Does weather sharpen income inequality in Russia?

Olga Popova
Leibniz Institute for East and Southeast European Studies (IOS),
CERGE-EI, Ural Federal University, and GLO

Vladimir Otrachshenko
Center for International Development and Environmental Research (ZEU),
Justus Liebig University Giessen

Global Labor Organization Virtual Seminar

July 8, 2021

Outline

1. Introduction and motivation
2. Background and mechanisms
3. Methodology and data
4. Results
5. Summary and discussion

Introduction and Motivation

The Guardian

Heat: the next big inequality issue

The deadly global heatwave has made it impossible to ignore: in cities worldwide, we are now divided into the cool haves and the hot have-nots

by Amy Fleming with Ruth Michaelson and Adham Youssef in Cairo, Oliver Holmes in Jerusalem, Carmela Fonbuena in Manila and Holly Robertson in Phnom Penh

Cities is supported by

About this content

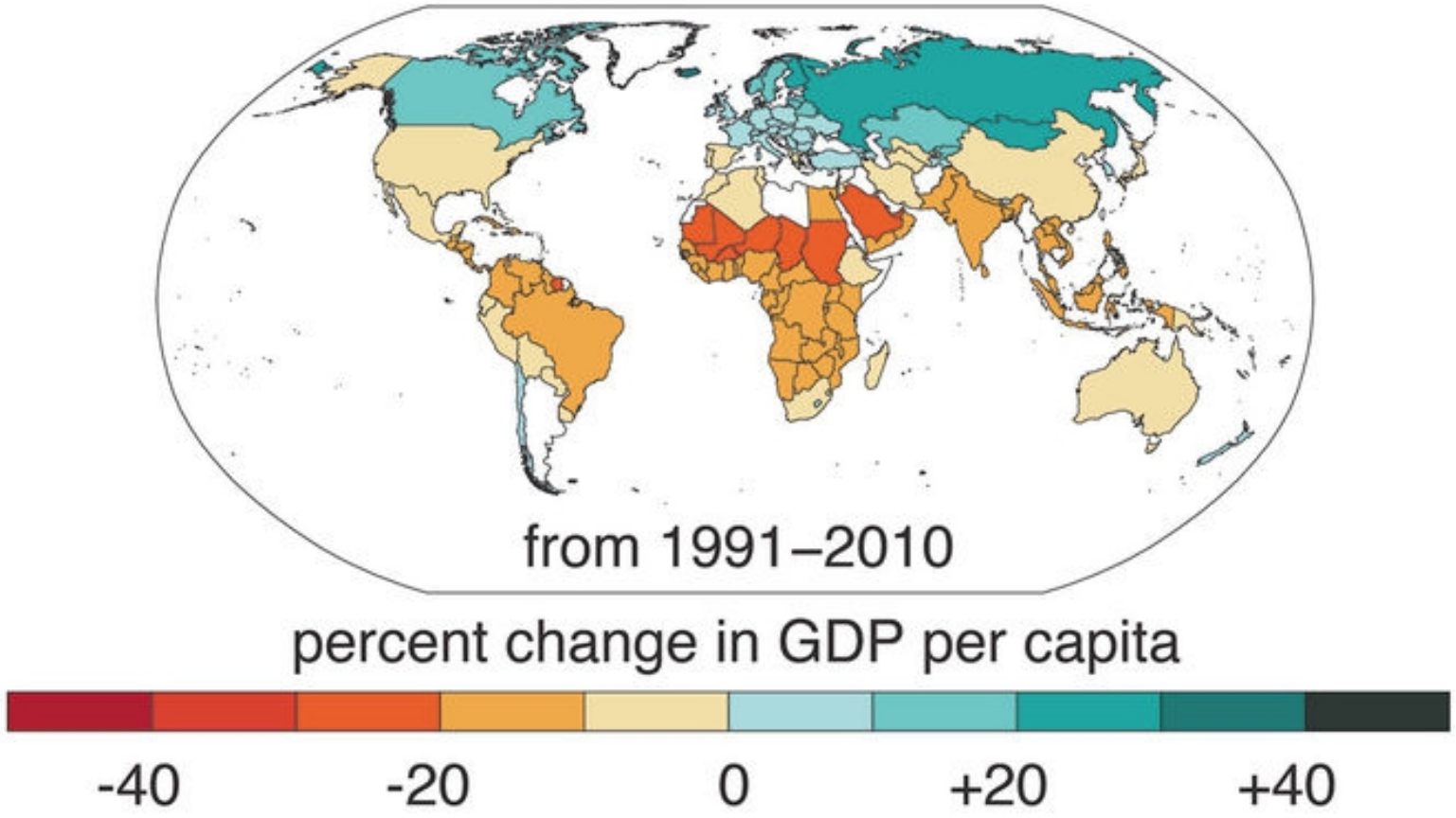
Mon 13 Aug 2018 10.42 BST

3,507 506

When July's heatwave swept through the Canadian province of Quebec, killing more than 90 people in little over a week, the unrelenting sunshine threw the disparities between rich and poor into sharp relief.

While the well-heeled residents of Montreal hunkered down in blissfully air conditioned offices and houses, the city's homeless population - not usually welcome in public areas such as shopping malls and restaurants - struggled to escape the blanket of heat.

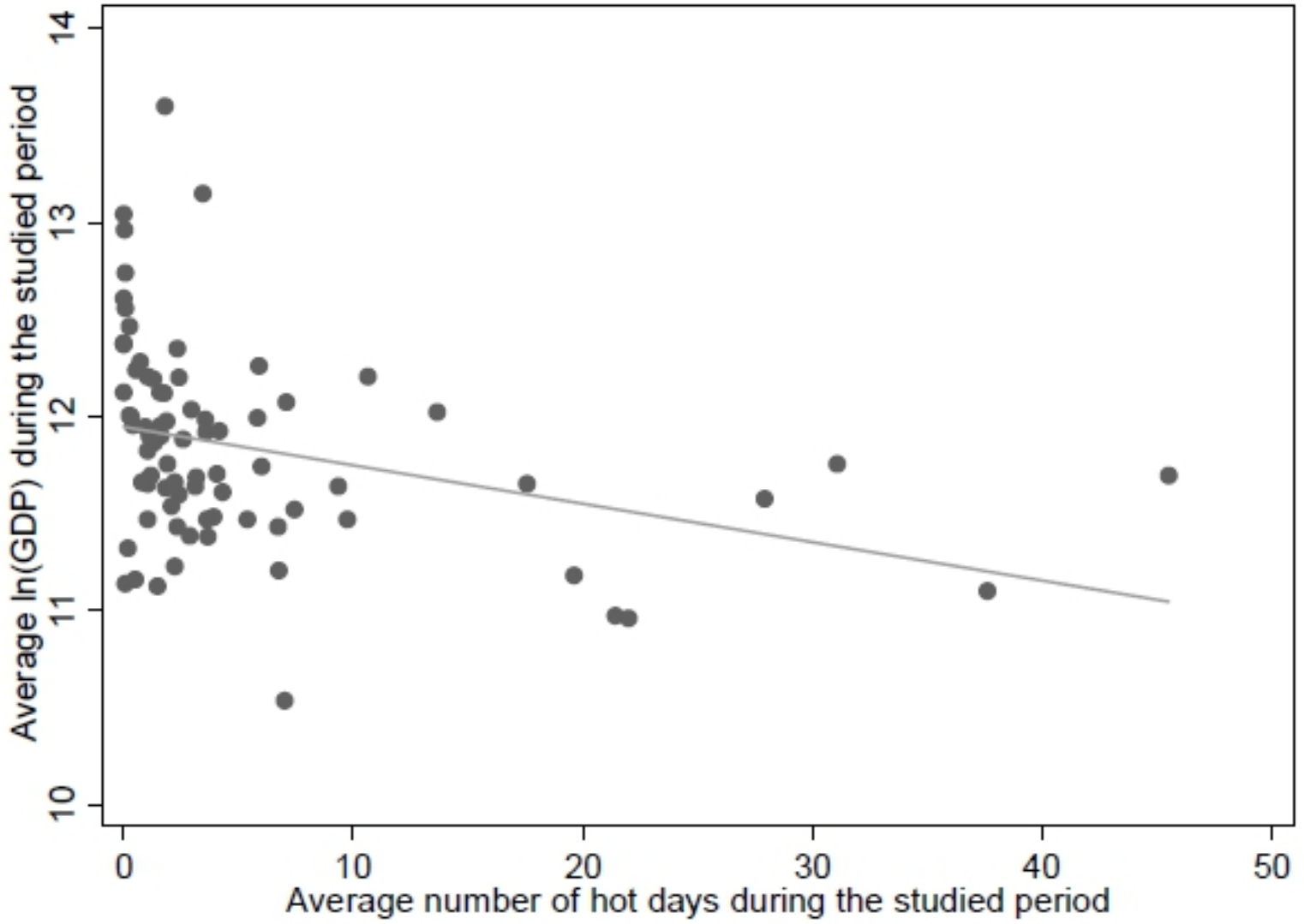
Poor countries become poorer



"As global temperatures have risen, some economies have wilted while others enjoyed an extra lift. The difference follows a geographic pattern: Hotter countries closer to the equator suffered, while cooler ones benefited."

(Diffenbaugh and Burke 2019)

Correlation between days above 25°C and ln(GDP) in Russia



Source: The authors' construction.

Research Questions and Contribution

1. Examine the distributional impacts of extreme temperature and precipitation shocks, using the regional panel data from Russia
2. Account for the intensity of extreme temperatures exposure by simultaneously examining the impacts of both single and consecutive days with extreme temperature
3. Identify and test the labor market channels behind the inequality-temperature relationship
4. Study if the impacts are heterogeneous
   - Poor vs. rich regions
   - Hot vs. cold regions

Literature

- **Hot and cold temperatures increase mortality**
  - *India*: Burgess et al. (2017), Banerjee & Maharaj (2020)
  - *Mexico*: Cohen & Dechezleprêtre (2017)
  - *USA*: Deschênes & Greenstone (2011), Deschênes & Moretti (2009)
  - *China*: Yu et al. (2019)
  - *Russia*: Otrachshenko, Popova, & Solomin (2017, 2018), Otrachshenko, Popova, & Tavares (2021)

- **Extreme heat harms the country-level economic growth and the poor countries suffer the most** (Dell et al., 2012, 2009; Diffenbaugh and Burke, 2019; Herold et al., 2017; Horowitz, 2009; Tol et al., 2004)

- **Subnational analyses of the impact of extreme temperatures on economic growth and income are rare** (Dell et al., 2009; Hsiang & Deryugina, 2014; Park et al., 2018)

Mechanisms (1)

Comfortable ambient air temperature

Winter: between 20-23.3°C; *Summer*: between 22.3-25.6°C

Thermal stress affects human health

This reduces

- cognitive performance,
- work productivity,
- hours worked in industries with direct exposure to temperature,
- leads to reallocation of time from work to leisure/non-work

(Cho, 2017; Goodman et al., 2018; Graff Zivin et al., 2018; Heal and Park, 2016; Kjellstrom et al., 2009; Zhang et al., 2018; Zivin and Neidell, 2014).

Mechanisms (2)

Extreme temperatures may affect regional GDP and income inequality via

several labor market channels:

(a) thermal stress may increase *transitions from employment to unemployment* due to low productivity and health reasons (Graff Zivin et al., 2018; Zivin and Neidell, 2014)

(b) lower productivity and work hours as a result of extreme temperatures may lead to *wage reductions*, especially in sectors with a greater exposure to ambient temperatures, e.g. agriculture (Dell et al., 2012, 2009; Park et al., 2018)

(c) thermal stress may lead to the *reallocation of labor* from sectors with a greater exposure to temperature risks to sectors with a lower exposure (Zhang et al., 2018)

(d) exposure to extreme temperatures increases *migration* (Deschênes and Moretti, 2009; Mueller et al., 2020).

additional channels:

(a) unequal industrial and agricultural development in rich and poor regions. Rich and cold countries therefore receive more benefits from global warming than do poor and hot countries (Heal and Park, 2016; Park et al., 2018; Tol et al., 2004)

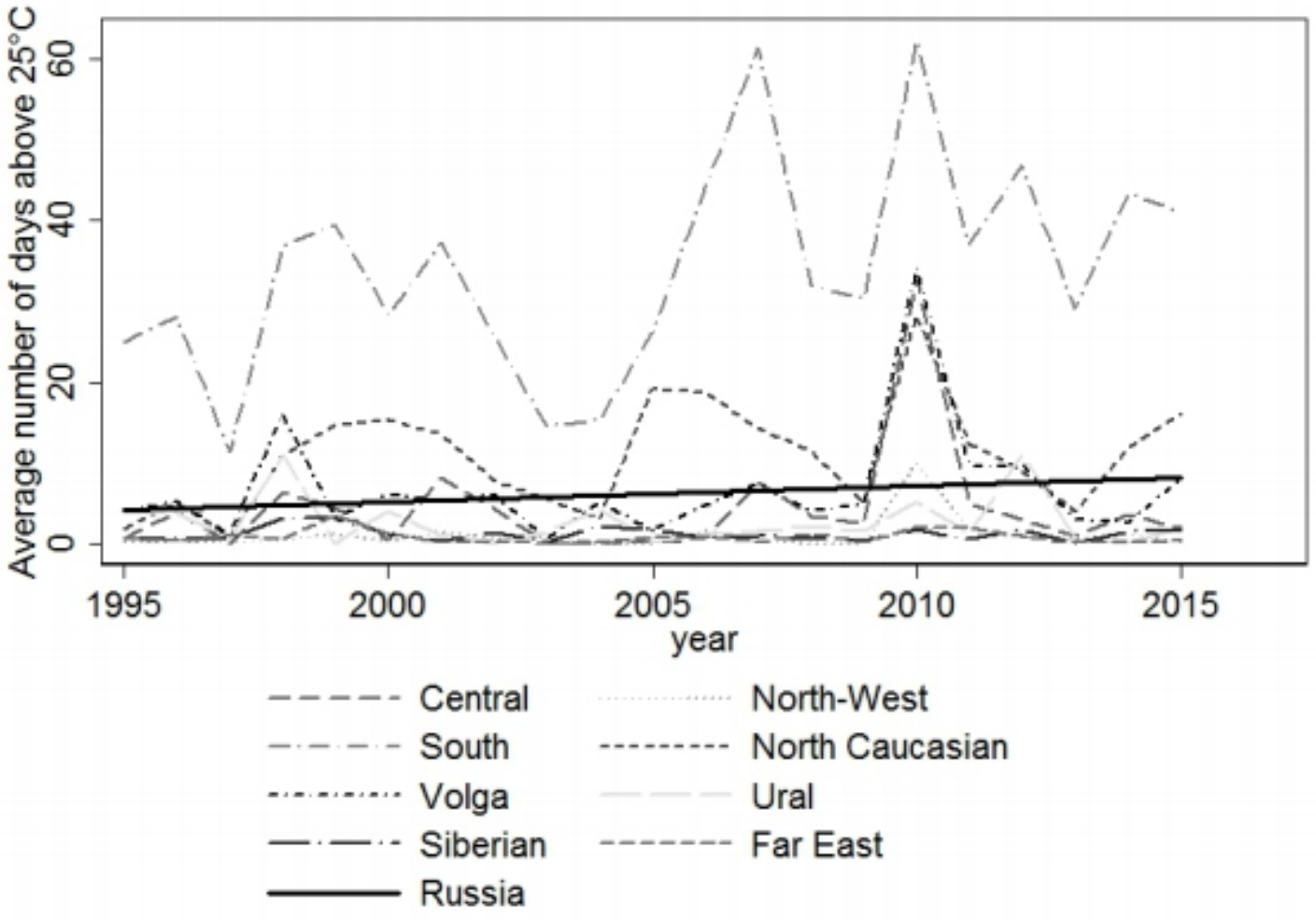
(b) effects on overall real income per capita via consumption *price changes* (Kahn, 2016)

Background: Income inequality in Russia

- GINI: 0.331 (the 2017 OECD estimate)
- Wage and income inequality grew in Russia during the transition period before 2000 and has been relatively stable or decreasing thereafter (Lehmann and Wadsworth 2007; Lukiyanova and Oshchepkov 2012; Commander et al. 1999; Dang et al. 2019; Gorodnichenko et al. 2010; Lokshin and Popkin 1999, Calvo et al. 2015).
  - pro-poor growth, i.e. a relatively faster growth in the income of the poorest income groups as compared to the income of the richest groups
  - changing returns to employment in different economic sectors
  - the share of persistently poor households is relatively low, but the upward mobility of the poor along the income distribution is still very limited
- Substantial differentiation between income distributions in the Russian regions (Fedorov 2002; Gluschenko 2011)

Background: Weather

- The coldest month is January, with average temperature -25.4°C and average precipitation 21.7 mm and the warmest month is July, with average temperature 15.4°C and average precipitation 63.6 mm
- The climate is mostly continental with hot summers and cold winters
- An increasing trend in the number of hot days over time. The average number of days above 25°C has doubled during the last years (from 3.24 in 1995 to 6.76 in 2015)



Source: Authors' compilation

Econometric model

$$Y_{it} = \beta_0 + \beta_1 Consec.Bin_{it}^{below-23°C} + \beta_2 Bin_{it}^{below-23°C} + \beta_3 Bin_{it}^{above\ 25°C} + \beta_4 Consec.\ Bin_{it}^{above\ 25°C} + \delta_1 Bin_{it}^{Prec.\ 10-20mm} + \delta_2 Bin_{it}^{Prec.\ above\ 20mm} + \alpha_i + \gamma_t + \boldsymbol{\Phi}' Region * Trend + u_{it} \quad (1)$$

Region *i*, year *t*

Y a set of income distribution indicators such as ln(real regional GDP per capita), income quintile groups, poverty rate, Gini, and the 90th/10th income percentile ratio

Bin the number of days in a region i and year t on which the average daily temperature was below -23°C, above 25°C, the mean daily precipitation was between 10 mm and 20 mm, and above 20 mm

Consec. Bin the number of days in spells of at least three consecutive days with the average daily temperature below $-23°C$ or above $25°C$

α regional fixed effects; γ year fixed effects; *Region*Trend* region-specific linear time trends

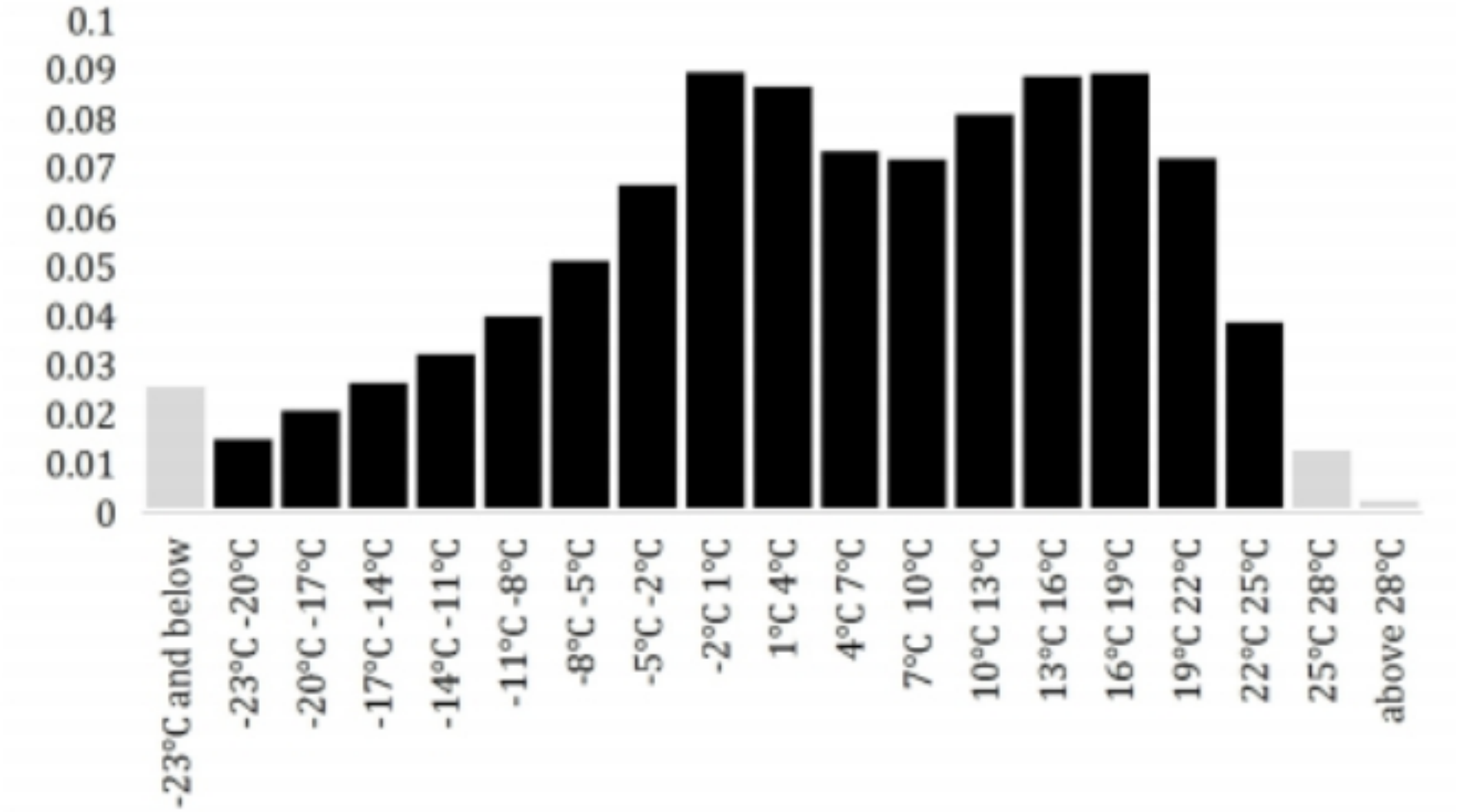
Days with temperature between -23°C and 25°C and with precipitation between 0mm and 10mm are used as a default categories

Data

- Daily data on precipitation and temperature from 518 meteorological stations in Russia for the period 1995-2015
  - ➢Data are aggregated to the regional level
  - ➢For each meteostation we find the nearest settlements (cities, towns, villages of city type) within 200 km and use the population of this settlement as weights

- Yearly data on regional GDP per capita, income quintile groups, Gini, $90^{th}/10^{th}$ percentile ratio, poverty, unemployment and migration rates, total monetary income, and distribution of wages and employment across industries from 79 regions

- To account for the heterogeneity in economic performance between the Russian regions, we analyze the impact of weather on inequality indicators in poor/rich and cold/hot regions separately.



Distribution of days with a specific temperature range, 1995-2015.

Source: Authors' construction. The intervals in black are used a default category

Estimation Results

Dep. Variables:	(1) Ln(real GDP per capita)	(2) Lowest income group	(3) Lower middle income group	(4) Middle income group	(5) Upper middle income group	(6) High income group	(7) Poverty	(8) Gini	(9) The 90th/10th income percentile ratio
Consecutive below -23°C	-0.0002	0.0012	-0.0009	0.0016	0.0024	0.0332	0.0367	-0.0001	-0.0067
	(0.0007)	(0.0027)	(0.0147)	(0.0025)	(0.0020)	(0.0511)	(0.0403)	(0.0001)	(0.0292)
below -23°C	-0.0007	0.0040	-0.0077	0.0034	-0.0024	-0.1161	-0.0388	-0.0001	-0.0234
	(0.0011)	(0.0041)	(0.0279)	(0.0032)	(0.0035)	(0.1152)	(0.0881)	(0.0002)	(0.0416)
above 25°C	0.0018	0.0225***	-0.0041	0.0119**	-0.0226	-0.4057	0.1839	-0.0002	-0.0355
	(0.0018)	(0.0071)	(0.0484)	(0.0050)	(0.0258)	(0.2489)	(0.2128)	(0.0004)	(0.1079)
Consecutive above 25°C	-0.0019***	0.0008	-0.0107	0.0013	-0.0019	0.0237	-0.0378	-0.0001	0.0062
	(0.0005)	(0.0020)	(0.0158)	(0.0015)	(0.0026)	(0.0444)	(0.0526)	(0.0001)	(0.0203)
10mm 20mm	-0.0009	0.0015	-0.0377	0.0073**	-0.0024	-0.0621	-0.0068	-0.0004***	-0.0148
	(0.0007)	(0.0039)	(0.0261)	(0.0030)	(0.0044)	(0.0743)	(0.0727)	(0.001)	(0.0315)
20mm 100mm	0.0009	0.0092	-0.0375	0.0053	0.0063	0.0121	0.0758	-0.0006*	-0.1062**
	(0.0015)	(0.0089)	(0.0532)	(0.0079)	(0.0061)	(0.1583)	(0.2154)	(0.0003)	(0.0513)
Observations	1,656	1,649	1,649	1,649	1,649	1,649	1,647	1,649	1,649
R-squared	0.943	0.555	0.514	0.553	0.074	0.240	0.576	0.626	0.373

Leibniz Institute for EAST AND SOUTHEAST EUROPEAN STUDIES

Estimation Results: Poor regions

Dep. Variables (in %):	(1) Ln(real GDP per capita)	(2) Lowest income group	(3) Lower middle income group	(4) Middle income group	(5) Upper middle income group	(6) High income group	(7) Poverty	(8) Gini	(9) The 90th/10th income percentile ratio
Consecutive below -23°C	0.0000	0.0022	-0.0037	0.0045	0.0011	-0.0313	-0.0481	-0.0002	0.0228
	(0.0007)	(0.0053)	(0.0159)	(0.0051)	(0.0014)	(0.0954)	(0.0605)	(0.0002)	(0.0596)
below -23°C	-0.0013	0.0079	0.0814*	0.0037	0.0001	-0.0074	-0.0287	-0.0001	-0.0430
	(0.0011)	(0.0100)	(0.0416)	(0.0081)	(0.0023)	(0.2009)	(0.2295)	(0.0004)	(0.0925)
above 25°C	0.0015	0.0167**	-0.0161	0.0081	0.0019	-0.3763*	0.1829	-0.0001	0.1301**
	(0.0023)	(0.0074)	(0.0574)	(0.0052)	(0.0013)	(0.2223)	(0.2853)	(0.0004)	(0.0553)
Consecutive above 25°C	-0.0019***	0.0034	0.0157	0.0027*	0.0004	0.0121	-0.0517	-0.0002**	-0.0308**
	(0.0006)	(0.0025)	(0.0186)	(0.0013)	(0.0004)	(0.0575)	(0.0794)	(0.0001)	(0.0222)
10mm 20mm	-0.0024**	0.0049	-0.0261	0.0088**	0.0017	-0.1162	-0.1054	-0.0006***	-0.0436
	(0.0011)	(0.0067)	(0.0346)	(0.0042)	(0.0011)	(0.1110)	(0.1127)	(0.002)	(0.0320)
20mm 100mm	-0.0005	0.0093	0.0173	0.0023	0.0013	0.1189	-0.2753	-0.0007	-0.0839
	(0.0019)	(0.0124)	(0.0620)	(0.0088)	(0.0019)	(0.2405)	(0.3784)	(0.0005)	(0.0726)
Observations	840	835	835	835	835	835	835	835	835
R-squared	0.940	0.569	0.584	0.694	0.527	0.241	0.622	0.587	0.327

Leibniz Institute for EAST AND SOUTHEAST EUROPEAN STUDIES

Estimation Results: Rich regions

Dep. Variables (in %):	(1) Ln(real GDP per capita)	(2) Lowest income group	(3) Lower middle income group	(4) Middle income group	(5) Upper middle income group	(6) High income group	(7) Poverty	(8) Gini	(9) The 90th/10th income percentile ratio
Consecutive below -23°C	-0.0002	-0.0007	-0.0260	-0.0020	0.0006	0.0906	0.1259**	0.0001	-0.0174
	(0.0011)	(0.0030)	(0.0227)	(0.0022)	(0.0020)	(0.0594)	(0.0465)	(0.0002)	(0.0294)
below -23°C	-0.0000	0.0025	-0.0355	0.0032	-0.0034	-0.1644	-0.0743	-0.0002	-0.0090
	(0.0015)	(0.0039)	(0.0362)	(0.0033)	(0.0057)	(0.1393)	(0.0866)	(0.0002)	(0.0411)
above 25°C	-0.0001	0.0465***	0.0192	0.0299**	-0.0676	-0.5800	0.2446	-0.0005	-0.3793
	(0.0029)	(0.0159)	(0.1095)	(0.0120)	(0.0764)	(0.6420)	(0.1856)	(0.0010)	(0.3140)
Consecutive above 25°C	-0.0015*	-0.0059	-0.0515*	-0.0009	-0.0151	-0.0204	-0.0173	0.0001	0.0706
	(0.0009)	(0.0036)	(0.0272)	(0.0061)	(0.0161)	(0.0912)	(0.0541)	(0.0002)	(0.0446)
10mm 20mm	0.0012	-0.0034	-0.0344	0.0046	-0.0078	0.0005	0.0793	-0.0002	0.0043
	(0.0008)	(0.0052)	(0.0393)	(0.0040)	(0.0102)	(0.0989)	(0.0919)	(0.002)	(0.0543)
20mm 100mm	0.0013	0.0087	-0.0981	0.0107	0.0087	-0.1271	0.5016**	-0.0005	-0.1370*
	(0.0024)	(0.0130)	(0.0908)	(0.0158)	(0.0114)	(0.2106)	(0.2016)	(0.0005)	(0.0792)
Observations	816	814	814	814	814	814	812	814	814
R-squared	0.934	0.557	0.495	0.516	0.091	0.278	0.514	0.679	0.435

Estimation Results: Hot vs. Cold Regions

Dep. Variables:	All regions Ln(real GDP per capita)	Hot regions Ln(real GDP per capita)	Cold regions Ln(real GDP per capita)
Consecutive below -23°C	-0.0002 (0.0007)	0.0012 (0.0008)	-0.0009 (0.0008)
below -23°C	-0.0007 (0.0011)	-0.0033* (0.0018)	0.0003 (0.0011)
above 25°C	0.0018 (0.0018)	0.0004 (0.0018)	0.0001 (0.0040)
Consecutive above 25°C	-0.0019*** (0.0005)	-0.0020*** (0.0006)	-0.0019 (0.0013)
10mm 20mm	-0.0009 (0.0007)	-0.0014 (0.0011)	-0.0000 (0.0010)
20mm 100mm	0.0009 (0.0015)	0.0018 (0.0022)	0.0008 (0.0020)
Observations	1,656	816	840
R-squared	0.943	0.950	0.939

Channels

To test the channels, we also estimate Eq. (1) for several other socioeconomic indicators:

- the changes in the monetary value of a fixed consumption basket
- relative wages in different economic sectors
- the share of employed in different economic sectors
- unemployment rate
- migration rate

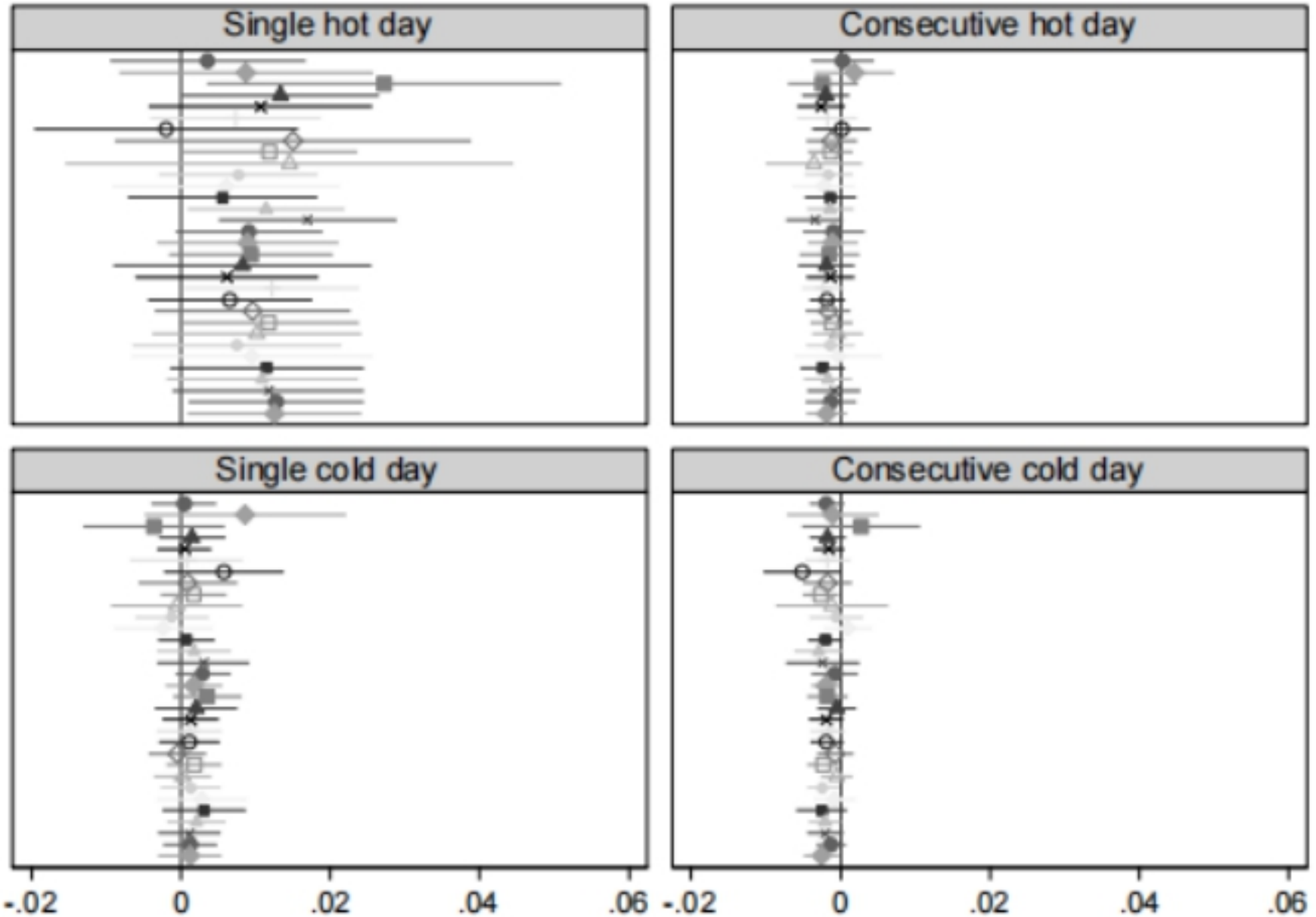
Channels: Prices

	All regions	Poor regions	Rich regions
	Change in the value of fixed basket	Change in the value of fixed basket	Change in the value of fixed basket
Consecutive below -23°C	0.0000 (0.0002)	0.0001 (0.0002)	-0.0001 (0.0002)
below -23°C	0.0003 (0.0002)	0.0004 (0.0005)	0.0004 (0.0003)
above 25°C	0.0000 (0.0007)	-0.0003 (0.0009)	0.0017 (0.0013)
Consecutive above 25°C	0.0004** (0.002)	0.0005** (0.0002)	-0.0000 (0.0003)
10mm 20mm	-0.0000 (0.0003)	0.0002 (0.0004)	-0.0001 (0.0004)
20mm 100mm	0.0014** (0.0006)	0.0015** (0.0007)	0.0014 (0.0010)
Observations	1,106	560	546
R-squared	0.649	0.657	0.661

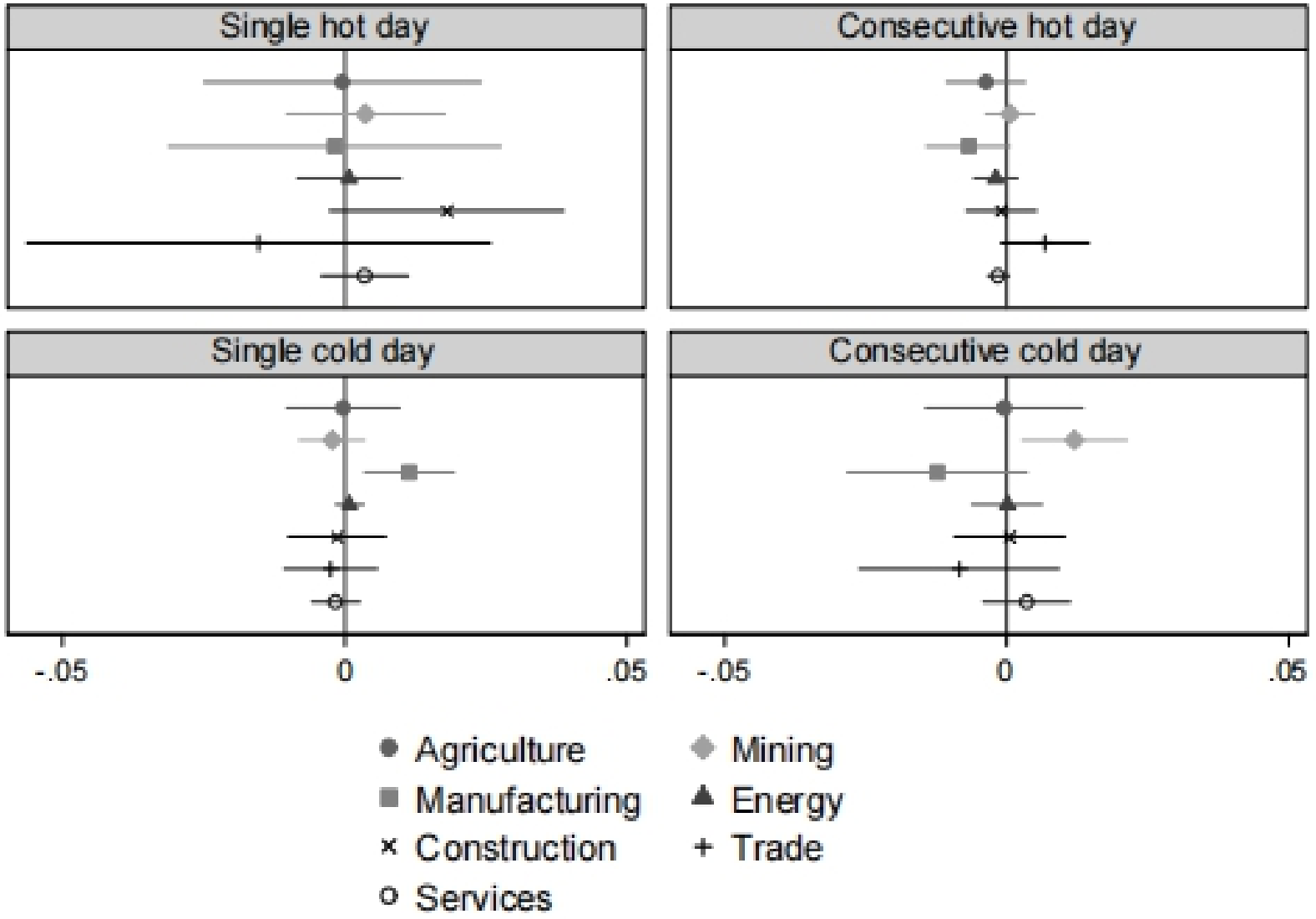
Channels: Unemployment

	All regions	Poor regions	Rich regions	Hot regions	Cold regions
Consecutive below -23℃	0.0104	0.0130	0.0024	0.0011	0.0150
	(0.0096)	(0.0175)	(0.0115)	(0.0178)	(0.0118)
below -23°C	-0.0155	0.0156	-0.0235	0.0238	-0.0328
	(0.0172)	(0.0360)	(0.0186)	(0.0352)	(0.0199)
above 25°C	-0.0505	-0.0390	-0.0186	-0.0357	-0.0438
	(0.0468)	(0.0589)	(0.0622)	(0.0530)	(0.0991)
Consecutive above 25℃	0.0219**	0.0282*	-0.0061	0.0275*	0.0283
	(0.0107)	(0.0142)	(0.0122)	(0.0137)	(0.0253)
10mm 20mm	-0.0212	-0.0231	-0.0277**	-0.0238	-0.0205
	(0.0150)	(0.0282)	(0.0137)	(0.0244)	(0.0187)
20mm 100mm	0.0169	0.0015	0.0139	-0.0518	0.0798
	(0.0417)	(0.0656)	(0.0440)	(0.0688)	(0.0621)
Observations	1,883	953	930	928	955
R-squared	0.650	0.611	0.753	0.613	0.702

Channels: Relative wages



Channels: Employment



Channels: Migration rate

	(1) All regions	(2) Poor regions	(3) Rich regions	(4) Cold regions	(5) Hot regions
Consecutive below -23°C	-0.3690	-0.0293	-0.4795	-0.4607	0.1382
	(0.3234)	(0.2448)	(0.4617)	(0.3693)	(0.2283)
below -23°C	0.5230	0.0896	0.7287	0.5057	0.8385
	(0.6319)	(0.8239)	(0.8054)	(0.7464)	(1.1897)
above 25°C	-0.2127	-2.1238	2.4174**	3.0811**	-1.7517
	(1.7315)	(2.9471)	(1.0898)	(1.4229)	(2.3435)
Consecutive above 25°C	0.1454	0.2168	-0.1154	-1.0366*	0.2635
	(0.1953)	(0.2761)	(0.2362)	(0.5136)	(0.2019)
10mm 20mm	-0.8680	-2.0229	0.4822	0.2024	-1.8761
	(0.9466)	(1.8500)	(0.4289)	(0.3720)	(1.8650)
20mm 100mm	-0.1770	0.4599	-1.2907	-2.0778**	1.4880
	(1.1980)	(1.7686)	(1.1941)	(0.9734)	(1.5544)
Observations	1,659	840	819	840	819
R-squared	0.325	0.173	0.652	0.659	0.178

Robustness checks

- Lag of ln(GDP)
- Using post-transition sample only
- Using 28C instead of 25C
- Lags of temperature and precipitation
- Including intermediate temperature bins

Summary and discussion

Leibniz Institute for EAST AND SOUTHEAST EUROPEAN STUDIES

- Consecutive extremely hot days exacerbate uneven development of poor and rich regions
- Consecutive hot days reduce GDP per capita, while single hot days induce pro-poor income redistribution through increasing the shares of income earned by poorer population groups
- Cold temperatures have little effect on income distribution in Russia
- The major channels behind the temperature-inequality relationship are changes in prices, changes in employment structure (to some extent), transition from employment to unemployment, and migration

Leibniz Institute for
EAST AND SOUTHEAST
EUROPEAN STUDIES

Thank you!

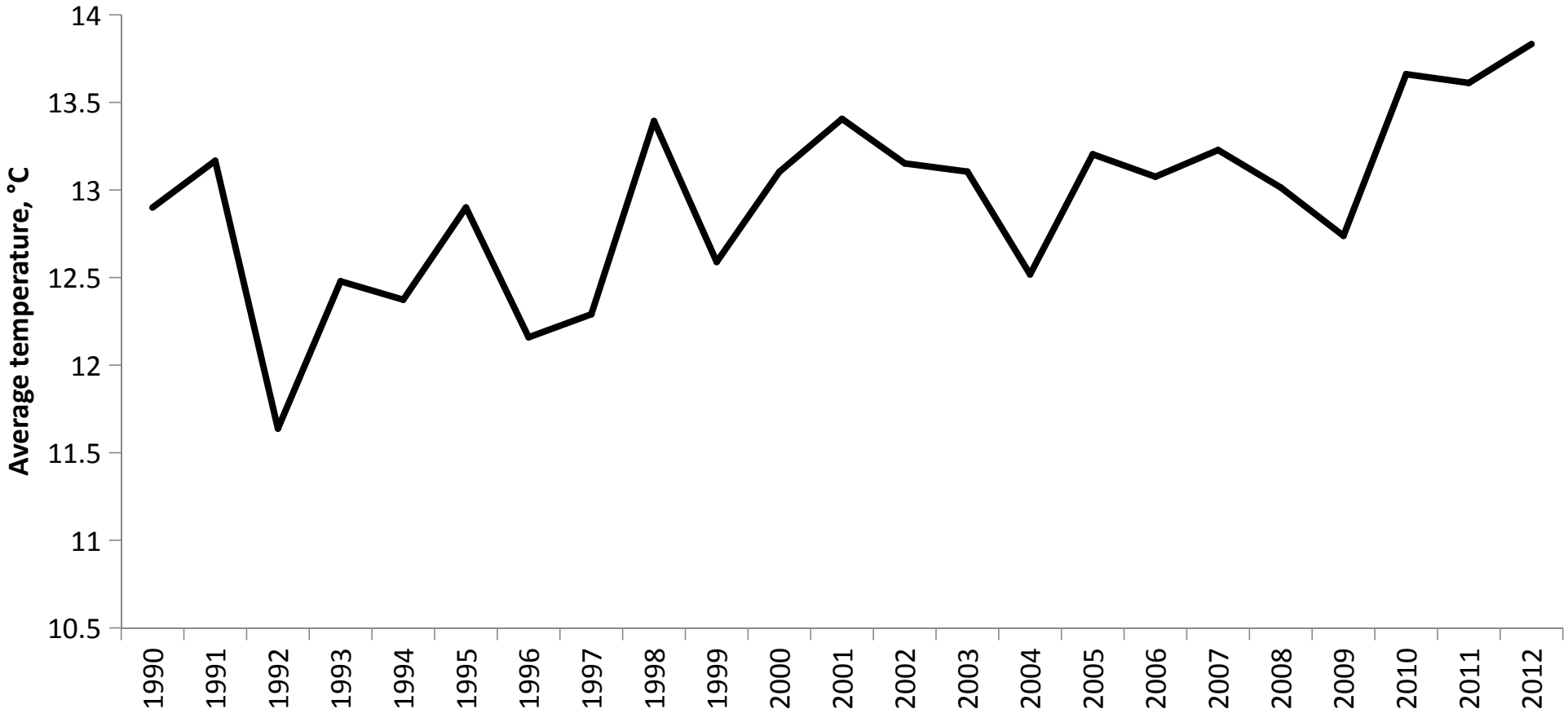
popova@ios-regensburg.de

Paper:

Otrachshenko, V., Popova, O. (2021) Does weather sharpen income inequality in Russia? *Review of Income and Wealth*, forthcoming

Appendix

Average monthly temperature in June-August for Russia



Source: Authors' construction based on the data from the Climate Change Knowledge Portal of the World Bank

AVERAGE SHARES OF EMPLOYMENT IN SELECTED INDUSTRIES BY FEDERAL DISTRICT (2005-2015), IN % TO TOTAL LABOR FORCE IN THE FEDERAL DISTRICT

	Agriculture	Mining	Manufacturing	Construction	Trade	Energy	Services
South	17.91	0.78	11.43	6.76	16.61	2.90	1.82
North Caucasian	19.06	0.80	11.18	7.21	14.14	2.49	1.83
Volga	12.97	0.93	19.16	7.29	16.39	2.71	1.60
Ural	8.35	4.28	17.90	8.06	15.30	3.28	1.58
Central	11.52	0.46	18.93	6.96	18.09	2.99	1.55
Siberian	11.63	2.71	11.39	6.90	15.27	3.21	1.70
Far East	3.42	5.31	7.31	7.81	15.14	5.74	1.68
North-West	8.75	1.81	16.18	7.37	15.79	3.56	1.90

Source: Authors' construction based on data from the Federal State Statistical Service of Russia. *Note*: The federal districts are ranked according to average number of days above 25°C in 2015 from the highest to the lowest.

Variable	Period	Definition and units of measurement
Ln (Real gross domestic product per capita)	1995-2015	The natural logarithm of regional domestic product per capita (in Russian Rubles). The real value is calculated by the authors using the consumer price index for Russia from the World Bank. Base year is 2010.
Income quintile groups (population income shares)	2000-2015	A share of income earned by each 20% population group in total regional income of population, %. The first 20% are the poorest and the fifth 20% are the richest population groups. The ranking of income groups is based on the gross nominal income of regional population
Share of population in poverty	2000-2015	Population with the gross nominal income below the regional minimum substance level to total regional population, %
Gini coefficient	1995-2015	Index of income dispersion from 0 to 1, where 0 is the perfect income equality and 1 is the maximal inequality
$90^{th}/10^{th}$ income percentile ratio	1995-2015	A share of gross nominal income of top 10% to the gross nominal income of the bottom 10%
Unemployment rate	1995-2015	The average yearly number of unemployed to the total average yearly labor force (International Labor Organization definition), %
Net migration rate	1995-2015	The difference between the number of immigrated and the number of emigrated per 10,000 of population
Relative wage in each industry	2005-2015	Average monthly nominal gross wage in each industry distinguished according to the Russian Classification of Economic Activities (OKVED, Rev. 2), Russian Rubles. Relative wages for each industry are calculated by the authors by dividing the average monthly nominal gross wage in each industry to the average monthly nominal gross wage in industry "manufacturing, other"
The share of employed in each industry	2005-2015	The average yearly number of employed in each industry to the total average yearly labor force, %. Industries distinguished according to the Russian Classification of Economic Activities (OKVED, Rev. 2)

Variable	Whole sample			Rich regions			Poor regions			Cold regions			Hot regions		
	N obs.	Mean	S.D.	N obs.	Mean	S.D.	N obs.	Mean	S.D.	N obs.	Mean	S.D.	N obs.	Mean	S.D.
Ln (Real GDP)	1,656	11.85	0.62	816	12.24	0.53	840	11.47	0.44	840	12.00	0.63	816	11.70	0.57
Lowest income group	1,649	6.33	1.04	814	6.03	1.06	835	6.63	0.93	830	6.35	0.98	819	6.32	1.10
Lower middle income group	1,649	8.42	4.70	814	7.56	4.73	835	9.27	4.50	830	8.53	4.65	819	8.31	4.74
Middle income group	1,649	15.91	1.20	814	15.58	1.50	835	16.22	0.69	830	15.96	0.80	819	15.85	1.51
Upper middle income group	1,649	22.79	1.28	814	22.62	1.80	835	22.96	0.15	830	22.89	0.23	819	22.70	1.80
High income group	1,649	40.91	10.82	814	42.28	10.47	835	39.57	10.99	830	40.55	11.09	819	41.27	10.53
Share of population in poverty	1,647	21.84	14.32	814	17.86	9.79	835	25.71	16.77	828	21.81	13.55	819	21.88	15.07
Gini	1,649	0.37	0.05	814	0.39	0.05	835	0.36	0.04	830	0.37	0.04	819	0.37	0.05
90/10 ratio	1,649	10.72	5.46	814	12.06	6.30	835	9.41	4.10	830	10.45	4.73	819	10.99	6.10
Unemployment rate	1,883	9.32	5.96	930	7.80	3.30	953	10.81	7.43	955	9.31	4.30	928	9.33	7.29
Net migration rate	1,659	-6.94	111.07	819	-15.52	114.68	840	1.43	106.84	840	-31.38	106.95	819	18.12	109.67
Share of employed in agriculture	878	12.14	5.63	429	9.04	4.48	449	15.11	4.98	440	10.21	4.25	438	14.08	6.16
Share of employed in mining	878	1.84	2.98	429	3.02	3.81	449	0.72	0.96	440	2.93	3.81	438	0.75	0.90
Share of employed in manufacturing	878	14.90	6.12	429	14.69	6.17	449	15.11	6.07	440	14.28	6.88	438	15.53	5.18
Share of employed in construction	878	7.22	2.00	429	7.80	2.03	449	6.66	1.80	440	7.19	2.01	438	7.24	1.99
Share of employed in trade	878	16.16	3.35	429	16.22	3.41	449	16.10	3.30	440	15.11	2.79	438	17.21	3.54
Share of employed in energy	878	3.32	1.45	429	3.67	1.91	449	2.99	0.65	440	3.95	1.76	438	2.69	0.59
Share of employed in services	877	1.69	0.52	429	1.81	0.50	448	1.56	0.51	440	1.70	0.47	437	1.67	0.56

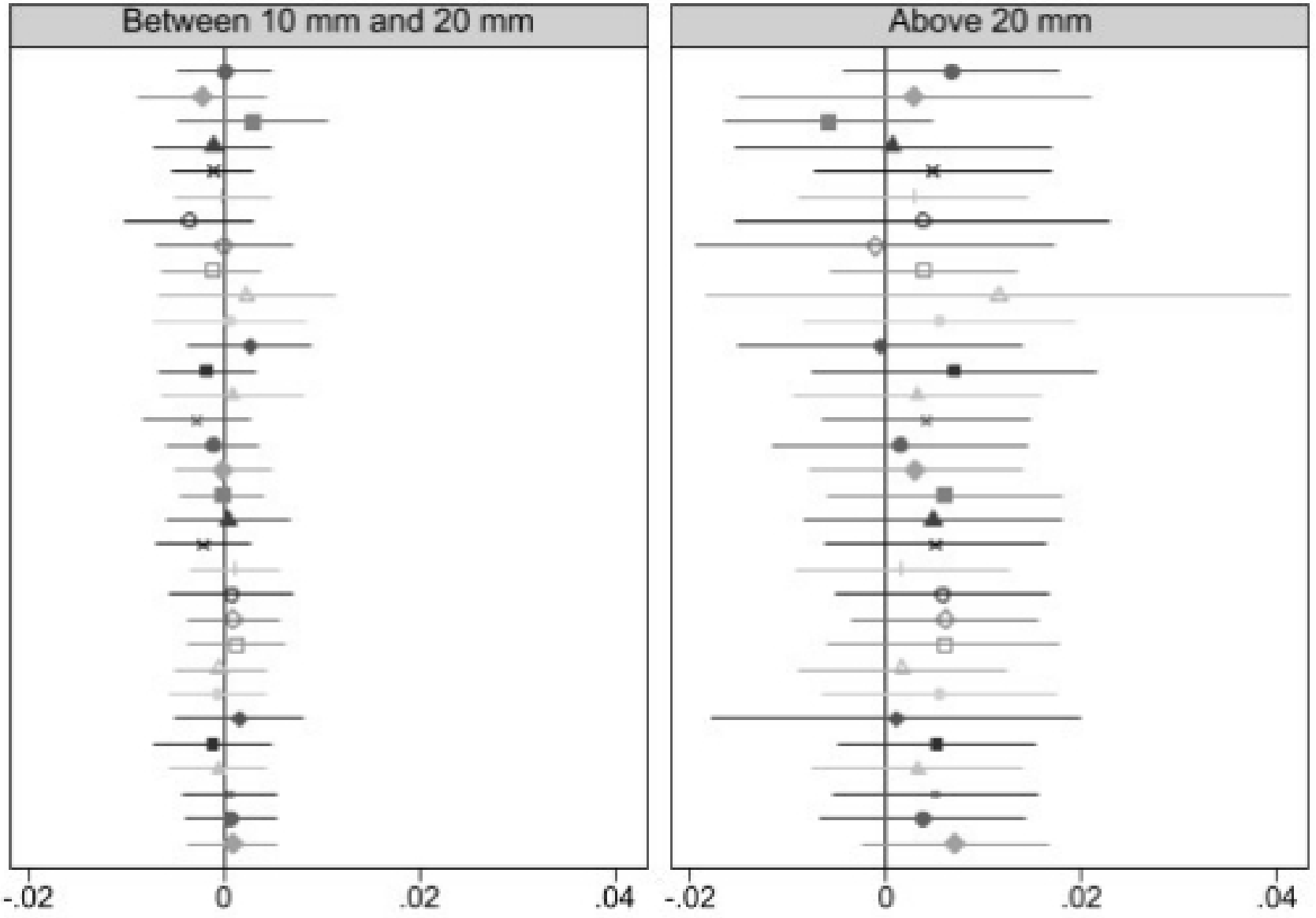
Wages are measured for 32 industries according to the extended Russian Classification of Economic Activities.

1. agricultural, hunting, and forestry;
2. fishing and aquaculture;
3. extraction of crude petroleum and natural gas;
4. mining,
5. manufacturing of food and tobacco;
6. manufacturing of textiles;
7. manufacturing of leather and related products;
8. manufacture of wood and related products;
9. manufacturing of paper and paper products;
10. manufacturing of coke, refined petroleum products, and nuclear materials;
11. manufacturing of chemical and chemical products;
12. manufacturing of rubber and plastic products;
13. manufacturing of non-metallic mineral products;
14. metallurgy and related products;
15. manufacturing of electronic and optical products;
16. manufacturing of motor vehicles and equipment;
17. electricity, gas, and water supply;
18. construction;
19. wholesale and retail trade and repair of motor vehicles and motorcycles;
20. wholesale trade;
21. retail trade and repair;
22. accommodation and food service activities;
23. transport;
24. communication;
25. financial service activities;
26. real estate activities;
27. programming and broadcasting activities;
28. scientific research and development;
29. national security;
30. education;
31. human health activities;
32. social services and utilities.

Robustness

Dep. Variables:	(1) ln(GDP) Baseline model	(2) ln(GDP) with lag of ln(GDP)	(3) ln(GDP) without transition period (2000-2015)	(4) Poverty (2000-2015)	(5) Gini (2000-2015)	(6) The 90th/10th income percentile ratio (2000-2015)	(7) ln(GDP) with above 28°C	(8) Ln(GDP) with linear and quadratic trends
lag ln(GDP)	-	0.5679***	-	-	-	-	-	-
		(0.0280)						
Consecutive below -23°C	-0.0002	-0.0005	-0.0002	0.0721	0.0001	0.0085	-0.0001	-0.0003
	(0.0007)	(0.0007)	(0.0006)	(0.0438)	(0.0001)	(0.0254)	(0.0007)	(0.0008)
below -23°C	-0.0007	0.0004	-0.0009	-0.0983	-0.0002	-0.0205	-0.0006	-0.0005
	(0.0011)	(0.0009)	(0.0012)	(0.0795)	(0.0002)	(0.0401)	(0.0010)	(0.0009)
above 25°C	0.0018	0.0025	0.0020	0.2435	0.0003	-0.0203	-	0.0016
	(0.0018)	(0.0017)	(0.0015)	(0.1773)	(0.0004)	(0.1181)		(0.0018)
Consecutive above 25°C	-0.0019***	-0.0014***	-0.0013***	-0.0493	-0.0001	0.0134	-	-0.0017***
	(0.0005)	(0.0004)	(0.0004)	(0.0404)	(0.0001)	(0.0208)		(0.0005)
above 28°C	-	-	-	-	-	-	-0.0119***	-
							(0.0042)	
Consecutive above 28°C	-	-	-	-	-	-	-0.0005	-
							(0.0006)	
10mm 20mm	-0.0009	-0.0005	-0.0001	0.0409	-0.0002	0.0012	-0.0007	-0.0005
	(0.0007)	(0.0006)	(0.0007)	(0.0622)	(0.0001)	(0.0351)	(0.0007)	(0.0007)
20mm 100mm	0.0009	-0.0003	0.0002	0.1241	-0.0002	-0.0968	0.0011	0.0008
	(0.0015)	(0.0011)	(0.0013)	(0.1338)	(0.0003)	(0.0628)	(0.0015)	(0.0016)
Observations	1,656	1,577	1,264	1,262	1,264	1,264	1,656	1,656
R-squared	0.943	0.965	0.953	0.653	0.677	0.391	0.943	0.959

Precipitation and wages



Precipitation and employment