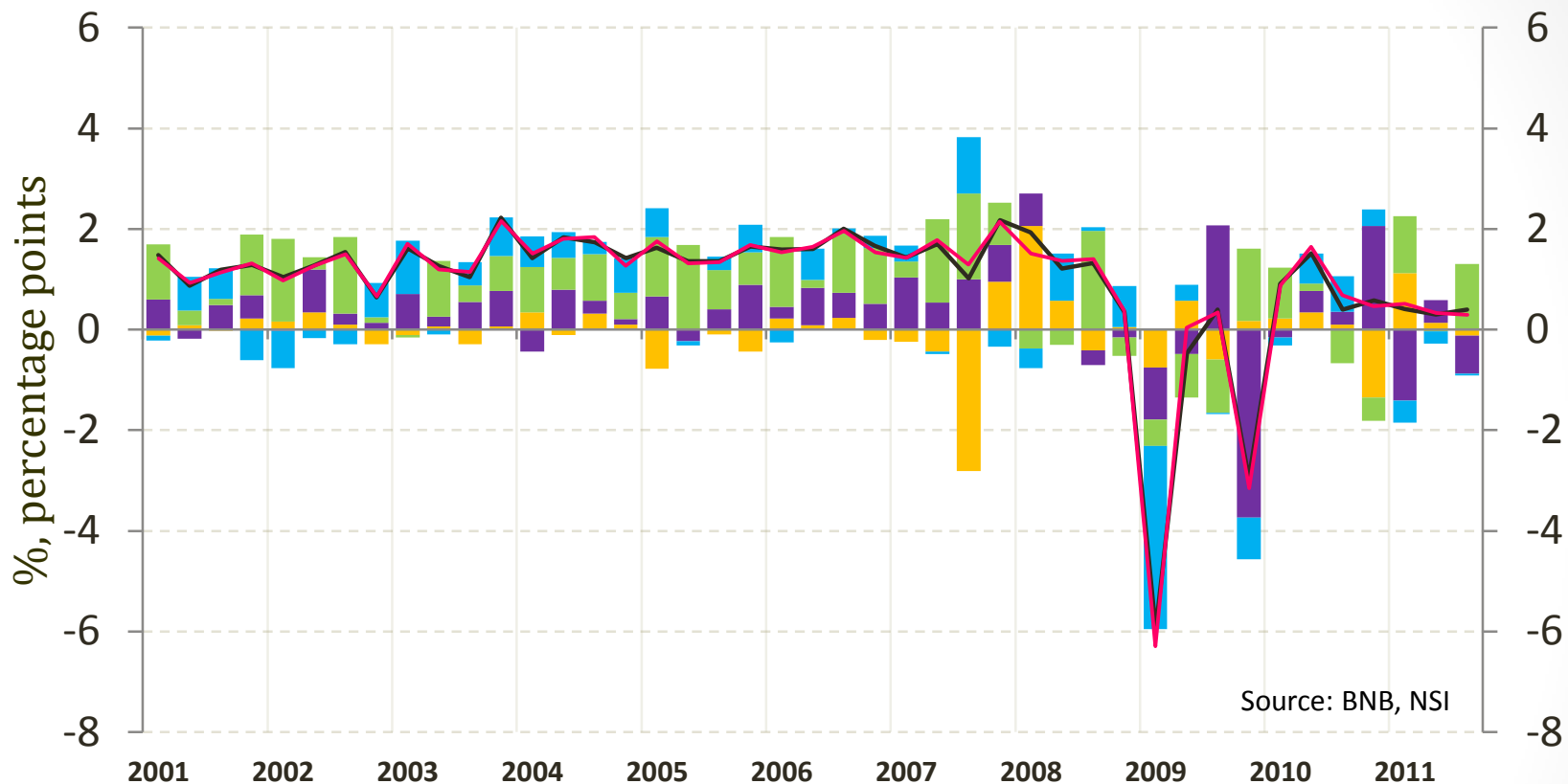


Source: BNB, NSI

- Net exports
- Gross capital formation
- Final consumption expenditure of general government
- Household and NPISH final consumption expenditure
- Gross domestic product - Multivariate Seasonal Adjustment
- Gross domestic product - Official NSI Estimates

Contributions to quarterly growth – Production Approach

(Conditional multivariate seasonal adjustment)



Source: BNB, NSI

- Taxes less subsidies on products
- Services
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- Gross domestic product - Multivariate Seasonal Adjustment
- Gross domestic product - Official NSI Estimates

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