Labor Market and Inflation

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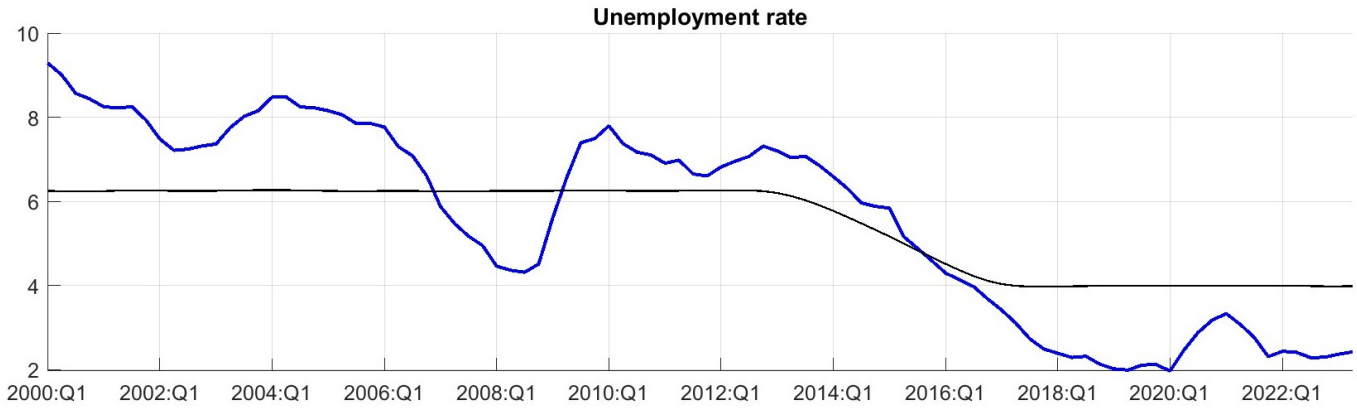
Outline of my talk

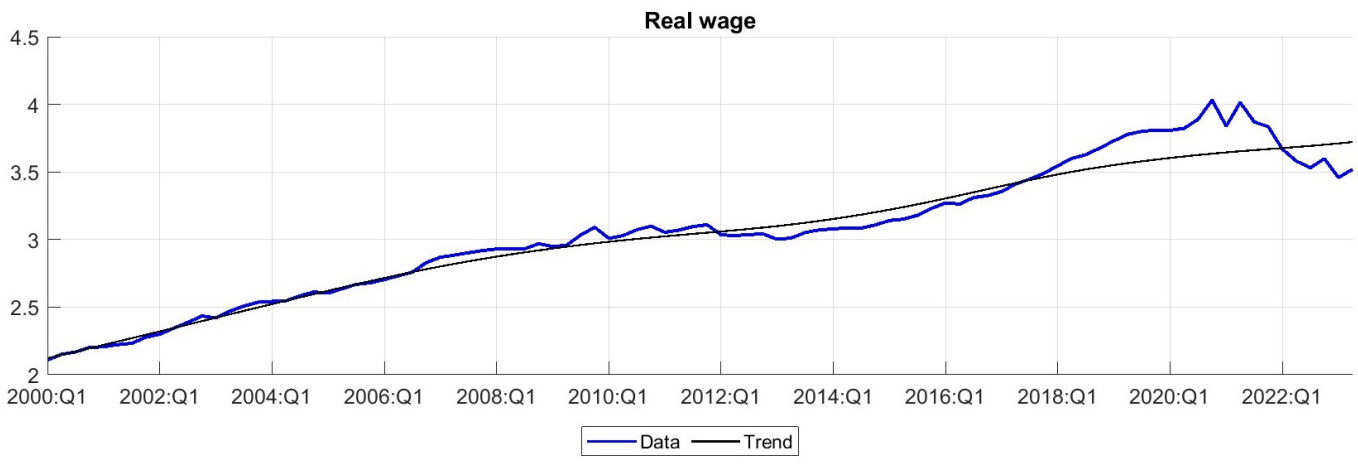
1. Motivation
2. LUCI Indicator: Formulation and Estimation
3. LUCI Indicator: Its Development over Last 20 years
4. Some Applications

Motivation

The state of the labor market is one of the important topics discussed by central banks:

- prominent example to assess the extent of the domestic inflation pressures coming from the labor market.





It is useful to have a cyclical index

- Labor market time series may give conflicting results – this is true especially around turning points.
- The question is how to weight particular information – a rationale for dimension reduction techniques.

- It is also necessary to disentangle cycles from trends and from noise

Some examples

- Armstrong, Kamber, Karagedikli (2016): "*Developing a labour utilisation composite index for New Zealand*," Reserve Bank of New Zealand Analytical Notes series AN2016/04.
  - 17 time series,
  - prefiltered series,
  - static PCA.
- Chung, Fallick, Nekarda, Ratner (2014). "*Assessing the Change in Labor Market Conditions*," Finance and Economics Discussion Series 2014-109, FED.
  - 19 time series,
  - prefiltered series,
  - dynamic factor model.
- Now, there are indexes for other countries.
- CNB has started to built its own index (LUCI – **L**abour **U**tilisation **C**omposite **I**ndex for the Czech Economy) in 2017.

LUCI for the Czech Economy

LUCI introduced by Šolc (2017) was based on a prefiltered series and static PCA.

In 2018, we started to work on a dynamic index:

- allow for multivariate model-based filtering,
- dynamic PCA (allowing for lead-lag relationship among data),
- asynchronous data ”release” (by means of KF).

The formulations of the dynamic index were changed in time (mixed frequency data, the formulation of the econometric model, the number of time series).

Model (1)

Each time series considered $x_{i,t}$ is decomposed to a **trend component** $\bar{x}_{i,t}$, a **cyclical component** $\widehat{x}_{i,t}$ and a **high-frequency component** $\dot{x}_{i,t}$:

$$x_{i,t} = \bar{x}_{i,t} + \widehat{x}_{i,t} + \dot{x}_{i,t}.$$

- The cyclical components are linked to a dynamic factor model: $\widehat{x}_{i,t} = \sum_{j=0}^{J} \sum_{k=1}^{K} c_{i,j,k} f_{t-j,k}$, where factors $f_{t,k}$ are zero mean independent AR processes.
  - No need to prefilter data by univariate statistical filters

  The LUCI is the first dynamic principal component $f_{t,1}$.

- The noise components $\dot{x}_{i,t}$ follow independent processes.

Model (2)

- The trend components follow either an I(2) process $\bar{x}_{i,t} = \bar{x}_{i,t-1} + \bar{\bar{x}}_{i,t-1}$, where $\bar{\bar{x}}_{i,t}$ is a random walk,
  - this is used for trending variables such as wages;
- or a random walk: $\bar{x}_{i,t} = \bar{x}_{i,t-1} + \varepsilon_{i,t},$,
  - this is used for rates such as unemployment, participation or employment rates.
- Why not to use the I(2) formulation for all trends?
  - After all, it is a well known flexible Harvey and Jaegger (1993) process,
  - excellent in-sample properties ...
  - but terrible behavior near the end of the sample for some series (analogy of the end-point bias of the HP filter).

Model: Kalman filter

Kalman filter machinery is then used:

- to filter unobserved states
  - It is not wise to blindly rely on automatic filtration;
  - labor markets experts monitor closely the filtration outcome and if they do not like some of them, the filtration can be changed using expert judgments.
- to deal with missing data and asynchronous data realize;
- to evaluate the likelihood, etc.

Model: parameters

The model contains a set of parameters that have to be estimated / calibrated:

the loadings of the principal component on cyclical part of the model $c_{i,j,k}$

the coefficients related to the dynamics of principal components $f_{t,k}$ – we use an AR(2) process

standard errors of innovations to the trend, cyclical and high-frequency components

- the relative standard errors determine the decomposition of the observable time series

Model: identification

The model is identified by a couple of restrictions on the unobserved factors $f_{t,k}$:

- First, we impose the stationary restrictions: $f_{t,k}$ are zero-mean stationary processes.
- The standard errors of innovations driving the factors are set so that $(std)(f_{t,k}) = 1$.
- Sign restriction: the loading of unemployment to the first component (LUCI) is negative.
  - I.e., the positive LUCI means a labour market tightness.

This is a set of standard identification assumptions needed to be used for any PCA / DFM.

Model: estimation (1)

The model can be estimated by various techniques:

- maximum likelihood or prediction error minimization
  - disadvantage: huge parameter space, many local maxima, some of them not reasonable,
- Bayesian techniques
  - convenient as the estimation can iterate between drawing of states and parameters
  - given states (drawn), the estimation of the paramaters is an easy task, mainly linear reagression for the cyclical part of the model,
  - various forms of the prior can be used
  - given parameters, unobserved states can be easily draw.
- EM algorithms

Model: estimation (2)

Currently, we use the `stochastic EM algorithm`. The algorithm iterates between following steps:

1. Make an initial guess of unknown parameters $\vartheta^{(1)}$.
2. Given the guess of model parameters $\vartheta^{(k)}$, sample the unobserved states $\{x_t^{(k)}\}_{t=1}^T$ from the model.
3. Given the sample of states $\{x_t^{(k)}\}_{t=1}^T$, one updates the parameters $\vartheta^{(k+1)}$ by means of simple regressions with regularization (such as ridge or LASSO regression).
4. **regularization is crucial for the successful run of the algorithm**.

Why is regularization needed?

A large number of time series with significant comovement: both in time and across series

- DFM is implicitly a regression where the column of the "design" matrix X are correlated
  - recall the equation for the cyclical component: $\widehat{x}_{i,t} = \sum_{j=0}^{J} c_{i,j} f_{t-j}$.
  - estimating $c_{i,j}$ in the EM iteration is a regression with nT observation and JT coefficients (after playing with Kronecker products and vec operators).
  - It may seem fine as long as $n > J$, but the design matrix is typically poorly conditioned,
    1. the cyclical dynamics far from being iid,
    2. the columns of the design matrix are shifted copies of f_t.
- This is why a regularization is very useful for estimating such models
  - Bayesian techniques use regularization sui generis

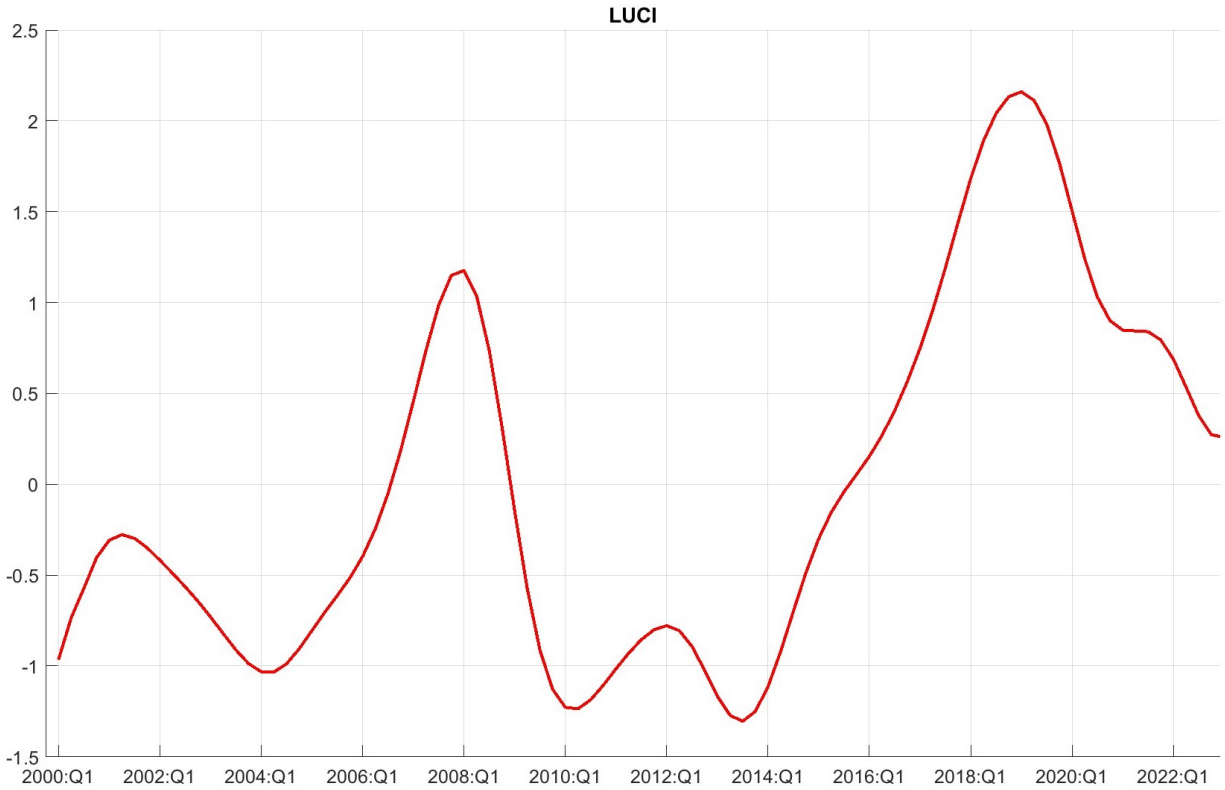
LUCI: time series used

We currently use 31 labor market related time series that can be roughly divided into 5 categories:

1. Wages and labor costs
2. Employment
3. Unemployment (including various durations)
4. Demand for work
5. Other

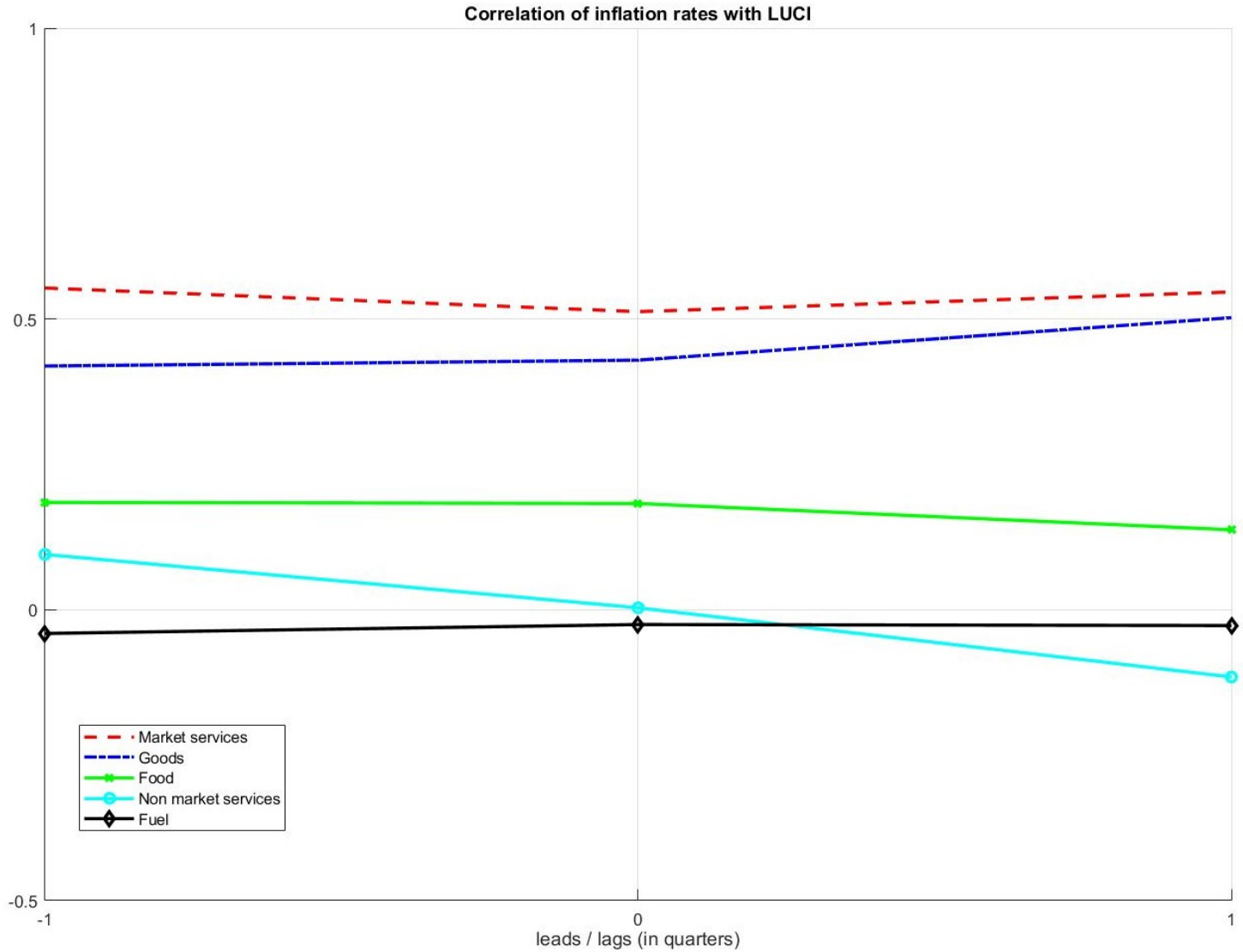
In past, we used about 40 time series. We ceased using some of them for various reasons, including ambiguous interpretation.

LUCI index: current estimate



Source: Monetary policy report, 2023, CNB

LUCI index and inflation



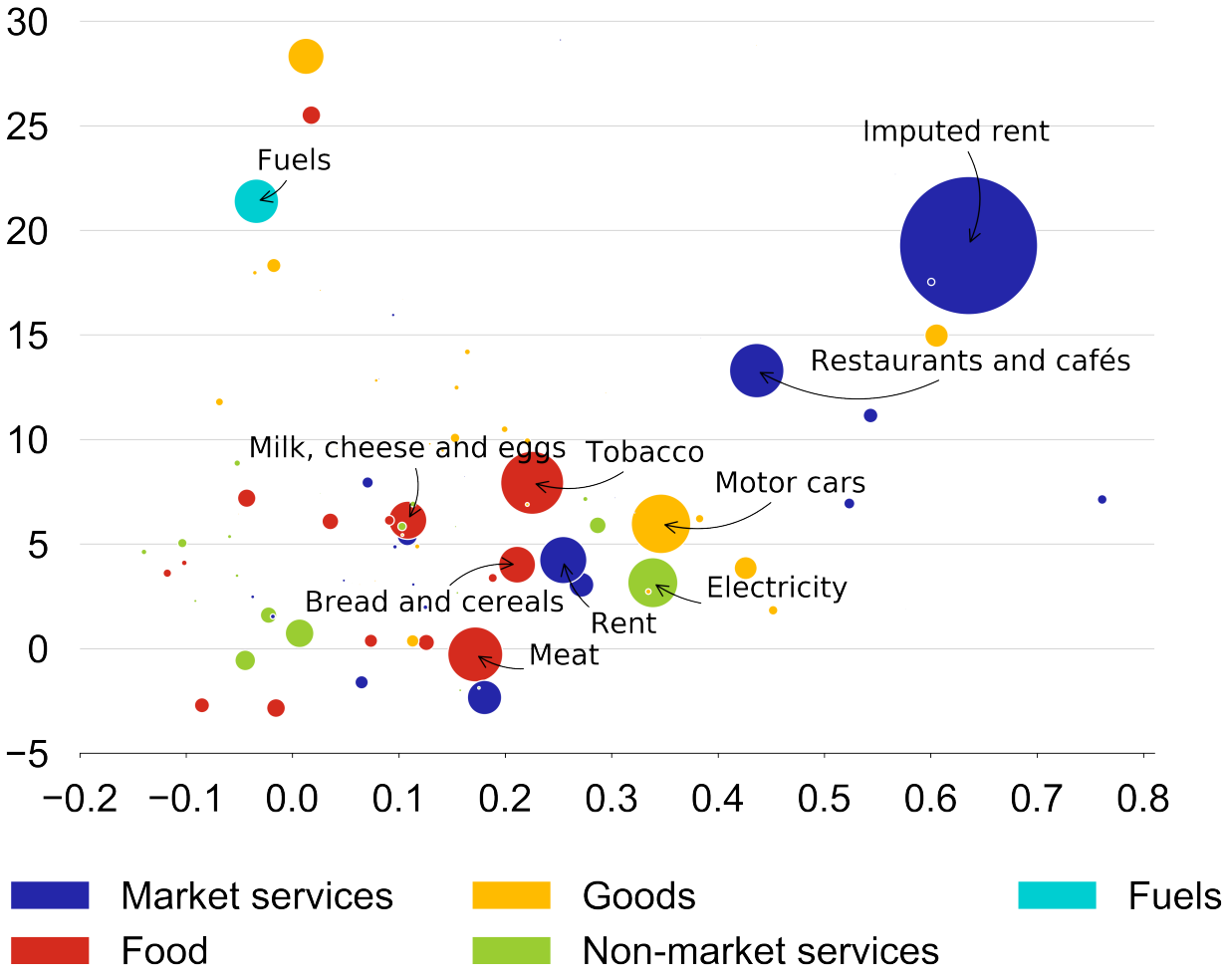
Application: disentangling domestic (demand) versus foreign (supply) inflation pressures

- Inflation rose dramatically at the end of the summer 2021 and has been continuing to rise since than.
- there were and continue to be significant cost effects from abroad ....
- .... but also a strongly inflationary domestic environment should not be ignored.
  - The pandemic dampened consumer appetite and cooled the labour market only temporarily and to a limited extent.
  - In addition, this happened in the context of a significant easing of fiscal, monetary and macroprudential policy during the pandemic.

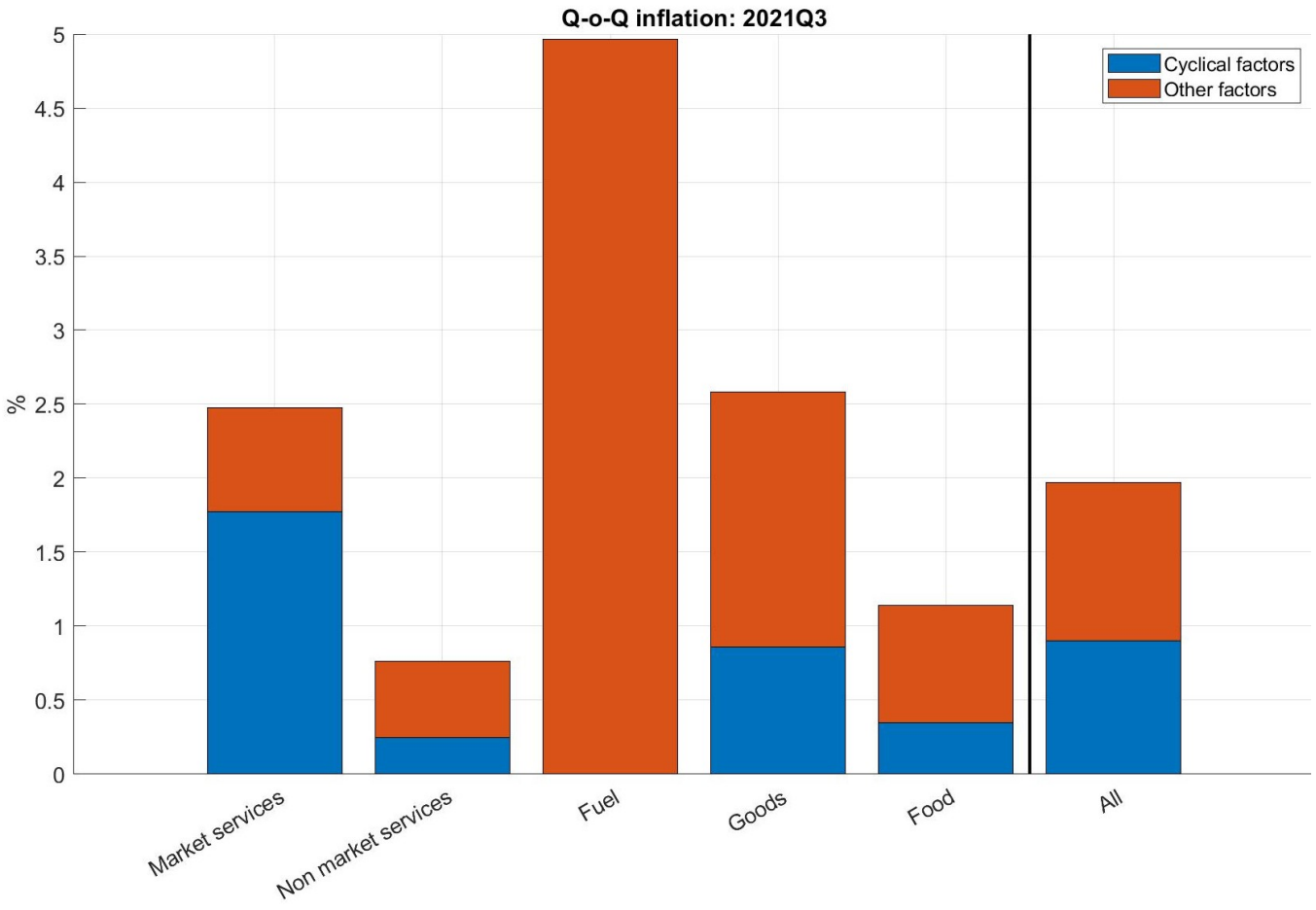
Source: Jan Brůha, Jan Šolc, Natálie Tomanová: To what extent are the domestic demand environment and the labour market contributing to the current growth in consumer prices? (box in Monetary Policy Report, Autumn 2021)

How can LUCI be helpful?

We compute the correlation of LUCI with inflation of COICOP 4-digit subcategories to see to what extent the items correlated with LUCI are (or are not) those that contribute to inflation.

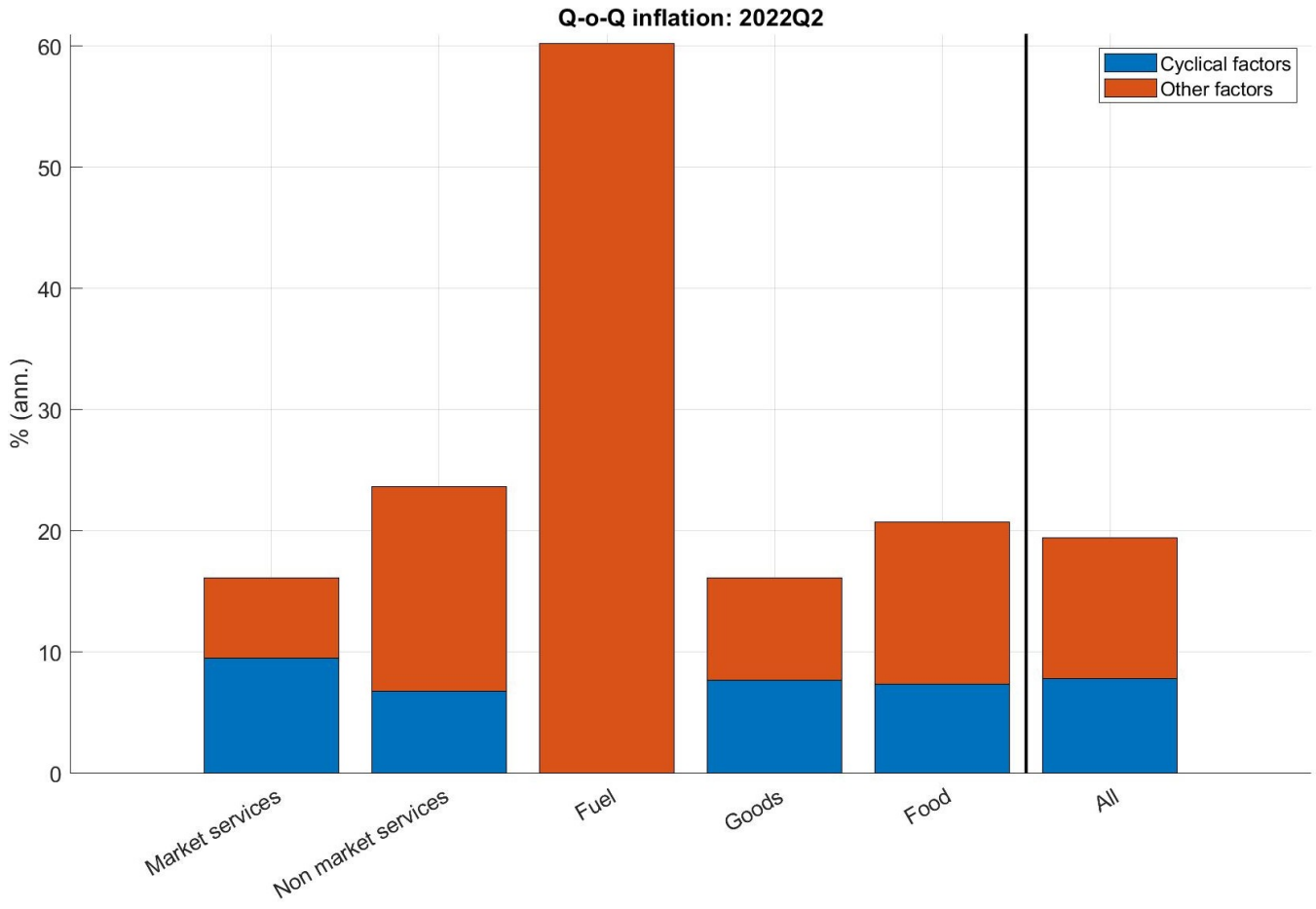


The decomposition in 3Q2021



The domestic labor market contributed to the overall inflation, but differently for different CPI items

The decomposition in 2Q2022

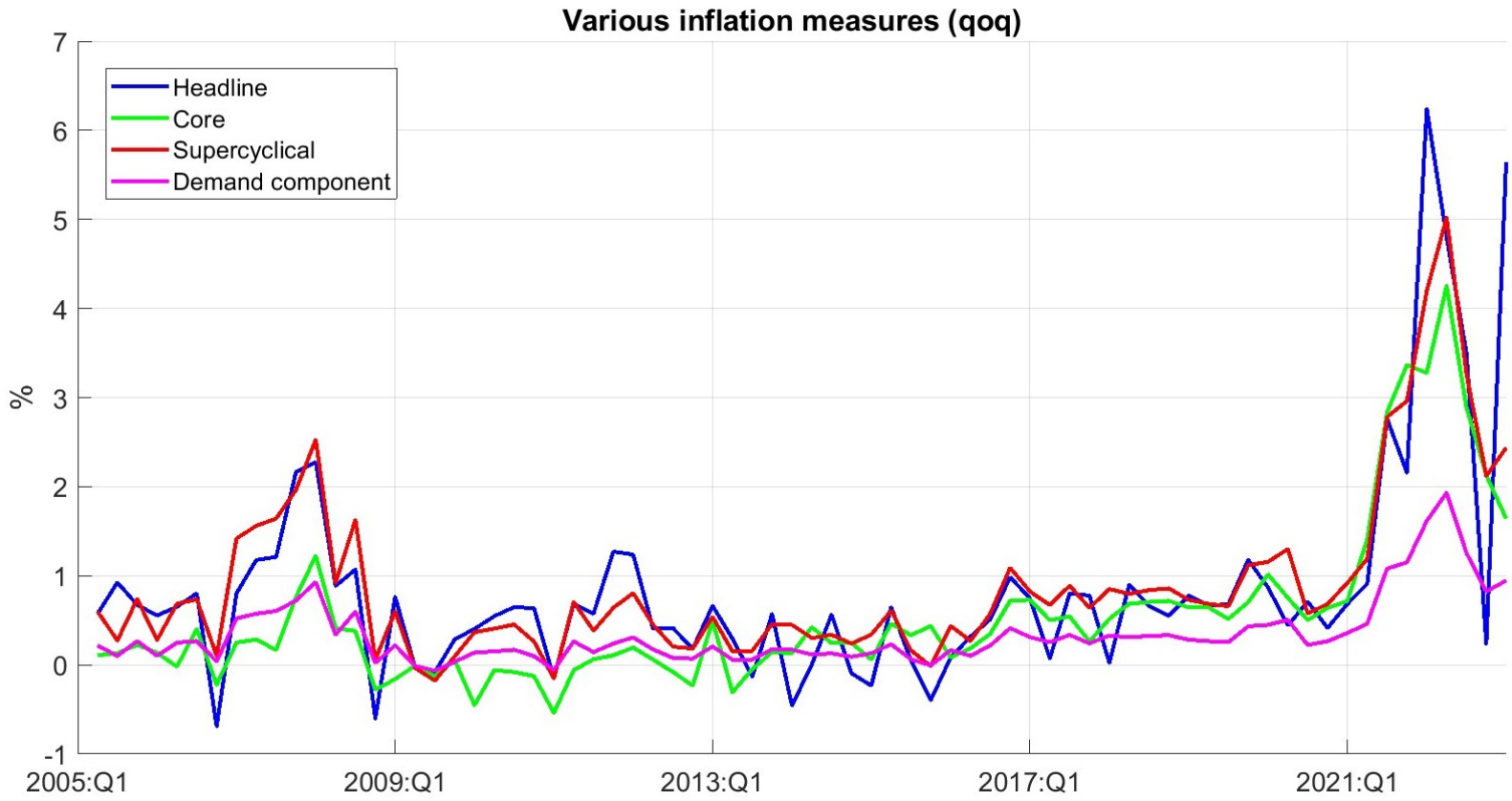


The share of external factors has increased, but domestic factors still play the role.

'Supercycle' inflation: the approach

- There is a quest for cyclical inflation measures:
  - usually by excluding certain volatile items (core inflation) or by using robust measures (median inflation or trimmed mean inflation)
  - there is evidence that robust inflation measures are more aligned with cyclical position of the economy (cf. Andrle, Bruha, Solmaz, 2013, 2016, or Ball and Mazumder, 2019).
- Recently, the ECB proposed 'supercore' inflation based on the alignment of individual items inflations with output gap.
- We did something similar with the LUCI index and call the resulting index as supercyclical inflation:
  - more precisely, the supercyclical inflation is based on modified CPI weights $\varpi_i \propto w_i \times \max(0, \max_k \rho_{i,k})$, where w_i are actual weights and $\rho_{i,k}$ is the item i correlation with LUCI at lag $k \in \{-2, \ldots 2\}$.

Various inflation measures



Conclusion

- Labour markets monitored by central banks
- An aggregate index useful as a summary of various pieces of information
- It can be used for various applications, such as disentangling demand and supply inflation pressures

Thank you for your Attention

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