



ECONOMISTS
FOR UKRAINE

WORKING PAPER SERIES

WORKING PAPER No. 21

MARCH 2026

REBUILDING UKRAINE'S CITIES: MAXIMIZING BENEFITS AND MINIMIZING COSTS

**Edward L. Glaeser, Martina Kirchberger,
and Andrii Parkhomenko**

This paper was prepared for presentation at the Centre for Economic Policy Research's 1st Economic Policy: Papers on European and Global Issues Conference, December 4-5, 2025, in Paris. We thank Corey Scher and Jamon Van Den Hoek for sharing damage data and Eoghan Darbyshire from the Conflict and Environment Observatory who sourced this data from deepstate.ua; Alona Shmygel for sharing house price data; and Maksym Terzi and Jay Sweitzer-Shalit for excellent research assistance. We also thank Ufuk Akcigit, Simeon Djankov, Yuriy Gorodnichenko, Sebnem Kalemli-Özcan, Margaryta Klymak, and Matthew Turner for helpful comments and suggestions. Thank you also to Harvard University, NBER, Trinity College Dublin, CEPR, University of Southern California and Kyiv School of Economics. Glaeser has received speaking fees from organizations that organize members that invest in real estate markets, including the National Association of Real Estate Investment Managers, the Pension Real Estate Association and the Association for International Real Estate Investors.

The views expressed herein are those of the author(s) and do not necessarily reflect the views of Economists for Ukraine.

Econ4UA working papers are circulated to encourage discussion. They often represent preliminary work and have not been peer-reviewed.

© 2026 by Edward L. Glaeser, Martina Kirchberger, and Andrii Parkhomenko. All rights reserved.

Economists for Ukraine (Econ4UA)

Website: <https://econ4ua.org/> Email: info@econ4ua.org

ABSTRACT

Rebuilding Ukraine's Cities: Maximizing Benefits and Minimizing Costs

This paper discusses the rebuilding of Ukrainian cities. We start by outlining key facts about Ukraine and its cities: (i) the country's population is declining; (ii) there is a shift in demand for housing from east to west; (iii) Kyiv's advantage is growing; (iv) house prices are rising in Kyiv and western cities; (v) Ukraine's cities are slow and congested. We then present a theoretical framework for maximizing the benefits of Ukraine's rebuilding effort to highlight the welfare effects of different allocations of post-war infrastructure. Finally, we consider the cost curve for reconstruction, as determined, in particular, by the cost of materials, labor, the industrial organization of the building industry and public practices in procurement and regulation. We highlight three broad strategies for shifting the cost curve: openness, standardization and investing-in-investing. We conclude by outlining areas for future research.

JEL CLASSIFICATION: F51, H54, O40, R11

KEYWORDS: reconstruction, security, procurement and economic geography

Edward L. Glaeser
Harvard University
NEBR
Cambridge, Massachusetts
eglaeser@harvard.edu

Martina Kirchberger
Trinity College Dublin
CEPR
Dublin, Ireland
martina.kirchberger@tcd.ie

Andrii Parkhomenko
University of Southern California
Kyiv School of Economics
Los Angeles, California and
Kyiv, Ukraine
parkhome@marshall.usc.edu

1. Introduction

How can the post-war rebuilding of Ukraine's cities maximize benefits and minimize costs? Should Ukraine's post-conflict reconstruction follow pre-war regional patterns, or should rebuilding reflect either changes in the demand for space that are reflected in the growth of Kyiv or the shift from east to west? What institutional, material and structural choices shape the reconstruction cost curve? What steps can feasibly be taken to lower those costs?

In Section 2 of this paper, we highlight five facts about Ukraine and its cities before the 2022 full-scale invasion. First, the country's population is declining, largely because of a low fertility rate. The combination of declining population and durable housing implies that Ukraine began the war with an abundance of housing, although that housing may not have been in the more desirable places or of the most desirable quality. Second, the population has been shifting from east to west. The demand for westward space has only risen with the war. The extent to which underlying fundamentals have moved west is a fundamental determinant of the benefits of rebuilding in different places.

Third, the regional advantage of Kyiv appears to be growing. It has added population, while other large cities have shrunk, and its share of GDP has risen even faster than its share of overall population. A central question about rebuilding is whether this growth represents endogenous agglomeration economies, which could justify expanding Kyiv further than its current fundamentals would suggest, or whether the city just has very strong fundamentals, associated with the seat of government and its location. Fourth, housing prices are low in most of the country and most of the housing stock was built before 1990. These facts support the view that the country was essentially overbuilt, at least in 2022. If pre-war city populations reflect durable housing not demand (as in [Glaeser and Gyourko \(2005\)](#)), then the case that reconstruction should not follow pre-war patterns becomes stronger. Also, if pre-war patterns reflect housing supply rather than demand, then failing to rebuild low-demand areas will have profound impacts on future population levels.

Fifth, even before the war, Ukraine's cities were often congested and slow even when the number of drivers was low. These facts suggest that expanding and improving infrastructure, like roads and public transit, may be at least as important as rebuilding housing. This fact motivates our focus in Section 4 on procuring and funding infrastructure.

Section 3 of our paper presents our framework for maximizing the benefits of Ukraine's rebuilding effort. Our framework is regional and focuses on the benefits of building in different places. Our model assumes that there are unobserved local amenities and productivity, which can be inferred from current levels and trends in population, earnings and housing prices. We also assume the possible existence of agglomeration economies, which could potentially explain the strong attraction of Kyiv. However, we do not have enough sources of exogenous variation to identify the magnitude of agglomeration economies in Ukraine.

Kyiv is quite productive but it is unclear if that productivity represents fixed and unobserved location attributes, or agglomeration economies. We can handle this uncertainty by presenting welfare analyses with different assumptions about the strength of agglomeration economies.

We then present welfare analyses associated with different allocations of post-war infrastructure. We focus on the benefits associated with different regional choices holding the level of post-war investment fixed. We are less confident in the ability of our model to determine the appropriate total level of investment.

As we have assumed that consumers differ in their tastes for specific regions, there are equity-efficiency tradeoffs. For example, an additive utilitarian planner would skew reinvestment heavily towards Kyiv and the western regions of Ukraine. A more equity-driven planner would place more reinvestment towards the east to reduce the hardship in that region. Our framework does not consider whether building in the east could deter future aggression against that region, but we recognize that is a possibility.

In Section 4, we turn to the cost curve for reconstruction. We see the cost curve as shaped by four distinct elements: (i) cost of materials and equipment, (ii) cost of labor, (iii) the industrial organization of the building industry and (iv) public practices including both procurement and regulation. We highlight three broad strategies for shifting the cost curve downward (i.e. shifting costs): (1) openness, (2) standardization, and (3) investing-investing (Collier, 2011). Procurement reform and deregulation provide tools for advancing these strategies, as well as alternative channels for either increasing or decreasing costs.

The openness strategy can be applied to most of the different sources of high procurement costs, including labor, materials and firm markups. For example, openness can reduce labor costs by reducing licensing requirements for occupations like plumbing or making it easier for immigrants to come and work in Ukraine's construction industries. Openness could reduce material costs by making it easier to import foreign materials and making it easier to substitute to cheaper materials when they are available. Openness with procurement can mean online procurement platforms, which Ukraine has had since 2016, or lowering the barriers to entry for new firms and foreign firms. In some of the cases (but not all), there is likely to be a cost to openness as well. For example, the skills that Ukrainian workers could gain from working reconstruction projects might be lost if the work is done by non-Ukrainians. Of course, there could also be unexpected benefits from openness. For example, the presence of multinational firms in Ukraine might enable skill spill-overs to Ukrainian workers from exposure to new technology and management practices.

Standardization is also relevant for labor, materials and procurement, and it will interact with industrial organization. More standardized structures and infrastructure will lower design costs and make mass production more plausible. However, mass production will limit

the number of firms that can possibly do the work. Consequently, it might make particular sense to combine a standardization strategy with a strategy for encouraging participation by global producers of mass produced products such as homes. We see particular value in nationwide regulations about structures and standardized rules about land use in the immediate post-conflict settings. Japan's system, which allows only twelve types of land use, provides a particularly interesting model that could make it easier for more firms to bid on more projects.

Our third proposed strategy is investing-in-investing, which means taking steps to lower costs and raise quality before core physical reconstruction begins. This investment can mean investing in workers' skills, such as providing more construction-related vocational training in secondary skills. Investing-in-investing can also mean institutional reform, such as improving procurement practices or land use regulations. Finally, investing-in-investing can even be preparatory physical investments, such as ensuring enough electricity generation to power the reconstruction effort.

We also discuss more general issues around procurement management, including the regulation of the procurement entity, the ease of using the system, and dealing with ex post negotiation. In some cases, such as the regulation of procurement officers, there is a trade-off between fighting corruption (with more regulation) and potentially lowering costs and raising quality (by allowing the use of local knowledge). Ukraine's recent experience with military procurement and purchasing mass-produced drones may also yield lessons going forward.

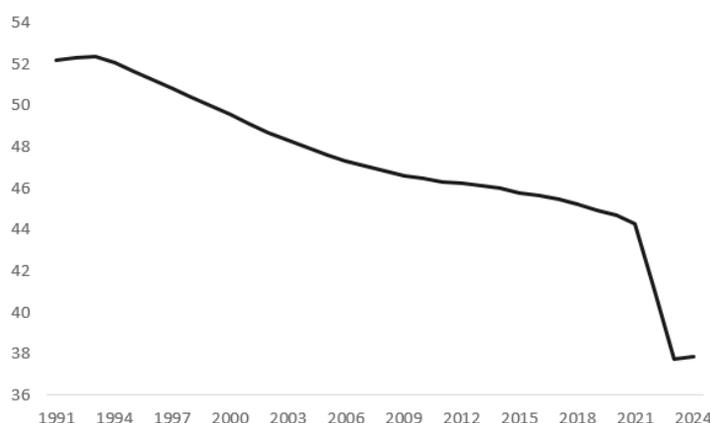
We generally treat the "benefits of reconstruction," which focused on the location of reconstruction, and the "costs of reconstruction" as unrelated objects. They are not. The location of reconstruction will play a role in shaping the costs. In the final part of Section 4, we briefly provide evidence on how procurement efficiency differs by location. Hopefully, future work will be able to look at costs per region more generally and can bring costs and benefits together in a coordinated analysis.

We conclude the paper by sketching a future research agenda around rebuilding. We have tried to focus on two core aspects of reconstruction: where to do it and how to do it more cheaply? Even this analysis raises as many questions as it answers. For example, standardization is a possible strategy, but is it really plausible in the Ukrainian context? We highlight a small number of questions that seem particularly germane to us.

2. Ukraine's Cities before the 2022 Full-Scale Invasion

In this section, we present an overview of long-term demographic and economic changes that Ukraine's urban system was undergoing well before the 2022 full-scale invasion. Five facts are central: (1) population decline, (2) a spatial shift to the West, (3) increasing

Figure 1: Population of Ukraine, mln people



Note: The figure shows population of Ukraine in mln people. Source: World Bank World Development Indicators.

concentration around Kyiv, (4) an old and misallocated housing stock, (5) inadequate urban infrastructure.

Population decline and aging. Ukraine has lost population continuously since the collapse of the Soviet Union in 1991 (Figure 1). The decline reflects low fertility, high mortality, and out-migration. Slow economic and productivity growth have played a major role in the loss of population.¹ Between 1991 and 2021, the population fell by about one-fifth, and most cities shrank. From 1965 and 1990, the total fertility rate for Ukrainian women hovered around two, but the fertility rate dropped from 2.04 to 1.09 between 1988 and 2001. The fertility rate then recovered to a level of 1.53 in 2012, which is still far below the rate needed to maintain population, before dropping again to 1.15 in 2021.²

The World Bank calculates net migration rates at five year intervals, and the latest data was from 2017. In that year and in 2012, net migration was slightly positive (50,000 and 130,000 respectively).³ The United Nations also publishes net migration figures for Ukraine, and these were negative in every year between 2013 and 2023.⁴ Neither source suggests that migration to Ukraine is remotely large enough to offset the fertility deficit.

Low fertility and lack of economic opportunities for working-age Ukrainians have also resulted in a dramatic population aging. The average age has increased from 36.7 years in 1991 to 42.1 years by 2021, and the share of Ukrainians aged 65 and above rose from 12%

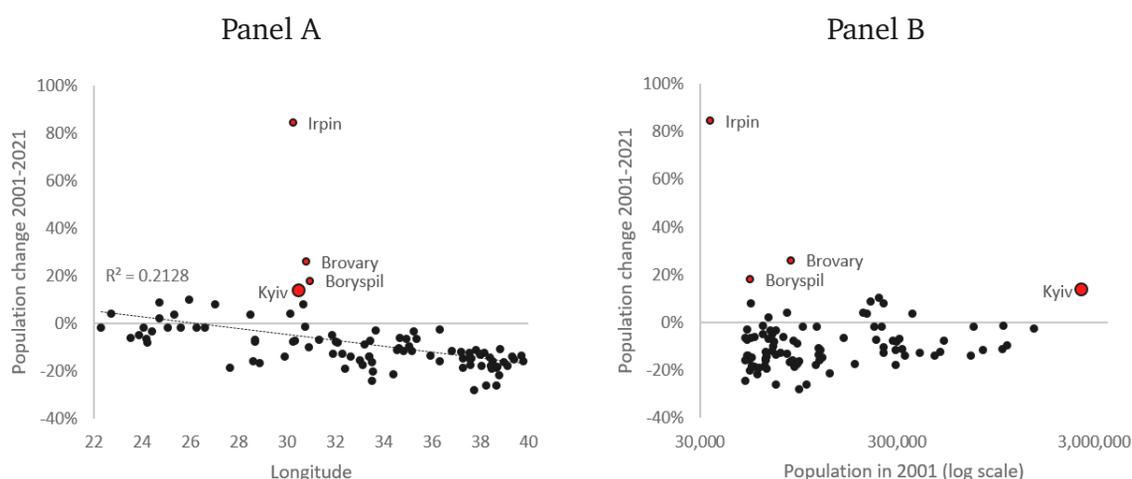
¹Ukraine's real GDP per capita in 2021 was still below the level of 1990, just before the collapse of the Soviet Union, according to the World Bank data. See Akcigit et al. (2025) for an analysis of sluggish productivity growth and the decline of business dynamism in Ukraine.

²World Bank World Development Indicators: <https://fred.stlouisfed.org/series/SPDYNTFRTINUKR>

³World Bank World Development Indicators: <https://fred.stlouisfed.org/series/SMPOPNETMUKR>

⁴<https://data.worldbank.org/indicator/SM.POPNETM?locations=UA>

Figure 2: Population change in Ukraine's cities, 2001–2021



Note: Panel A shows the relationship between a city's longitude and percentage population change from 2001 to 2021 for 95 largest Ukrainian cities. It also reports R^2 from an OLS regression of population change on longitude. Panel B shows the relationship between a city's population in 2001 and percentage population change from 2001 to 2021. Red circles represent Kyiv and its satellite cities. The data was obtained from Ukraine's State Statistical Service.

to 18% during the same period. The employment-to-population ratio fell from 0.58 to 0.49 from 1991 to 2021.⁵ While we will not dwell on the impact that the aging of Ukraine will have on demand for urban space in different parts of the country, we believe that as total population continues falling, the aggregate demand for space will keep shrinking.

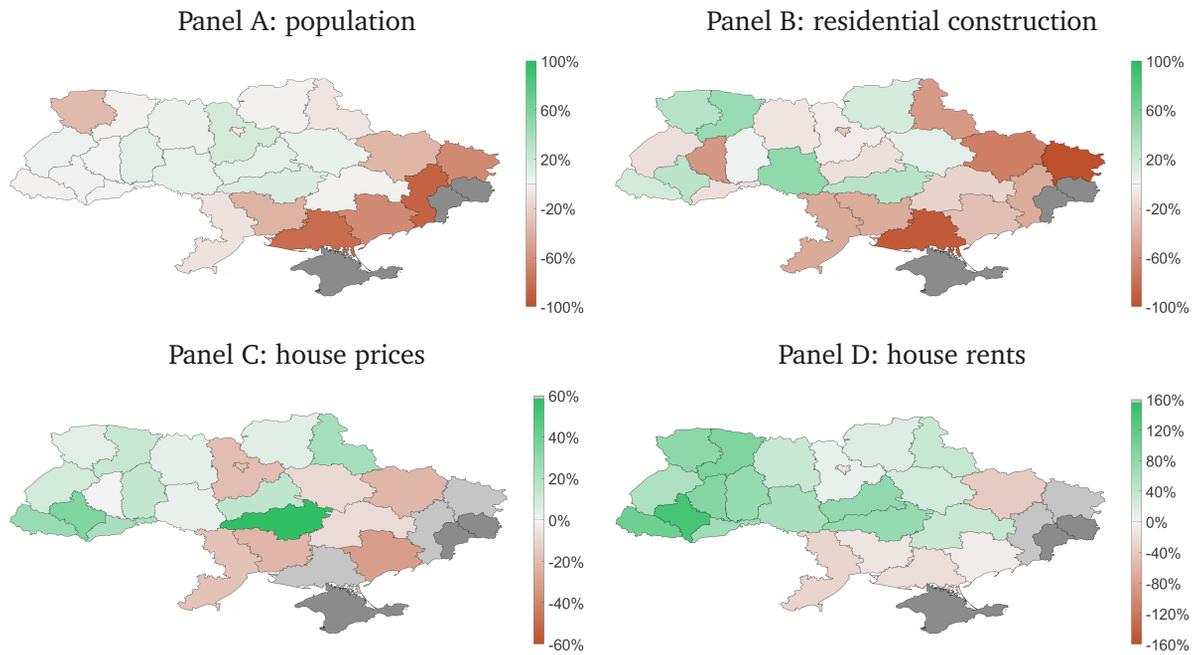
The East-West Shift. The distribution of population has changed in two systematic ways. First, there is a westward shift: cities located further west declined less between 2001 and 2021. As can be seen in Panel A of Figure 2, cities in the west of the country were far more likely to add population than cities elsewhere. Longitude alone explains 21 percent of the variation in population growth across Ukraine's 95 largest cities.⁶ Remarkably, not a single city to the east of Kyiv metropolitan area grew during this period. This pattern is consistent with weaker economic ties with Russia, stronger integration with the EU, and structural change away from heavy industry concentrated in the east. This shift might reflect the possibility that under communism, Ukraine was artificially overbuilt in regions that were closer to Moscow for political or other reasons, or alternatively that conditions changed after 1991 to favor western regions of the country.

The shift to the West accelerated after the full-scale Russian invasion began in 2022, as a large number of individuals and firms fled Eastern and Southern regions toward safer areas in the West, as well as Kyiv. Figure 3 shows how population, house prices, and housing

⁵World Bank World Development Indicators: <https://datacatalog.worldbank.org/search/dataset/0037712>

⁶This is not the result of the 2014 annexation of Crimea and occupation of a part of Donbas. The same regression over the 2001–2013 has an even higher R-squared.

Figure 3: Changes in population, construction, house prices and rents, 2021–2024



Note: The maps show percentage changes in population (panel A), construction (panel B), house prices (panel C), and rents (panel D) by oblast from 2021 to 2024. Population, construction, and rent data are from the State Statistical Service at the oblast level. Construction refers to the quantity of square meters of new housing built in a given year. House prices are average house prices in U.S. dollars from LUN real estate agency; the data is missing for Kherson, Donetsk, and Luhansk oblasts (shown in light gray in panel C). House rents are average rents for a one-bedroom apartment; the data is missing for Donetsk, and Luhansk oblasts (shown in light gray in panel D). Territories occupied by Russia before February 2022 are shaded gray.

supply changed between 2021 and 2024. While there is regional heterogeneity in these outcomes, it is apparent that the distribution of population has moved away from East and South, and changes in house prices and housing supply reflected this movement.

Agglomeration Economies in Kyiv. While Ukraine’s population fell by 14% from 2002 to 2021, Kyiv’s population grew by 7%. Its share of the national population rose from 9.2% to 11.5%. Moreover, Kyiv is the only large city whose population grew before 2022, as can be seen in Panel B of Figure 2.⁷ Its share in Ukrainian GDP grew from 21% to 30% between 2002 and 2021 (Green et al., 2022). GDP per capita in Kyiv is roughly four times the national average. Living standards in the capital are comparable to middle-income European countries, while most of Ukraine remains much poorer.

This pattern is typical in post-Soviet countries. The planned nature of the Soviet economy allowed the population to be artificially decentralized, and internal passports made it difficult to move to big cities like Moscow or Kyiv.⁸ Decentralization served at least two political

⁷The four fastest growing cities were Kyiv, and its three satellite cities: Irpin, Brovary, and Boryspil.

⁸The Soviet Union ran a registration system similar to the hukou system in China. It was extremely difficult for residents of rural areas and smaller cities to move to large cities.

goals. Large cities have often posed risks for regimes because they make coordination opposition easier (Ades and Glaeser, 1995). This coordinating capacity appeared in 1991 when Boris Yeltsin appeared at the head of the Moscow demonstrations that stopped a military coup. Dispersed populations may have also served a regime goal of creating spatial equity. As market forces took over in the early 1990s, rapid centralization took place, reflecting the far greater opportunity in places like Kyiv. The limits of the Soviet era transportation infrastructure may have meant that the returns to co-locating in a single city were particularly large. The consumption advantages of locating in Kyiv may have also been high, given the lack of amenities in lower density parts of Ukraine, especially for the young and single. An important question for our simulations is whether the attraction of Kyiv largely represents exogenous forces or endogenous agglomeration economies. If the attraction of the city is exogenous, then optimal rebuilding will respond to that attraction but it will not add to that attraction. If the attraction represents endogenous factors, then that increases the case for building Kyiv up. Of course, the relevant question is the agglomeration on the margin (Glaeser and Gottlieb, 2009), and so even if there were substantial positive agglomeration effects at lower population levels, it is at least possible that at the margin extra population reduces welfare because of congestion forces, such as travel delays.

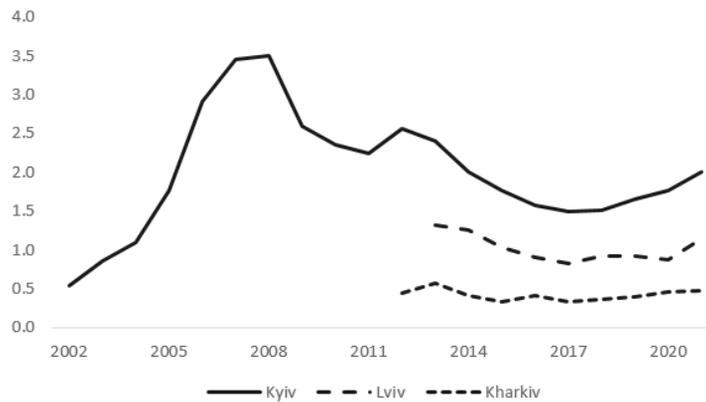
Housing. Ukraine's population decline means that housing in much of Ukraine is old and generally affordable. Across the country as a whole, about 90% of units were built before 1990. In shrinking cities, housing is abundant and affordability is not a major concern. In essence, these cities are in the same position as the declining rust belt cities highlighted by Glaeser and Gyourko (2005) in which populations are propped up because the structures remain even after the economic rationale of the city has disappeared.

By contrast, Kyiv and a few western cities face housing shortages due to the robust demand that generates population inflows. About one-third of new construction in Ukraine occurs in Kyiv. Moreover, prices in Kyiv remain high in relative terms, though they have not recovered to pre-Global Financial Crisis levels (Figure 4).

This asymmetry between Kyiv and the shrinking cities relates to reconstruction and future city growth. Davis and Weinstein (2002) famously found that Japanese cities returned to pre-war trajectories regardless of the extent of destruction during World War II.⁹ But that occurred amidst massive urban growth in post-war Japan. We suspect that the level of destruction will have permanent effects on eastern Ukrainian cities, especially if those cities are not rebuilt, because the demand for space in those cities is below their cost of supplying space. This asymmetry between growing and declining places will play a role in

⁹A more recent study by Takeda and Yamagishi (2024) finds that the *within*-city structure of Hiroshima was also preserved and persisted after 1945, despite total destruction of the city center by the atomic bombing.

Figure 4: Average house prices, thousand US dollars per sq. meter



Note: The figure shows average house prices in thousand US dollars per square meter for Kyiv, Lviv, and Kharkiv. Source: LUN real estate agency.

our assessment of the returns to building in different parts of Ukraine.

Urban mobility. Infrastructure is largely inherited from the Soviet period and has not adjusted to modern conditions. Transportation provides a key example. In 1983, car ownership in the Soviet Union was 32 per 1,000 people; by 2020, Ukraine had 245 per 1,000. Limited state capacity and a poor fiscal situation meant that there was no equivalent increase in road capacity. The improvements in public transit have also been moderate at best. As a result, based on the evidence from Akbar et al. (2023), even shrinking Ukrainian cities are highly congested (Table 1).¹⁰ The rise in car ownership more than offsets the decline in the total number of residents. Notably, Kyiv and Lviv are the 36th and 41st most congested cities in the world, despite not being even among the 100 largest cities by population.

Table 1 also shows that Ukraine's cities score quite poorly on uncongested speed as well, which means speeds late at night. The standard interpretation of low uncongested speeds is that the roads are rough. We will not focus on road maintenance in either of the subsequent sections, but it is particularly important. It is also possible that road roughness may represent problematic procurement, and if so, then this data suggests that there is scope for improvement in ensuring the quality of road procurement. Another reason is that large Ukrainian cities lack major thoroughfares and limited-access highways.

We take this data to suggest that outside of Kyiv the larger need may be public infrastructure not housing. The model that follows will include both forms of investment, although we will typically think of housing construction as private. Consequently, much of our regional discussion will focus on where to put the public investment in infrastructure, and not where

¹⁰We thank Victor Couture for producing this table.

Table 1: Ranking of Ukrainian cities by speed, congestion, and uncongested speed

| Speed rank | | | Congestion rank | | | Uncongested speed rank | | |
|------------|--------|--------------|-----------------|--------|--------------|------------------------|--------|--------------|
| Ukraine | Global | City | Ukraine | Global | City | Ukraine | Global | City |
| 1 | 321 | Donetsk | 1 | 36 | Kyiv | 1 | 376 | Zaporizhzhya |
| 2 | 344 | Zaporizhzhya | 2 | 41 | Lviv | 2 | 413 | Donetsk |
| 3 | 358 | Luhansk | 3 | 86 | Odesa | 3 | 428 | Luhansk |
| 4 | 380 | Kryvyi Rih | 4 | 99 | Simferopol | 4 | 442 | Mariupol |
| 5 | 381 | Mariupol | 5 | 200 | Sevastopol | 5 | 505 | Kyiv |
| 6 | 536 | Mykolaiv | 6 | 294 | Kharkiv | 6 | 519 | Vinnytsa |
| 7 | 549 | Vinnytsa | 7 | 361 | Vinnytsa | 7 | 520 | Kryvyi Rih |
| 8 | 558 | Dnipro | 8 | 434 | Dnipro | 8 | 524 | Kharkiv |
| 9 | 583 | Kharkiv | 9 | 493 | Mykolaiv | 9 | 531 | Simferopol |
| 10 | 686 | Sevastopol | 10 | 620 | Zaporizhzhya | 10 | 550 | Dnipro |
| 11 | 703 | Simferopol | 11 | 723 | Mariupol | 11 | 558 | Mykolaiv |
| 12 | 780 | Kyiv | 12 | 783 | Luhansk | 12 | 589 | Sevastopol |
| 13 | 809 | Odesa | 13 | 880 | Donetsk | 13 | 640 | Odesa |
| 14 | 911 | Lviv | 14 | 963 | Kryvyi Rih | 14 | 692 | Lviv |

Note: The table shows speed, congestion, and uncongested speed indices estimated by Akbar et al. (2023) for the Ukrainian cities in their sample.

to put the houses. But given that there will surely be public investment in housing, it seems appropriate to also think about the relative amounts of both types of building.

3. Optimal Allocation of Rebuilding Resources

3.1. Model

This section presents a spatial equilibrium model of Ukraine that we use to study the optimal spatial allocation of reconstruction investment. It starts with a standard Rosen-Roback model, although individuals will have idiosyncratic tastes for specific locations. The economy evolves over time as a sequence of static spatial equilibria, and time subscripts are omitted unless necessary. The housing stock is a state variable that evolves over time. Infrastructure is treated as exogenous before rebuilding and the key reconstruction choice of the social planner.

Regions. There are I regions in Ukraine, indexed by $i \in \{1, \dots, I\}$, as well as an outside location that represents other countries.

Individuals and consumption. There is a fixed number N of workers that are identical other than their preferences for places. N_U of them live in Ukraine and N_O outside of Ukraine. They live for one period and make two types of choices. First, they choose where to live. Then, they choose how much to consume.

Workers consume two types of goods: traded consumption good c (numeraire) and housing h . They also enjoy the local amenity X_i . The utility function is Cobb-Douglas:¹¹

$$u_i(c, h) = c^{1-\gamma} h^\gamma X_i.$$

A household who lives in region i solves

$$\max_{c, h} u_i(c, h) \quad \text{s.t.} \quad w_i = p_i h + c,$$

where w_i and p_i are the wage and the cost of housing in location i . Optimal consumption choices are

$$h_i = \frac{\gamma w_i}{p_i} \quad \text{and} \quad c_i = (1-\gamma)w_i,$$

and the indirect utility function is

$$v_i(w_i, p_i) = (1-\gamma)^{1-\gamma} \gamma^\gamma w_i p_i^{-\gamma} X_i.$$

Location choice. Prior to choosing consumption, workers decide where to live in two stages. First, they draw a preference shock for living in Ukraine versus abroad, and choose whether to live in Ukraine. Second, if they have chosen to live in Ukraine, they draw a vector of preference shocks for each region and choose the region of residence. The utility of individual n from living in region i in Ukraine is given by

$$V_{in}(w_i, p_i) = v_i(w_i, p_i) \xi_{in} \psi_{Un},$$

where ξ_{in} is the preference shock for living in region i and ψ_{Un} is the preference shock for living in Ukraine versus abroad. We assume that the region and country shocks are i.i.d. and drawn from Fréchet distributions with shape parameters ϵ and σ , respectively. The utility of living abroad is represented by reservation utility \bar{V} .

Optimal location choices imply that the equilibrium population of region i is

$$N_i = \frac{v_i(w_i, p_i)^\epsilon}{\sum_i v_i(w_i, p_i)^\epsilon} \times N_U, \quad (1)$$

and the population of Ukraine is

$$N_U = \frac{V_U^\sigma}{V_U^\sigma + \bar{V}^\sigma} \times N, \quad (2)$$

¹¹In Appendix Table B.1, we explore the sensitivity of our results to assuming a minimum housing consumption requirement (Stone-Geary utility function).

where

$$V_U \equiv \Gamma\left(\frac{\epsilon-1}{\epsilon}\right) \left(\sum_i v_i(w_i, p_i)^\epsilon\right)^{1/\epsilon}$$

is the expected utility of living in Ukraine and is also our measure of aggregate welfare, and $\Gamma(\cdot)$ is the Gamma function.

Infrastructure and amenities. Local amenities are characterized as

$$X_i = \bar{X}_i I_i^c N_i^\rho, \quad (3)$$

where \bar{X}_i is an exogenous component and I_i^c represents immobile consumer-related infrastructure (e.g., transit, schools, medical facilities). Parameter ρ captures the relationship between population and amenities.

Production of the traded good. There is a representative firm in each region that produces the numeraire good with production technology

$$Y_i = A_i N_i^\alpha K_i^{1-\alpha},$$

where A_i is local total factor productivity (TFP) and K_i is capital. The TFP is specified as

$$A_i = \bar{A}_i I_i^p N_i^\lambda, \quad (4)$$

where λ represents productive externalities, \bar{A}_i is an exogenous term, and I_i^p stands for immobile producer-related infrastructure (e.g., quality of transportation, reliability of electricity).

We assume that, unlike infrastructure, production capital K_i is fully mobile and the rental rate of capital is the same across regions: $r_i = r$ for all i . Moreover, we treat Ukraine as a small open economy. As a result, the cost of capital is given exogenously. Profit maximization then implies that the equilibrium wage is

$$w_i = \alpha A_i^{\frac{1}{\alpha}} \left(\frac{1-\alpha}{r}\right)^{\frac{1-\alpha}{\alpha}}. \quad (5)$$

Housing. Housing supply is characterized by

$$p_i = \chi_i H_i^{1/\zeta}, \quad (6)$$

where χ_i is an exogenous term (e.g., construction costs), H_i is housing supply, and ζ is the price elasticity of housing supply.¹² The equilibrium house price is therefore equal to

$$p_{it} = \chi_i^{\frac{\zeta}{1+\zeta}} (\gamma w_{it} N_{it})^{\frac{1}{1+\zeta}}. \quad (7)$$

Equilibrium. An equilibrium consists of the population N_{it} of each region and the population of Ukraine N_{Ut} , productivity w_{it} , amenities X_{it} , wages w_{it} , and housing rents p_{it} , such that equations (1), (2), (3), (4), (5), and (7) are satisfied.

3.2. Quantification of the Model

Next we build a quantitative model of Ukraine for year 2021. Regions correspond to oblasts, plus the city of Kyiv. We exclude parts of Ukraine that were occupied as of 2021, i.e., Crimea and parts of Donbas, as can be seen in the maps in Figure 5 and other figures that follow. Table 2 summarizes nationwide parameter values.

Local house prices. As a measure of house prices, we use average listed house prices per square meter from the real estate agency LUN for each oblast capital city. Since our model is at the oblast level, we assume that prices in the rest of the oblast are the same as in the oblast capital. We do not have prices for Kherson and Luhansk regions in 2021 and we predict prices there using the data from other regions.¹³

Model calibration and inversion. We do not have enough sources of exogenous variation in order to identify the magnitude of agglomeration economies in Ukraine, hence we use the productive agglomeration elasticity $\lambda = 0.05$ from the meta-analysis by Ahlfeldt and Pietrostefani (2019). This study also looked at the elasticity of various types of amenities with respect to density and found a wide range of effects from negative to positive. Thus, in our baseline model we use $\rho = 0$. In Appendix Table B.1, we examine the sensitivity of our results to different values of λ and ρ . We find that higher values of agglomeration parameters amplify welfare losses as productivity and amenities deteriorate more when people leave Ukraine.

Labor share in the production function is set to 0.56, which corresponds to the share of labor compensation in Ukraine's GDP from Penn World Tables.¹⁴ The interest rate r is set

¹²This is a standard functional form in the literature. It can be microfounded by profit-maximizing choices of a developer who operates a decreasing returns to scale production function using capital only. In our quantitative model, we abstract from profit redistribution.

¹³In particular, we estimate $\ln p_i = \beta_0 + \beta_1 \ln pop_i + \beta_2 \ln w_i + \varepsilon_i$, where p_i are observed prices, pop_i is the population of the oblast capital, and w_i is the average wage in the oblast. This regression has an R-squared of 0.62. Then, for the two oblasts with no data, we predict prices as $\hat{p}_i = \exp(\hat{\beta}_0 + \hat{\beta}_1 \ln pop_i + \hat{\beta}_2 \ln w_i)$.

¹⁴Penn World Tables version 11.0. Accessed on November 16, 2025.

Table 2: Model parameters

| Parameter | Description | Value | Target or source |
|------------|------------------------------------|-------|--|
| λ | productive externality | 0.05 | Ahlfeldt and Pietrostefani (2019) |
| ρ | amenity externality | 0 | Ahlfeldt and Pietrostefani (2019) |
| α | labor share in production | 0.56 | Penn World Tables |
| r | interest rate | 0.036 | World Bank |
| γ | housing preference term | 0.24 | Davis and Ortalo-Magné (2011) |
| ζ | housing supply elasticity | 1.75 | Saiz (2010) |
| σ | Fréchet elasticity, country choice | 3.08 | change in Ukraine's population 2021–2024 |
| ϵ | Fréchet elasticity, city choice | 3.46 | elasticity of oblast population to damages |

Note: The table describes model parameters. See the text for more details.

to 0.036 which is the real interest rate in Ukraine in 2020, according to the World Bank.¹⁵

Due to the absence of reliable estimates for Ukraine, we take the housing consumption share in the U.S. of 0.24 from Davis and Ortalo-Magné (2011). We also take the U.S. housing supply elasticity of 1.75 from Saiz (2010).

The Fréchet shape parameter σ determines idiosyncratic preferences to live in Ukraine vs abroad, and we calibrate it to match the observed change in total population between 2021 and 2024. The Fréchet shape parameter ϵ determines idiosyncratic preferences to live in a particular oblast in Ukraine, and we calibrate it to match the elasticity of local population changes to wartime damages (described below). We obtain $\sigma = 3.08$ and $\epsilon = 3.46$. This means that idiosyncratic preferences for living in Ukraine versus abroad are stronger than the preferences to live in a particular region.

We assume that the total population of Ukraine and the outside location is 50 million (roughly, Ukraine's population in 1991, after which it kept falling for reasons described in Section 2) and calibrate the reservation utility \bar{V} to match Ukraine's population in 2021.

Recall that we use a Cobb-Douglas utility function. However, it is also reasonable to assume that there is a minimum housing consumption requirement. In Appendix Table B.1, we show that our results barely change if we use a Stone-Geary utility function where the minimum consumption requirement is equal to 1/4 of the average housing consumption in Ukraine in the 2021 calibration.

Local exogenous productivity and amenity terms, \bar{A}_i and \bar{X}_i , cannot be separately identified from producer infrastructure I_i^D and consumer infrastructure I_i^C , respectively; see equations (3) and (4). This will not be important since in the war scenario we will consider a *pro-*

¹⁵Source: <https://data.worldbank.org/indicator/FR.INR.RINR?locations=UA>, accessed on November 16, 2025.

Figure 5: Percentage of damaged or destroyed structures



Note: The maps show the percentage of damaged and destroyed structures in each oblast based on [Scher and Van Den Hoek \(2025\)](#) estimates. Territories occupied by Russia before February 2022 are shaded gray.

proportional reduction in the quantity of infrastructure, and in the optimal policy exercise we will consider a *proportional* increase in the quantity of infrastructure. Thus it is sufficient to identify products $\bar{A}_i I_i^p$ and $\bar{X}_i I_i^c$. These and other local parameters are obtained by inverting the model. We describe model inversion in Appendix Section A. Appendix Figure B.1 shows some region-specific parameter values and variables.

3.3. The Effect of the War on the Spatial Equilibrium

Modeling the war. The Russia-Ukraine war can be divided into two stages: 2014–2022 and 2022 to the present. With the annexation of Crimea in 2014 and the conflict in Donbas that began in the same year, Ukraine lost a part of the territory but the conflict was localized and the functional border was more or less stable at the contact line. In February 2022, Russia launched a full-scaled invasion. Ukraine lost more land and the functional border has been shifting over time.

We do not distinguish between the two phases of the war, although we believe that would be an interesting path for future work. In what follows, we look at the equilibrium just before the full-scale invasion (2021), then the equilibrium during the war (2024). In Section 3.4, we also consider the post-war planner’s equilibrium.

The war is modeled as a negative shock to the quantity of both types of infrastructure. The negative shock corresponds to the fraction of damaged structures and is denoted by $\eta_i \in [0, 1]$. Thus, the shock is represented by a proportional reduction in consumer infrastructure from I_i^c to $(1 - \eta_i)I_i^c$. Since our data does not allow distinguishing between residential and non-residential damages, we assume that the shock to producer infrastructure is the same. We assume that all other fundamentals remain the same as in the 2021 economy.

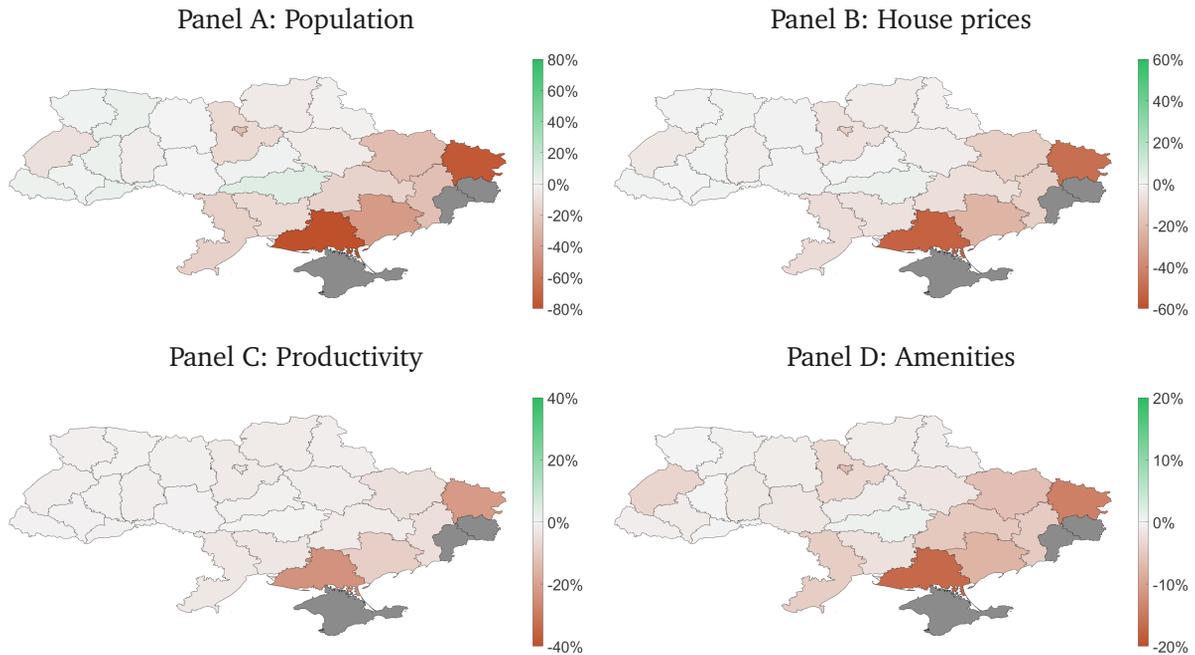
As our measure of η_i , we use damage estimates based on satellite imagery from [Scher and Van Den Hoek \(2025\)](#), aggregated to the oblast level. Figure 5 shows the percentage of damaged structures for each oblast as of December 2024.

Table 3: Results

| Aggregate results, percentage change | | | |
|--------------------------------------|--------|-------------|---------|
| Population | Output | Output p.w. | Welfare |
| -14.4 | -18.0 | -4.1 | -6.6 |

Note: The table show aggregate changes in population, output, output per worker, and welfare as a result of wartime damages in the 2024 model economy.

Figure 6: Wartime changes



Note: The figure shows percentage changes in population, house prices, productivity, and amenities as a result of wartime damages in the 2024 model economy. Territories occupied by Russia before February 2022 are shaded gray.

Results. Table 3 shows aggregate equilibrium effects of infrastructure destruction. Output declines primarily due to a 14.4% reduction in population and to a lesser extent due to changes in productivity. We slightly underestimate the fall in real GDP; in the data the drop was 23% from 2021 to 2024 versus 18% in our model. Welfare falls by over 6%.¹⁶ These aggregate results mask substantial regional heterogeneity in the effects of wartime destruction.

In a new spatial equilibrium, the economy adjusts to the damages to infrastructure shock.

¹⁶Our welfare calculations ignore other economic and non-economic costs of the war and true welfare losses are almost certainly much larger. Artuc et al. (2023) use a migration model to infer welfare losses from observed location choices and find substantially larger welfare losses for Donbas residents from the 2014–2022 occupation.

Figure 6 reports the changes in population, house prices, amenities, and productivity in response to the war shock. Population falls in damaged areas, as some people move to less affected areas while others leave Ukraine entirely. Changes in productivity, amenities, and house prices mirror the changes in the distribution of population. While we do not target changes in local population and house prices, our model captures both pretty well. As can be seen in Appendix Figure B.2, the correlation between model-generated and observed population changes by oblast is 0.78, and the correlation for house prices is 0.77.

3.4. Reconstruction Policy

Next we use our model to examine optimal reconstruction policy across Ukraine's regions. We consider a social planner that has access to some quantity of reconstruction funding. For simplicity, we assume that reconstruction funds can only be spent on improving consumer- and producer-related infrastructure, I_i^c and I_i^p . Our working assumption is that post-war Ukraine will contain all territories lost since February 2022 but not the territories occupied by Russia from 2014 to 2022.¹⁷

We focus on the first-order perturbation approach and consider a small ε percent increase in the quantity of each type of infrastructure in each oblast.¹⁸ Then we calculate the elasticities of nationwide welfare with respect to this small increase in consumer- and producer-related infrastructure: $\mathcal{E}_i^c(V_U) \equiv \partial \ln V_U / \partial \ln I_i^c$ and $\mathcal{E}_i^p(V_U) \equiv \partial \ln V_U / \partial \ln I_i^p$. The results are reported in panels A and B of Figure 7.

Reconstruction funding yields the highest return in Kyiv, Lviv, Odesa, Dnipro, and Kharkiv oblasts. At the same time, the relative benefit of spending funds in the unoccupied parts of Donbas, Kherson, and many other regions is low.

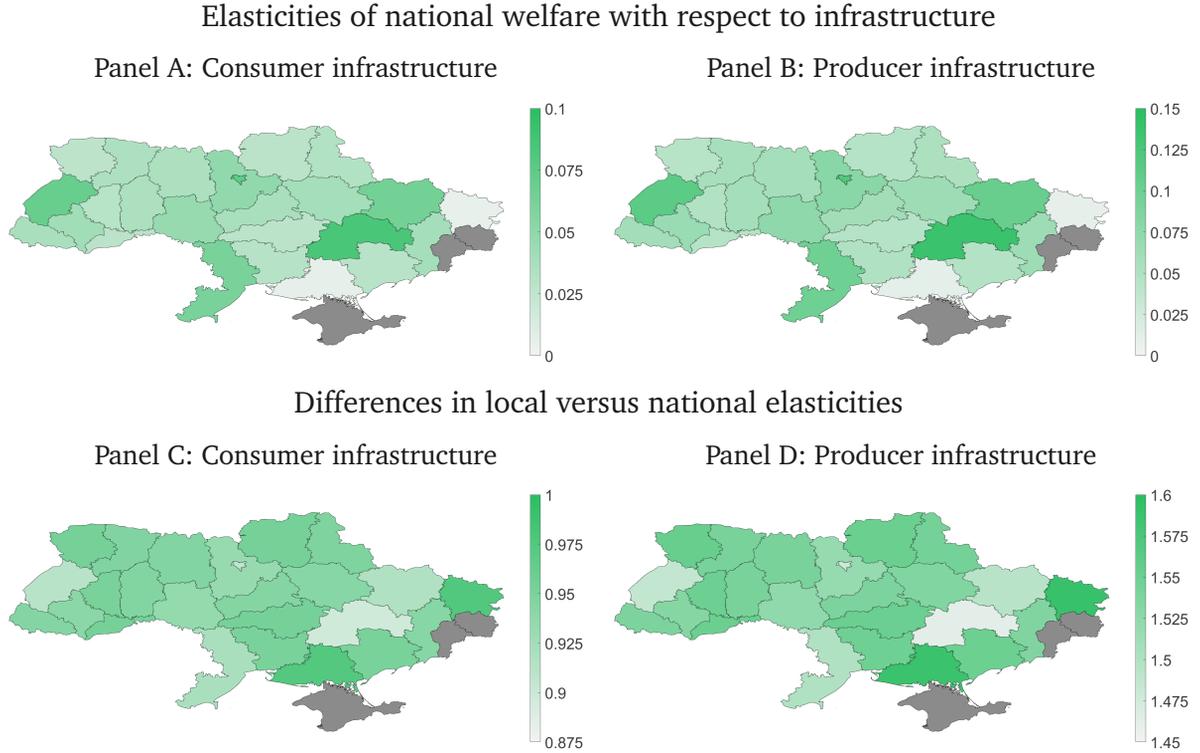
What determines the regional variation in the marginal benefits of rebuilding? To answer this question, we regress the values of the elasticities $\mathcal{E}_i^c(V_U)$ and $\mathcal{E}_i^p(V_U)$ on three variables: log change in population between pre-war and war economies, the level of amenities A_i in the war economy, and the level of productivity X_i in the war economy. These three variables explain 90% of variation in both $\mathcal{E}_i^c(V_U)$ and $\mathcal{E}_i^p(V_U)$. Based on Shapley R^2 decomposition, changes in population account for 8%, level of productivity for 24%, and level of amenities for 58%.

These results suggest that a utilitarian reconstruction policy would prioritize locations that are more productive and have more attractive amenities, as well as those that received larger inflows of migrants during the war. In other words, it would support the fundamental

¹⁷Our optimal policy results are likely to be sensitive to our assumptions about the post-war composition of Ukraine. At the moment of writing the war is still ongoing and we abstain from assuming how the war will end and what territories Ukraine will retain.

¹⁸This implies that we do not consider possible decreasing returns to scale in rebuilding. We also abstract from public-finance considerations and assume that reconstruction funding is supplied exogenously.

Figure 7: Spatial differences in benefits of reconstruction



Note: Panels A and B show the values of $\mathcal{E}_i^c(V_U)$ and $\mathcal{E}_i^p(V_U)$ for each oblast. Panels C and D show the values of the differences $\mathcal{E}_i^c(v_i) - \mathcal{E}_i^c(V_U)$ and $\mathcal{E}_i^p(v_i) - \mathcal{E}_i^p(V_U)$. See the text for more details. Territories occupied by Russia before February 2022 are shaded gray.

forces that have shaped Ukraine's spatial equilibrium before and during the war.

We have so far assumed a benevolent social planner that operates at the national level and examined where rebuilding infrastructure has higher marginal effects on national welfare.¹⁹ What if instead reconstruction choices were decentralized and determined by a group of oblast-level planners who do not coordinate between each other and do not internalize the effects of their actions on the welfare of the rest of Ukraine? To study this question, we also calculate the elasticities of oblast-level welfare with respect to increasing the quantity of infrastructure: $\mathcal{E}_i^c(v_i) \equiv \partial \ln v_i / \partial \ln I_i^c$ and $\mathcal{E}_i^p(v_i) \equiv \partial \ln v_i / \partial \ln I_i^p$. Then we look at the differences between local and national elasticities for each oblast, $\mathcal{E}_i^c(v_i) - \mathcal{E}_i^c(V_U)$ and $\mathcal{E}_i^p(v_i) - \mathcal{E}_i^p(V_U)$, and report them in panels C and D of Figure 7.²⁰

First, note that local elasticities have much higher magnitudes than national elasticities, because in the latter case spending in a given region has a small effect on other regions, and hence the difference between the two is always positive. However, as panels C and D

¹⁹In practice, reconstruction fund allocation will be shaped by donor priorities, lobbying, local interests, and possibly, corruption.

²⁰Local elasticities have much higher magnitudes than national elasticities, because in the latter case spending in a given region has a small effect on other regions.

reveal, the difference between local and national benefits of rebuilding infrastructure are the highest in southeastern regions close to the current frontline.

Our findings point at an important equity-efficiency tradeoff in reconstruction policy. Focusing on rebuilding the East and South that suffered larger damages during the war has a much larger local payoff and helps reduce regional disparities that will emerge after the war. Such a strategy can also be rationalized by symbolic and strategic considerations that are outside the scope of our model. At the same time, millions of people have already moved away from the East and South, and many of them may not come back. Prioritizing spending in more productive and attractive areas where refugees chose to move has a greater potential to improve the average well-being of the country as a whole.

3.5. The Sequencing of Reconstruction

What is the optimal sequencing of rebuilding? Should apartment buildings be rebuilt first or factories? Should the east have priority or the west? Should infrastructure construction take priority over private buildings? While we think that these are important questions, answering them requires a dynamic model and more evidence on past rebuilding efforts.²¹ We mostly leave these issues for future research, but we will provide a few thoughts about sequencing here.

First, while our model does not have all the relevant components to answer this question precisely, we can compare the effects on welfare of rebuilding consumer versus producer infrastructure. To this end, we calculate the weighted-average elasticities $\frac{1}{N_U} \sum_i N_i \mathcal{E}_i^c(V_U)$ and $\frac{1}{N_U} \sum_i N_i \mathcal{E}_i^p(V_U)$ using the model-predicted 2024 population distribution for N_i . We find that the average elasticity of rebuilding producer infrastructure is 63% higher than the average elasticity of rebuilding consumer infrastructure. While the latter can restore the amenity value of cities, our model predicts that it is far more important to restore productive capacity of Ukraine's economy first. In practice this could mean prioritizing reconstruction of the energy sector, transportation links, and industrial facilities, all of which have suffered severe damage during the war.

Second, sequencing should respect the role of learning by doing and not try to do the most difficult things first. The rebuilding of Ukraine is an enormous undertaking and there will inevitably be mistakes, as there have been in all past rebuilding efforts. Prioritizing tasks that will generate the most learning seems important, as does leaving options open. If the first actions then determine all paths that follow, then an early mistake can have costs that reverberate for decades.

²¹A proper dynamic spatial model with migration and housing frictions, such as [Greaney et al. \(2025\)](#), may allow us to estimate welfare losses from the war and gains from reconstruction more precisely. It would take into account the fact that mobility across locations and housing units is costly and, if anything, it would likely reinforce our conclusion that it is optimal to focus rebuilding efforts on areas where people have already moved since 2022.

Third, geopolitical concerns will also impact sequencing. The east is both more vulnerable to future attack and more important to stand as a bulwark against that attack. We do not know what that implies for sequencing, but surely both of these considerations matter. The interest of the international donor community is likely to wane over time. This fact suggests that it may be wise to build infrastructure that needs to be donor financed first, and delaying infrastructure and structures that can be user-financed. We are sure that there are many other impact questions related to the sequencing of reconstruction and we hope that future work will address this issue.

4. The Reconstruction Cost Curve

The Reconstruction Cost Curve is shaped by at least four major components: materials (such as concrete), labor (skilled and unskilled), industrial organization (the number and size of firms) and public procurement capacity. The elasticity of the supply curve in the construction sector - the extent to which higher demand for the construction of structures translates to higher unit costs of construction - determines to what extent the increased demand for (re)construction translates into higher prices. The government of Ukraine and countries that will be funding rebuilding have the direct ability to shape the procurement process and to determine the building that will occur. Yet these decisions will also shape costs by impacting materials, labor and even the industrial organization of the firms that are involved in rebuilding.

We think about the cost of an individual project as being captured by:

$$(1 + \text{Markup}) \times C_{ij} (\text{Wages, Material costs, Equipment costs}),$$

where C_{ij} reflects the project's cost for firm i and project type j . The cost can be reduced by reducing the costs of labor, materials, and equipment. Alternatively, the project can be made more inexpensive, perhaps through economies of scale, costs can be reduced by using more efficient firms or through providing better supporting infrastructure. Providing better supporting infrastructure can include restoring key transport arteries, as well as ensuring that essential inputs, such as a stable supply of electricity are available to producers of construction sector inputs. Finally, it is possible to reduce markups through a more competitive procurement process or by choosing to buy more standardized products. Indeed, Ukraine's use of mass-produced drones provides a perfect illustration of how standardization can reduce costs through scale economies and increased competition.

To a certain extent, the supply curves of cement and craftspeople are fixed in the short term, and the Ukrainian government can't just decree that new firms will emerge. Yet there are indirect ways in which public policy can interact with all three more exogenous components of the cost curve, such as favoring local producers or focusing on more inexpensive

materials. Project selection, appraisal and procurement to replace damaged and destroyed physical structures and a reorientation of investment priorities can all potentially shape the costs of inputs and the number of firms.

In what follows, we first give an overview of the construction costs pre-invasion and then turn to the damage done by the war. We then focus on the three external cost components: industrial organization, materials and labor. Throughout this discussion, we discuss the costs and benefits of three broad strategies: openness, standardization and investing-in-investing. We finally turn to procurement reform and regulation. Procurement reform is a necessary input into openness, standardization and it is a form of investing-in-investing. For example, allowing global firms to bid is a procurement reform that increases openness. Different auction strategies will provide alternative paths towards lower costs. We will not make any policy recommendations but we will highlight the costs and benefits of different approaches.

What we call openness strategies are meant to increase the number of firms and workers that are available for rebuilding. These will reduce wages and material costs in the equation, and allow the selection of firms with lower cost curves. Openness strategies include making the procurement process more accessible to outside bidders, allowing easy, online procurement registration and ensuring that local regulations don't create barriers to non-local builders. Standardization is meant to take advantage of scale economies and possibly to reduce markups as well by turning a one-on-one negotiation into a purchase from a global market.

Standardization inevitably pushes against local governments' desire for autonomy and local customization. Structure that allows some local control, while still ensuring enough similarity across many places, would make it easier for more firms to compete for more projects. Construction typically faces two types of regulation: building codes and land use regulations. Building codes regulate the structure itself and the typical goal of these codes is to promote safety. While many countries have local building codes, it is hard to see how a structure can be safe in one town but unsafe in a neighboring jurisdiction. Consequently, the case for national building codes seems relatively strong.

There is, however, a much stronger case for allowing heterogeneous local land use regulations, often referred to as "zoning," in order to capture the differences between an inner city industrial zone and a low density suburb. However, if every locality imposes its own idiosyncratic rules these rules can serve as a barrier to outside builders. Japan offers a middle way. Japan has twelve land use types, such as "Category 1 Low Rise Residential" and "Category 2 Medium/High Rise Residential" and communities can choose their preferred land use type. This system gives localities the option to be more or less dense, but still creates a common set of rules throughout the country because all "Category 1 Low Rise

Residential” zones have the same set of rules.

Modular structures that are pre-fabricated in factories offer the hope of substantial scale economies, and Ukraine could eventually be both a significant user and a significant exporter of such structures. If some of the zone types specify that particular models can be placed on any lot over some minimum size, this would facilitate the mass production of housing for Ukraine. Investing in a factory to mass produce a housing model will be far more plausible when there is a large amount of Ukrainian land area that permits the model to be placed as of right. Eliminating the barriers to mass-produced housing may have particular value because Ukraine’s industrial capacity and relatively low labor costs means that the country could export significant amounts of mass produced housing, although high transport costs will always hinder long-distance trade in pre-fabricated homes.

Collier (2011) emphasized the value of “investing-in-investing,” especially in low-income countries that experience natural resource-related windfalls.²² Investing-in-investing means physical and institutional investments that occur before scaling up investment in physical structures. Examples include public investment management reform, ensuring a steady supply of electricity required for the production of many key construction sector inputs and creating simple and transparent procurement procedures. Transportation infrastructure that enables construction firms to get around also seems like an important pre-condition for efficient rebuilding. In the equation, investing-in-investing can both lower markups and provide infrastructure that lowers costs. The need to invest-in-investing is particularly important because of the harm done to the construction sector by the full-scale invasion.

4.1. The Construction Sector in Ukraine before and during the Full-Scale Invasion

The International Comparison Project provides data on average price levels in the construction sector. It would be far better to have detailed information on a broad range of construction inputs, but unfortunately, these costs were not collected for OECD countries by the International Comparison Project (World Bank, 2024). Table 4 shows the price level of gross capital formation and several components in Ukraine in 2017 and 2021 (World Bank, 2024).

For comparison, we also show the price level for upper middle income countries and Europe and Central Asia. The overall price level of gross fixed capital formation is about 45-50% lower in Ukraine than in either the upper middle income benchmark or in Europe and Central Asia. Since Ukraine was only classified as an upper middle income country in 2024, we also compare the price level to lower middle income countries. Even relative to this group, the overall price level, and the price level of each of the components of gross fixed

²²Some of the key construction sector issues in reconstruction therefore closely relate to countries with large spending booms in structures, for example, due to natural resource discoveries, as discussed in Kirchberger (2020).

Table 4: Price level of gross capital formation (World =100)

| | 2017 | 2021 |
|---|-------|-------|
| <i>Ukraine</i> | | |
| Gross Capital Formation | 50.0 | 48.8 |
| Gross Fixed Capital Formation | 49.2 | 47.4 |
| Machinery And Equipment | 79.7 | 83.4 |
| Construction | 36.0 | 35.0 |
| <i>Upper middle income (Benchmark)</i> | | |
| Gross Capital Formation | 91.0 | 90.9 |
| Gross Fixed Capital Formation | 90.2 | 90.6 |
| Machinery And Equipment | 114.2 | 115.1 |
| Construction | 84.4 | 85.1 |
| <i>Europe & Central Asia (Benchmark)</i> | | |
| Gross Capital Formation | 99.4 | 96.5 |
| Gross Fixed Capital Formation | 99.8 | 97.4 |
| Machinery And Equipment | 87.8 | 90.3 |
| Construction | 124.8 | 119.3 |

Note: This table shows costs of capital formation in Ukraine, and the benchmark for upper middle income countries and Europe and Central Asia compared to the world average based on [World Bank \(2024\)](#).

capital formation is between 14% and 19% lower in Ukraine.

These facts make us hopeful that Ukraine can efficiently rebuild itself, although war itself has both destroyed buildings and at least temporarily reduced Ukraine's capacity to rebuild those buildings. Table 5 shows that between 2021 and 2022, the total space generated by new residential buildings fell from 11.4 million square meters to 7.1 million square meters, which is a 37 percent drop. Between 2021 and 2022, the volume of civil construction also dropped by 42 percent and transport infrastructure construction declined by 26 percent. New residential construction remained low in 2023, but rose in 2024 to 9.8 million square meters, which is greater than the amount of new construction in 2020. Of course, if Ukraine is going to rebuild itself, the amount of new construction is going to have to be much higher than pre-war levels.

Figure 8 shows the geographic pattern in residential building in 2024. As before the war, there is a clear westward tilt in new construction, which is particularly unsurprising given the fighting in the east. There is the same heavy focus on Kyiv that we noted before the

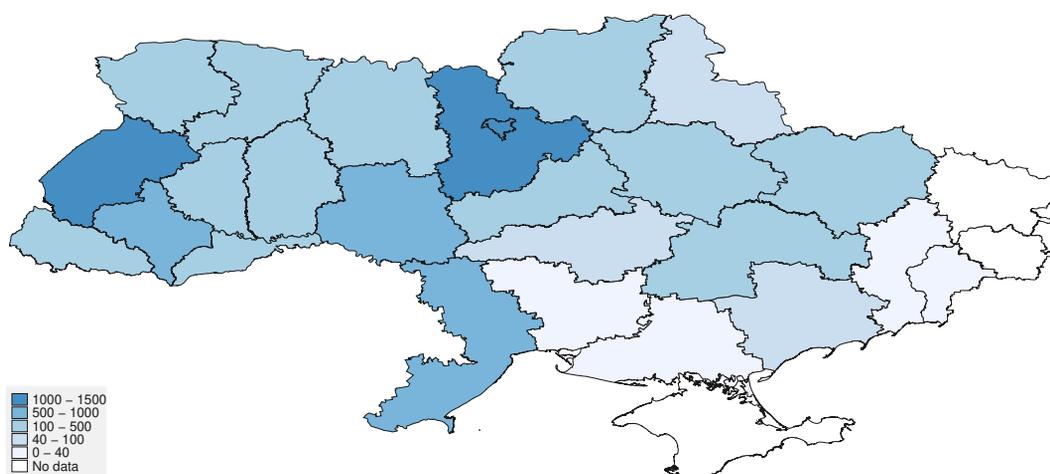
Table 5: Total area of new housing construction in Ukraine

| Year | Total Area (million sq. m) | Growth Rate (%) |
|------|----------------------------|-----------------|
| 2020 | 8.451 | 76.6 |
| 2021 | 11.414 | 135.1 |
| 2022 | 7.110 | 62.3 |
| 2023 | 7.381 | 103.8 |
| 2024 | 9.759 | 132.2 |

Note: This table reports the total area of newly constructed housing in Ukraine and the corresponding year-on-year growth rate (State Statistics Service of Ukraine, 2025c).

Figure 8: Putting into service of residential buildings across regions, 2024

(thousand sqm)



Note: This figure shows the total area of new residential buildings across regions in thousand square meters (State Statistics Service of Ukraine, 2025c).

conflict.

According to a report by the [International Finance Corporation \(2025\)](#), construction costs have almost doubled between 2022 and 2025. This sharp increase reflects a shortage of skilled workers, rising material costs due to damaged factories in the east, and electricity shortages. Moreover, supply chains needed to be reorganized to make up for the construction inputs previously imported from Russia. Blockages of ports and border crossings have also created logistical problems and increase the costs of imported materials. The workforce in the construction sector dropped by 28 percent after the full-scale invasion ([Sibbel and Mihes, 2025](#)), although presumably some of that shift will reverse itself at the end of the war.

Ending the conflict is probably the single most important way to reduce the costs of building. Political insecurity seems likely to increase the costs of physical capital through a number

of channels, including the direct costs of keeping staff and workplaces secure, and reducing the number and types of firms that are willing to bid for contracts. Political instability or conflict can also disrupt supply chains. [Collier et al. \(2016\)](#) use data from road projects across 99 low-and middle-income countries and show that the cost of road construction is significantly higher in countries that are in conflict, experience political instability, or those with higher levels of corruption.

4.2. Industrial Organization of the Construction Sector in Ukraine

As in many countries, Ukraine's domestic construction industry is dominated by small firms. In 2022, 80 percent of firms in construction had 10 people or less, 96.8 percent had up to 50 people. Only 3.2 percent were medium sized (51-250 persons) and only 7 firms had more than 250 people ([Sibbel and Mihes, 2025](#)). These small firms will be fine for rebuilding individual houses, but only larger firms have the capacity to build the larger structures and infrastructure that are more common in larger cities.

Of course, foreign firms can also play a major role in reconstruction. Table 6 provides information on the top global construction contractors who were operating in Ukraine from 2005 to 2024 (taken from [Bernard et al. \(2025\)](#)). The table shows that the number of top global firms active in Ukraine has fallen in half since 2010. In 2024 only 10 top global contractors were active, which is less than the number (12) present in 2005. Importantly, this decline began before the war.

Column (2) shows that the composition of firms active in Ukraine has also changed. The average rank in terms of global revenue of the active firms dropped to 139 in 2024, which means that the size of contractors in Ukraine has shrunk dramatically. While in 2005, 2010, 2015 and 2020, at least one of the globe's top five contractors were operating in Ukraine, the rank of the top firm dropped to 19 in 2024. While this shift surely reflects war risk, it is less clear that there is a longer-term trend.

Finally, in 2024, the active firms in Ukraine come from only three countries. In 2010, nine countries sent top contractors to Ukraine. While it is hard to know if that pre-invasion trend is important, it does seem clear that international presence in Ukrainian construction was certainly not becoming more broad-based.

Opening strategies can shift the industrial organization of the construction sector in several ways. Most obviously, opening the construction sector to foreign contractors will make scaling up far easier. The small number of large domestic firms makes it particularly implausible that the big infrastructure projects can be handled by Ukrainian firms. It is possible that foreign firms can be encouraged to employ Ukrainian workers if that is politically necessary, but prioritizing anything other than low costs will inevitably lead to higher costs, at least in the short run. Opening to foreign firms both involves hard barriers, such as legal require-

Table 6: International contractors, 2003–2024

| Year | # of firms | Av rank | Max rank | # of countries | Countries |
|------|------------|---------|----------|----------------|---|
| 2005 | 12 | 71 | 1 | 8 | Belgium, China, France, Germany, North Macedonia, Norway, Turkey, United States |
| 2010 | 19 | 83 | 1 | 9 | Austria, China, Denmark, France, Germany, Italy, Spain, Turkey, United States |
| 2015 | 17 | 53 | 3 | 8 | Austria, China, Denmark, France, Italy, Spain, Turkey, United States |
| 2020 | 16 | 62 | 3 | 7 | Austria, China, France, Italy, Spain, Turkey, United States |
| 2024 | 10 | 139 | 19 | 3 | China, Italy, Turkey |

Note: This table shows the number of top global construction firms reporting activity in Ukraine. A contractor's rank is based on total international revenue of the firm.

ments that work be done by domestic entities, and soft barriers involving regulations (of both building and procurement), and potentially outreach.

For domestic firms, opening means reducing the costs to start or restart a construction company. Labor regulations can also be a barrier to entry (for both domestic and foreign firms). Ultra-specific building and land-use regulations can also limit the ability of firms to expand. A small set of nationwide building and land use codes can make it much easier to enter into new markets. In this context, standardization will enable scale economies. Mass production by both large domestic and global firms can allow reconstruction at faster speed and lower costs. Factory-built homes provide a particularly important example of mass-produced housing. For example, modular homes built in the Marakiv community consist of three modules (kitchen, bathroom, and bedroom) and cost USD 5,000 per module. These take only 4 weeks to produce ([Serhiy Prytula Charity Foundation, 2025](#)). These homes can be used year-round and have a service life of about 5 years. The Ukraine-based startup HOMERs, offers small three-unit homes for about USD 20,000.

A recent study by the International Finance Corporation on investment opportunities in the rebuilding of Ukraine classified a number of materials and construction solutions by risk and adoption duration ([International Finance Corporation, 2025](#)). Pre-cast construction elements and modular pre-fab units are classified as low risk investments that can be adopted in the short term and therefore present immediate investment opportunities. A high level of automation and fast speed of construction make them particularly suitable to a context of labor shortages and post-conflict reconstruction settings with large demand for reconstruction.

While many modular homes are built to last as long as standard housing, we do not see the short life of the Marakiv homes as a problem. In many cases, planning for impermanence may make sense. If we expect Ukrainians to get rapidly richer over time, then short term solutions make sense. If we are unclear about long term conditions, then short term solutions make sense. In the transportation context, the option value associated with changing routes or services levels gives buses an advantage relative to trains.

Mass-production can also be relevant in non-housing forms of infrastructure. For example, New York University's Transit Cost Database argues that the costs of Swedish subways are so much lower than the costs of New York's subways, because the Swedish stations all follow a common design, while the New York subway stations are all idiosyncratic. Buses can be customized or ordered from big producers, such as Kia.

With housing, there are two ways to introduce standardization depending on whether housing production is largely private and decentralized or public and centralized. If the process is public, then standardization just involves ordering mass produced homes instead of contracting with buildings. If the process is private, then standardization shouldn't be forced on consumers. Instead, a viable system is to invite private builders to suggest models and prices, conditional upon the number of sales reaching a threshold. The government then pre-approves the models for safety and for conforming with land use controls. Individual households then choose whether or not they want to buy a mass-produced model or engage in more traditional building methods.

Finally, there are many ways in which investing-in-investing relates to the industrial organization of firms. In a sense, the procurement and regulatory reform that we have already as opening strategies also qualify as investing-in-investing. Public infrastructure reconstruction will make it easier for firms to cross boundaries and supply different parts of the country. Ensuring the public officials who handle procurement and regulation have different languages, for example, may make it easier for foreign firms to enter into the market.

4.3. Materials

Construction is a very large user of intermediate inputs (Çakmaklı et al., 2021), and consequently, sectors that are upstream in production networks (Liu, 2019), will play a particularly important role in replacing destroyed physical assets. Kirchberger and Beirne (2021) study the global cement industry and highlight that distortions in upstream, capital-producing sectors lead to large long-run effects on output due to input-output linkages. These distortions are even more important for largely non-traded inputs, such as cement, sand or gravel.

Ukraine has a strong domestic production capacity of key construction sector inputs. The country can source 80 percent of construction inputs domestically. Going forward, reliable

Figure 9: Cement plants in Ukraine



Note: Black dots show operating cement facilities, red dots show facilities which are damaged, mothballed, or in occupied territories. Labels list the ownership group of active cement plants.

electricity is crucial to allow for scaling up of production of major domestically supplied inputs. In a survey of construction material producers and industry associations, 80 percent reported the shortage of electricity as a problem (USAID, 2023). A number of critical industries producing construction inputs depend not only on electricity but require steady flows of electricity as well. This includes key inputs for reconstruction such as cement: while fuel is the primary energy source to provide heat for kilns, essential processes such as crushing and grinding of materials and kiln rotation are powered by electricity (Van Oss, 2005). Reliable electricity is therefore crucial, irrespective of whether plants operate at or below full capacity.

According to USAID (2023), the key inputs with possible production deficits during reconstruction are cement, PVC profile, mineral wool, concrete, glass and electrical panels. The black dots in Figure 9 show operational cement facilities in Ukraine. The three red dots show the Baltsem cement plant which was damaged and is not operational, the mothballed Kramatorsk cement plant, and the Amvrosiivka cement plant, now in the occupied territories. These three plants had a combined capacity of more than 7 Mt per year, representing about 35% of domestic capacity (Global Energy Monitor, 2025). Following the acquisition of 2 Buzzi plants by CRH, the market consists of three main players that are currently operating active cement plants. During the war, exports have played an important role in maintaining production levels. It is worth noting that demand will increase further to construct the bomb shelters required by new legislation.

Glass was previously imported from Russia and there was no domestic production capacity. Two recent investments in glass production in the regions of Kyiv and Ivano-Frankivsk are

under way to aim to increase domestic capacity.

For materials, opening primarily means more access to external suppliers, which is far more plausible in high value-per-ton items than in low value-per-ton products like cement. Trade in these inputs involves both physical investment, we will discuss as part of investing-in-investing and also ensuring that the regulatory aspects of trade are as light as possible. There is an idiosyncratic advantage to import products that need to be made by particularly costly factories, since those factories are likely to be safer from Russian aggression if they are located in NATO countries.

Standardization can also play a role with materials as well, especially for items such as electric panels. There is little case for pushing uniformity on the private market by government fiat, but there is a good case for reducing the artificial heterogeneity that can be created by local building codes and land use regulations. Taking steps to make sure that the same building inputs are legally acceptable everywhere would seem to enable scale economies.

For parts that are procured as part of a public procurement process, then standardization is particularly easy. The key is just to coordinate across regions and across inputs in a way that allows large purchase orders which can push down costs. If there are large reasons for needing an idiosyncratic type of glass or electric panel, then it may make sense to purchase specialization products, but there is no reason to have idiosyncrasies that only reflect the vicissitudes of uncoordinated public purchasing.

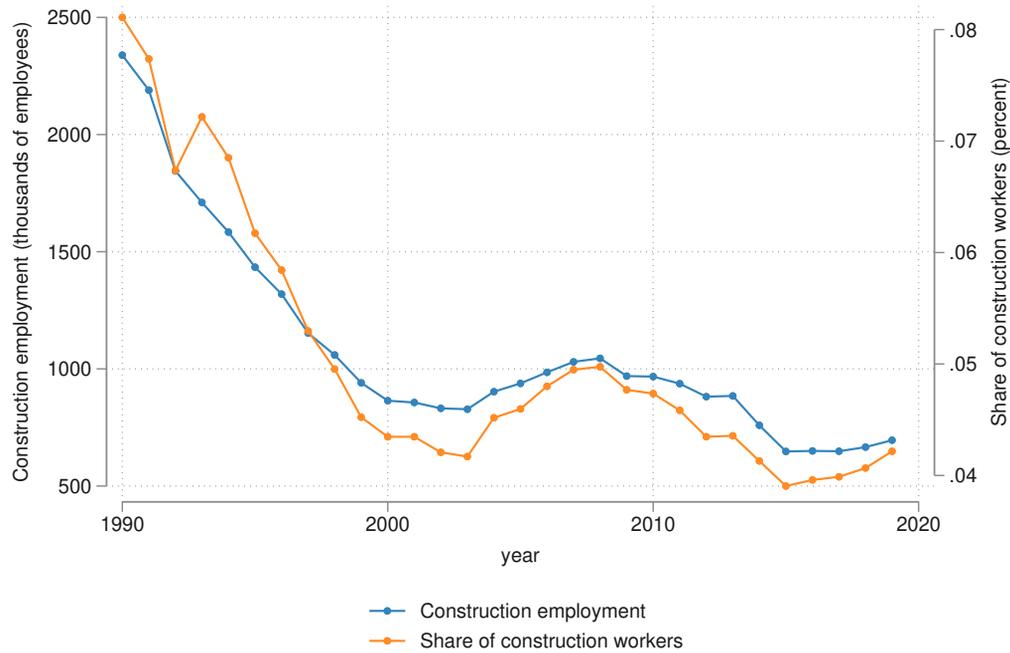
Finally, investing-in-investing is particularly important in this category. The physical inputs that are crucial for many of these industries, especially electricity, will require investment. Even in 2020, Ukraine ranked only 128th in the world in ease of getting electricity according to the World Bank's Doing Business Report. If materials need to be imported, then the ports and roads need to be in good shape.

Moreover, the institutional arrangements could also be updated both to enable imports and to address risks around inputs in procurement. There could be a special trading system that makes it easy to import key construction inputs. Many procurement contracts essentially insure contractors around changes in contract specification, but not around changes in input prices. If input prices are likely to be highly volatile, then there is a better case for insuring against those price swings as well.

4.4. Labor

At the end of the Soviet era, eight percent of all workers – 2.5 million people – were employed in the construction sector in Ukraine. As Figure 10 shows using data from the Economic Transformation Database of Transition Economies (Hamilton and de Vries, 2025), both the number of workers in construction and the share of employment in that sector declined sharply over the 1990s. Between 2000 and 2020, those figures have undulated

Figure 10: Construction Employment



Note: This figure shows construction employment (thousands of employees) on the left axis and the share of workers employed in construction on the right axis. Data comes from [Hamilton and de Vries \(2025\)](#).

and gently trended downward. In 2019, almost 700 000 workers were employed in construction, representing 4 percent of total employment. It is worth noting that the number of regular workers, about 192 000 in January 2019, is significantly smaller ([State Statistics Service of Ukraine, 2025a](#)).

The low and declining levels of employment in the construction sector are matched with relatively low wages. Table 7 shows that in 2019 the average monthly salary in the construction sector was 9356 hryvnias, or 327 Euros (which is equal to 400 2024 Euros). By 2024, the monthly salary had risen to 16928 hryvnias, which is about 389 Euros. Real wages in construction appear to have declined over the five year period. Wages in the construction sector are in every year the lowest among a set of comparison sectors that might attract similar types of workers such as industry or transportation and storage. They are lower than wages in agriculture, forestry and fishing. Informal employment also represents a sizable chunk of construction jobs (17 percent as of the last quarter of 2021), which may contribute to the low earnings in this sector.

The combination of declining employment and low wages suggest limited demand for construction workers, which may, in turn, reflect Ukraine’s declining population. The major question going forward is whether Ukraine has the capacity to increase the supply of available labor. Certainly, the history of construction work in Ukraine suggests that the country has enormous capacity to build. The devastation of Ukraine in World War II also led to a

Table 7: Average monthly salary (nominal) of a full-time employee in Ukraine, UAH

| Economic activity type | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 |
|---|--------|--------|--------|--------|--------|--------|
| Agriculture ^a | 8,856 | 9,757 | 12,287 | 13,061 | 14,625 | 18,012 |
| Construction | 9,356 | 9,832 | 11,289 | 9,781 | 12,634 | 16,928 |
| Industry | 11,788 | 12,759 | 14,902 | 15,176 | 18,390 | 23,150 |
| Wholesale and retail trade ^b | 10,795 | 11,286 | 13,488 | 15,103 | 20,630 | 25,286 |
| Transporting and storage | 11,704 | 11,951 | 13,837 | 13,731 | 17,184 | 21,699 |
| Total | 10,497 | 11,591 | 14,014 | 14,847 | 17,442 | 21,473 |

Note: This table shows the nominal average monthly salary of full-time employees in Ukraine from 2019 to 2024; ^a includes forestry and fishing; ^b includes repair of motor vehicles and motorcycles.

Source: [State Statistics Service of Ukraine \(2025b\)](#).

vast rebuilding effort. Ukraine certainly has a robust labor force, and the ability to allow in-migration of less skilled construction laborers. The larger question is whether there are enough Ukrainian workers with the skills to operate the sophisticated machinery used in some types of construction.

Opening can mean two distinct strategies regarding construction labor. The easier strategy involves focusing on the domestic labor force. Key opening steps are to rationalize any regulatory systems that make it difficult to hire workers, especially in the formal sector. For the building professions that require certification, such as becoming a plumber, it may make sense to issue temporary permits to workers in large firms, trusting that the firms' desire to avoid reputational damage will ensure quality better than licensing.

The harder strategy involves easing the in-migration of non-Ukrainian construction workers, especially when those workers are less skilled. The number of skilled workers are smaller, and it is especially easy to make the case for allowing skilled workers in if Ukraine is facing a genuine shortage in this area. Bringing in less skilled workers is also a plausible opening strategy, but there are more likely to be political costs of that strategy. For example, Ukraine's attempt to import workers from Bangladesh has already received political blowback from the Bangladeshi embassy in Poland. It is even more common for domestic unions to oppose the inflows of workers from abroad.

In this case, standardization works to reduce the skills needed to be an effective construction worker and to allow capital to substitute for labor. For example, modular housing can largely be produced in factories, in which machines do a great deal of the work. The assembly process can be made relatively easy, so that it can be done by workers with limited amounts of skills. One of the many advantages of mass production is that the workers need only learn one small part of the production process, as on an automobile assembly line.

Standardization can also reduce the skills requirements in more conventional construction. If skills learned on one building task transfer readily toward skills needed doing another building task, the easier it will be for workers to learn-by-doing. If plumbing is common and HVAC systems are common, then this reduces the amount needed to learn ex ante and makes it easier to learn on the job. This claim does not imply that the public sector should attempt to regulate private sector construction to create uniformity; that would create myriad downsides. Rather, within public sector construction, there may be advantages from coordinating the planning and procurement to standardize the tasks needed from workers.

For labor, investing-in-investing means both vocational training and appropriate institutional design. The vocational training strategy involves working with educational institutions, labor units and building companies to spread construction-relevant skills through the population. It might make sense to seek international cooperation from large building contractors to get their input about what skills to teach and what places can be seen as models for appropriate vocational training. During the war, this might make particular sense for people who are too young to actually participate in the fighting. After the war, vocational training might be an appropriate benefit for veterans seeking to reenter civilian life.

Investing-in-investing can also mean for labor market institutions to make it easy to use workers flexibly. This could mean changing labor regulations in the construction industry or working with labor unions to reduce inefficiencies. A large increase in construction activity will inevitably lead to a large increase in construction wages, which will be partially funded by outside nations. The construction unions may be more willing to be flexible about work terms in a time of rapidly rising incomes for their members.

4.5. Procurement and Reconstruction

Reconstruction of large quantities of infrastructure and housing will require massive amounts of public and private procurement. We have discussed procurement in almost every part of this section. Procurement is central to the reconstruction cost curve, but procurement design impacts everything from markups to material costs. We will focus much of this strategy on a particular opening strategy, e-procurement, but we begin by discussing the appropriate level of regulation of procurement entities, standardization and investing-investing.

The central question of procurement reform is the tradeoff between discretion and corruption (Bosio et al., 2022). If procuring agents are allowed freedom to design their processes, then they can respond to local information and nimbly react. However, that freedom also allows public agents to create corrupt deals with suppliers, and public works is among the sectors most prone to corruption globally. The costs of corruption may be particularly high when rebuilding Ukraine, because evidence of misbehavior will lead donor countries to walk away from funding the reconstruction effort. Consequently, it may be appropriate to have greater regulation of procuring entities when funds come from outside (and donors

may insist on such regulation), than when funds are internal.

The advantages of standardization in procurement have been vividly illustrated by Ukraine's purchasing of mass produced drones. When a product is bought and sold on the open market, then the price should be obvious to everyone and that makes corruption much harder. While it is possible that a corrupt procuring entity could elicit some sort of special discount for quantity and keep that discount for himself, even that possibility could be managed by using multiple independent buyers who serve as checks on one another.

The government could also consider maintaining a formulary such as the U.S. General Service Administration, Multiple Award Schedule. This list contains products that have been approved for purchase at set prices. Government buyers who purchase from this list do not need to go through a cumbersome procurement process and can simply just buy the goods from the suppliers at the listed price. Providers suggest their products and prices to the government in order to enter the list.

Developing such a public purchase list is one example of investing-in-investing related to procurement. Reforming procurement practices and even training buying agents are other examples. Recent work by [Deryugina et al. \(2025\)](#) suggest that Ukraine's construction procurement performance fares poorly relative to other countries. This work makes the case for taking the investing-in-investing process seriously.

The easiest and most obvious opening strategy is to switch to online procurement. E-procurement makes it possible to select, appraise and procure a large number of projects transparently, and to make it easier for outsiders to bid on a project. Many countries have moved to online procurement and the results appear to have been most positive. [Lewis-Faupel et al. \(2016\)](#) show that a shift to e-procurement in India and Indonesia both improved quality and reduced delays.

Following the Euromaidan protests there was a strong public demand for transparency and accountability. In a collaboration between civil society volunteers, the private sector, non-governmental institutions and government, a new procurement system via e-procurement was developed in 2014–2015 ([Kyiv School of Economics, 2016](#)). The system was tested by a number of ministries. From 1 August 2016 onwards, all public authorities were requested to conduct procurement via the online platform Prozorro (“transparent” in Ukrainian), for purchases above a minimum threshold and considering specific exceptions.²³ By comparing purchases below and above the minimum threshold before and after the introduction of Prozorro, [Kovalchuk et al. \(2019\)](#) were able to evaluate the impact of Prozorro on competitive bidding. They find that after the introduction of Prozorro, the number of bidders increased, which supports the view that e-procurement is an opening strategy. The opening advantages of e-procurement are also shown by the fact the Prozorro seems to have increased the

²³See here for Prozorro <https://prozorro.gov.ua/en>.

number of suppliers working with any given procurement entity. Finally, they also find that the time between announcement of the bid and contract signing shortened after the introduction of Prozorro.

As we have already argued, the regulation of procurement entities reduces corruption but may also reduce buyer discretion and just slow things down. Unsurprisingly, in the wake of the full-scale invasion, the government of Ukraine decided to regulate procurement less stringently. In October 2022, the Ukrainian government issued Decree No. 1178, which simplified procurement procedures and effectively deregulated procurement. [Klymak and Vlandas \(2024\)](#) explore the effect of war on procurement and find a drop in the quantity of goods and services procured via Prozorro and a move from online toward offline auctions. Greater discretion enables buyers to find suppliers even for difficult jobs, which means the success rate of projects increases. The cost of a higher success rate is that the ratio of the winning bid to the estimated cost widens, which suggests an increase in costs. This fact only highlights tradeoffs that exist when regulating procurement.

In 2024, the government launched an online platform fully integrated with Prozorro: the Digital Reconstruction Ecosystem for Accountable Management (DREAM). This platform is meant to provide donors with transparency. In parallel, the government also undertook to reform public investment procedures. Future work will hopefully be able to use DREAM to monitor the progress of procurement in Ukrainian reconstruction.

4.6. The Geography of Procurement Efficiency

We now turn to the connection between our geographic work on the benefits of reconstruction with this section's discussion of the reconstruction cost curve. We have so far treated that cost curve as a national function, but there are also regional differences in the costs of labor and materials, and perhaps also in the efficiency of procurement. In this section, we will not focus on the costs of labor and materials, but rather on differences in procurement efficiency across space. These differences in efficiency may provide information about where to invest in procuring efficiency. These differences are also relevant for the cost side of where to put reinvestment dollars.

Our basic strategy is to use Prozorro data for all competitive procurements that were announced in 2019, and compare the estimated cost of projects with the realized cost of projects at the point of procurement. The data does not allow us to tell if the project's cost changes after its has been awarded. Ideally, estimated costs would be engineers' estimates of the difficulty of doing a task, although we cannot rule out the possibility that these estimates also reflect some expectations about the efficiency of the procurement system itself. Realized costs then show how well the procurement system is performing relative to these expectations.

Table 8: CPV categories selected for analysis

| CPV Code | Description | Percent |
|------------|---|---------|
| 43000000-3 | Machinery for mining, quarrying, construction equipment | 0.84% |
| 44000000-0 | Construction structures and materials; auxiliary products to construction (except electric apparatus) | 2.76% |
| 45000000-7 | Construction work | 89.99% |
| 50000000-5 | Repair and maintenance services | 3.95% |
| 70000000-1 | Real estate services | 0.15% |
| 71000000-8 | Architectural, construction, engineering and inspection services | 1.02% |
| 90000000-7 | Sewage, refuse, cleaning and environmental services | 1.31% |

Note: This table reports the CPV (Common Procurement Vocabulary) categories selected for analysis, along with their share in the dataset.

We chose to use 2019 because it was the last year before the full-scale invasion. As the online procurement system was only introduced in 2016, we thought it was better to allow more time for the procuring entities to adjust.²⁴ We limit the data to (i) reconstruction-relevant procurement categories (these are listed in Table 8), (ii) contracts over USD 250 000 and (iii) we exclude procurements classified as “Below Threshold” and defense procurements. This leaves us with a total of 3447 competitive procurements, with a minimum of 43 auctions in each region.

The database records an estimated contract value (“Estimate”) published by the procurement entity for each auction, and the actual contract value (“Actual”) obtained by the firm. Our measure of procurement efficiency is the gap between the estimated contract value and the actual contract value. Formally, we define the procurement savings rate as

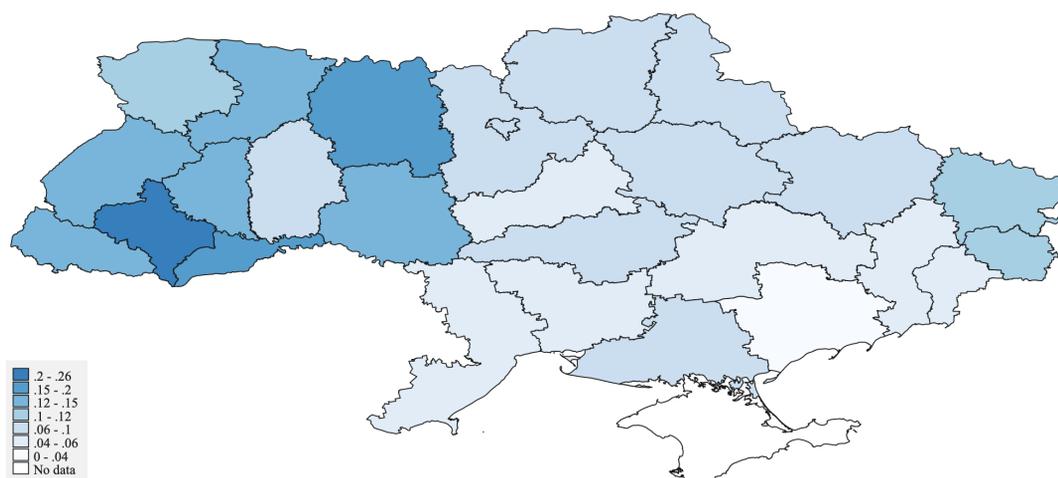
$$\text{Savings} = (\text{Actual} - \text{Estimate}) / \text{Estimate}.$$

Across all contracts, we observe an average savings rate of about 8 percent. The median savings rate was 3 percent, which suggests that the savings rates are heavily skewed. In principle, we could do more to control for contract type, but for the purpose of this illustrative exercise, we just average savings across regions to highlight the geography of procurement savings. In the Appendix we show robustness to alternative moments such as the median.

Figure 11 shows that there is substantial heterogeneity across regions. We observe the high-

²⁴See here for the dataset <https://www.kaggle.com/datasets/oleksastepaniuk/prozorro-public-procurement-dataset>.

Figure 11: Average cost savings for each Oblast for 2019.



Note: The figure shows average cost savings for procurements in construction-related categories. Darker shades represent higher cost savings compared to the estimated cost provided by the procurement entity before the auction. Appendix Figure B.3 shows median cost savings.

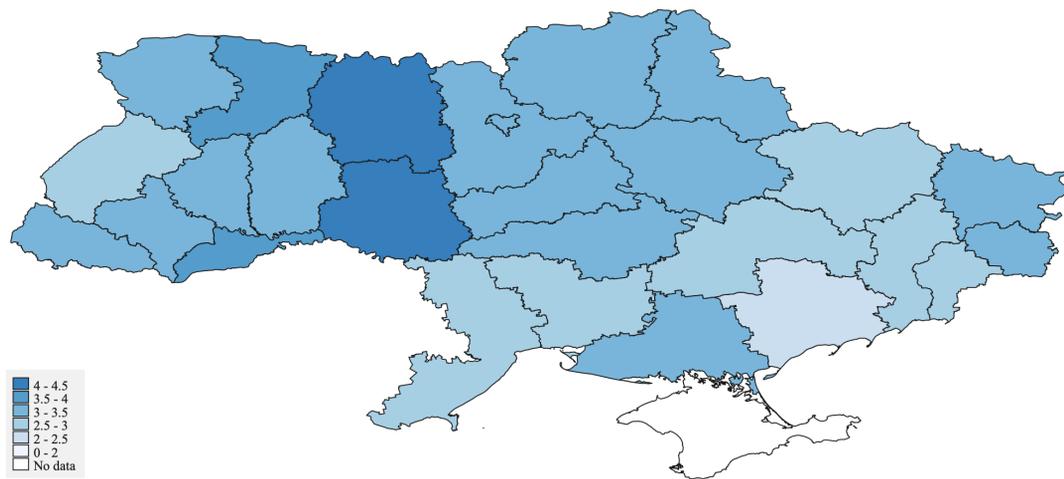
est cost savings in Ivano-Frankivsk and Chernivtsi and the lowest in Zaporizhzhia, Donetsk and Odesa. These findings suggest that procurement may be more efficient in the western oblast, which would provide a further rationale for rebuilding more aggressively in the west. Kyiv, however, does not have particularly high procurement savings.

At this point, it is at least possible that these differences reflect regional patterns of estimating costs or noise. As a test of whether these figures do reflect the reality of procurement, we use the standard economic logic that cost savings should increase with the number of bidders. For each auction, we calculate the number of bidders. As the minimum number of bidders needed for any auction is two, we do not see auctions that have totally failed to attract multiple bidders. We next compute the oblast-wide average in the number of bidders.

Figure 12 shows substantial regional heterogeneity in the number of bidders. The highest number of bidders are in Zhytomyr, Vinnytsia, and Chernivtsi and the lowest number of bidders are in Zaporizhzhia, Dnipropetrovsk, and Kharkiv. In general, there are more bidders in the western regions where the savings rate is highest. This fact leads us to suspect that the savings rate patterns have some reality to them and that procurement is more efficient in the western oblasts.

This data does not imply that the officials in the western oblasts are somehow better at their jobs. The more likely explanation for the differences is that there are just more available firms in the growing western regions that are further away from the eastern threat. Yet even if these geographic differences reflect the decisions of firms rather than the quality of government, they are still relevant for determining the location of reconstruction. Obviously, the efficiency of procurement is only one of many considerations that should influence the

Figure 12: Average number of bidders for each Oblast for 2019.



Note: This figure shows the average number of bidders for procurements in construction-related categories. Darker shades represent higher a higher number of bidders. Appendix Figure B.4 shows the median number of bidders.

location of reconstruction, and it may not be a particularly important consideration. It has likely changed since 2019, the last year of our dataset. Our goal was to suggest that it was relevant and to introduce the geography of costs as a balance to the geography of benefit. We also believe that the geography of procurement efficiency may help to identify bottlenecks to rebuilding, which can help maximize the value of investing-in-investing.

4.7. Institutions for Rebuilding and Procurement

What institutions can ensure that donor countries will believe that the recovery process is both efficient and honest? One possible structure to consider is a tripartite institutional, with a group responsible for deciding what is to be built (the planning authority), a group overseeing the flow of funds (the financial authority) and scattered groups overseeing the projects themselves (the implementors). This structure would make it possible for the Ukrainian people and their government to decide what is to be built, for donors to have oversight over their funds that they contribute and to nimbly spend that money making use of the expertise that Ukraine has already developed and displayed in the field of military procurement.

The planning authority would be formed by the government of Ukraine, perhaps including donor representatives as well. That authority's job would be to develop a feasible plan for a five to ten year rebuilding effort. The financial authority would work with the planning authority at this stage, helping to ensure that the plan is actually financially feasible. The donors should get a voice at these proceedings, since their ability to give funds will depend on the appeal of the projects to their voters and stakeholders, but not a veto. With a plan in place, control largely passes to the financial authority.

The financial authority could have a leadership structure that is based on financial contributions to the common fund. If this fund is independent of Ukraine's own spending, then Ukraine could get observers on the board. If Ukraine contributes to this fund, then Ukraine could receive votes on the board which are commensurate with its financial contribution. The financial authority's job is then to design a system for procurement and operations that is then implemented by different operating bodies.

This system involves designing procurement systems and audit systems, and then overseeing personnel who will implement audits and guide procurement processes. In some cases, the "procurement system" could just mean allocating funds to an operating entity and expecting the entity to implement. In other cases, particularly for large infrastructure investments, the financial entity could run the procurement auction itself. Regulating the activity of an operating entity lies between these two extremes.

While it probably makes sense for there to be one planning authority and one fiscal authority across the country, we believe that operating entities could well be regional and domain-specific operating entities. They could be local governments or special entities that are brought forth to handle a specific rebuilding task.

Ukraine has shown remarkable skill at military procurement, especially in purchasing mass produced products, such as drones. We expect that mass produced products will also play a significant role in rebuilding, and we hope that Ukraine can use the human capital that it has developed through military procurement as part of rebuilding procurement. This could take the form of a special group made solely of ex-military procurement officers, who are then lent to operating entities for a limited amount of time. This special group might have a particular relationship with the financial authority, and provide them with informal auditing.

The tension between over regulation, which stymies local innovation, and under regulation, which allows corruption is ubiquitous. We hope that flexibility will allow the financial authority to appropriately monitor local procurement while still allowing local initiative. It will be a work in progress and hopefully the system will evolve productively over time.

5. Conclusion

Rebuilding Ukraine will be one of the great construction tasks of the 21st century. In this paper, we have argued that the rebuilding process can be divided into two admittedly connected parts: maximizing the benefits from rebuilding and reducing the costs from rebuilding. We presented a simple model to help frame discussions around the benefits of building in different areas. The model can also provide guidance on investment in different types of infrastructure (business oriented vs. consumer oriented) and housing. We also contain a less formal discussion of shifting the cost curve for rebuilding.

Our benefits exercise suggested that rebuilding following the pre-war regional pattern is unlikely to be welfare maximizing. The underlying location advantages seem to favor western regions and Kyiv. There is an equity-efficiency tradeoff, however, because rebuilding away from the previously declining regions does cause pain for those citizens with strong idiosyncratic tastes for those regions. There might be strategic reasons for rebuilding in line with pre-war residential patterns that are outside our model.

Our discussion of costs focused on three strategies: openness, standardization and investing-in-investing. The openness strategy focuses on attracting foreign contractors and making it easier for Ukrainian firms to open, re-open or expand. Simple and transparent procurement rules can help make this system more open. Nationwide building codes and restricting the number of land use regimes can also increase entry and competition.

Standardization aims at generating returns to scale in building housing and other forms of infrastructure. A limited number of zoning types, as in Japan, can make this easier, as can national building codes. If home-building is public, the public sector can experiment with ordering large numbers of pre-fabricated homes. If home-building is private, then the government can invite private firms to add models to a list. The homes on the list get pre-approved for safety and other attributes. The firm promises a price that it commits to charge if the number of orders reaches a certain minimum.

Our final approach was investing-in-investing, which includes both physical and institutional investments. We include procurement reform as a form of such investing, but also ensuring a stable supply of electricity to enable domestic production capacity of key construction inputs to scale up as demand increases. This will require significant time and expenditure, which means that it is plausible to begin planning this process while the war still rages.

We conclude with a future research agenda for external scholars, researchers associated with the rebuilding effort, and economists working in countries that are engaged with the rebuilding process. The most obvious task for external scholars is to further develop our spatial and essentially static model. We assume that infrastructure investment yields immediate productivity effects, never suffers possible delays or coordination failures and never benefits from the learning-by-doing that can accompany large-scale reconstruction. Rebuilding is essentially dynamic and we hope that future work will produce a more dynamic model.

A dynamic model would make it possible to investigate the costs and benefits of faster rebuilding speeds. Ramping up slowly would make it possible to develop experience before undertaking the most sensitive tasks, but going slowly also means waiting for benefits. A dynamic model could explore optimal reconstruction sequencing. Does it make sense to focus on homes or factories or to do both simultaneously but slowly? Can input-output

linkages help us to understand what types of firms need to reopen first? A dynamic model would also make it possible to think about different financing models.

While a better model can be developed by scholars working in San Francisco or Sri Lanka, there is also a more data-driven research agenda which would require working together with the Ukrainian government and the entities that are guiding rebuilding. By directly observing rebuilding costs and outcomes, it would be possible to learn what factors predict success and failure in projects. Data transparency can make it relatively easy to understand the role of competition in procurement auctions and the costs of adding new features to infrastructure projects.

We have argued that openness to foreign firms can help ease supply constraints in producing construction sector goods, especially with the biggest projects. That openness can potentially lead to spillovers to Ukrainian workers and Ukrainian businesses. Future work could study how to foster technology transfer to local firms, and whether it is possible to encourage such transfer without raising costs of construction projects or introducing burdensome and discriminatory practices.

Finally, reconstruction in Ukraine will impact neighboring countries, donor countries and key trading partners. Scholars in those countries may want to study how the rebuilding of Ukraine is impacting the economies of their home countries. Ukraine's rebuilding needs are likely to be orthogonal to these local economies and so the rebuilding effort can potentially provide a source of exogenous variation. If the rebuilding effort ends up helping other countries then that might encourage future rebuilding. If the rebuilding effort causes harm, then the rebuilding process could potentially be tweaked to reduce that harm.

References

- ADES, A. F. AND E. L. GLAESER (1995): “Trade and circuses: explaining urban giants,” *The Quarterly Journal of Economics*, 110, 195–227.
- AHLFELDT, G. M. AND E. PIETROSTEFANI (2019): “The economic effects of density: A synthesis,” *Journal of Urban Economics*, 111, 93–107.
- AKBAR, P. A., V. COUTURE, G. DURANTON, AND A. STOREYGARD (2023): “The Fast, the Slow, and the Congested: Urban Transportation in Rich and Poor Countries,” Working Paper 31642, National Bureau of Economic Research.
- AKCIGIT, U., F. KILIC, S. LALL, AND S. SHPAK (2025): “Engineering Ukraine’s Wirtschaftswunder,” Tech. rep., National Bureau of Economic Research.
- ARTUC, E., N. GOMEZ-PARRA, AND H. ONDER (2023): “The true cost of war,” .
- BERNARD, A., M. KIRCHBERGER, AND M. PETERS (2025): “Cross-border flows in construction,” Work in Progress.
- BOSIO, E., S. DJANKOV, E. GLAESER, AND A. SHLEIFER (2022): “Public procurement in law and practice,” *American Economic Review*, 112, 1091–1117.
- ÇAKMAKLI, C., S. DEMIRALP, KALEMLI-ÖZCAN, S. YEŞILTAŞ, AND M. A. YILDIRIM (2021): “The Economic Case for Global Vaccinations: An Epidemiological Model with International Production Networks,” Working Paper 28395, National Bureau of Economic Research.
- COLLIER, P. (2011): “Savings and investment decisions in low-income resource-rich countries,” *Centre for the Study of African Economies, Department of Economics. Oxford University*.
- COLLIER, P., M. KIRCHBERGER, AND M. SÖDERBOM (2016): “The Cost of Road Infrastructure in Low-and Middle-Income Countries,” *World Bank Economic Review*, 30, 522–548.
- DAVIS, D. R. AND D. E. WEINSTEIN (2002): “Bones, bombs, and break points: the geography of economic activity,” *American Economic Review*, 92, 1269–1289.
- DAVIS, M. A. AND F. ORTALO-MAGNÉ (2011): “Household Expenditures, Wages, Rents,” *Review of Economic Dynamics*, 14, 248 – 261.
- DERYUGINA, T., A. ŽALDOKAS, A. FEDYK, Y. GORODNICHENKO, J. HODSON, AND I. SOLOGOUB (2025): “Rating Government Procurement Markets,” Working Paper 34479, National Bureau of Economic Research.
- GLAESER, E. L. AND J. D. GOTTLIEB (2009): “The wealth of cities: Agglomeration economies and spatial equilibrium in the United States,” *Journal of Economic Literature*, 47, 983–1028.
- GLAESER, E. L. AND J. GYOURKO (2005): “Urban decline and durable housing,” *Journal of Political Economy*, 113, 345–375.
- GLOBAL ENERGY MONITOR (2025): “Global Cement and Concrete Tracker,” July 2025 (V1)

release.

- GREANEY, B., A. PARKHOMENKO, AND S. VAN NIEUWERBURGH (2025): “Dynamic Urban Economics,” Working Paper 33512, National Bureau of Economic Research.
- GREEN, R. K., J. HENDERSON, M. E. KAHN, A. NIKOLSKO-RZHEVSKYY, AND A. PARKHOMENKO (2022): “Accelerating urban economic growth in Ukraine,” *Rebuilding Ukraine: Principles and Policies*, 241–282.
- HAMILTON, C. AND G. J. DE VRIES (2025): “The Structural Transformation of Transition Economies,” *World Development*, 191, 106977.
- INTERNATIONAL FINANCE CORPORATION (2025): “Rebuilding Ukraine: Investment Opportunities in Innovative and Sustainable Construction,” Tech. rep., International Finance Corporation, report prepared by the Country Advisory and Economics team for Europe, IFC.
- KIRCHBERGER, M. (2020): “The Construction Sector in Developing Countries: Some Key Issues,” in *Mining for Change: Natural Resources and Industry in Africa*, Oxford University Press.
- KIRCHBERGER, M. AND K. BEIRNE (2021): “Concrete Thinking About Development,” Trinity Economics Papers tep0621, Trinity College Dublin, Department of Economics.
- KLYMAK, M. AND T. VLANDAS (2024): “Governance in times of war: Public procurement in Ukraine,” *PLOS One*, 19, e0305344.
- KOVALCHUK, A., C. KENNY, AND M. SNYDER (2019): “Examining the Impact of E-Procurement in Ukraine,” Working Paper, Center for Global Development.
- KYIV SCHOOL OF ECONOMICS (2016): “Co-creation of ProZorro: An Account of the Process and Actors,” ISBN 978-3-96076-046-7, Transparency International.
- LEWIS-FAUPEL, S., Y. NEGGERS, B. A. OLKEN, AND R. PANDE (2016): “Can Electronic Procurement Improve Infrastructure Provision? Evidence from Public Works in India and Indonesia,” *American Economic Journal: Economic Policy*, 8, 258–83.
- LIU, E. (2019): “Industrial Policies in Production Networks,” *The Quarterly Journal of Economics*, 134, 1883–1948.
- SAIZ, A. (2010): “The Geographic Determinants of Housing Supply,” *The Quarterly Journal of Economics*, 125, 1253–1296.
- SCHER, C. AND J. VAN DEN HOEK (2025): “Nationwide conflict damage mapping with interferometric synthetic aperture radar: A study of the 2022 Russia–Ukraine conflict,” *Science of Remote Sensing*, 11, 100217.
- SERHIY PRYTULA CHARITY FOUNDATION (2025): “NEST,” <https://nestprytulafoundation.org/about/>, accessed: August 2025.
- SIBBEL, L. AND C. MIHES (2025): “Towards an effective, influential and inclusive social

dialogue in Ukraine: the path to recovery and reconstruction: 2025 update of the 2019 green paper,” in *Towards an effective, influential and inclusive social dialogue in Ukraine*, ed. by L. Sibbel and C. Mihes, International Labour Organization, ill.

STATE STATISTICS SERVICE OF UKRAINE (2025a): “Average number of regular workers by type of economic activity (monthly information),” <https://www.ukrstat.gov.ua>, accessed: 2025-11-11.

——— (2025b): “Labor statistics enterprises survey,” https://stat.gov.ua/en/explorer?urn=SSSU%3ADF_ENTERPRISE_LABOR_STATISTICS, accessed: 2025-11-20.

——— (2025c): “Start and completion of construction indicators,” <https://stat.gov.ua/en/publications/start-and-completion-construction-indicators>, accessed: 2025-08-28.

TAKEDA, K. AND A. YAMAGISHI (2024): “The economic dynamics of city structure: evidence from Hiroshima’s recovery,” .

USAID (2023): “White Paper – Activating and Strengthening Ukraine’s Reconstruction Capacity,” White paper, U.S. Agency for International Development, Washington, DC.

VAN OSS, H. G. (2005): “Background Facts and Issues Concerning Cement and Cement Data,” *US Geological Survey Open File Report*, 1152, 44.

WORLD BANK (2024): “International Comparison Program (ICP) 2021,” DataBank - World Bank Group.

A. Appendix: Quantitative Model

Model inversion. The TFP of a location can be obtained from equation (5) as

$$A_i = \left(\frac{w_i}{\alpha}\right)^\alpha \left(\frac{r}{1-\alpha}\right)^{1-\alpha}.$$

Then, its exogenous part can be separated from the part that depends on local employment. Since we do not observe the level of infrastructure, we can only identify the product

$$\bar{A}_i I_i^p = \frac{A_i}{N_i^\lambda}.$$

Similarly the value of amenities can be obtained from equations (3) and (1). The amenity value of location i relative to location j is

$$\frac{X_i}{X_j} = \left(\frac{N_i}{N_j}\right)^{\frac{1}{\epsilon}} \frac{w_j p_j^{-\gamma}}{w_i p_i^{-\gamma}}.$$

We can normalize X_i for one of the locations to 1 without loss of generality. The exogenous component of amenities can be separated from the endogenous component that depends on local employment. Since we do not observe the level of infrastructure, we can only identify the product

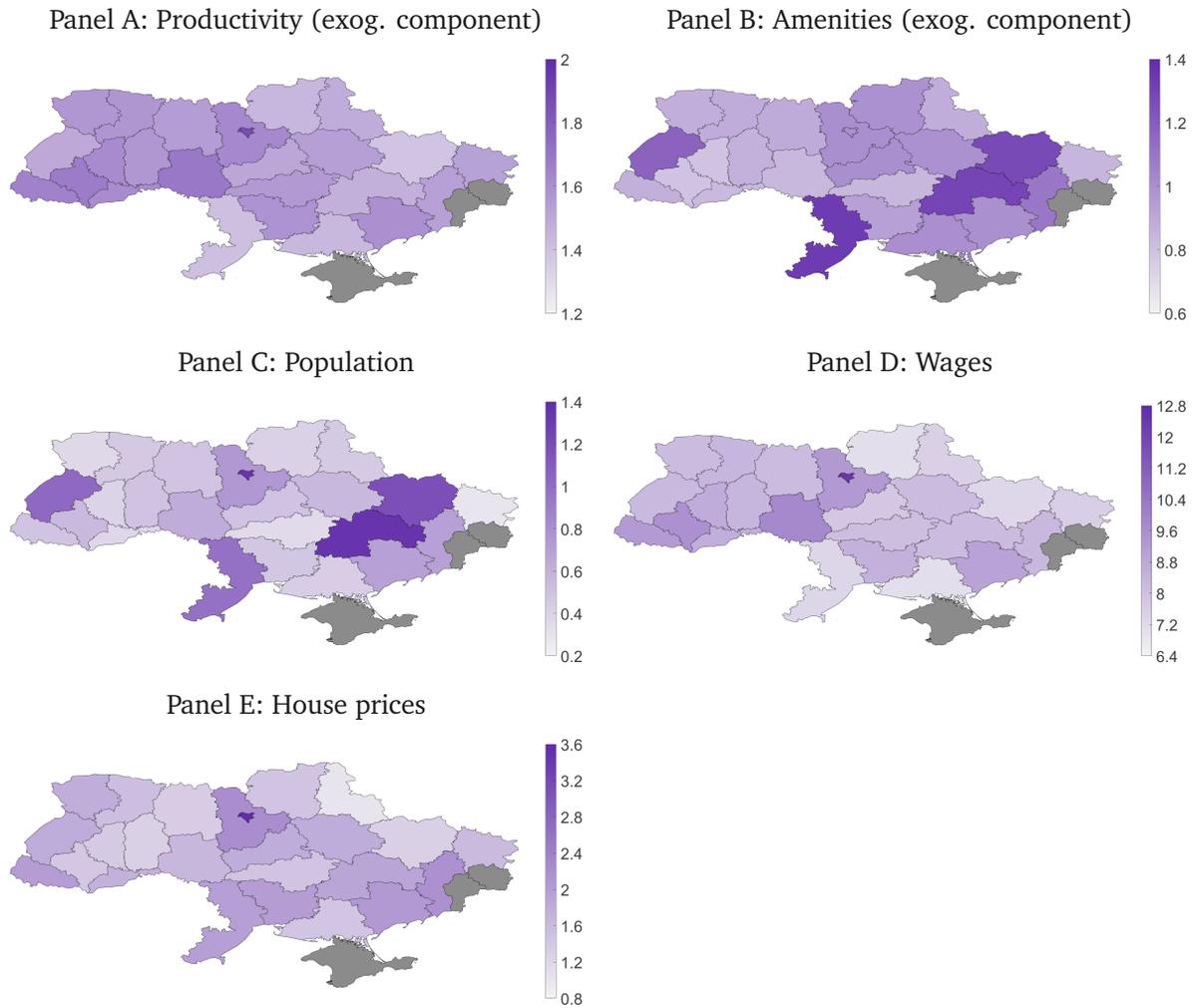
$$\bar{\theta}_i I_i^c = \frac{\theta_i}{N_i^\rho}.$$

Finally, construction costs can be inferred by assuming that demand is sufficiently high and inverting equation (7):

$$\chi_i = p_i^{\frac{1+\zeta}{\zeta}} (\gamma w_i N_i)^{-\frac{1}{\zeta}}.$$

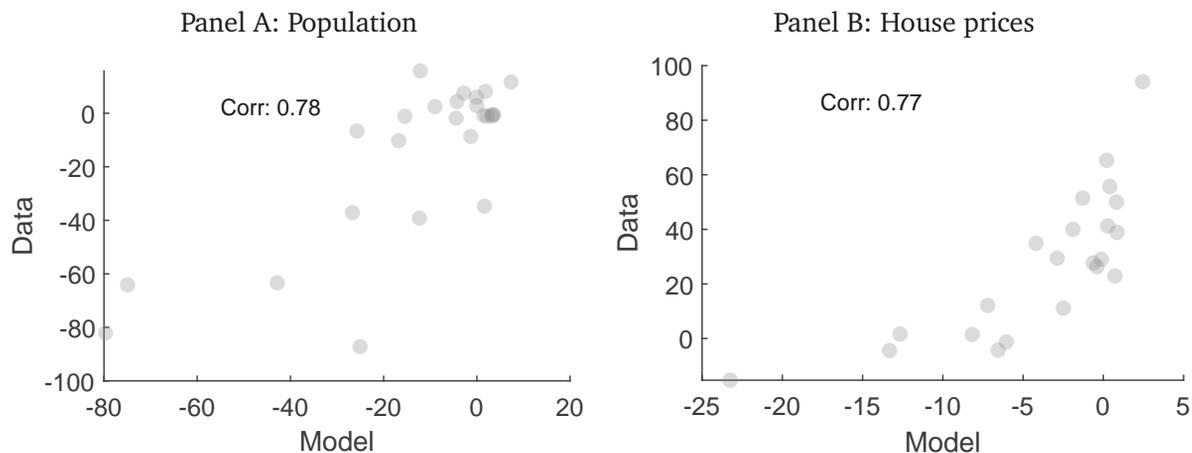
B. Appendix: Figures and Tables

Figure B.1: Benchmark economy



Note: The figure shows parameters and equilibrium variables in the 2021 economy. Territories occupied by Russia before February 2022 are shaded gray.

Figure B.2: Percentage changes in population and house prices, model vs data



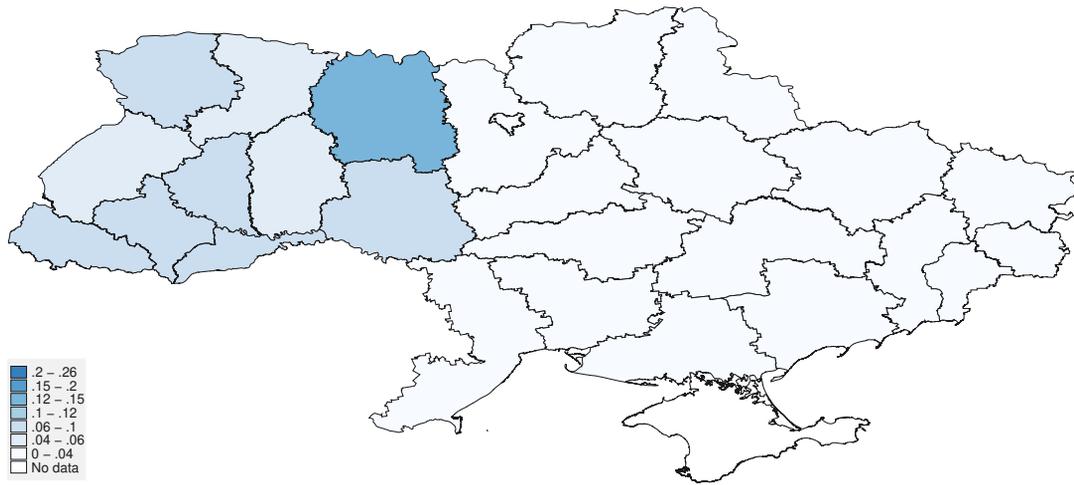
Note: The figure compares percentage changes in population and house prices between the model and the data.

Table B.1: Results for alternative specifications

| Aggregate results, percentage change | | | | |
|---|------------|--------|-------------|---------|
| | Population | Output | Output p.w. | Welfare |
| Main model: $\lambda = 0.05$ and $\rho = 0$ | -14.4 | -18.0 | -4.1 | -6.6 |
| Low production agglomeration: $\lambda = 0$ | -14.4 | -16.8 | -2.8 | -3.3 |
| High production agglomeration: $\lambda = 0.08$ | -14.4 | -18.8 | -5.2 | -9.6 |
| Low amenity agglomeration: $\rho = -0.05$ | -14.4 | -17.8 | -4.0 | -4.6 |
| High amenity agglomeration: $\rho = 0.05$ | -14.4 | -18.1 | -4.3 | -8.5 |
| Stone-Geary utility | -14.4 | -17.9 | -4.0 | -5.9 |

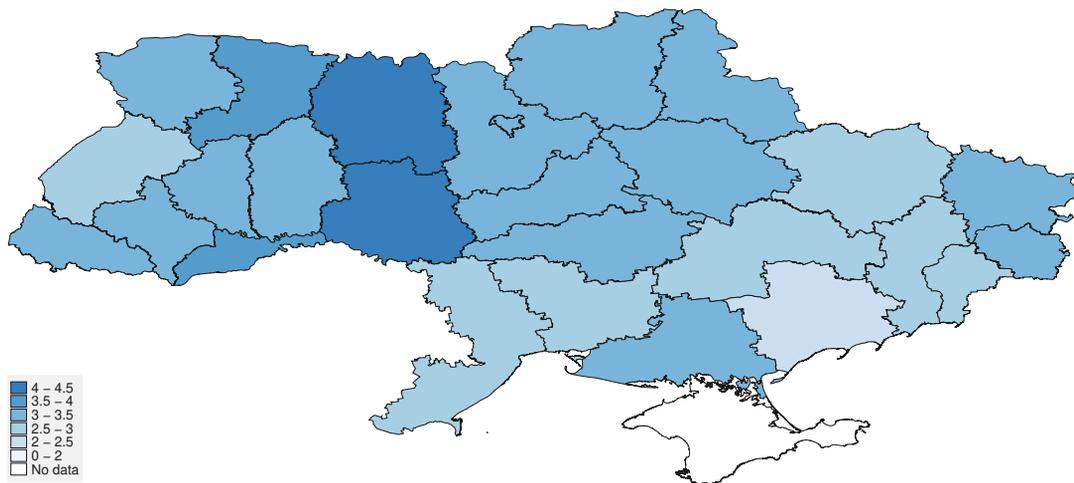
Note: The table shows aggregate results of wartime damages in the main model, as well as four alternative scenarios with lower and higher values of λ and ρ . It also shows the results for an alternative model with Stone-Geary utility function where the minimum consumption requirement is equal to 1/4 of the average housing consumption in Ukraine in the 2021 calibration. See the text for more details.

Figure B.3: Median cost savings for each Oblast for 2019.



Note: The figure shows median cost savings for procurements in construction-related categories. Darker shades represent higher cost savings compared to the estimated cost provided by the procurement entity before the auction.

Figure B.4: Median number of bidders for each Oblast for 2019.



Note: This figure shows the median number of bidders for procurements in construction-related categories. Darker shades represent a higher number of bidders.