Analysis Of Economic Sanctions On Russia

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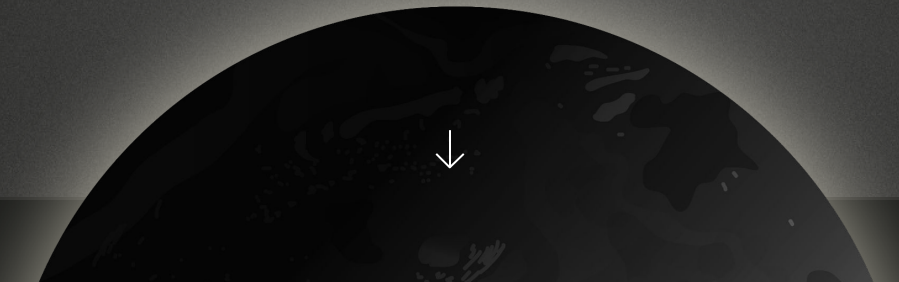


Motivation

What are we studying?

The effects of western sanctions on Russian nighttime lights over three sanctions regimes.

Relevance

Economists: Understanding economic resilience and adaptation

Non-Economists: Effects on daily life, trade, and global politics

Motivation

Why satellite data?

Russian economic data is opaque and unreliable. NTTL data provides external validity to claims.

Project Overview

Examined impact of three sanctions on NTTL output using an indicator variable approach for each regime.

Background/Context

Crimea 2014

In response to the Russian annexation of Crimea

Skripal 2018

In response to the poisonings of Sergei and Yulia Skripal

Ukraine 2022

In response to the Russian invasion of Ukraine

Crimean Sanctions

Historical Context:

- Russian forces invaded Crimea in February 2014, and later annexed the oblast in March 2014
- This was in response to the power vacuum created by the Revolution of Dignity, where President Viktor Yanukovych fled Ukraine

https://www.rand.org/content/dam/rand/pubs/research_reports/RR1400/RR1498/RAND_RR1498.pdf

Economic Motivations & Goals Behind Sanction:

- Restrictions on accessing Western financial markets by state-owned enterprises
- Embargos on exports of technology used for gas and oil exploration
- Embargos on exports of military equipment

https://www.themoscowtimes.com/archive/third-wave-of-sanctions-slams-russian-stocks

Skripal Sanctions

Historical Context:

- Known as the Salisbury Poisonings, Sergei Skripal and his daughter Yulia were poisoned by a Novichok nerve agent
- Russian GRU officials were found guilty of executing the botched assassination attempts

https://www.rferl.org/a/report-third-russian-agent-involved-in-skripal-mission-identified-/29514321.html

https://www.bellingcat.com/news/uk-and-europe/2018/10/08/second-skripal-poisoning-suspect-identified-as-dr-alexander-mishkin/

Economic Motivations & Goals Behind Sanction:

- Freezing the operations of Russia's state-controlled banks in dollars, tanking the value of the ruble
- Denial of export licenses for Russian companies to purchase items which pose concerns for American national security

https://apnews.com/general-news-38104d89b0e744cba157e813c0442c43

Ukraine Sanctions

Historical Context:

- Russia invaded the Ukrainian city of Kharkiv in the north and northern Ukraine (near Kharkiv) and the Luhansk and Donetsk Oblasts in the south on February 24, 2022
- Has become the largest forced European migration since WWII

https://cisac.fsi.stanford.edu/news/russia-vs-ukraine-how-does-end

https://www.peopleinneed.net/the-ukrainian-refugee-crisis-current-situation-9539gp

Economic Motivations & Goals Behind Sanction:

- The European Union banned the importation of crude oil, petroleum products, iron, and steel originating in Russia
- The United States embargoes all Russian fuel imports

https://enterprise.gov.ie/en/publications/eu-trade-sanctions-in-response-to-situation-in-ukraine-.html

https://www.bruegel.org/analysis/european-union-russia-energy-divorce-state-play

Literature Review

Economic Sanctions and Regional Differences: Evidence from Sanctions on Russia

Casualties of Border Changes: Evidence from Nighttime Lights and Plant Exit

Paper 1: "Economic Sanctions and Regional Differences: Evidence from Sanctions on Russia" by Zhentao Li and Tianzi Li

Objective: To analyze the relationship between economic sanctions and regional differences within Russia.

Key Points:

- Sanctions increased brightness in Moscow, St. Petersburg, and provincial capitals.
- Brighter lights in manufacturing cities; dimmer lights in mining areas.
- Increased economic activities near the Chinese border.

Methodology:

- Data: Nighttime lights from VIIRS DNB, administrative division data, port data, mining areas data.
- Sanctions Index: Constructed based on sanctioned sectors (financial, military, energy, and others).
- Regression Model: Relationship between economic sanctions and regional differences.

Results:

- Brightness increased in major cities and manufacturing areas under sanctions.
- Brightness decreased in mining areas under sanctions.
- Economic activities increased near the Chinese border.

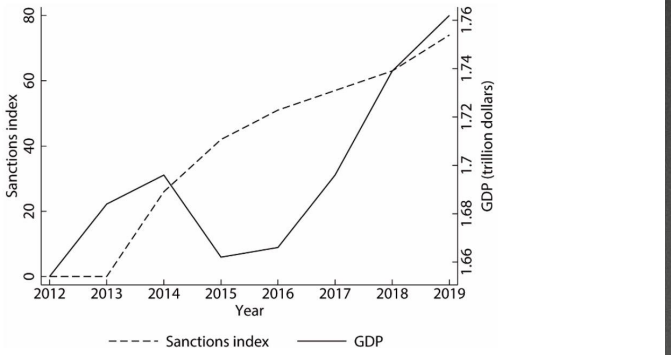


Figure 1. Sanctions index and GDP. Data source: World Bank, GDP (2010 constant price USD).

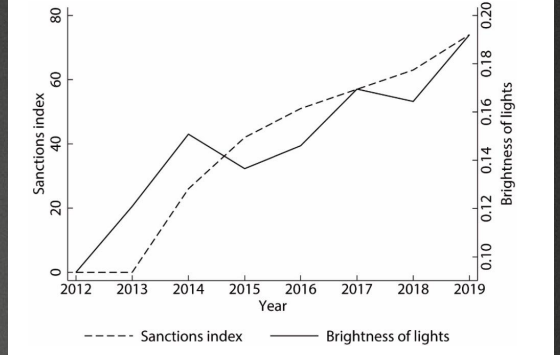


Figure 3. Sanctions index and the brightness of lights of Russia.

Paper 2: "Casualties of Border Changes: Evidence from Nighttime Lights and Plant Exit" by Kristian Behrens

Objective: Examine the economic effects of the Russia-Ukraine conflict, focusing on changes in market access for Russian border regions.

Key Points:

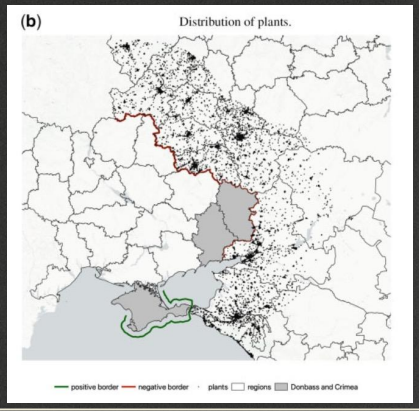
- Northern regions lost market access to Ukraine.
- Southern regions gained market access to Crimea.
- Nighttime lights and plant-level data were used to assess economic performance.

Methodology:

- Data: Nighttime lights (NTL) data and geo-referenced plant-level data.
- Measures: NTL intensity, plant exit probability, and market potential.
- Comparison: Pre- and post-2014 changes in NTL and plant exit rates in border regions.

Results:

- Northern regions experienced a 43% lower growth in nighttime lights compared to southern regions.
- This difference corresponds to a 6-12% lower GDP growth.
- Northern regions saw a 35% increase in plant exit probability post-2014.



<- Figure 1b: Study area and distribution of Russian manufacturing plants along the Ukrainian border.

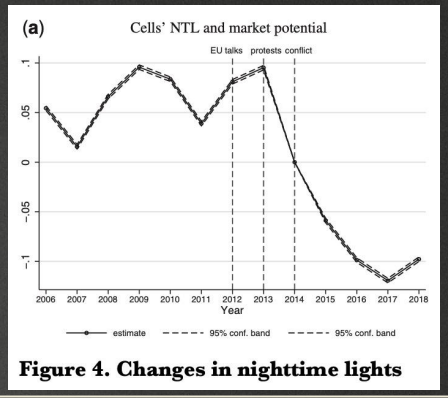


Figure 4. Changes in nighttime lights

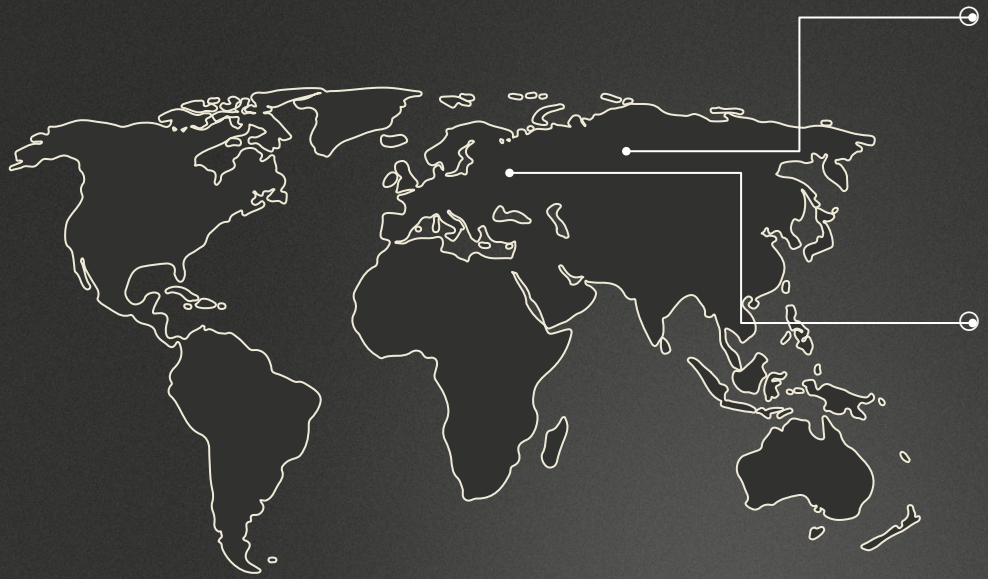
Initial Hypotheses:

- Hypothesis 1: Sanctions significantly increase nightlight intensity in affected regions
- Hypothesis 2: Different sanctions periods show varying levels of impact
- Assumptions: Sanctions lead to measurable economic disruption reflected in nightlight data

Data

Sources	Usage
Nightlight data from VIIRS [Oct 2012-Oct 2023]	Data preprocessing steps
Crimea: March 2014	Bounding boxes for specific regions
Skripal: August 2018	Monthly Averages
Ukraine: March 2022	Regions of interest from Tile 2/3

Measurement



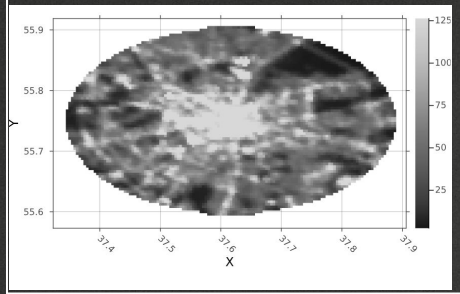
Nightlight intensity as a proxy for economic activity

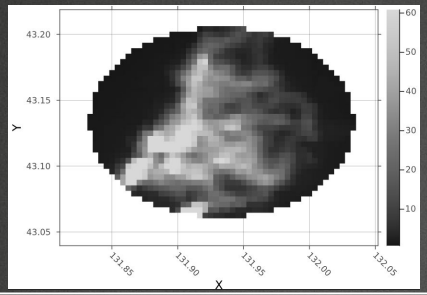
Monthly nightlight data over selected regions before, during, after sanctions

Methodology:

Visualization:

- Creating bounding boxes over visible portions of eastern and western Russia using VIIRS satellite data tiles
- Created annular rings to analyze the lights of specific cities.
- Calculating mean/total radiance values
- Plotting nightlight data over time





Methodology:

Analytical Methods:

- Aggregated both the monthly total and mean radiance of Russian land between the months of October 2012 and October 2023
- Created dummy variables signifying the data points taken before and after the implementation of sanctions
  - Crimean: March 2014
  - Skripal: August 2018
  - Ukrainian: March 2022
- Ran these regressions on the data:
  - $\text{total\_radiance}_t = \alpha + \beta * \text{post\_sanction}_t + \gamma_t + \varepsilon_t$
  - $\text{mean\_radiance}_t = \alpha + \beta * \text{post\_sanction}_t + \gamma_t + \varepsilon_t$

Results: Crimean Sanctions

Total Radiance:

```
                 model_crimea
Dependent Var.: total_radiance

post_crimea      83.41* (28.68)
Fixed-Effects:   --------------
month                      Yes
_______________ _______________
S.E.: Clustered       by: month
Observations                 56
R2                      0.46899
Within R2               0.09758
---
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

Mean Radiance:

```
                 model_crimea
Dependent Var.:  mean_radiance

post_crimea      13.90* (4.779)
Fixed-Effects:   --------------
month                      Yes
_______________ _______________
S.E.: Clustered       by: month
Observations                 56
R2                      0.46899
Within R2               0.09758
---
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
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Analysis:

Crimean sanctions were associated with both an 83.41 increase in total radiance across Russia, and a 13.90 increase in mean radiance per city accounted for

Results: Skripal Sanctions

Total Radiance:

```
                 model_skripal
Dependent Var.: total_radiance

post_skripal     68.62* (22.96)
Fixed-Effects:   --------------
month                       Yes
_______________ _______________
S.E.: Clustered       by: month
Observations                 56
R2                      0.47738
Within R2               0.11184
---
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

Mean Radiance:

```
                 model_skripal
Dependent Var.:  mean_radiance

post_skripal     11.44* (3.827)
Fixed-Effects:   --------------
month                       Yes
_______________ _______________
S.E.: Clustered       by: month
Observations                 56
R2                      0.47738
Within R2               0.11184
---
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

Analysis:

Skripal sanctions were associated with both a 68.62 increase in total radiance across Russia, and a 11.44 increase in mean radiance per city accounted for

Results: Ukranian Sanctions

Total Radiance:

```
                 model_ukraine
Dependent Var.: total_radiance

post_ukraine      55.88 (56.56)
Fixed-Effects:  --------------
month                      Yes
_______________ _______________
S.E.: Clustered       by: month
Observations                 56
R2                      0.42821
Within R2               0.02828
---
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

Mean Radiance:

```
                 model_ukraine
Dependent Var.: mean_radiance

post_ukraine     9.314 (9.426)
Fixed-Effects:  --------------
month                      Yes
_______________ _______________
S.E.: Clustered       by: month
Observations                 56
R2                      0.42821
Within R2               0.02828
---
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

Analysis:

Ukranian sanctions were associated with both a 55.88 increase in total radiance across Russia, and a 9.314 increase in mean radiance per city accounted for

Results: Main Findings

In all cases, sanctions led to an <u>increase</u> in radiance from Russia.

Possible explanations:

- Increased production to compensate for restricted imports
- Expansion of oil use due to newfound domestic surplus
- Gearing up for retaliatory sanctions on other countries

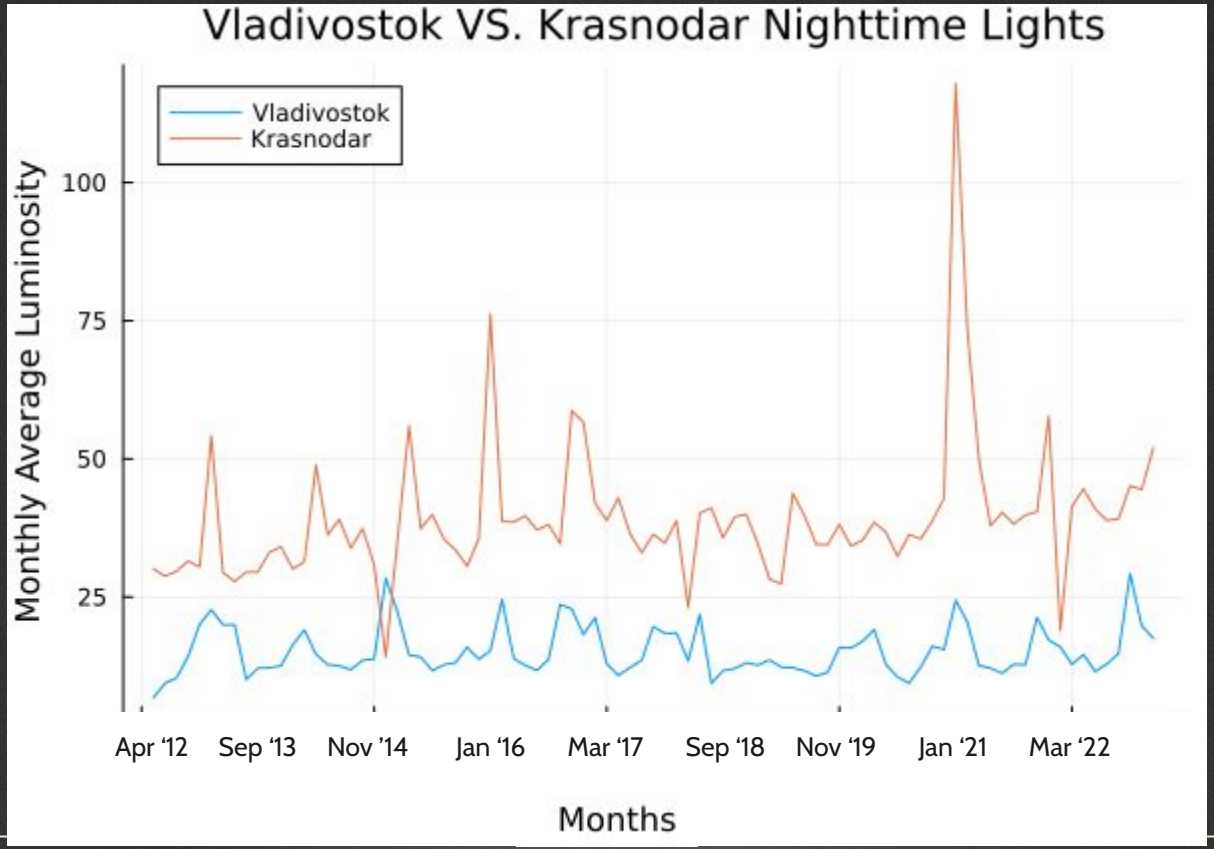
Conclusion/Next Steps

Sanctions lead to measurable economic disruption

Next steps: analyze which type of sanctions have the most impact

Key limitation: the inconclusiveness of the Mar. - Sept. data

Next steps: find more concrete data from these months


Vladivostok VS. Krasnodar Nighttime Lights
Vladivostok
Krasnodar
Monthly Average Luminosity
100
75
50
25
Apr '12
Sep '13
Nov '14
Jan '16
Mar '17
Sep '18
Nov '19
Jan '21
Mar '22
Months