Finding the Goldilocks data collection frequency for the Consumer Price Index

LUIGI PALUMBO[1] AND TIZIANA LAURETI[2]

[1] BANK OF ITALY

[2] UNIVERSITY OF TUSCIA

How often is “just right”?

Assumptions:

- Timing of CPI price collection: prices often vary during the period
- Data collection, processing, and storage has a cost

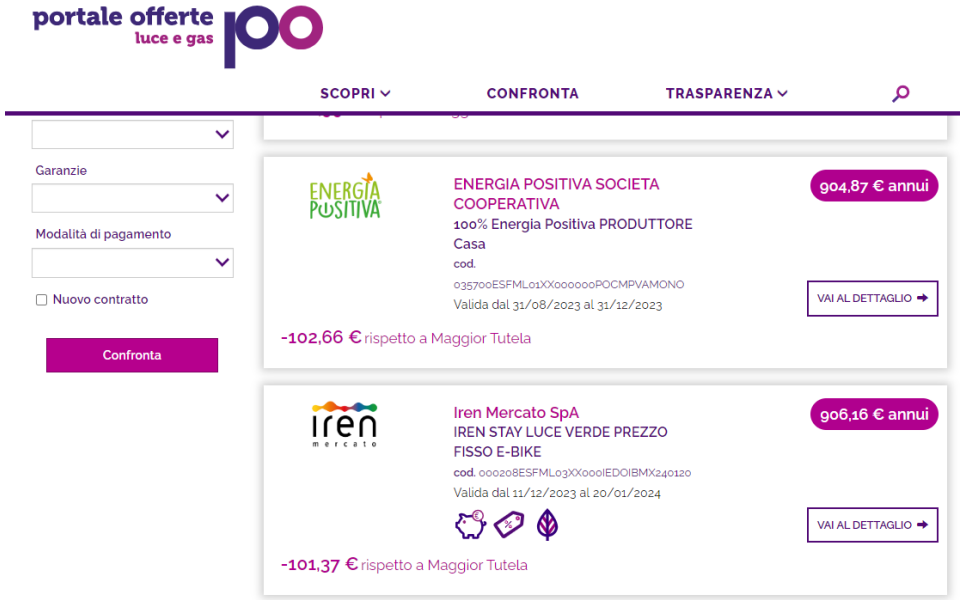
Objectives:

Estimate variability of CPI m-o-m variations at different sampling-in-time frequencies

Propose and empirically validate a framework to determine the optimal data collection frequency

Electricity and gas prices in Italy

- Mandatory publication of unregulated market offers for electricity and gas to guarantee transparency
- Used by ISTAT for official CPI price data collection
- Simplified data collection:
  - 9 cities
  - National consumption profile
    - Electricity consumption: 2700kWh/year
    - Gas consumption: 1400 m3/year
  - Selection of rates for electricity
  - Providers weighted by national market shares
  - Type of contracts (fixed or variable prices) weighted according to official reports



Daily Time-Product-Dummy index

- Weighted Time-Product Dummy index:

$$\ln p_{it} = \sum_{t=1}^{T} \delta_t D_t + \sum_{i=1}^{N} \beta_i D_i + \varepsilon_{it}$$

p_{it} : average price of operator *i* in month *t*

D_t : dummy equal to 1 if month is equal to t and zero otherwise

D_i : dummy equal to 1 for prices of operator *i* and zero otherwise.

- Weighted Least Squares using operator *i* market share as weight for each observation.
- Aggregate daily price level:

$$P_t = e^{\delta_t}$$

Month-on-month CPI variations

- Month-on-month rate of change:

$$\pi_t = \frac{\sum_{j=1}^{k} CPI_j^t}{\sum_{l=1}^{k} CPI_l^{t-1}} - 1$$

- Number of potential changes at each sampling frequency:

$$C(15,k)^2 = \binom{15}{k}^2 = \left(\frac{15!}{k!\,(15-k)!}\right)^2$$

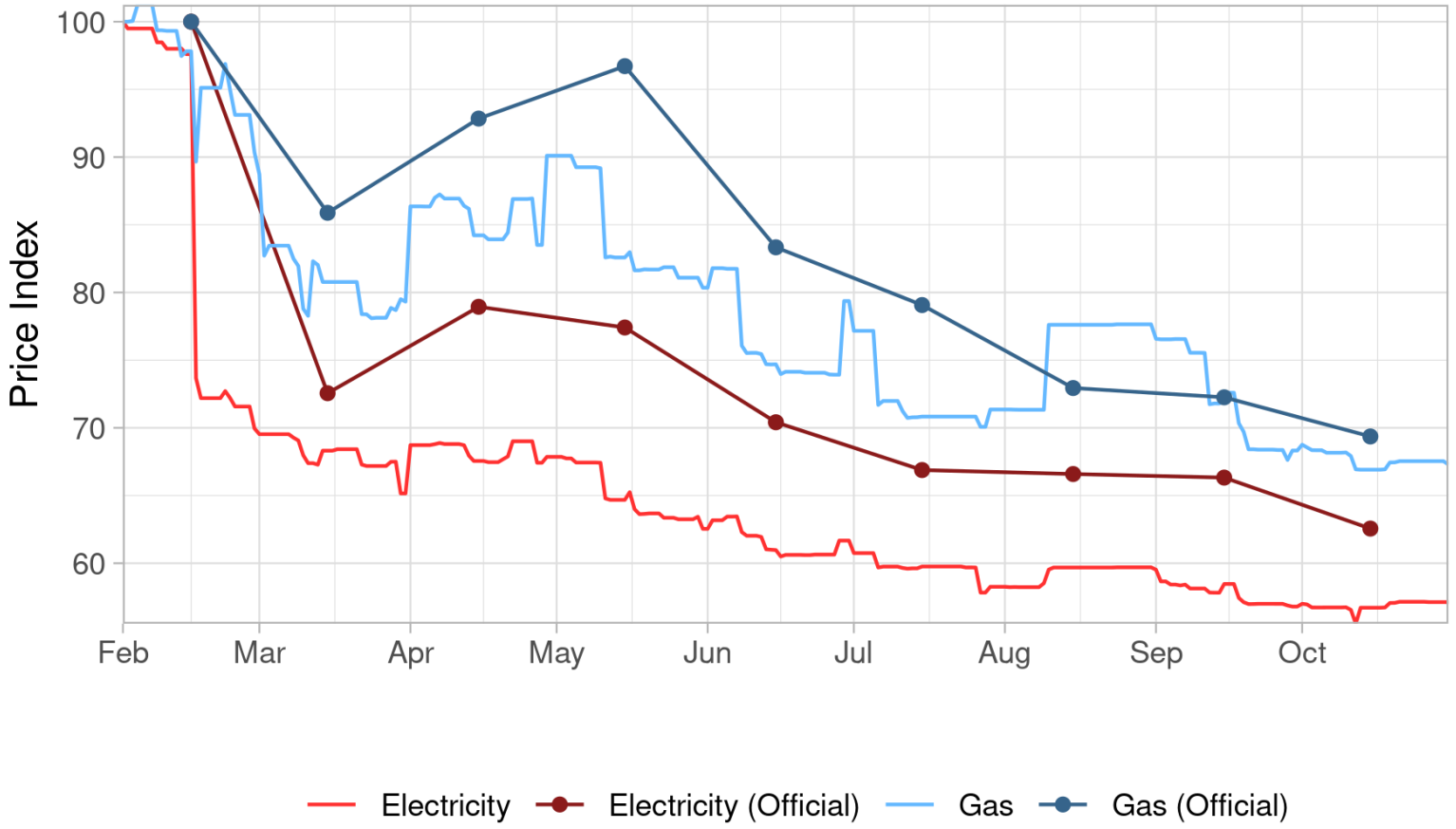
- Very large total number of combinations, over 155M each month for each utility. Almost 2.5B combinations for this research

Optimization framework

- Uncertainty on CPI measurement can be represented by the StDev of potential m-o-m rates of change
- Costs for data collection, processing, and storage are usually expressed in monetary terms
- **Need to convert one of the two metrics (or both) to have a common unit of measure for optimization**
- Our approach: express the collection cost in minimum reduction of StDev to be obtained through additional data collection efforts

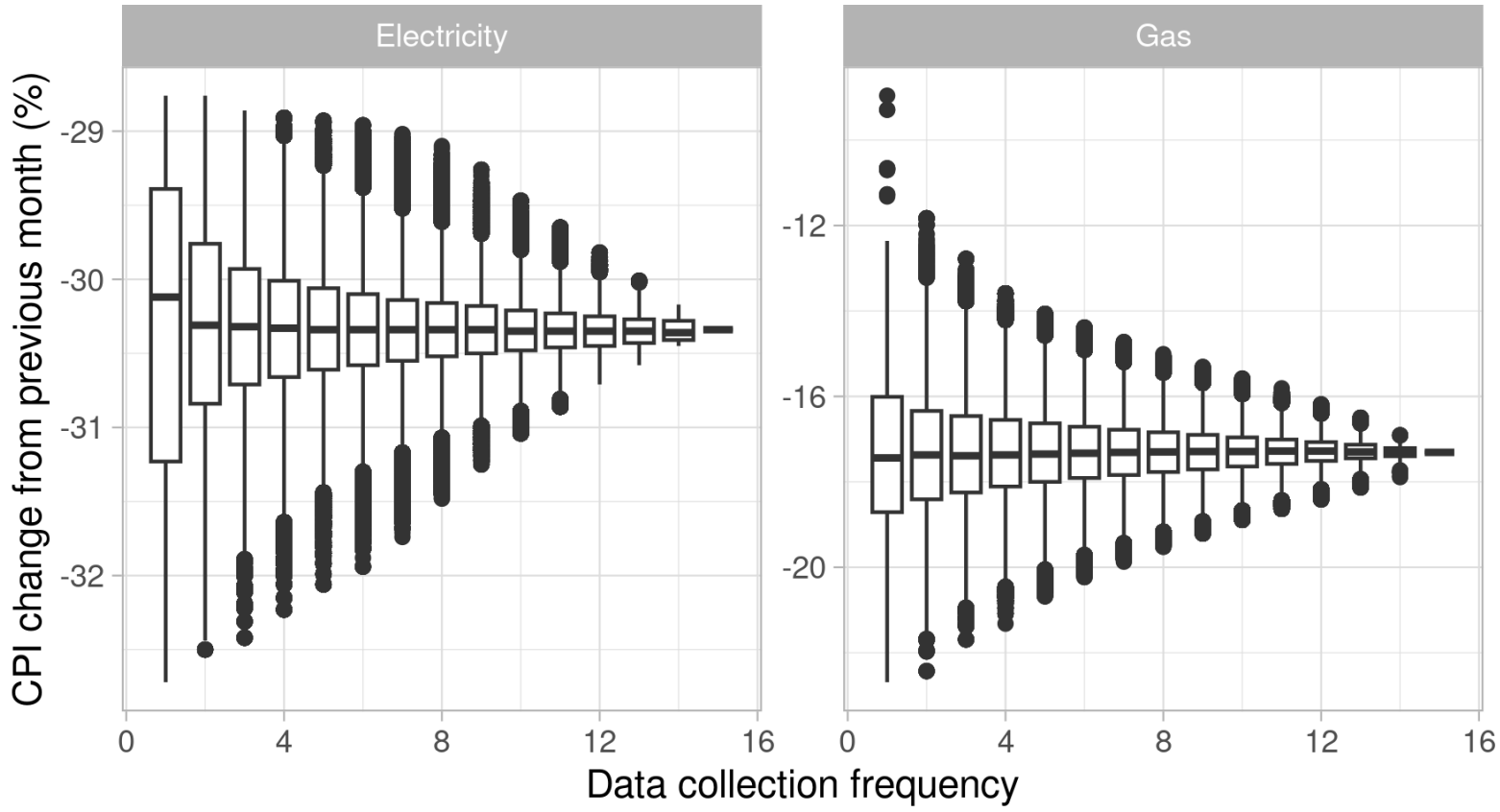
$$min\big(UncertaintyCost(k) + CollectionCost(k)\big), k \in \mathbb{N}^{+}: \{1 \leq k \leq 15\}$$

Daily vs. official CPI

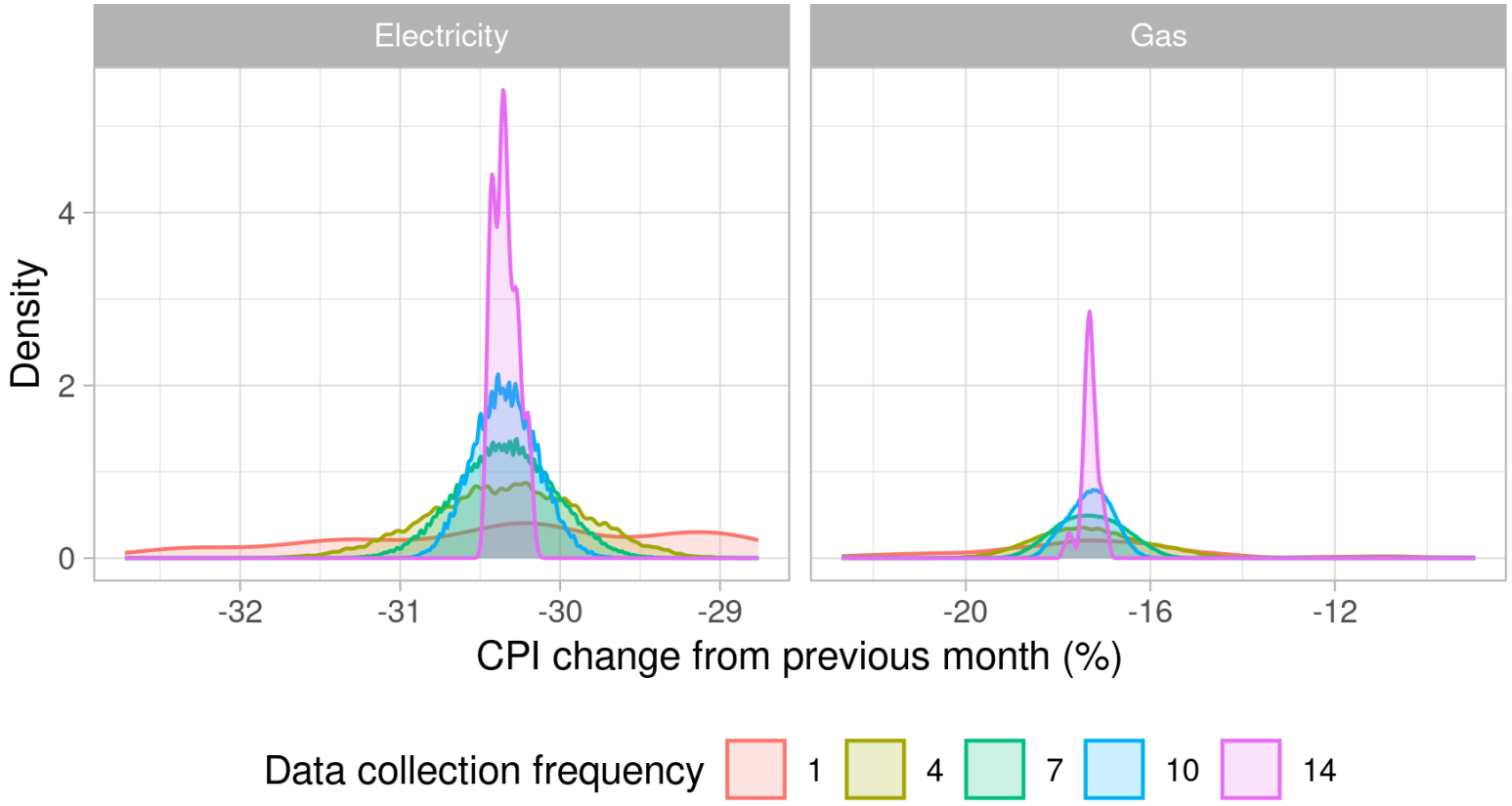


- Substantial intra-month price variation
- Daily CPI is not adjusted for changes in energy price subsides

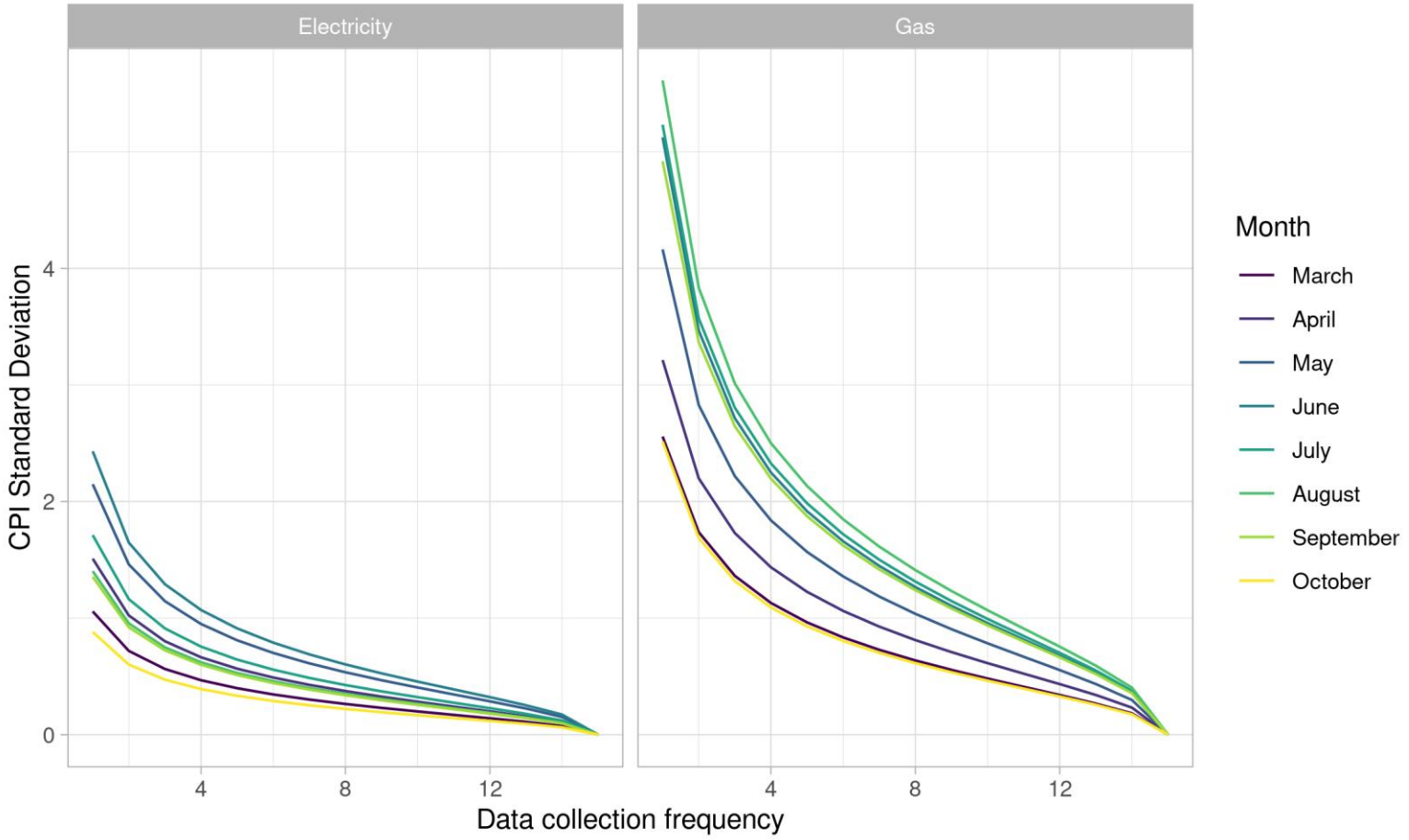
Boxplot of potential m-o-m CPI variations



Density of potential m-o-m CPI variations



StDev of potential m-o-m CPI variations



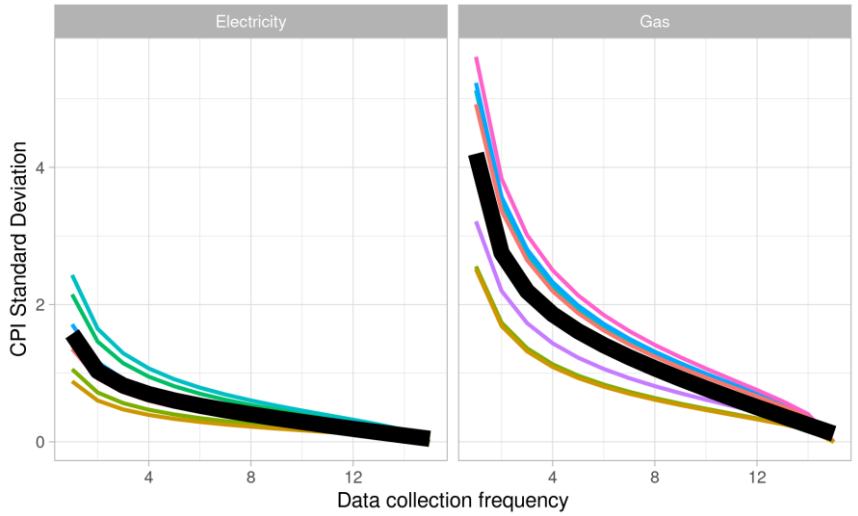
- Gas prices were much more volatile than electricity ones
- Levels vary across months and utilities, but paths are consistent

Modeling uncertainty

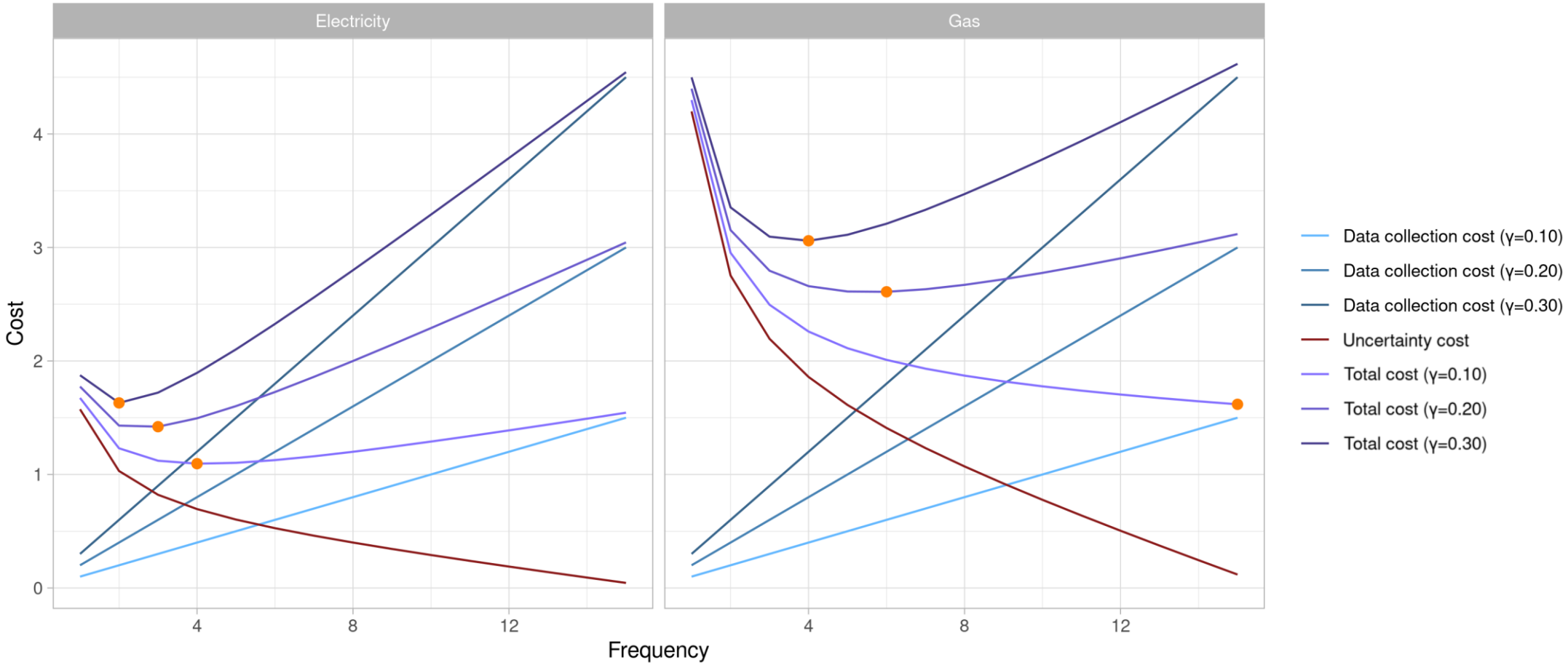
$$UncertaintyCost(k) = \beta_0 + \beta_1 k + \frac{\beta_2}{k} + \eta$$

- Approximately hyperbolic cost function
- Parameter estimates consistent with expectations and across utilities

	Standard Deviation					
	Electricity			Gas		
	(1)	(2)	(3)	(4)	(5)	(6)
β_0	0.147*** *(0.029)*	1.167*** *(0.049)*	0.614*** *(0.075)*	0.394*** *(0.073)*	3.117*** *(0.124)*	1.649*** *(0.182)*
β_1		-0.084*** *(0.005)*	-0.042*** *(0.006)*		-0.224*** *(0.014)*	-0.114*** *(0.016)*
β_2	1.581*** *(0.090)*		1.002*** *(0.117)*	4.218*** *(0.225)*		2.664*** *(0.283)*
Adjusted-R2	0.720	0.668	0.794	0.746	0.694	0.824
Note:	*p<0.1; **p<0.05; ***p<0.01					



Finding the Goldilocks frequency



Conclusions

- Variability of CPI m-o-m changes can be substantial at low data collection frequencies, affecting aggregated CPI figures
- Increasing data collection frequency yields diminishing returns in terms of CPI uncertainty reduction
- It is possible to determine an optimal data collection frequency leveraging historical price volatility and a cost function for data collection
- Optimality should be periodically reassessed, since both price variability and data collection costs may vary

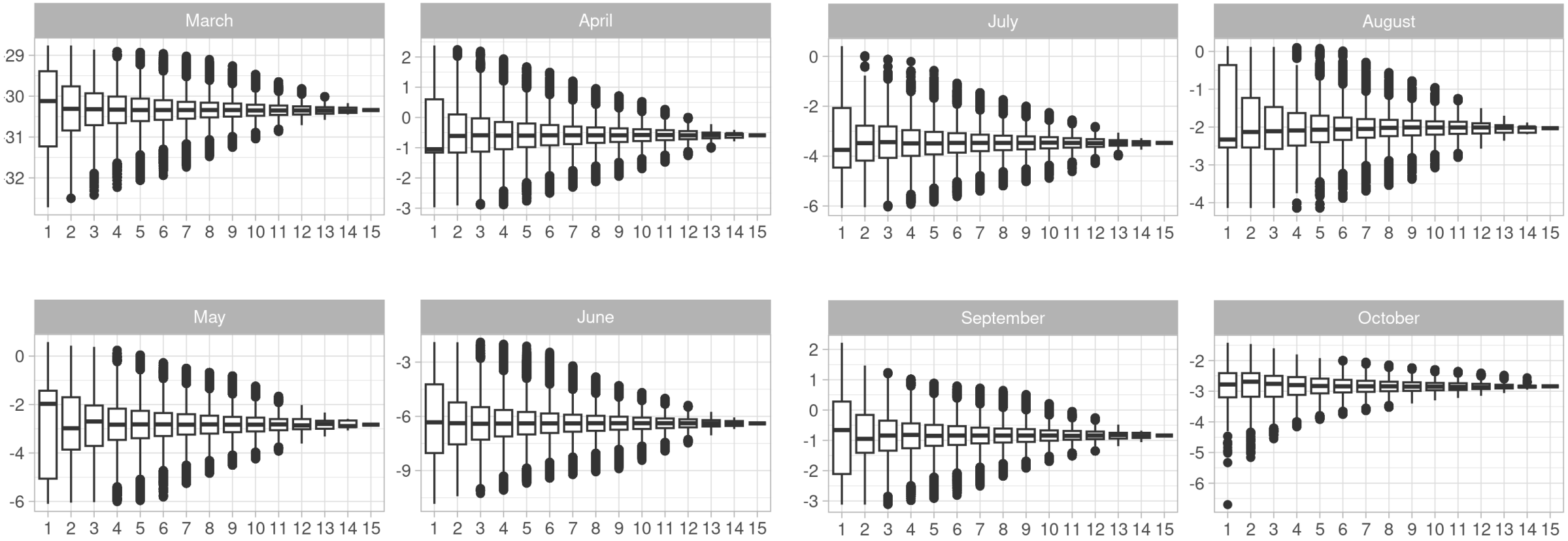
Thank you!

Q&A

LUIGI PALUMBO – LUIGI.PALUMBO@BANCADITALIA.IT

TIZIANA LAURETI – LAURETI@UNITUS.IT

Electricity:
Boxplot of potential m-o-m CPI variations



Gas:
Boxplot of potential m-o-m CPI variations