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Российская экономическая школа

ЭКОНОМИЧЕСКИЙ ЛЕКТОРИЙ РЭШ

Цикл просветительских лекций от лучших экономистов России и мира

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The long-run consequences of Chernobyl: Evidence on well-being and mental health

в рамках Цикла лекций по экономике здоровья Экономического лектория РЭШ-2018

Motivation

- Economists care about **welfare** (the aggregate ‚well-being' of individuals living in a country)

- Disasters (low probability-high loss event) entail **welfare losses:**
  - **Explicit costs**: Recovery work, disaster relief, monetary compensation of victims, etc.
  - **Implicit costs**: Higher order effects (e.g., on mental health)
    - Mostly ignored in conventional economic and risk analyses
    - Challenge: Measurement and monetary evaluation

- This talk is not
  - about the explicit costs of the Chernobyl disaster
  - a complete medical assessment of the consequences of the disaster
  - about energy politics

This talk

- Joint research with Alexander Danzer, published in the Journal of Public Economics

The long-run consequences of Chernobyl: Evidence on subjective well-being, mental health and welfare

Alexander M. Danzer [a,b,c,d,e,1], Natalia Danzer [b,f,2]

- Our focus:
  - Long-run study on the *implicit costs* of the Chernobyl disaster
  - Implicit costs in terms of subjective well-being and mental health in Ukraine
  - Estimation of the associated aggregate welfare loss

NPP Chernobyl, 26 April 1986

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Background

- Chernobyl castastrophe in 1986: largest nuclear accident globally
- Open graphite fire; radionuclides released into atmosphere
- Radioactive material precipitated onto parts of western USSR and Europe
- Enourmous manpower for fighting the disaster, clean-up and recovery
- Until today Ukraine spends substantial amounts of public funds as a consequence of the nuclear accident
- *Explicit costs* for 1986-2015 are estimated at 5-7 % of Ukraine‘s annual GDP (e.g., clean-up/recovery work, compensation payments)

Health consequences

- Number of official direct fatalities: around 40

- Health implications mixed (UNSCEAR 2008)
  - Cancer rates in adults not causally elevated
  - Thyroid cancer rates in children went up
  - Subjective health lower, but not objective health (Lehmann and Wadsworth 2011)

- General conclusion of the health literature: physical health damage smaller than initially expected

- Evidence focuses almost exclusively on liquidators and resettled population (highly affected group: 4% of Ukrainian population)

Idea

Idea

- Can psychological effects and worse mental health explain the gap between subjective and objective health?

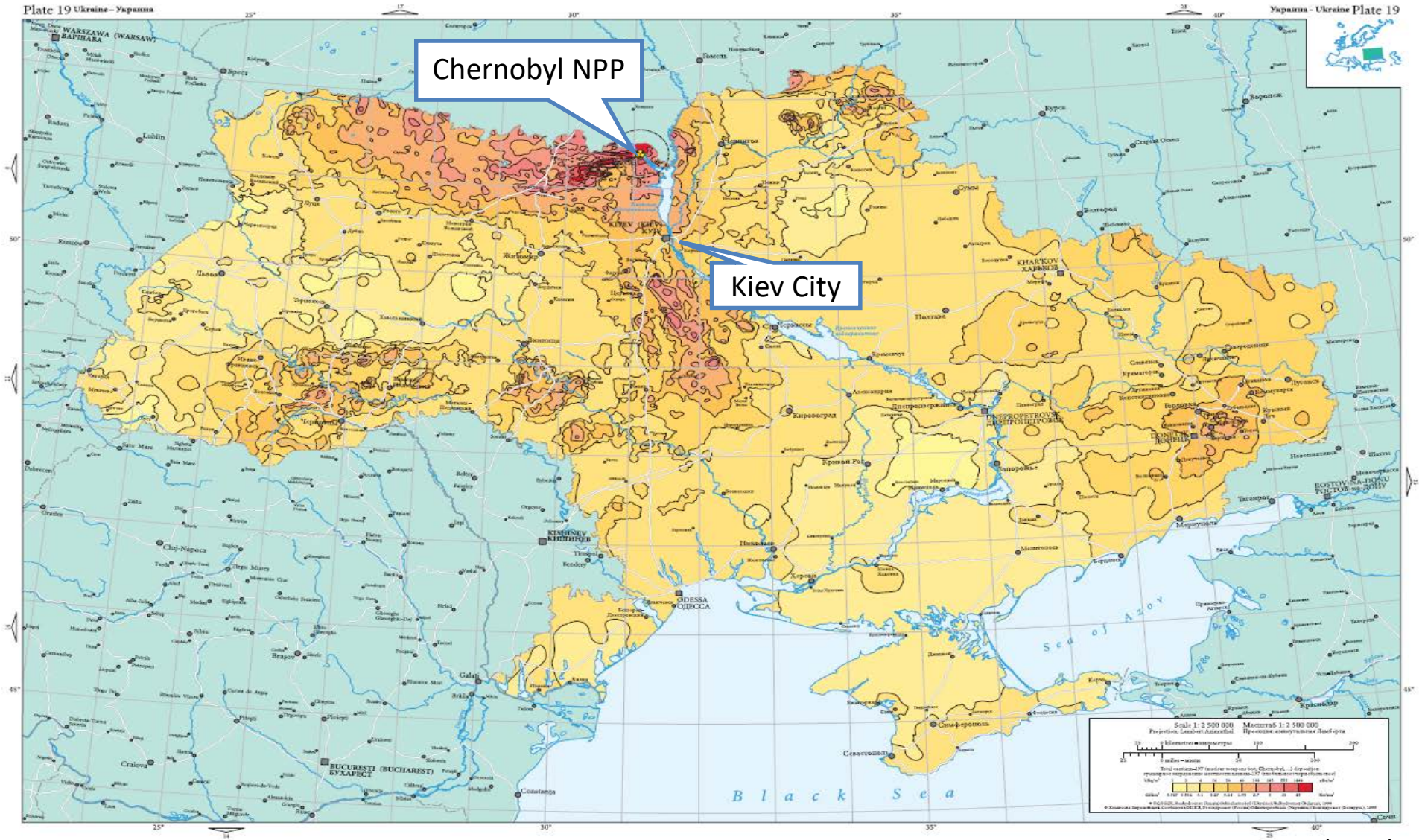
- Humans are frightened by disasters involving toxic exposure (Slovic 1987; Bromet et al. 2011)
  - potential catastrophic and uncontrollable health impact
  - exposure and contamination is undetectable by human senses

- Nuclear radiation as „slow poison“?

Idea

- Research plan:
  - Focus on the general population, not the liquidators and resettled persons (96% of the population)
    - If health of highly exposed has been hardly affected, then low exposed should not suffer from somatic health consequences
  - Investigate outcomes that reflect mental health
    - Subjective well-being (Headey et al. 1993; Gargiulo and Stokes 2009)
    - Diagnosed depression or anxiety disorders
  - Exploit variation in radiation caused by weather conditions (wind, rainfall) for the disaster impact

Caesium-136 deposition



Source: European Commission (1998).

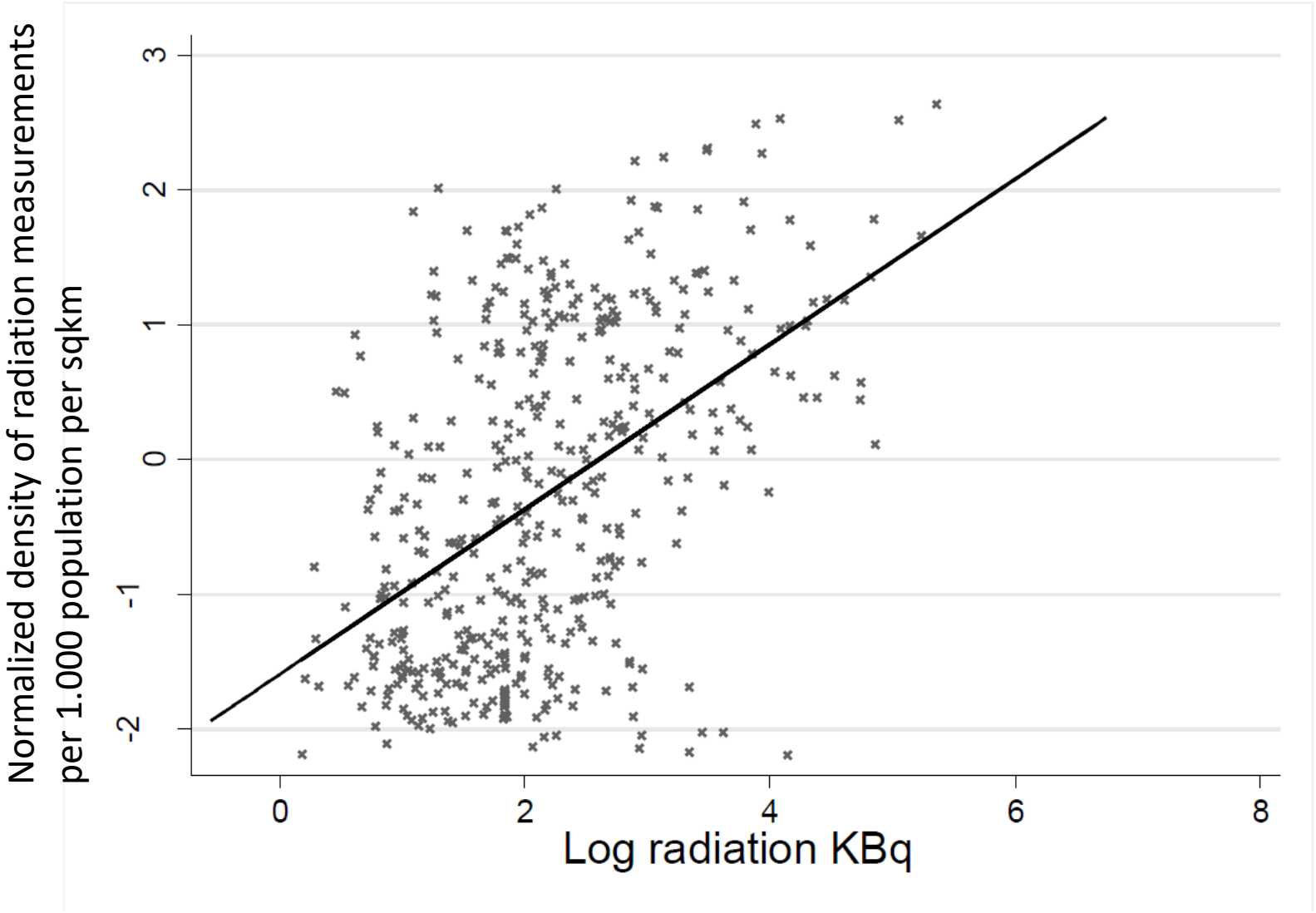
Radiation and disaster signals

- Soviet authorities:
  - Publicly secretive about the accident (scale and danger)
  - Initiated serious counter-measures, for example.
    - distribution of more than 6 mio. doses of Iodine prophylaxis
    - screening of population (dosimetric measurements, blood tests, etc.)
    - Food screening, medical registries

- Countermeasures
  - were regionally concentrated in areas with high radiation
  - signalled the population their level of radiation exposure

- Contradictive information created room for rumours on the possible consequences and generated intense stress and fear (Rahu 2003)

Radiation and disaster signals



Source: Data compiled from European Commission (1998).

Interpretation

- Our results will capture the effect of the disaster on mental health, and not the effect of radiation on mental health
- In line with the medical literature suggesting that low dose radiation cannot cause neural or brain damage (UNSCEAR 2000, 2008)
- Radiation in the low-exposure sample was too low to change health status → all findings suggest mental state of health (= worries)
- As high- and low-affected regions did not differ significantly before the disaster (education, migration, earnings, demographic composition), all long-run differences can be attributed to Chernobyl
  - random assignment of regional exposure to disaster)

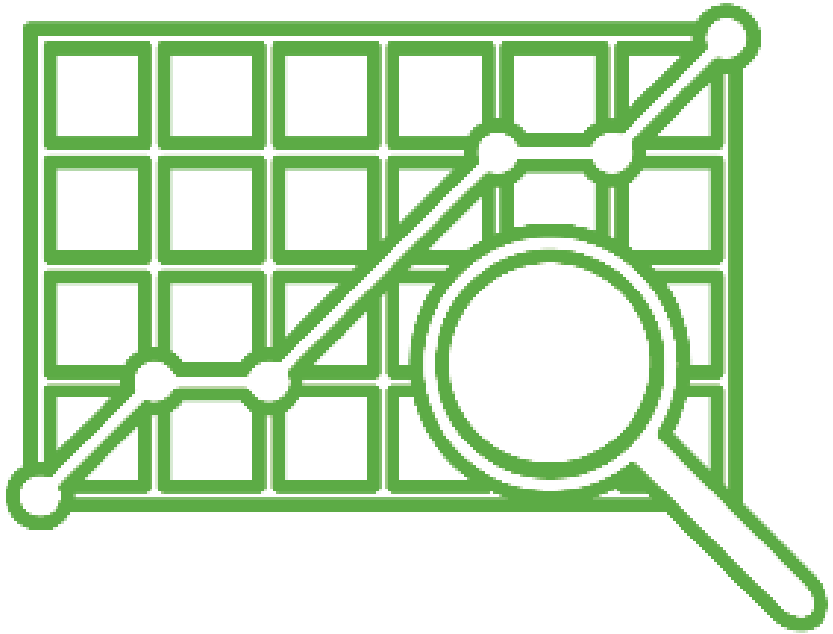
Approach

- Link data sources
  - Official **regional radiation data** following the accident in 1986 (Baloga V. I. et al. (2006), National Report of Ukraine, Kiev, Atika.)
  - Individual level, nationally representative data for 2003-2007
    - **Subjective well-being**: Ukrainian Longit. Monitoring Survey
    - 11,922 person-year observations
    - Crucial: information on place of residence in 1986
    - **Mental health:** Ukrainian Household Budget Survey

- Estimate the long-run effect of the disaster, expressed in units of natural background radiation (2 mSv = uncritical and subclinical dose)

- Idea: Compare outcomes of persons with similar characteristics (e.g., age, gender, education, household characteristics) who were more or less exposed to the disaster by coincidence

Results



1. Subjective well-being

Life satisfaction:

To what extent are you satisfied with your life in general at the present time (UMLS data)?

1 Very dissatisfied
2 Dissatisfied
3 Neutral
4 Satisfied
5 Very dissatisfied

Effect on life satisfaction

Fig. 1. Cumulative distribution of life satisfaction. Source: Conditional distribution, controlling for age and time fixed effect, ULMS 2003–2007, number of observations: 11,922; own calculations.

Effect on life satisfaction

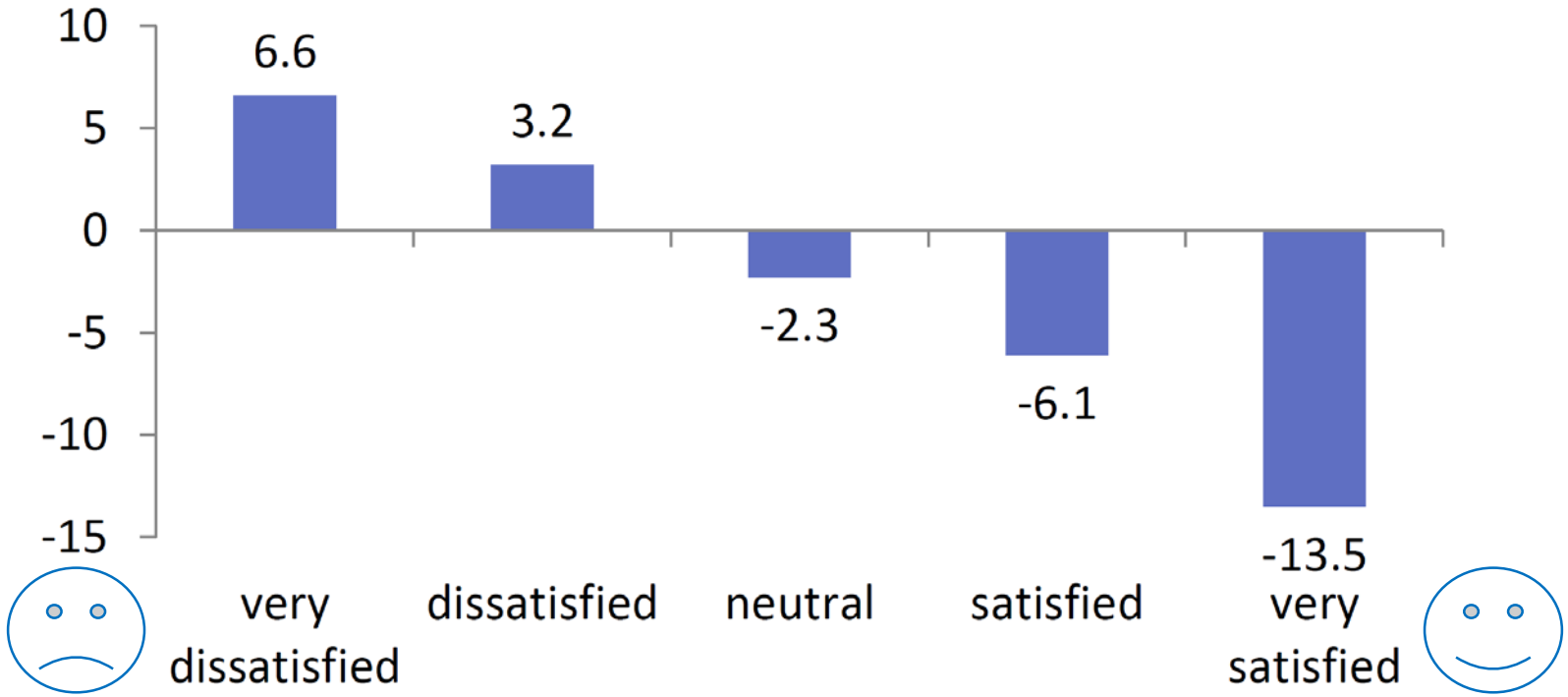


Fig. 2. Long-run effects of the disaster on life satisfaction (in %-points)

Notes: Graphical representation of marginal effects on the probability to report one out of five possible answer categories in the life satisfaction survey. All five marginal effects are highly significant (1%-significance level; clustered standard errors). The results are based on ordered probit estimates which control for age, education, labor market participation, marital status, health stats, risky behavior (smoking, alcohol consumption), household size, household income, size of appartment per person, type of place of residence, oblasts and years. Source: ULMS, own calculations.

2. Mental health and worries

Mental health diagnosis:

Have you been diagnosed for six months or longer with depression or anxiety (UHBS data)?

Yes or No

Worries/Subjective survival probability:

What is the probability that you will survive until age „X“?

X= 65 for respondents aged 46-55
X= 70 for respondents aged 56-60
X= 75 for respondents aged 61-65
X= 80 for respondents above 66 (up to age 72)

Effect on mental health

Table 1. The long-run effect of the disaster on …

1. depression or anxiety disorders	1.7***
	(0.2)
2. subjective surival probability	-7.5***
to cut-off age	(2.7)

Notes: The values reflect the estimated effect (in %-points) of on additional radiation dose equivalent to a dose of natural background radiation (2 mSv) on the incidence of depression and the subjectively assessed survival probability. The estimates are based on regression analyses which keep age, education, labor market participation, marital status, health stats, risky behavior (smoking, alcohol consumption), household size, household income, size of appartment per person, type of place of residence, oblasts and years constant. Standard errors are reported in parentheses. *** indicates statistical significance at the 1% level. Source: ULMS, own calculations.

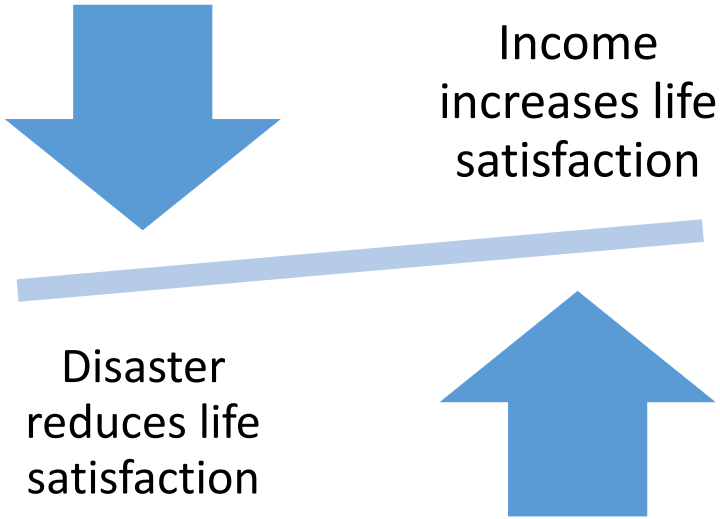
Summary of individual effects

- Strong and persistent negative effects on well-being and mental health
- Results do not differ by gender or age
- Individuals living in more strongly exposed areas seem to worry more about their future (lower subjective life expectancy)

What are the implications for aggregate welfare in Ukraine?

Can we quantify the damage?

- Newer life satisfaction literature (Clark and Oswald 2002; Frey et al. 2010; Levinson 2012; Lüchinger 2009; Lüchinger and Raschky 2009; van Praag and Baarsma 2005; Winkelmann and Winkelmann 1998) suggests the following thought experiment:



- Can use these two relationships to compute the income equivalent of the disaster effect (income necessary to „compensate“ individuals)

Monetary equivalent

Table 2. Monetary evaluation of the aggregated welfare loss

	Size of the relevant population group (in mio.)	Estimated monthly compensation payment per household (in US$)	Aggregate share in annual GDP
Scenario 1: Compensation of entire population	38.1	13.5 – 25.5	2.2% – 4.2%
Scenario 2: Compensation of more affected population (> 0.8 mSv)	20.8	61.0 – 147.9	2.4% – 5.5%

Notes: Average household size: 3.4 persons. Exchange rate: 1 UAH = 0.18192 USD. The average monthly household income is 446.4 USD.

Summary of aggregate effects

- The disaster had high implicit costs, which are internalized by the population
- Estimates of these implicit costs range between 2.2% - 5.5% of Ukraine‘s annual GDP
- Additional implicit costs: Affected working-age individuals are more dependent on governmental social transfers (benefit take-up goes up by 4%-points)

Outlook on preferences

- In follow-up research of the long-run consequences of the Chernobyl disaster we find that individuals also changed their preferences
  - **Willingness to take risks** (important for investments and education): less willing to take risks
  - **Time discounting** (important for savings and inter-temporal choices): less future-oriented/patient, less savings
  - **The political and economic system**: less market-oriented, more Soviet type strong government

Conclusions

- Nuclear disaster of Chernobyl has long-term consequences that are
  - not financially compensated
  - externalized to the population in the form of poor mental health
  - of similar size as the overall annual spending of Ukraine‘s government on clean-up, recovery work, compensation payments

- Mental health crucial for productivity & economic growth (WHO 2013)

- Implications for public policy
  - Nuclear disasters entail large implicit costs (cost-benefit assessment)
  - Reliable information and risk communication in the aftermath of disasters is important (Rubin et al 2011)
  - Prompt post-disaster mental health interventions can reduce psychological morbidity

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Appendix

Table 1
Descriptive statistics of areas with above vs. below median radiation.

	Above radiation median	Below radiation median	Difference	S.E.	T-stat
Radiation (in natural background units)	0.704	0.243	0.461	0.091	5.1***
Life satisfaction	2.561	2.627	−0.066	0.021	−3.1***
Male	0.373	0.429	−0.056	0.046	−1.24
Age‡	45.702	45.618	0.084	0.102	0.83
Height	167.525	167.874	−0.349	0.744	−0.47
Years of schooling	11.937	11.852	0.085	0.071	1.19
Married	0.731	0.682	0.049	0.041	1.21
Widowed	0.088	0.087	0.001	0.007	0.16
Separated	0.076	0.102	−0.026	0.027	−0.99
Unemployed	0.068	0.070	−0.002	0.015	−0.16
Pensioner	0.243	0.244	−0.001	0.008	−0.17
Inactive	0.153	0.154	−0.000	0.021	−0.01
Chronic disease	0.581	0.545	0.036	0.025	1.44
Drink alcohol	0.453	0.466	0.024	0.027	0.93
Smoking	0.272	0.303	−0.031	0.025	−1.25
Household size	3.402	3.324	0.078	0.082	0.95
Log(income)	6.552	6.496	0.056	0.043	1.31
Log(living space pc)	2.356	2.230	0.126	0.104	1.21
Rural	0.341	0.337	0.004	0.005	0.89

Note: Number of observations: 19,222. The two groups have been balanced by age and region, as differences in the age composition of regions existed prior to the Chernobyl disaster. The difference of the mean comparison is the β_1 from the following OLS regression: $Y = \beta_0 + \beta_1 \text{abovemediandose} + \sum \beta_a \text{age}_a + \tau_k + \varepsilon$, where age_a are age dummies. Robust standard errors clustered by region of radiation in parentheses. ‡The means comparison of age is balanced only on regions. *** $p<0.01$. Source: ULMS 2003-2007; own calculations.

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