A DUAL-CONTOUR MODEL OF INVESTMENT-DRIVEN RECOVERY OF UKRAINE'S REGIONAL HOUSING MARKETS

UNDER SECURITY ASYMMETRY

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Uneven destruction, uneven recovery capacity

$176.1 bn

Total direct damage all sectors

as of 31 Dec 2024

$523.6 bn

Total recovery needs

all sectors

$83.7 bn

Housing recovery needs

2025–2035 estimate

Recovery needs

Housing reconstruction needs are concentrated in regions exposed to elevated security risks.

Investment-construction capacity

Observed investment and construction activity is unevenly distributed across regions.

Analytical problem: spatial mismatch between housing reconstruction needs and observed regional investment-construction activity.

Research objective and scientific contribution

Where do normalized housing recovery needs exceed investment-construction activity scores – and where does the reverse occur?

01

Develop an integrated system of normalized regional indices.

02

Identify two directions of structural mismatch.

03

Distinguish four states of regional housing markets.

Unit of analysis: 24 oblasts of Ukraine; Kyiv city is excluded for comparability of regional datasets.

Index architecture and measurement logic

SDI Normalized direct physical destruction

$$SDI = min–max(D)$$

HNI Normalized housing reconstruction needs (2025–2035)

$$HNI = min–max(N)$$

ICI Investment-construction activity proxy (2024; equal weights)

$$ICI = (zX_1 + zX_2 + zX_4 + zX_5) / 4$$

IRG Direction of the relative structural mismatch

$$IRG = HNI - ICI$$

All scores are dimensionless; normalization compares relative positions and does not equate monetary needs with actual funding.

ICI components: X_1 – residential commissioning per 1,000 inhabitants; X_2 – construction scale; X_4 – residential construction activity; X_5 – total regional capital investment (not housing-specific financing).

Two complementary recovery contours

$$IRG = HNI - ICI$$

CONTOUR I IRG > 0

Normalized recovery needs (HNI) exceed the investment-construction activity score (ICI).

Priority: reconstruction feasibility and risk sharing

CONTOUR II IRG < 0

The normalized ICI exceeds the recovery-needs score (HNI).

Priority: private investment and housing market development

The sign of IRG describes a relative structural configuration — not a monetary deficit, surplus, or causal effect.

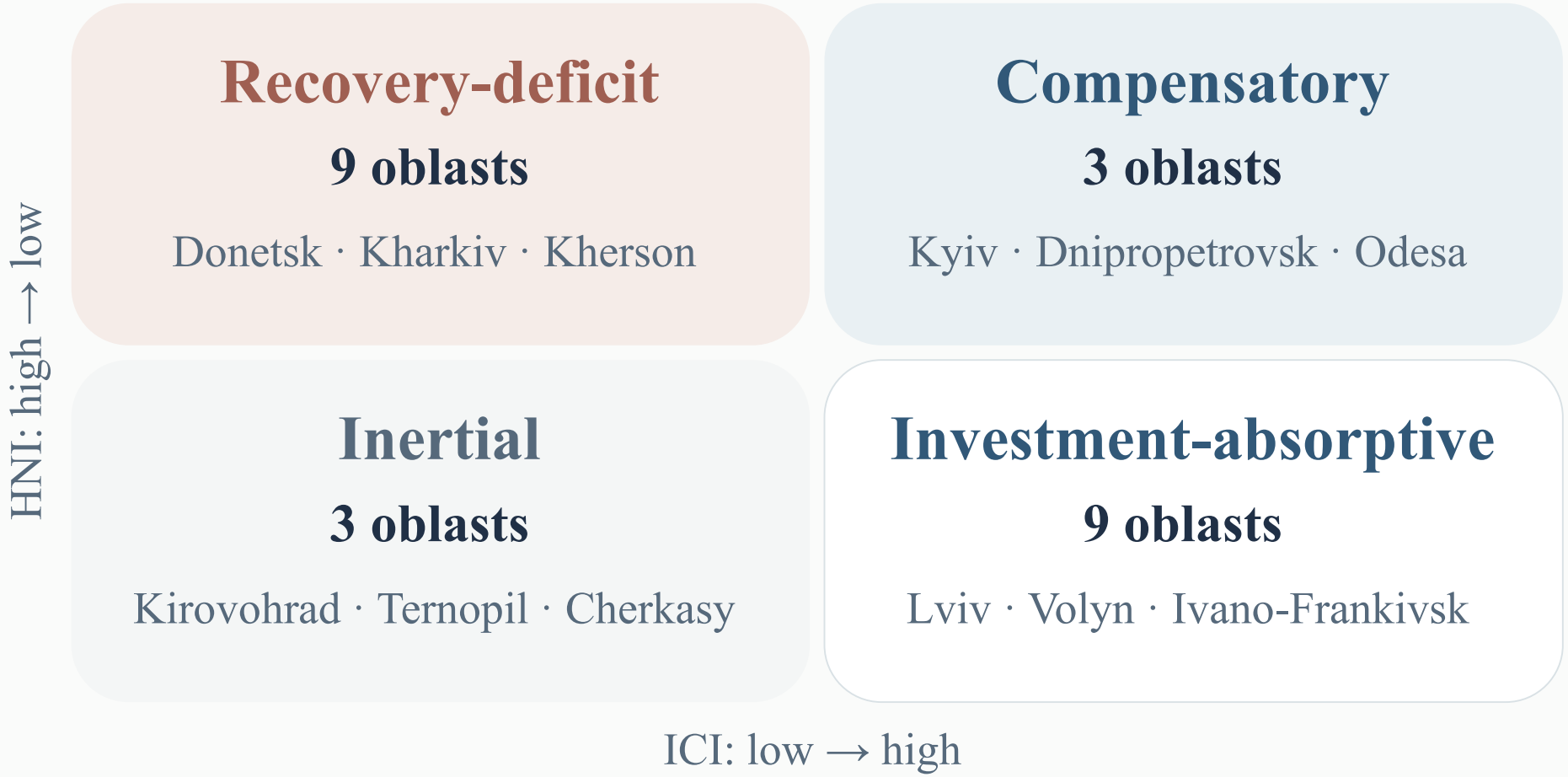
The structural gap across all 24 oblasts

Ordered IRG values · terracotta = Contour I (IRG > 0) · blue = Contour II (IRG < 0)



Contour assignment is based on the sign of IRG, not on the quadrant of the HNI × ICI matrix.

The HNI × ICI matrix reveals four regional states



Median cut-offs: HNI = 0.0083; ICI = 0.1624. Matrix state and IRG contour are distinct classifications.
Selected oblasts are shown as examples; state counts cover all 24 oblasts.

Security groups display sharply different profiles

Median HNI, ICI and IRG by RDNA4 security category

Security group	n	HNI median	ICI median	IRG median
Frontline	6	0.1902	0.0393	**+0.1882**
Support	5	0.0021	0.2257	**-0.1991**
Backline	9	0.0013	0.2633	**-0.2585**
Regained control	4	0.0631	0.1323	**-0.0897**

Frontline median HNI is high while median ICI is low; the backline pattern is reversed.

Statistical evidence of security-related differentiation

Kruskal–Wallis test across four security groups

HNI

H = 15.610 p = 0.0014

ICI

H = 11.054 p = 0.0114

IRG

H = 13.975 p = 0.0029

Spearman rank correlations (24 oblasts)

SDI × ICI ρ = −0.414

p = 0.0444 · statistically significant

HNI × ICI ρ = −0.384

p = 0.0637 · not significant at 5%

Interpretation: security categories differ systematically, but correlations do not demonstrate causality.

Robustness: a stable core with sensitivity at the margins

21 / 24
unchanged under rank normalization

6 / 6
frontline oblasts remain in I under rank normalization

3
normalization-sensitive cases

Rank normalization moves Dnipropetrovsk, Sumy and Chernihiv from Contour II to Contour I.

$\rho = 0.942–0.988$
Leave-one-indicator-out ICI agreement

$r(X_2, X_4) = 0.946$
Potential information overlap

Indicator-exclusion tests preserve a five-oblast core. Alternative weights yield $\rho = 0.996$ (Mykolaiv changes contour). The historical 2021–2024 comparison yields $\rho = 0.808$, with 23 of 24 assignments unchanged (Zaporizhzhia changes contour). This does not validate future financing adequacy.

Differentiated instruments for regional housing recovery

CONTOUR / STATE	PRIORITY INSTRUMENTS	EXPECTED DIRECTION
I · Recovery-deficit	Public funding; international assistance; war-risk guarantees	Reconstruction feasibility
II · Recovery-deficit	Targeted grants; project preparation	Address residual reconstruction needs
II · Investment-absorptive	Private investment; mortgages; rental housing	Expand housing supply
II · Compensatory	Blended finance; infrastructure investment	Combine rebuilding with development
II · Inertial	Investment promotion; institutional support	Improve investment conditions

Investment instruments must also be adjusted for security risks, available funding, migration-driven demand and institutional capacity. Contours are defined by IRG; regional states are defined by the HNI × ICI matrix. Policy outcomes are indicative.

Conclusions: from asymmetry to targeted investment policy

01	**Two contours**	6 oblasts with positive IRG; 18 with negative IRG.
02	**Four regional states**	The HNI × ICI matrix differentiates need and capacity beyond a simple frontline/backline split.
03	**Spatially differentiated policy**	Contour I prioritizes public support and risk-sharing instruments, whereas Contour II offers opportunities for private investment and housing market development, subject to regional demand and security conditions.

The model supports preliminary regional prioritization; financing adequacy requires a separate monetary assessment.