Sanctions and Russian Online Prices

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This presentation does not necessarily reflect the views of the Bank of Israel, the Bank of Italy, or the Eurosystem.

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Origins

2022-02-24: Russia invades Ukraine

- ▶ The US, EU, and other countries impose economic sanctions on Russia due to the invasion of Ukraine.
- ▶ Russia suspends the publication of several official statistics.
- ▶ Timely information on the Russian economy becomes a fundamental policy instrument.

Objectives

Our research questions:

- ▶ How reliable are current Russian official price statistics?
- ▶ Did sanctions affect Russian consumer prices?
- ▶ Can we quantify this effect in real-time?

Data

Webscraping Source

- ▶ Consumer prices and product inventory[3] information since Feb 2021 for a major Russian multi-channel retailer
- ▶ Daily data, aggregated in ~8M weekly observations on ~120k unique daily products covering 37 CPI categories

Official Source

- ▶ Monthly CPI from Rosstat for COICOP 1999[4] Level 4 aggregates
- ▶ Sanctions data from Peterson Institute for International Economics (Bown, 2023)
- ▶ RUB/USD exchange rate

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[3]Detail not visible on webpage but included in the page metadata.

[4]Classification of individual consumption according to purpose, 1999 version

Time-Product Dummy

Unweighted multilateral index methodology to calculate Consumer Price Index (CPI).

$$lnP_{it} = \sum_{i=1}^{N} a_i D_i + \sum_{t=1}^{T} \gamma_t T_t + \mu_{it} \qquad (1)$$

lnP_{it}: log of the price of good i at time t
D_i, T_t: dummy variables for good i and time t, respectively, with
$i = 1, ..., N$ and $t = 1, ..., T$

Differences in the γ_t coefficients $=>$ measures of CPI change over time.

CPI levels:

$$CPI_t = e^{\hat{\gamma}_t} \qquad (2)$$

The same methodology applies to the Product Stock Index (PSI), using the quantity of products available for sale.

Tracking CPI - Econometric Approach

- ▶ Check that web scraping and official CPI have the same order of integration (Robinson and Yajima, 2002)
- ▶ Test for absence of cointegration (Marmol and Velasco, 2004)
- ▶ Estimate integration order (Nielsen and Shimotsu, 2007; Zhang et al., 2019) and stationarity of differences (Dickey and Fuller, 1979; Kwiatkowski et al., 1992)

Limitation: only 20 monthly observations.

- ▶ Complement the econometric approach with model validation

Tracking CPI - Model Validation Approach

Given the small number of official data points, we complement the econometric approach.

- ▶ Calculate MAPE[5] and MALPE[6] on differences (Rayer, 2007; Swanson, 2015)
- ▶ T-test on MAPE and MALPE levels before and after the invasion start (Gosset, 1908)
- ▶ Identify breakpoints in MAPE and MALPE series with BEAST (Zhao et al., 2019) ▶ BEAST

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[5]Mean absolute percentage error

[6]Mean algebraic percentage error

Sanctions Effect - CPI and PSI Trend Change

BEAST: Bayesian ensemble algorithm that performs time series decomposition into an additive model (Zhao et al., 2019).

$$y_i = S(t_i; \Theta_s) + T(t_i; \Theta_t) + \varepsilon_i \tag{3}$$

y_i: observed value at time t_i

Θ_s: seasonal signal

Θ_t: trend signal

ε_i: noise, assumed Gaussian distribution

Estimation of trend and trend change point probability for CPI and PSI

Sanctions Effect - Causality Analysis

Toda and Yamamoto (1995) test for Granger-Causality.

▶ Estimate VAR equation

$$y_t = A_1 y_{t-1} + ... + A_{p+dmax} y_{t-(p+dmax)} + CD_t + u_t \quad (4)$$

y_t: vector with the values of CPI (or PSI) trend change probability and sanctions in time t
CD_t: intercept and trend

▶ Wald Test on $A_1...A_{p+dmax}$ coefficients to validate Granger-Causality

▶ Same approach repeated between sanctions and trend change points in the exchange-rate, and between the later and trend change points in CPI and PSI
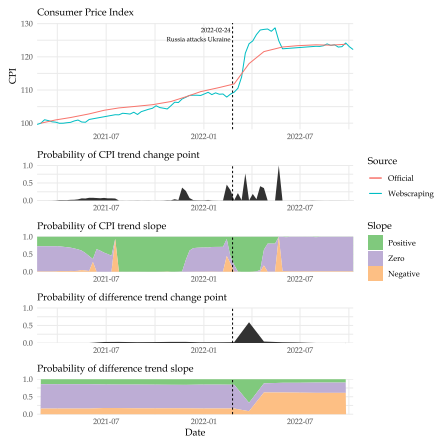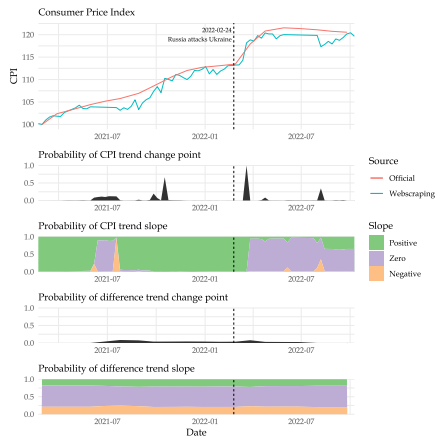
Sanctions Effect - Counterfactual

▶ Project pre-war web scraping CPI trend from BEAST to derive expected CPI levels in the absence of sanctions

▶ Calculate differences with observed web scraping CPI levels

▶ **Excess inflation**
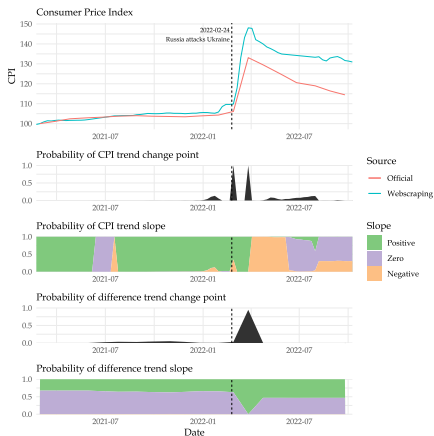
CPI from webscraping tracks well official data...
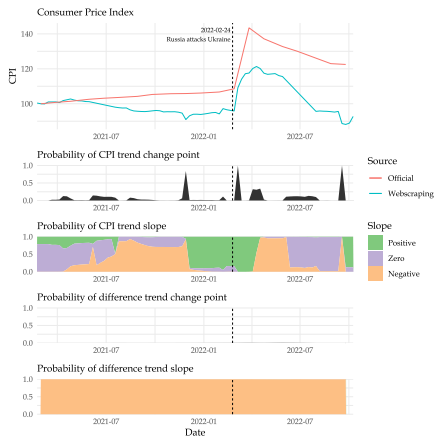
Meat prices

Fish prices

...but not in all aggregates

Major tools prices

Accessories prices

Econometrics tools confirm the tracking...

Web scraping and official CPI time series are:

- ▶ integrated of the same order: Reject 2/37
- ▶ not cointegrated: Reject 22/37
- ▶ stationary in their differences:
  - ▶ ADF: 5/37 (Reject non-stationarity)
  - ▶ KPSS: 37/37 (Not reject stationarity)

Web scraping data is a solid tracker for official CPI

...but tracking degraded after the invasion

Structural break probability

- MAPE below 5% and MALPE within ±5%: 21/37 cases
- After the invasion:
  - MAPE degrades in 21 cases
  - MALPE degrades in 18 cases
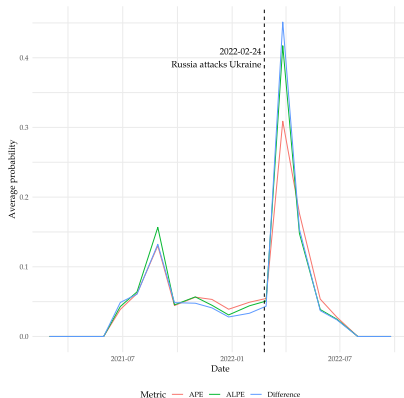
Sanctions and CPI Disruptions

Metric	Financial Sanctions	Trade Sanctions	Exchange rate SB
CPI +SB	28	24	27
Excess CPI	22	26	13
PSI SB	15	6	11

- ▶ Granger-causality from sanctions to exchange rate structural breaks
- ▶ Relatively larger impact on CPI compares to PSI
- ▶ Exchange rate seems to explain a large share of sanctions' impact on CPI and PSI

Impact on CPI Categories

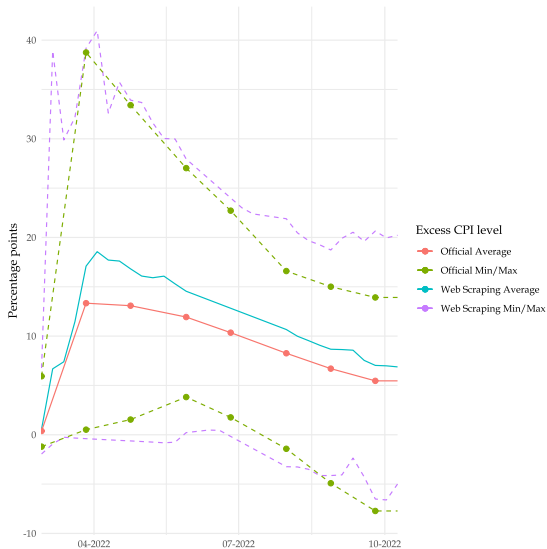**Figure 6.** Excess Official CPI and Excess WS-CPI by COICOP (1999) category
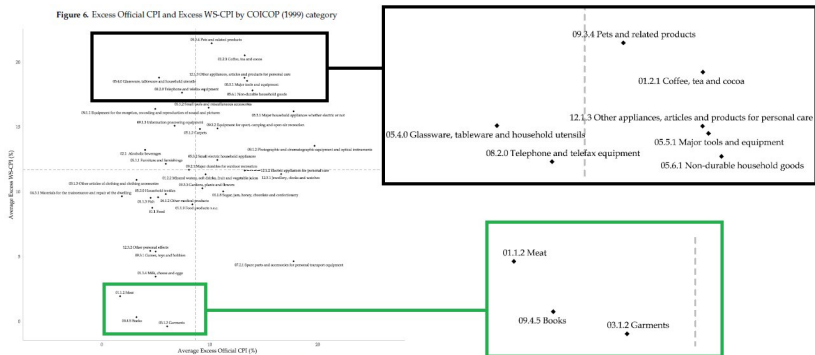
Notes: The dashed lines represent the average Excess Official CPI and WS-CPI across COICOP (1999) categories.

Substantially aligned between web scraping and official data

Relevant impact on CPI, but slowly reabsorbing

Conclusion

▶ Web scraping prices can effectively track official CPI and **inform decision-makers in real-time**

▶ Sanctions effectively impacted CPI patterns in Russia
   ▶ Excess CPI level peaked around 18% in April 2022

▶ The Russian economy is **slowly reabsorbing the impact**

▶ PSI impacted to a much lower extent

▶ **Financial sanctions had a wider impact than trade ones**, but trade sanctions are linked to more excess inflation

▶ Exchange rate is a plausible transmission channel for sanctions impact on CPI and PSI

Thanks

- ▶ Thank you for your attention.

- ▶ Working paper available on ResearchGate

- ▶ Comments: **luigi.palumbo@bancaditalia.it**

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