EUROPEAN CENTRAL BANK

EUROSYSTEM

# Seasonal Adjustment of Euro Area HICPs and Industrial Producer Price Indices

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European Central Bank – DG Statistics

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# Sketch of the presentation

## HICPs

### Energy price index.

- Can seasonality be identified?

### Unprocessed food price index.

- Provide seasonally adjusted series.
- Compare the direct and the indirect approach.
- X-12-ARIMA and TRAMO/SEATS.

### Services.

- Passenger transport and package holidays.
- Working-day adjustment? Easter effect ? A preliminary view.

# Sketch of the presentation

## Industrial Producer Price Indices

### Seasonality in

- Intermediate goods.
- Consumer goods excluding tobacco.

## Further issues

- National HICPs.
- Seasonal breaks.
- …

# HICPs. Overview I

## Sources

- **Eurostat** provides **unadjusted HICP** data.
- Upon the recommendations agreed by the Statistics Committee in 2000

**DG-S compiles:**

**Seasonally adjusted HICP** data for the **euro area**.

**Seasonally adjusted** data for the following **euro area aggregates**: unprocessed food, processed food, non-energy industrial goods and services.

**Seasonally adjusted all-items index** for **EU countries**.

# HICPs. Overview II

## Approach

- **Euro area** overall **HICP** is **indirectly** adjusted by aggregating the four seasonally adjusted components and the non-adjusted energy component.
- The **four components** for the **euro area** are **directly** adjusted.

## Methodology

- **X-12-ARIMA** is employed.
- **Monthly** seasonal adjustment **quality reports**.
- **Annual review** of **model, outliers** and **options**.

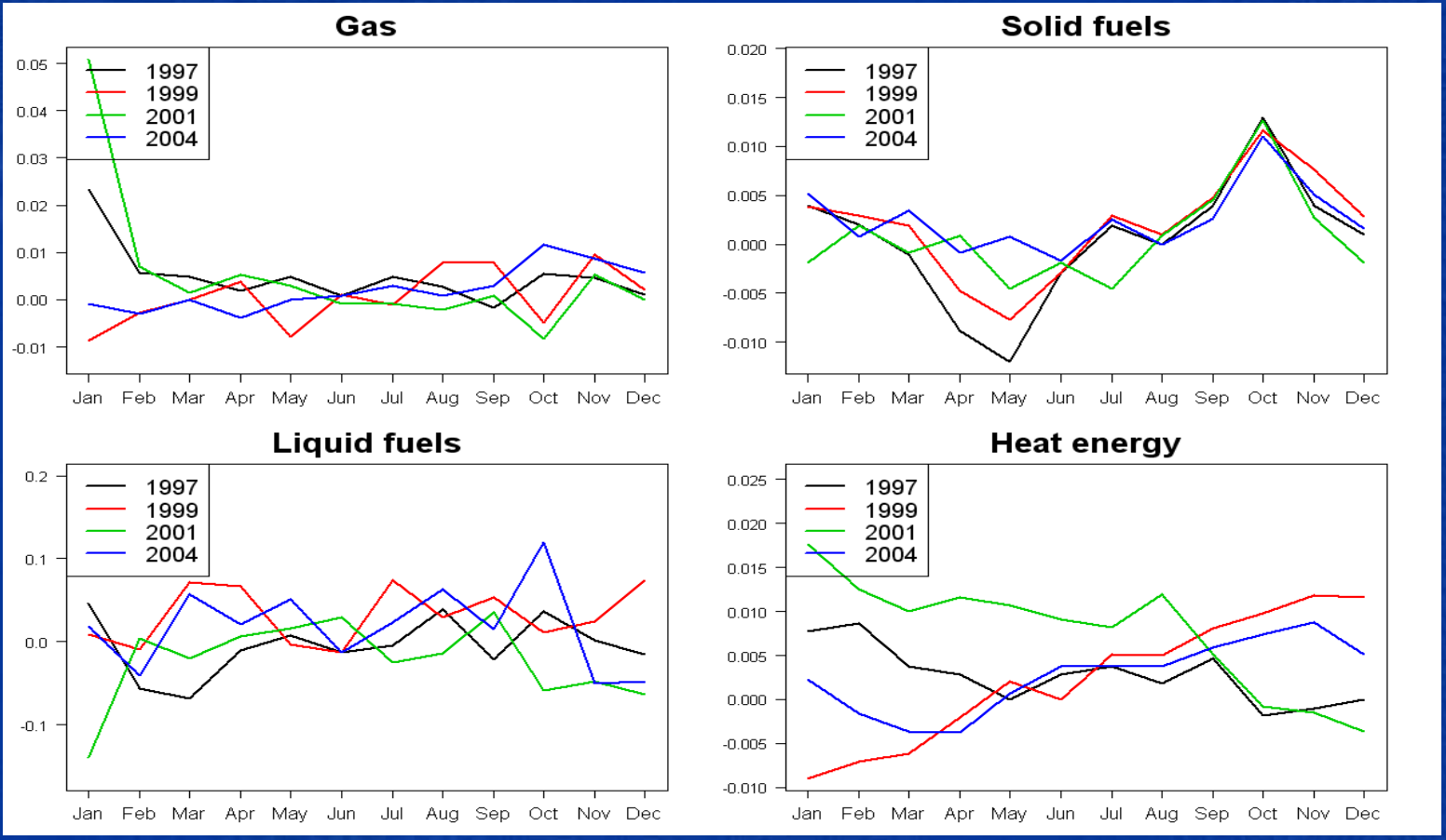
# HICPs. Energy price index

- The **energy price index** is **not seasonally adjusted.**
- The **4-digit COICOP-components** for this aggregate consists of six series.

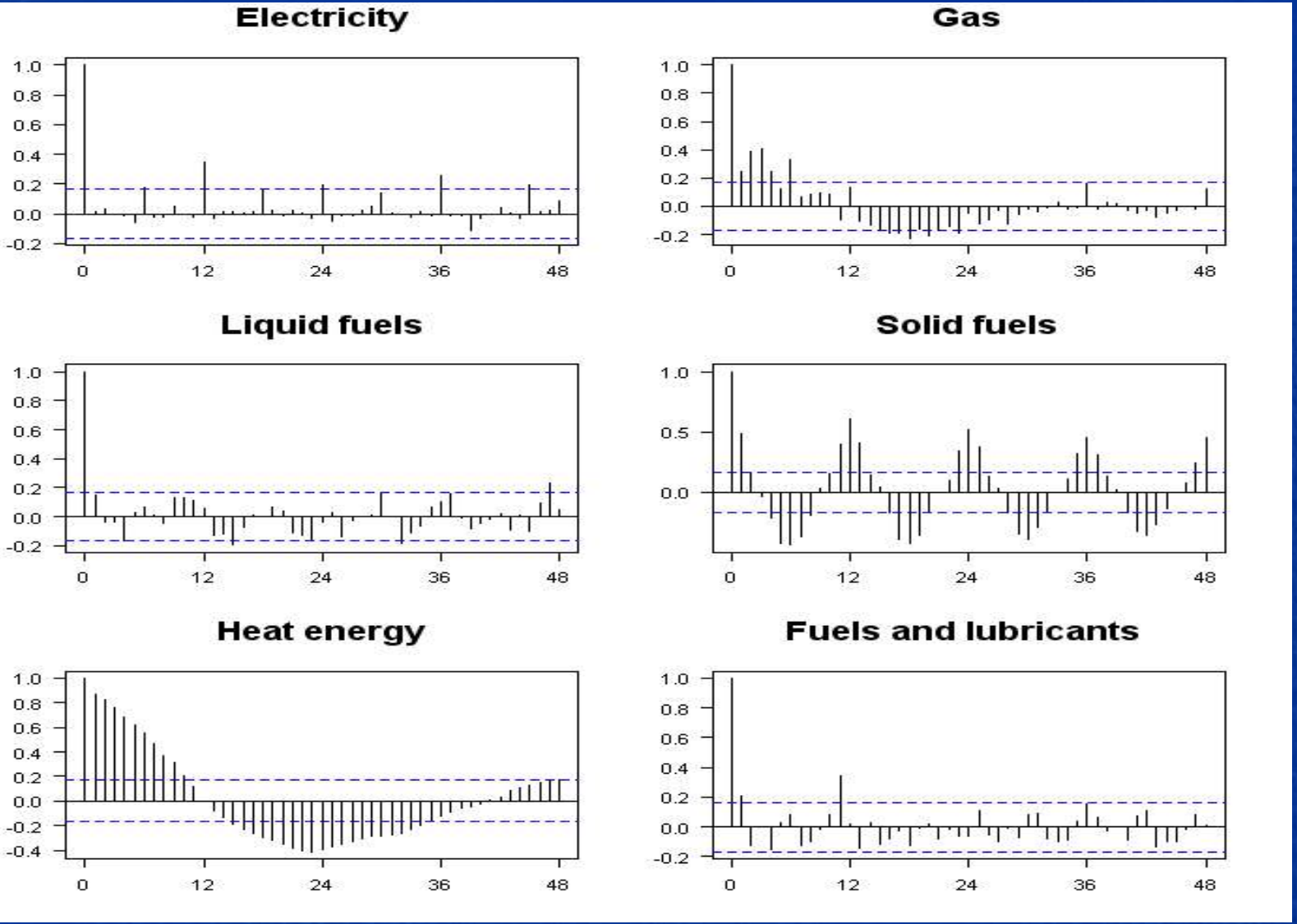
| Components | COICOP | Weight |
|---|---|---|
| Electricity | 045100 | 2.0% |
| Gas | 045200 | 1.5% |
| Liquid fuels | 045300 | 0.9% |
| Solid fuels | 045400 | 0.1% |
| Heat energy | 045500 | 0.5% |
| Fuels and lubricants | 072200 | 4.2% |

# Energy price index. Annual paths

- These components are influenced by the effect of **taxes** and **administered prices.**
- In general, the series do **not** exhibit a **major seasonal pattern.**



# Energy price index. Correlograms



# Energy price index. Seasonal dummies 1/2

## Regression on seasonal dummies.

| | electricity | | | gas | | | liquid fuels | | |
|---|---|---|---|---|---|---|---|---|---|
| | Coeff. | t-stat. | | Coeff. | t-stat. | | Coeff. | t-stat. | |
| SD1 | 71.88 | 5.28 | *** | 1.82 | 7.08 | *** | -0.66 | -0.48 | |
| SD2 | 4.80 | 0.38 | | -0.08 | -0.40 | | 0.53 | 0.38 | |
| SD3 | -0.95 | -0.08 | | -0.41 | -1.68 | . | 2.42 | 1.76 | . |
| SD4 | 24.91 | 1.93 | . | -0.23 | -0.93 | | -0.10 | -0.07 | |
| SD5 | -9.56 | -0.75 | | -0.08 | -0.40 | | -0.78 | -0.56 | |
| SD6 | 3.25 | 0.26 | | -0.05 | -0.24 | | -0.86 | -0.59 | |
| SD7 | 3.32 | 0.25 | | -0.09 | -0.35 | | 1.63 | 1.16 | |
| SD8 | 0.05 | 0.00 | | 0.21 | 0.98 | | 3.82 | 2.49 | * |
| SD9 | 0.26 | 0.02 | | 0.19 | 0.87 | | 4.92 | 3.36 | ** |
| SD10 | -9.01 | -0.66 | | 0.32 | 1.45 | | 1.97 | 1.28 | |
| SD11 | 7.48 | 0.56 | | 0.68 | 3.08 | ** | -2.20 | -1.50 | |
| SD12 | -1.37 | -0.10 | | 0.29 | 1.14 | | -2.21 | -1.49 | |
| | | | | | | | | | |
| | $R^2$ = | 0.38 | | $R^2$ = | 0.64 | | $R^2$ = | 0.26 | |
| | F-st = | 2.67 | ** | F-st = | 5.91 | *** | F-st = | 2.34 | * |
| | DW = | 1.80 | | DW = | 1.81 | | DW = | 1.96 | |
| | JB = | 758.88 | *** | JB = | 24.64 | *** | JB = | 24.86 | *** |

# Energy price index. Seasonal dummies 2/2

## Regression on seasonal dummies.

| | solid fuels | | | heat energy | | | f.l.p.t.e. | | |
|---|---|---|---|---|---|---|---|---|---|
| | Coeff. | t-stat. | | Coeff. | t-stat. | | Coeff. | t-stat. | |
| SD1 | 29.82 | 3.96 | *** | 0.18 | 1.58 | | 0.27 | 0.47 | |
| SD2 | 4.23 | 0.53 | | -0.24 | -2.04 | * | 0.73 | 1.32 | |
| SD3 | -3.18 | -0.38 | | -0.12 | -1.08 | | 0.98 | 1.79 | . |
| SD4 | -43.86 | -3.77 | *** | 0.23 | 2.06 | * | 1.32 | 2.42 | * |
| SD5 | -33.95 | -3.79 | *** | -0.08 | -0.70 | | 0.15 | 0.26 | |
| SD6 | -13.33 | -1.66 | . | -0.09 | -0.81 | | -0.21 | -0.38 | |
| SD7 | 12.48 | 1.54 | | 0.19 | 1.69 | . | 0.03 | 0.06 | |
| SD8 | 2.76 | 0.37 | | 0.03 | 0.22 | | 0.44 | 0.78 | |
| SD9 | 43.55 | 5.86 | *** | 0.13 | 1.12 | | 1.24 | 2.22 | * |
| SD10 | 98.07 | 11.29 | *** | -0.17 | -1.48 | | -0.25 | -0.44 | |
| SD11 | 34.87 | 2.86 | ** | 0.03 | 0.28 | | -1.38 | -2.44 | * |
| SD12 | 6.60 | 0.75 | | -0.03 | -0.26 | | -0.92 | -1.61 | |
| | $R^2$ = | 0.75 | | $R^2$ = | 0.41 | | $R^2$ = | 0.36 | |
| | F-st = | 17.06 | *** | F-st = | 2.14 | | F-st = | 1.86 | * |
| | DW = | 1.99 | | DW = | 2.07 | | DW = | 1.97 | |
| | JB = | 5.39 | . | JB = | 45.10 | *** | JB = | 1.70 | |

# Energy price index. TRAMO

## ARIMA model with regression variables

| | Model | Outliers | Diagnostic of the residuals | | |
|---|---|---|---|---|---|
| | | | DW[a] | JB[b] | Runs[c] |
| electricity | (0,1,0)(0,1,1) | LS 1996:01; LS 1999:01; LS 1999:04; LS 1999:10; LS 1996:07; TC 2000:01 | 1.87 | 19.33 *** | -0.18 |
| gas | (2,2,0)(0,0,0) | LS 1997:01; LS 2000:01; LS 2000:11; TC 2001:01; LS 2003:01; TC 2005:01; LS 2006:11 | 2.09 | 0.71 | -0.35 |
| liquid fuels | (0,1,1)(0,1,1) | TC 2000:09; LS 2001:01; LS 2003:04; TC 2004:10 | 2.02 | 0.06 | 0.91 |
| solid fuels | (1,1,0)(0,1,1) | LS 1995:07; LS 1998:10; AO 2000:04; LS 2001:01; LS 2005:10; | 1.84 | 0.68 | 0.00 |
| heat energy | (1,2,0)(0,0,1) | TC 2000:01; LS 2005:09; LS 2006:01; AO 2006:04; | 1.98 | 11.88 *** | -0.35 |
| f.l.p.t.e. | (1,1,1)(0,0,0) | LS 1999:04; TC2000:09 | 1.92 | 1.30 | -0.17 |

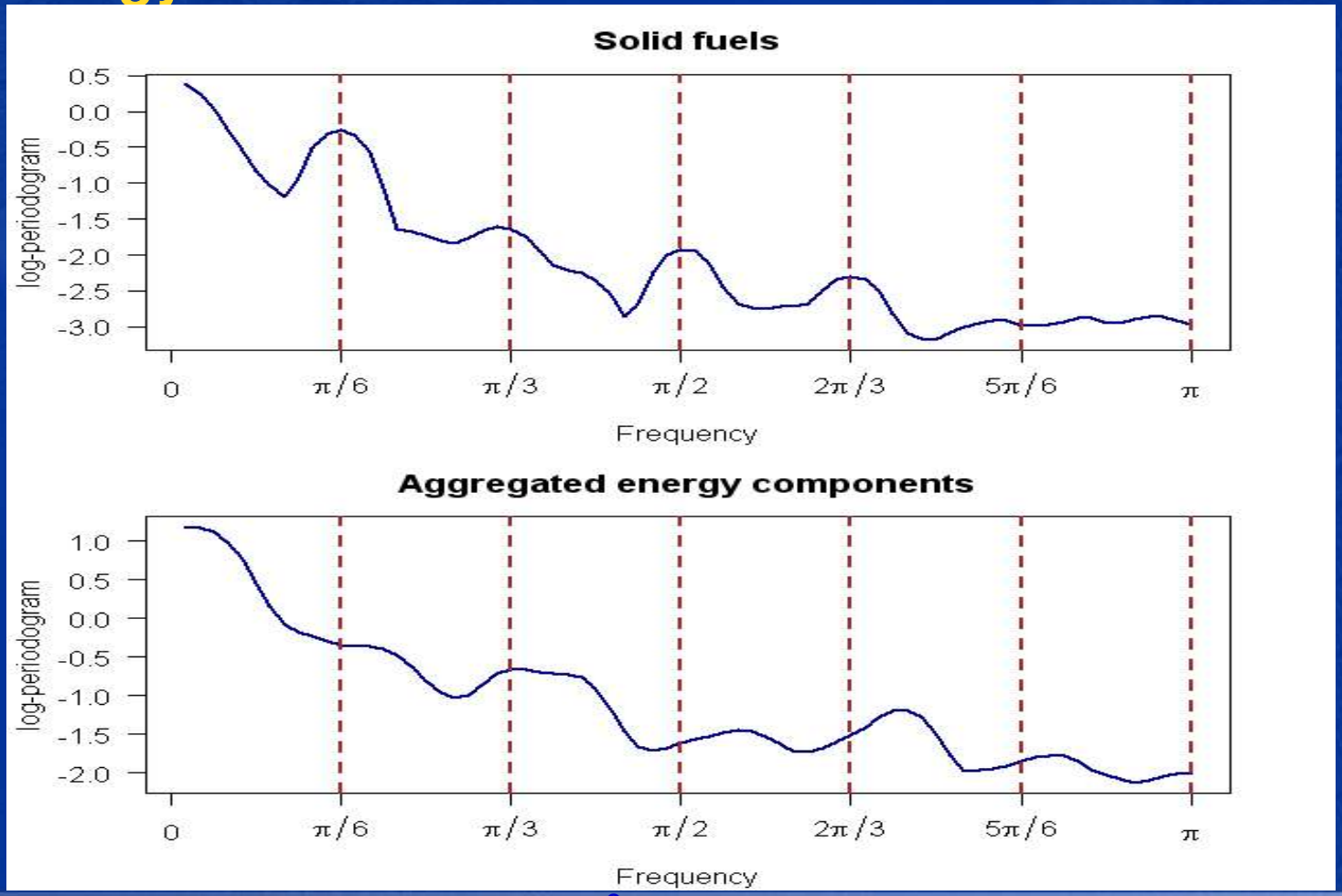
# Energy price index. X-12-ARIMA

## Tests for the presence of identifiable seasonality.

| | F-test | Kruskal-Wallis | Moving seasonality | Combined test |
|---|---|---|---|---|
| Electricity | Yes | Yes | Yes | Probably not present |
| Gas | No | Yes | No | Not present |
| Liquid fuels | No | Yes | Yes | Not present |
| Solid fuels | Yes | Yes | Yes | Present |
| Heat energy | No | No | No | Not Present |
| Fuels and lubricants | Yes | Yes | Yes | Not present |

# Energy price index. Log-periodogram

- **Seasonal cycles are not relevant in the aggregated energy index.**



# Energy price index. Summary

- **Seasonality** is reliably **identified** only in the **solid fuels** component.
- **Level shifts** and **temporary changes** are detected in all the energy components.
- **Changes in taxes remain as part of the seasonally adjusted series if** those events are **not identified** as a recurrent **seasonal pattern**.
- By **comparing unadjusted** and **semi-adjusted series**: Absolute **differences** are **negligible**.

  **Full agreement** in the growth rates.

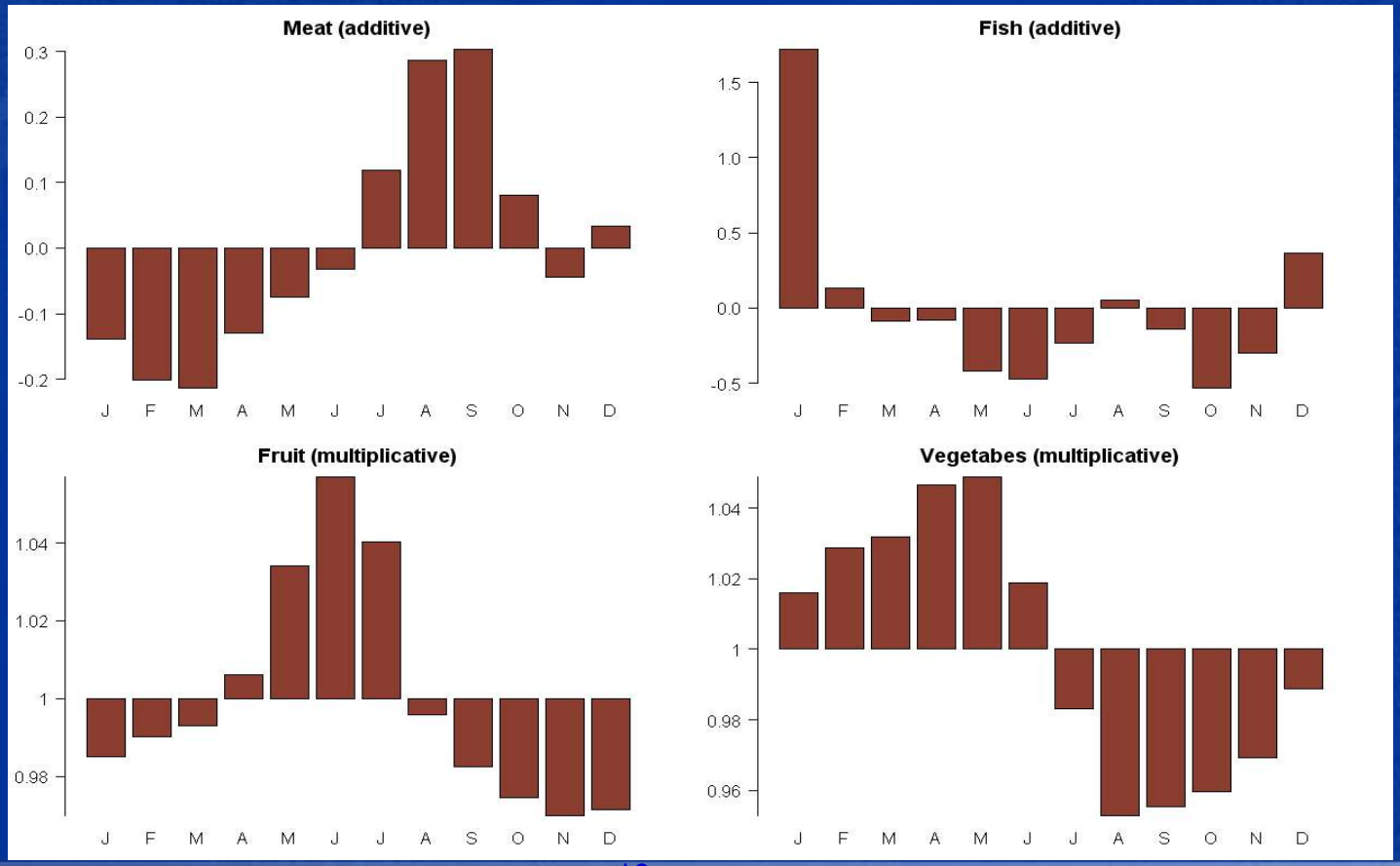
# HICPs. Unprocessed food price index

- The **4-digit COICOP-components** for this aggregate consists of four series.

| Components | COICOP | Weight |
|---|---|---|
| Meat | 011200 | 3.7% |
| Fruit | 011300 | 1.2% |
| Fish | 011600 | 1.1% |
| Vegetables | 011700 | 1.5% |

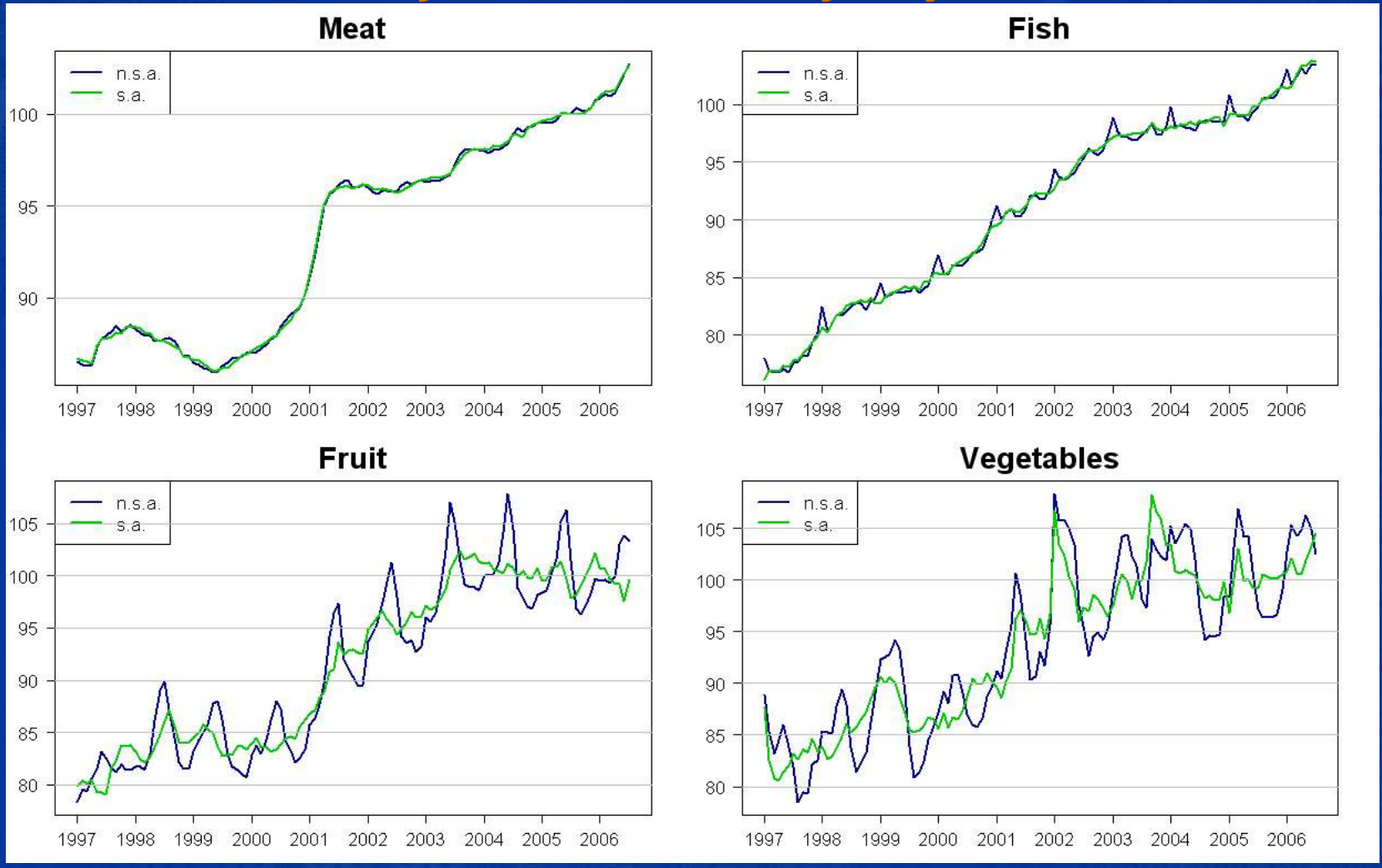
# Unprocessed food price index

- **Seasonal factors.** These components typically display seasonal patterns that are guided by weather conditions and other seasonal events.



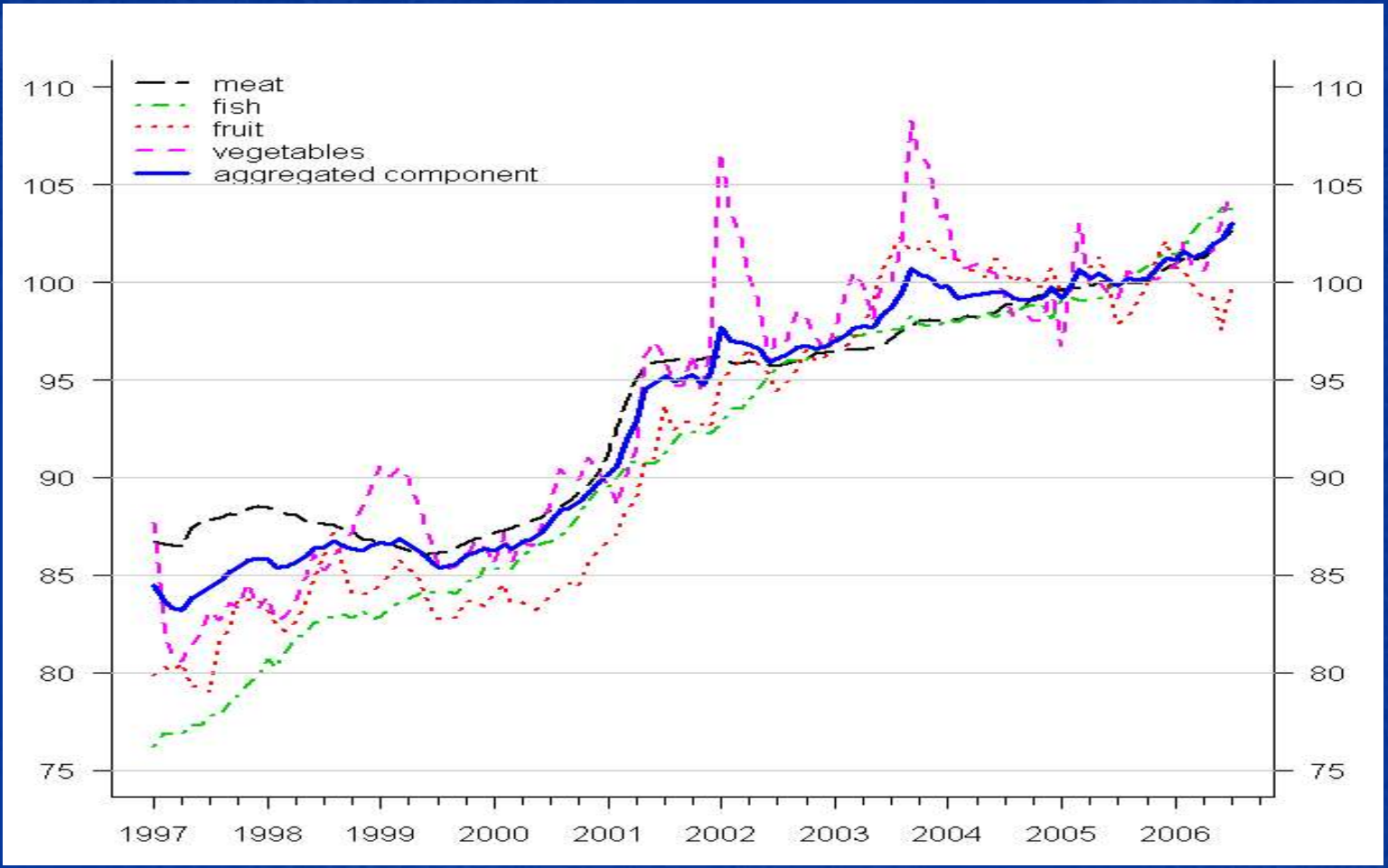
# Unprocessed food price index

- Non-seasonally and seasonally adjusted. X-12-ARIMA.



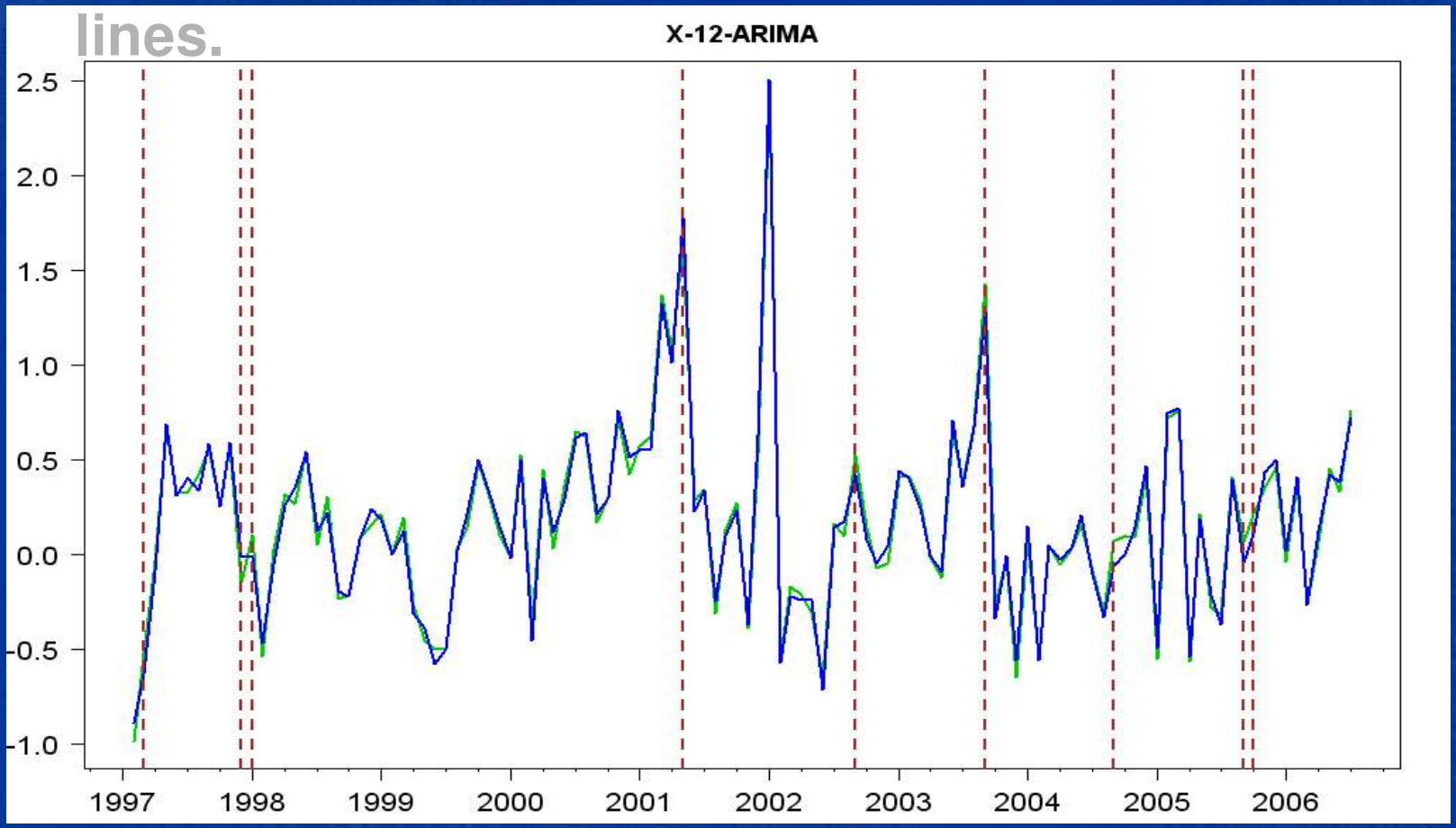
# Unprocessed food price index

- **Seasonally adjusted components and aggregated energy index. X-12-ARIMA.**



# Unprocessed food price index

- **Direct** and **indirect** approaches. (X-12-ARIMA).
- **Differences higher than 0.10 p.p.** see vertical lines.



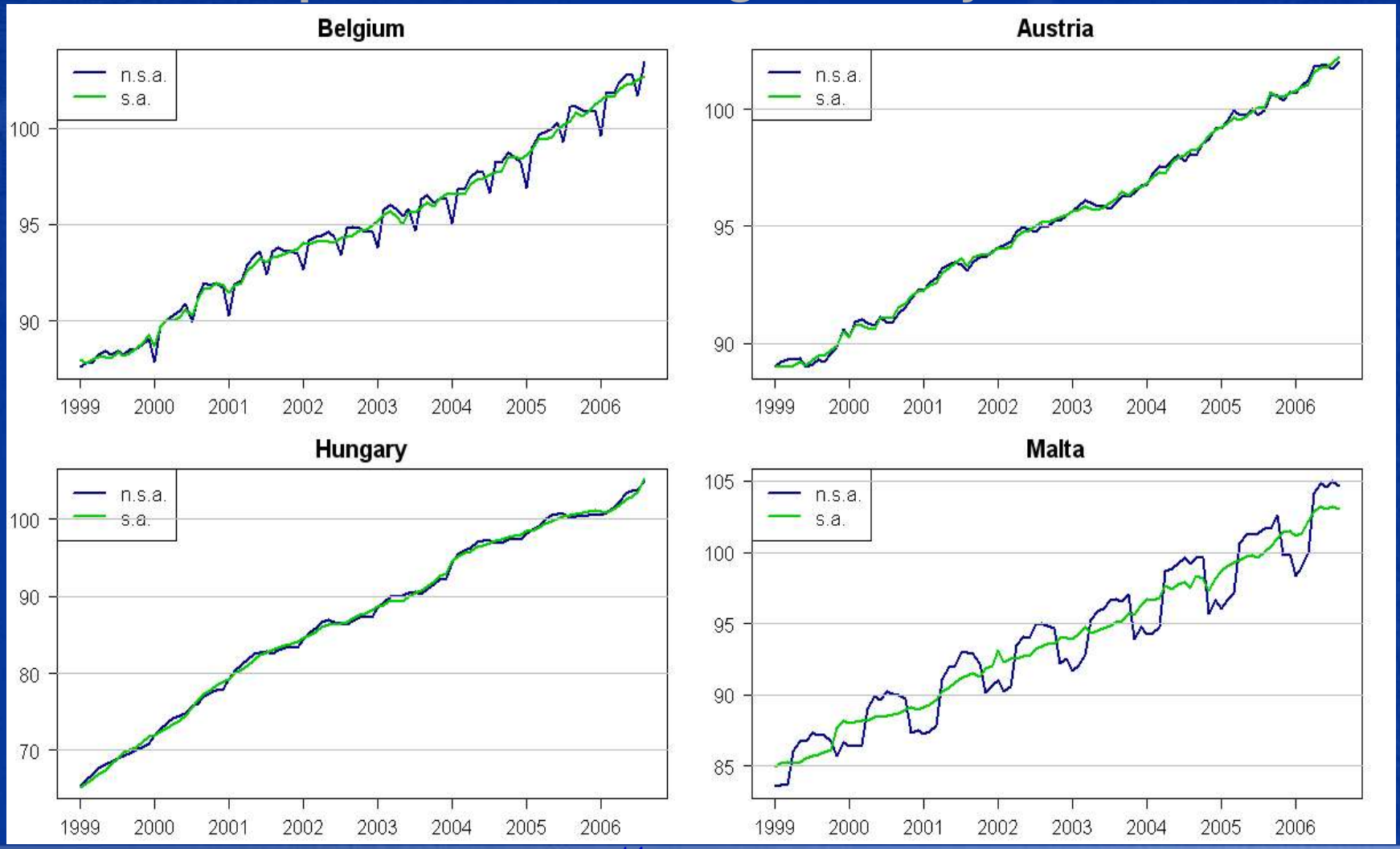
# Unprocessed food price index

- **Direct and indirect approaches: Comparison.**

| | | X-12-ARIMA | TRAMO/SEATS |
|---|---|---|---|
| Absolute percentage deviations | average | 0.05 | 0.10 |
| | maximum | 0.18 | 0.25 |
| Percentage of concordance in growth rates | | 92.98 | 93.86 |
| Percentage of differences in growth rates | mean | 0.00 | 0.00 |
| | minimum | -0.15 | -0.23 |
| | maximum | 0.14 | 0.23 |
| | variance | 0.00 | 0.01 |

# National HICP data

- Seasonal patterns varies significantly across



# HICPs. Services

- The following **4-digit COICOP-components** are analysed.

| Components | COICOP | Weight |
|---|---|---|
| Passenger transport | | |
| … by railway | 073100 | 0.4% |
| … road | 073200 | 0.5% |
| … air | 073300 | 0.5% |
| … sea and inland water | 073400 | 0.1% |
| Combined passengers transport | 073500 | 0.5% |
| Other purchased transport services | 073600 | 0.1% |
| Package holidays | 096000 | 1.4% |

# HICPs. Services

- **Calendar effects**

  **Trading-day.** This regressor is defined as:

$$TD_t = \#(Mo, Tu, We, Th, Fr) - \#(Sa, Su) \cdot 5/2$$

  **Easter effect.** This regressor captures a potential change in the series during the *w* days before Easter.

$$E_t = \beta[P(w)_t - 1/2]$$

  The values for **March** are the proportion of the *w* days that fall in that month minus the mean value of that proportion over a long period (0.5). The same for **April**. Zeros for the other months.

# HICPs. Services. Calendar effects

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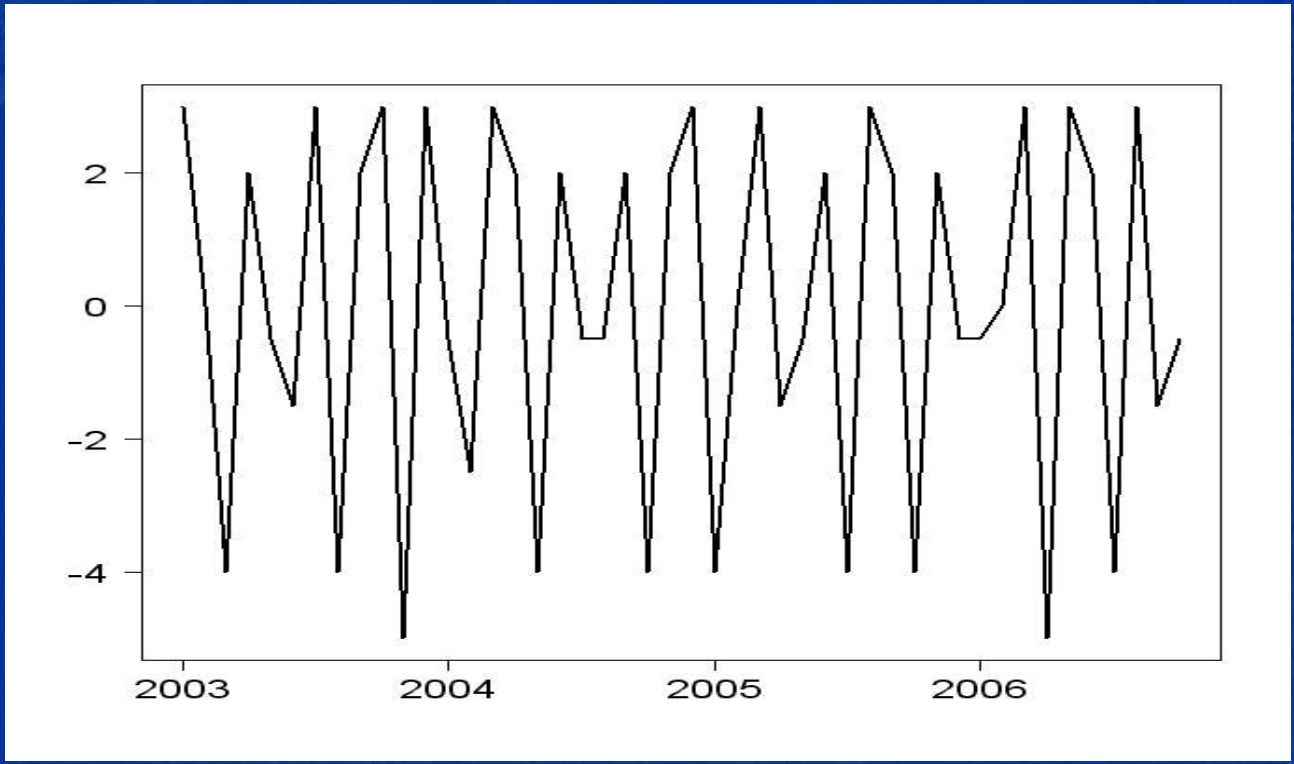

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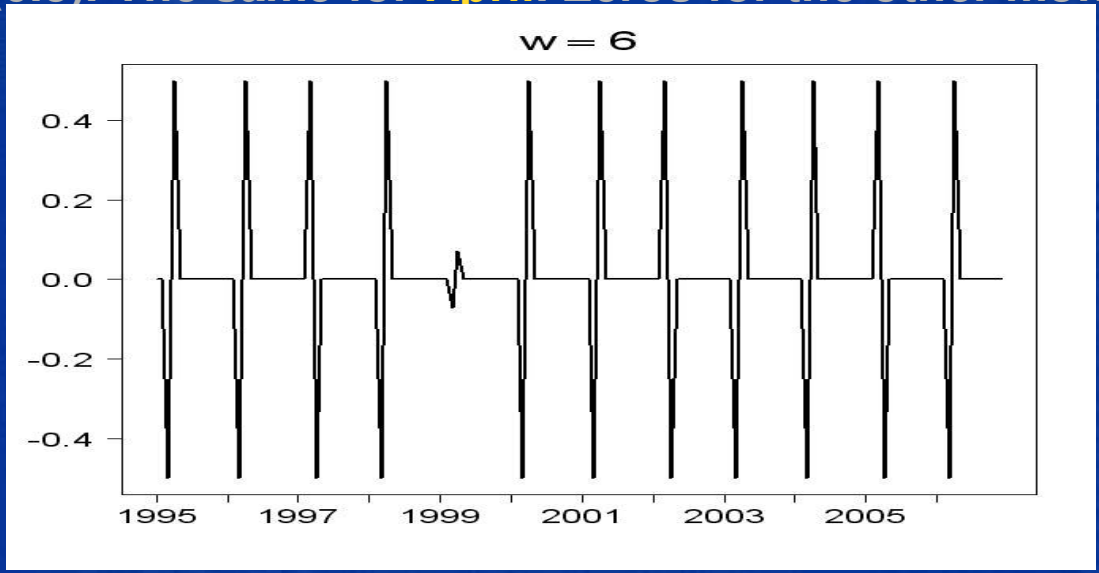

# HICPs. Services. Calendar effects

- **ARIMA model with regression variables.**

| | | Coefficient | t-stat. | p-value | |
|---|---|---|---|---|---|
| 073100 | Trading Day | 0.00 | -0.25 | 0.7989 | |
| | Easter | -0.09 | -1.92 | 0.0547 | * |
| 073200 | Trading Day | 0.00 | 0.47 | 0.6362 | |
| | Easter | 0.00 | 0.71 | 0.4755 | |
| 073300 | Trading Day | 0.00 | -0.46 | 0.6446 | |
| | Easter | 0.01 | 3.30 | 0.0010 | **** |
| 073400 | Trading Day | -0.03 | -1.33 | 0.1840 | |
| | Easter | -0.10 | -0.27 | 0.7873 | |
| 073500 | Trading Day | 0.00 | 0.79 | 0.4274 | |
| | Easter | 0.00 | 0.01 | 0.9907 | |
| 073600 | Trading Day | 0.01 | 1.59 | 0.1130 | |
| | Easter | -0.03 | -0.65 | 0.5136 | |
| 096000 | Trading Day | 0.00 | -2.32 | 0.0202 | ** |
| | Easter | 0.03 | 5.89 | 0.0000 | **** |

# HICPs. Services. Calendar effects

- **ARIMA model with regression variables.**

| | | Coefficient | t-stat | p-value |
|---|---|---|---|---|
| 073100 | Trading day | 0.00 | -0.25 | 0.7989 |
| | Easter | -0.09 | -1.92 | 0.0547 * |
| 073200 | Trading day | 0.00 | 0.47 | 0.6362 |
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| | Easter | 0.01 | 3.30 | 0.0010 **** |
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| | Easter | -0.10 | -0.27 | 0.7873 |
| 073500 | Trading day | 0.00 | 0.79 | 0.4274 |
| | Easter | 0.00 | 0.01 | 0.9907 |
| 073600 | Trading day | 0.01 | 1.59 | 0.1130 |
| | Easter | -0.03 | -0.65 | 0.5136 |
| 096000 | Trading day | 0.00 | -2.32 | 0.0202 ** |
| | Easter | 0.03 | 5.89 | 0.0000 **** |

# HICPs. Services

- **Easter effect** appears to be **significant** in **passenger transport by railway and by air and package holidays**.
- **Trading day** is found **significant** in **package holidays**.
- The performance of the *standard* trading day regressor is often improved by a regressor containing the specific **dates** of **holidays**.

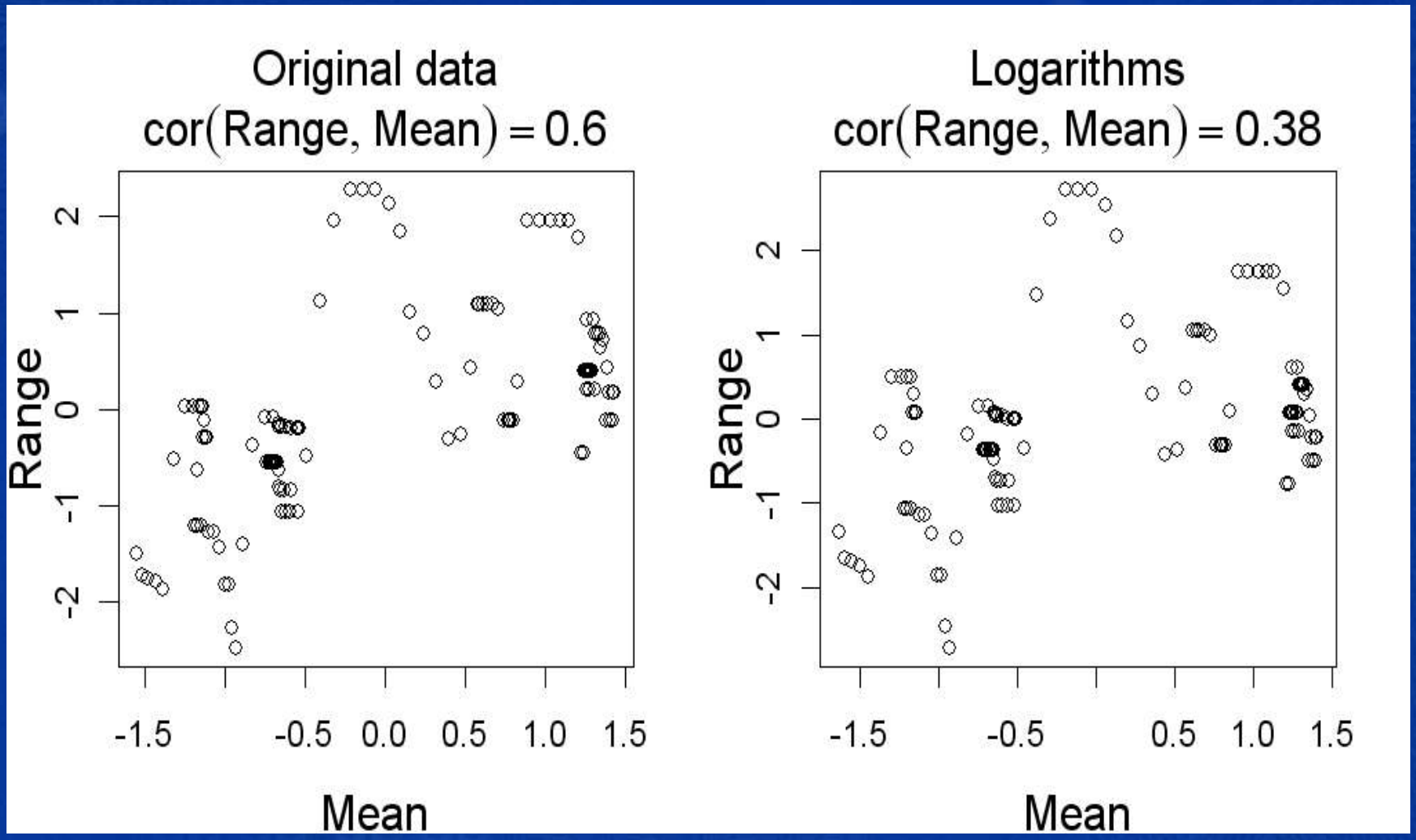
# Industrial Producer Price Indices

| | | SA series in $sts data base | Identifiable seasonality | |
|---|---|---|---|---|
| ns0030 | Mining, quarrying | No | Not present | |
| ns0040 | Intermediate goods | No | Present | * |
| ns0050 | Capital goods | Yes | Present | |
| ns0060 | Durable consumer goods | Yes | Present | |
| ns0070 | Non-durable consumer goods | Yes | Present | |
| ns0080 | Consumer goods | Yes | Present | |
| ns0081 | Consumer goods excl. tobacco | No | Present | * |
| ns0090 | Energy | No | Not present | |

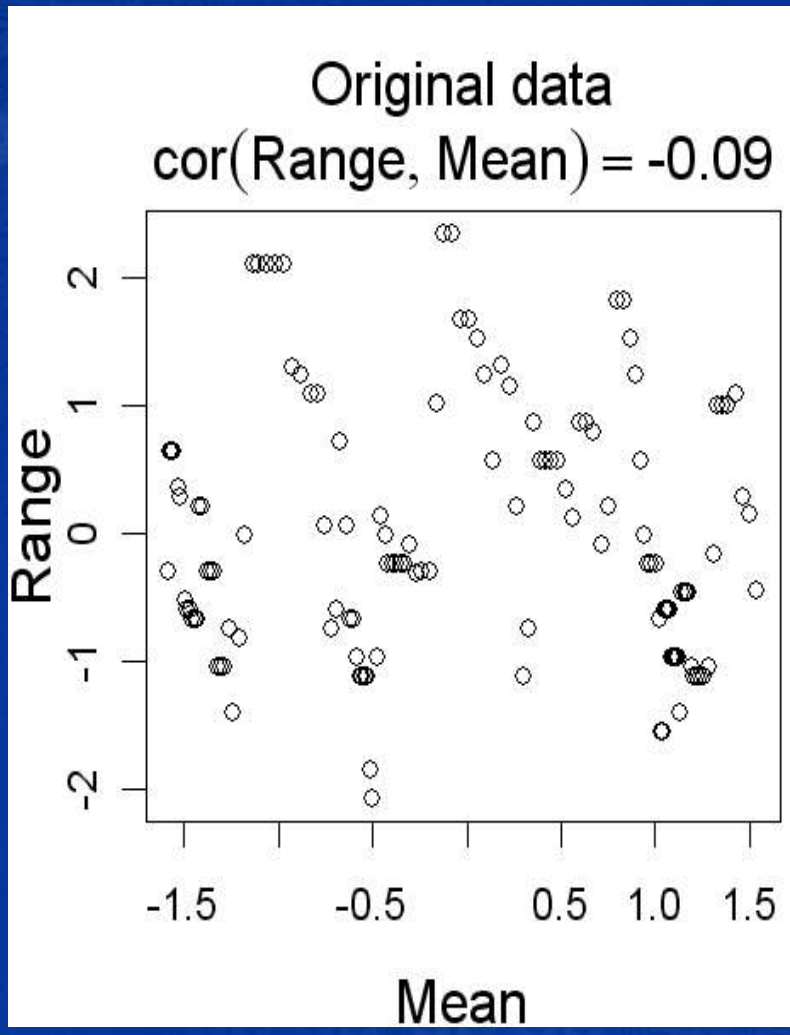
# Industrial Producer Price Indices

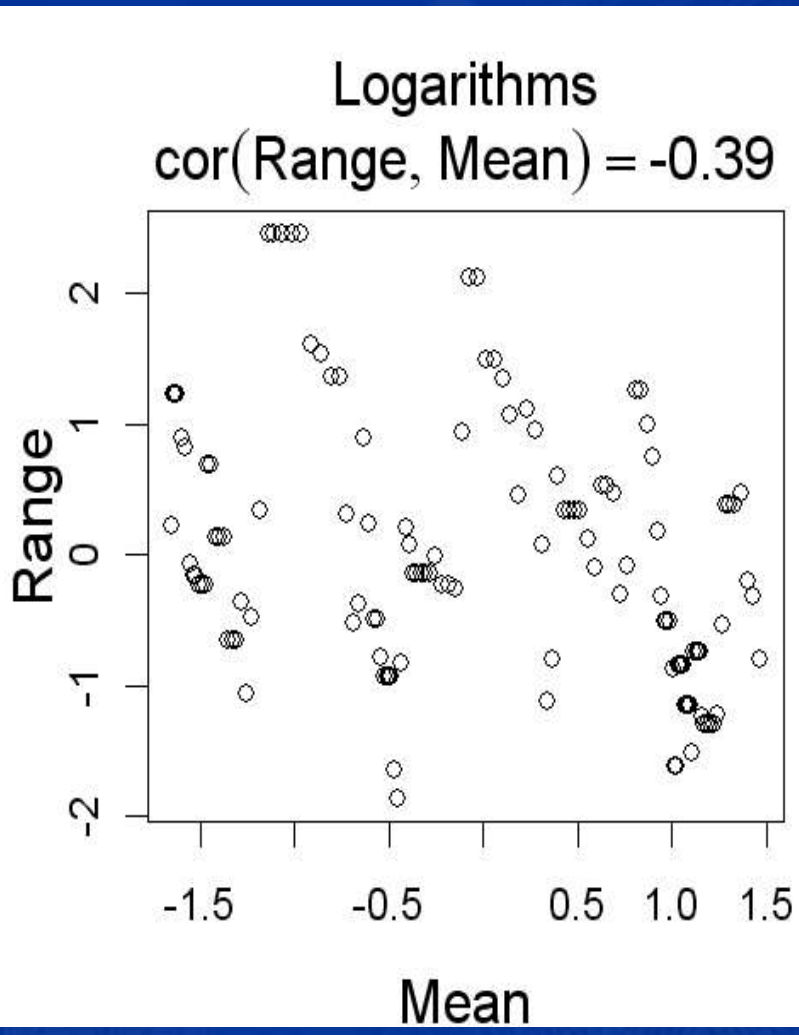
- **Intermediate goods price series**
  - Weak seasonality is identified.
  - Cycles of length 6-8 years are found to be relevant.
- **Consumer goods excluding tobacco**
  - A relatively stronger can be identified.
  - Weaker cycles of length 4 years are also relevant.

# fruit


Original data
cor(Range, Mean) = 0.6
Range
Mean
-2
-1
0
1
2
-1.5
-0.5
0.0
0.5
1.0
1.5
Logarithms
cor(Range, Mean) = 0.38
Range
Mean
-2
-1
0
1
2
-1.5
-0.5
0.5
1.0
1.5

# fish


Original data
cor(Range, Mean) = -0.09
Range
Mean
-2
-1
0
1
2
-1.5
-0.5
0.5
1.0
1.5


Logarithms
cor(Range, Mean) = -0.39
Range
Mean
-2
-1
0
1
2
-1.5
-0.5
0.5
1.0
1.5

- **Default critical values for the detection of outliers**

| Number of observations | 36 | 72 | 144 | 312 |
|---|---|---|---|---|
| X-12-ARIMA | 3.55 | 3.73 | 3.89 | 4.04 |
| TRAMO | 3.00 | 3.10 | 3.24 | 3.66 |

- The detection outliers should be specified in order to have a reasonable distinction between the seasonal component and the irregular component of a series.
- Forecast with ARIMA models the last observations are the most relevant.

# Summary I

⇒**Energy price index.** No evidence suggesting seasonal adjustment.

⇒**Unprocessed food.** Stable seasonal pattern in the components will be adjusted.

⇒**Outliers.** Significant outliers will remain part of the seasonally adjusted series for the energy index and also in fruit and vegetables.

⇒**Methods.** By comparing the current methodology with TRAMO/SEATS for the unprocessed food index, as far as **smoothness** and **stability** is concerned **X-12-ARIMA showed sensible performance.**

# Summary II

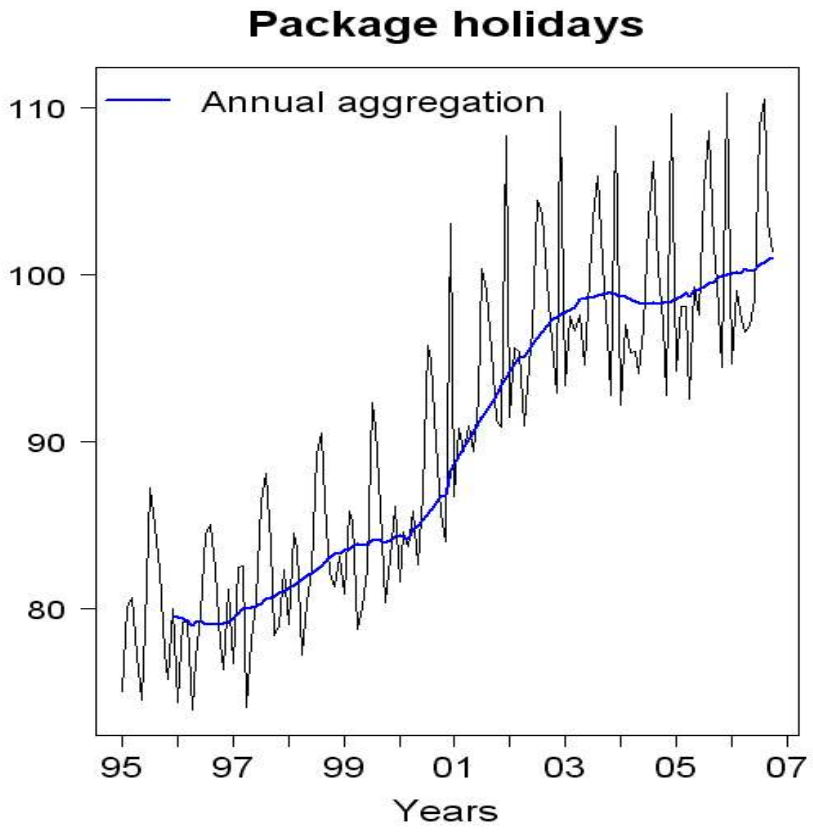
⇒**Direct and indirect approaches.**

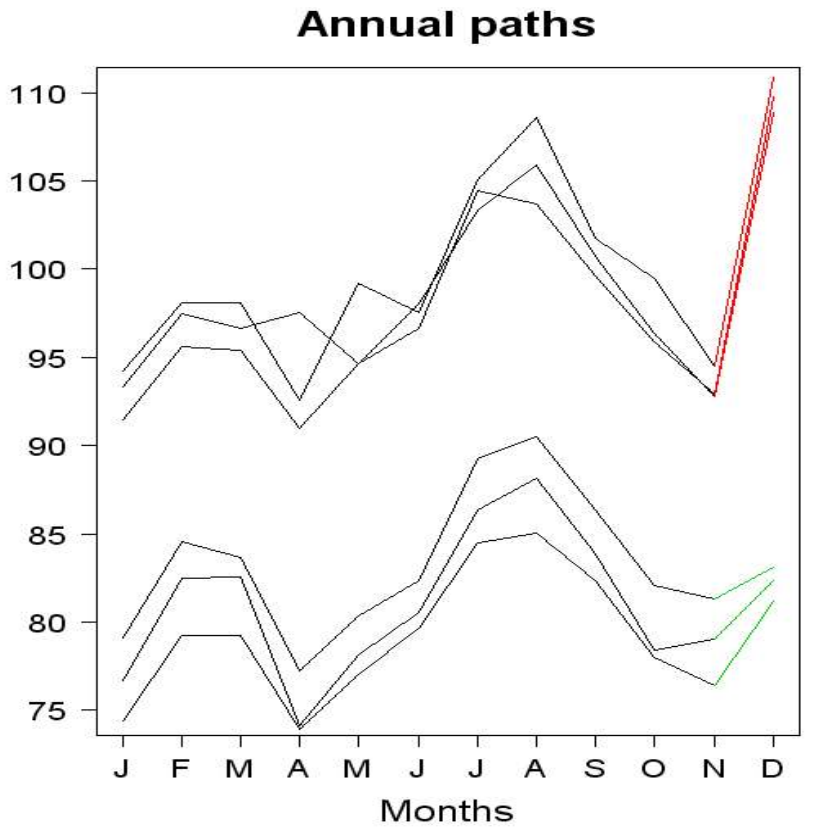
Due to **potentially higher uncertainty in estimating seasonal factors on a more detailed level,**

practical considerations suggest using the **indirect approach only if clear advantages.**

**Systematic discrepancies are not found** for the unprocessed food index.

# HICPs. Package holidays



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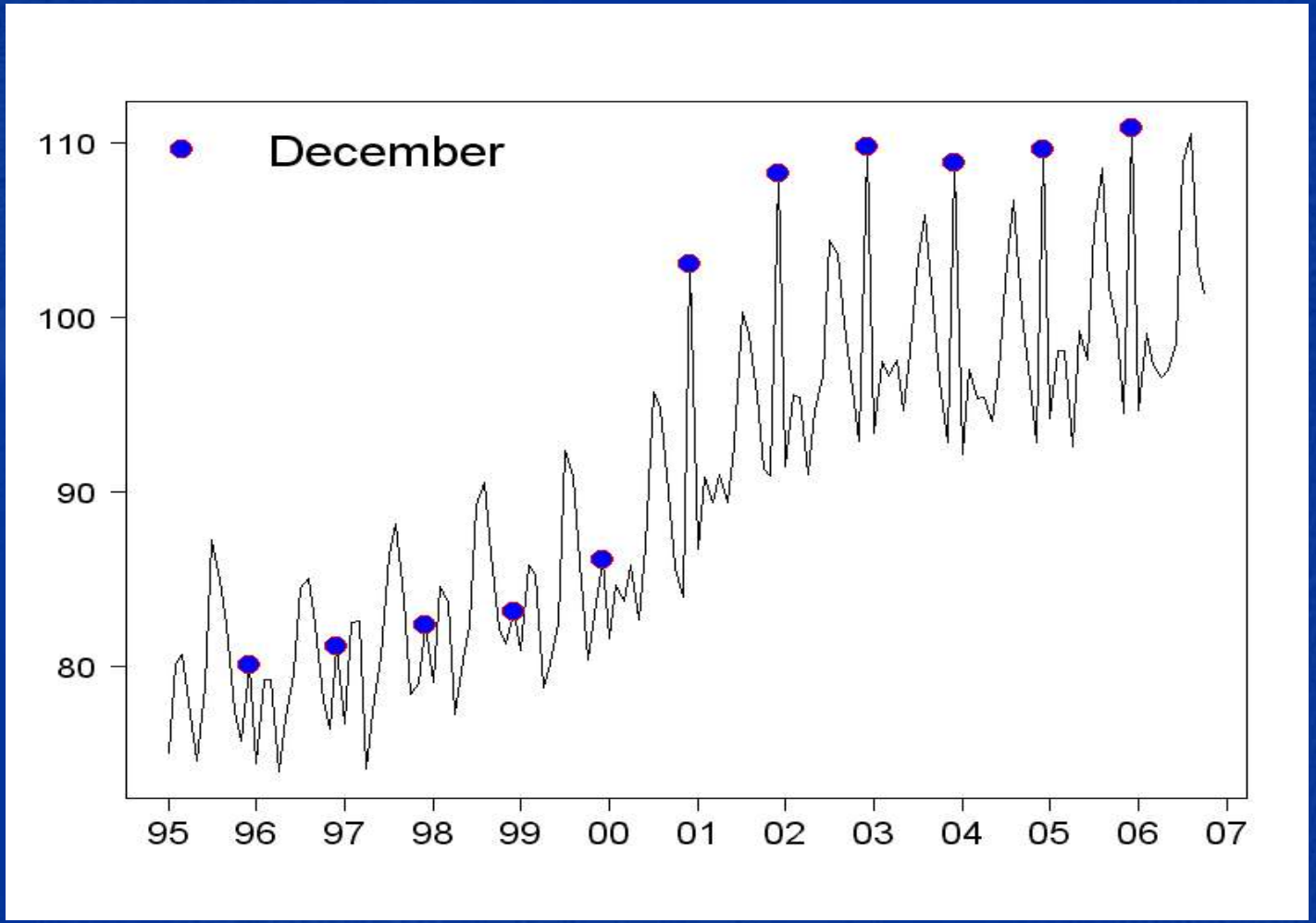
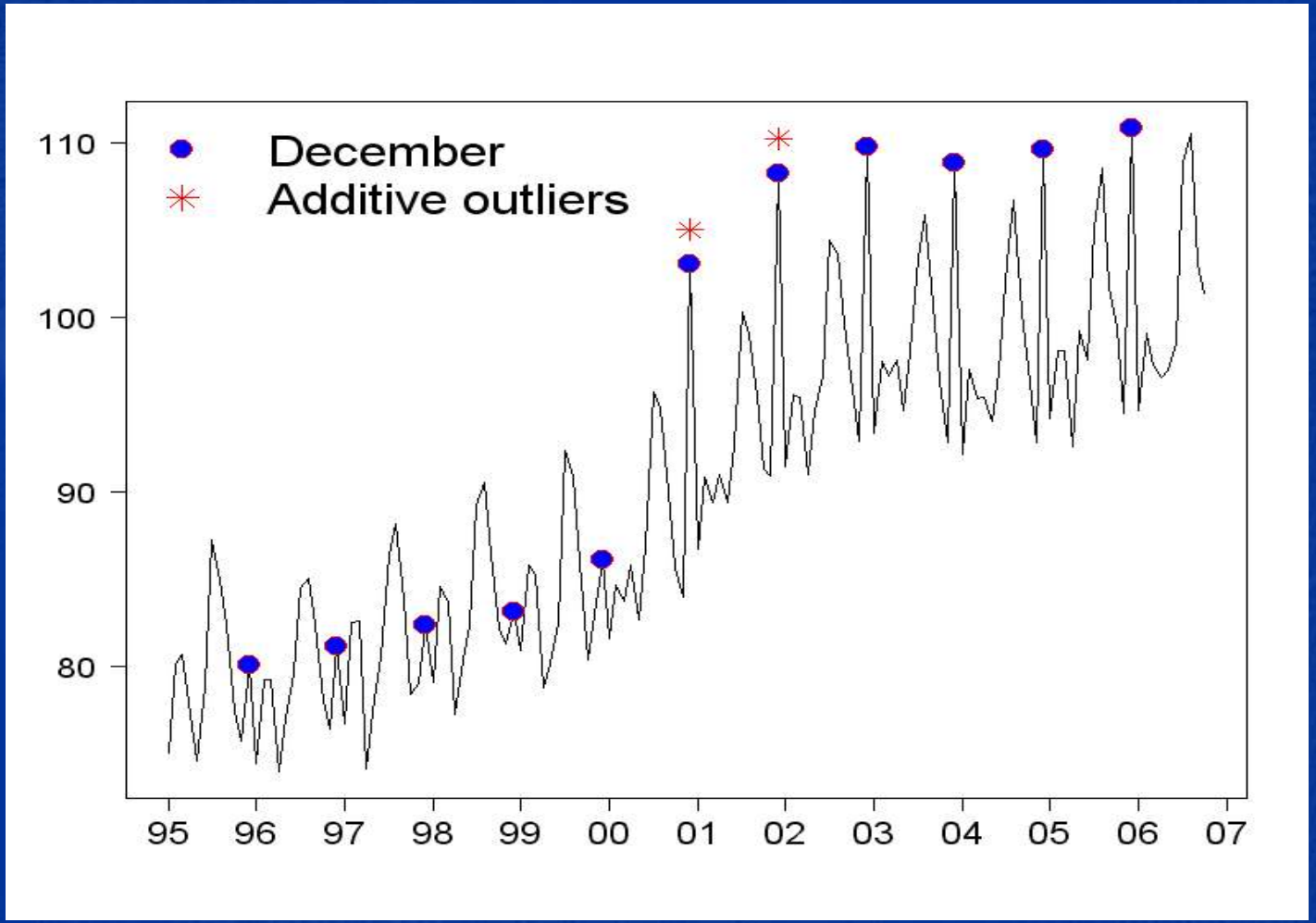


# HICPs. Package holidays



# HICPs. Package holidays

- A **level shift** in the seasonal sub-series for **December** can be detected.
- ***Standard* procedures do not detect** this type of breaks **and** will **remain**, to a large extent, **in the seasonally adjusted series**.
- The treatment of this outlier has **implications in the selection of the ARIMA model**.
- By including the seasonal break **Easter and trading day** remain **significant**.