

Sanctions and Russian Online Prices

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Economic Policies During Wartime and Post-War Recovery

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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.

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?

Webscraping Source

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

Official Source

- ▶ Monthly CPI from Rosstat for COICOP 1999³ Level 4 aggregates
- ▶ Sanctions data from Peterson Institute for International Economics (Bown, 2023)
- ▶ RUB/USD exchange rate

³Classification of individual consumption according to purpose, 1999 version

Time-Product Dummy

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

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

$\ln P_{it}$: log of the price of good i at time t

D_i, T_t : dummy variables for good i and time t , respectively, with $i = 1, \dots, N$ and $t = 1, \dots, T$

Differences in the γ_t coefficients \Rightarrow measures of CPI change over time.

CPI levels:

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

The same methodology applies to 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 MAPE⁴ and MALPE⁵ 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](#)

⁴Mean absolute percentage error

⁵Mean 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).

$$y_i = S(t_i; \Theta_s) + T(t_i; \Theta_t) + \varepsilon_i \quad (3)$$

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

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

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

CD_t : intercept and trend

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

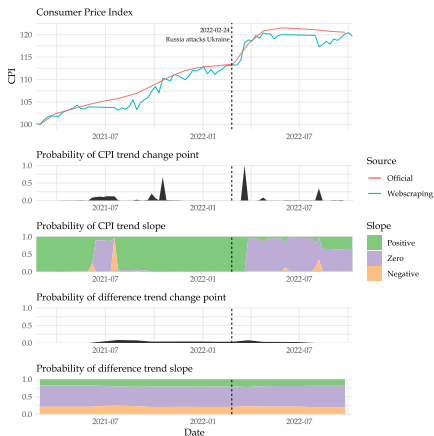
=> Same approach repeated between sanctions and trend change points in the exchange-rate, and between the later and trend change points in CPI and PSI

Sanctions Effect - Counterfactual

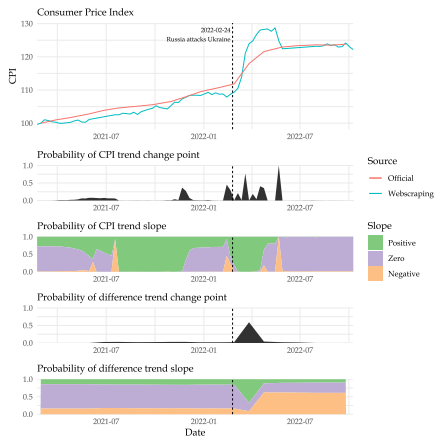
- ▶ Project pre-war web scraping CPI trend from BEAST to derive expected CPI levels in the absence of sanctions
- ▶ Calculate differences with observed web scraping CPI levels
=> **Excess inflation**

CPI from webscraping tracks well official data...

Meat prices

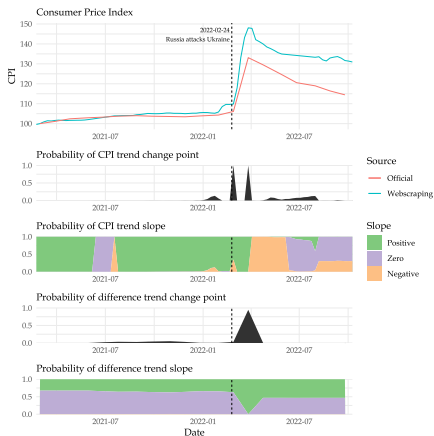


Fish prices

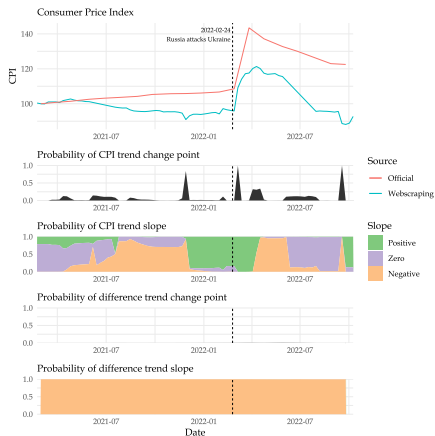


...but not in all aggregates

Major tools prices



Accessories prices



Econometrics tools confirm the tracking...

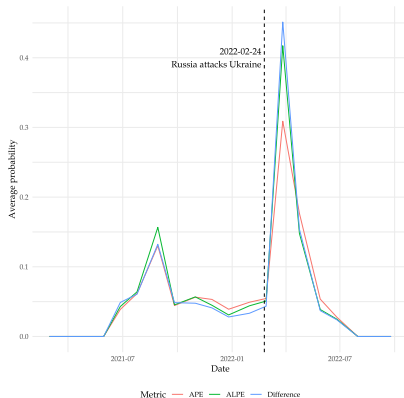
Web scraping and official CPI time series are:

- ▶ 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)

...but tracking degraded after the invasion

- ▶ MAPE below 5% and MALPE within $\pm 5\%$: 21/37 cases
- ▶ After the invasion:
 - ▶ MAPE degrades in 21 cases
 - ▶ MALPE degrades in 18 cases

Structural break probability

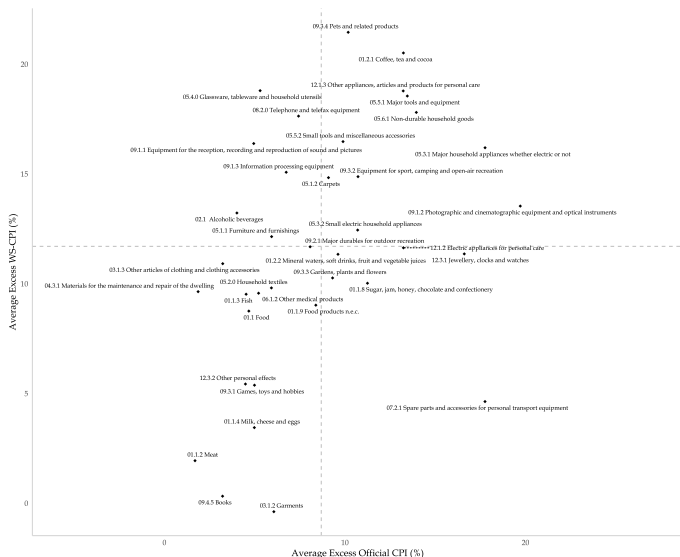


Sanctions and CPI Disruptions

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

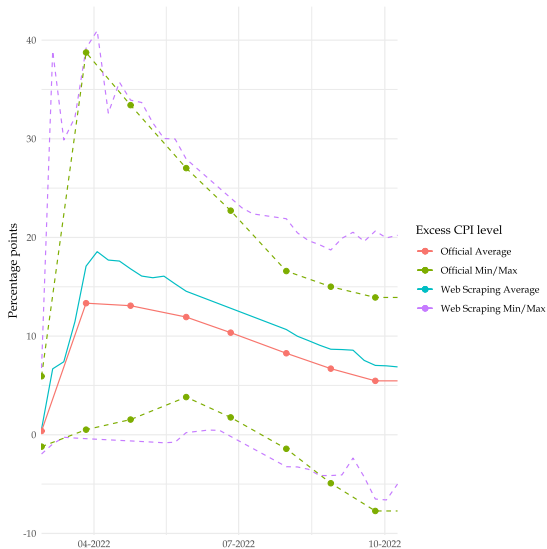
- ▶ Granger-causality from sanctions to exchange rate structural breaks
- ▶ Relatively larger impact on CPI compares to PSI
- ▶ Exchange rate seems to explain a large share of sanctions' impact on CPI and PSI

Impact on CPI Categories



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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