DECENTRALIZATION AND TERRITORIAL AMALGAMATION: ECONOMIES OF SCALE AND RESILIENCE UNDER WARTIME CONDITIONS

by

Luka Khukhua

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Thesis Supervisor: _____ Professor Oleg Nivievskyi

Approved by _____
Head of the KSE Defense Committee, Professor

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Date _____

Kyiv School of Economics

Abstract

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This thesis examines whether Ukraine's decentralization and territorial amalgamation reform generated economies of scale in local public finance and how wartime exposure affected hromada fiscal outcomes. The analysis uses an unbalanced panel of Ukrainian hromadas for 2013–2025 and focuses on own-source revenues, administrative expenditures, and comparable total expenditures. Pre-war effects of voluntary amalgamation are estimated using the Callaway and Sant'Anna staggered difference-in-differences framework, while wartime exposure and institutional maturity are analyzed using TWFE models with hromada and year fixed effects.

The findings do not provide clear evidence of cost-saving economies of scale. Voluntary amalgamation is associated with higher own-source revenues, but also with higher administrative and comparable expenditures. Wartime effects differ by exposure type. Direct exposure is associated with lower own-source revenues and expenditures, likely reflecting disrupted budget execution, while risk exposure is associated with higher expenditures. Institutional maturity does not consistently moderate direct exposure effects, but more mature hromadas experience smaller expenditure increases under risk exposure.

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AI USE DECLARATION

During the preparation of this thesis, several AI-based tools were used as supplementary support. Grammarly was used for correcting mechanical errors, spelling mistakes, grammar, punctuation, and improving the readability of selected passages. ChatGPT and Google Gemini were used for brainstorming, ideas, improving the structure of the text, clarifying methodological explanations, troubleshooting code-related issues, and organizing tables, figures, captions, and appendices.

All AI-generated suggestions were critically reviewed, verified, and substantially modified by the author before being incorporated into the thesis. The tools were not used as an autonomous source of empirical evidence, did not independently produce the research findings, and did not replace the author's own data analysis, econometric estimation, interpretation of results, or conclusions. The research question, theoretical framing, empirical strategy, data construction decisions, final interpretation, and policy implications were developed and approved by the author. The author takes full responsibility for the originality, validity, and academic integrity of the thesis.

LIST OF ABBREVIATIONS

ATT — Average Treatment Effect

BOOST — World Bank BOOST public expenditure database

CPI — Consumer Price Index

CS-DiD — Callaway and Sant'Anna Difference-in-Differences

SA-DiD — Sun and Abraham Difference-in-Differences

DiD — Difference-in-Differences

FE — Fixed Effects

H1 / H2 / H3 — Hypothesis 1 / Hypothesis 2 / Hypothesis 3

KATOTTG — Codifier of Administrative-Territorial Units and Territories of Territorial Communities

KOATUU — Classifier of Objects of the Administrative-Territorial System of Ukraine

KSE — Kyiv School of Economics

NASA — National Aeronautics and Space Administration

NTL — Nighttime Lights

PIT — Personal Income Tax

TWFE — Two-Way Fixed Effects

UAH — Ukrainian Hryvnia

Chapter 1

INTRODUCTION

Over the last several decades, there has been a wave of decentralization and amalgamation reforms implemented globally (Tavares 2018). Following this international trend, in 2014, the Ukrainian government started one of the most ambitious administrative restructuring efforts in Europe. This reform marked a shift from the Soviet-era hierarchical, fragmented model with thousands of small, financially weak local councils to a system of capable units.

The process ended in 2020 when the amalgamation transitioned from voluntary to mandatory. Over 10,977 minor entities were consolidated into 1,469 Amalgamated Territorial Communities (hromadas), and the administrative map of Ukraine was finalized. Each of them was endowed with expanded fiscal and administrative powers (Nivievskyi et al. 2021).

This reform was based on two distinct dimensions: the institutional and the territorial. The institutional dimension (decentralization) focused on transferring powers and resources to local governments to bring decision-making closer to citizens, following the classical fiscal federalism logic (Oates 1999; Tiebout 1956). The key fiscal incentive in this process was granting hromadas the right to keep 60% of the personal income tax (PIT) collected within their territory, which has radically strengthened their fiscal independence. Before 2014, local councils relied heavily on intergovernmental transfers (subventions) and lacked incentives for fiscal discipline because the central government covered their deficits. In exchange for an increase in fiscal resources, hromadas were obligated to provide most of their public services independently. Therefore, by shifting the PIT retention, the central government forced hromadas to rely on their own economic activity and local tax base (Nivievskyi et al. 2021). At the same time, the territorial dimension

(amalgamation) was conducted, aimed at consolidating fragmented jurisdictions to achieve economies of scale.

The territorial amalgamation component is based on a separate economies-of-scale argument, which suggests that larger municipalities can provide public services more efficiently by spreading administrative fixed expenditures over a larger population (Holzer et al. 2009; Tavares 2018). Supporters of consolidation argue that small local governments lack the capacity. As stated in broader literature on amalgamation, local governments with a population below a certain threshold, often 3000-5000 people, cannot provide a full range of services (Swianiewicz 2010). This logic suggests that bigger will be better for administrative efficiency. Larger municipalities can lower per-capita administrative costs by hiring specialized professional staff to replace generalist village heads who usually perform their functions (Andrews and Boyne 2009). Prior to 2022, this approach appeared to work; hromadas were improving their infrastructure, building schools, reconstructing hospitals, and other public facilities (OECD 2018).

However, the full-scale russian invasion, which started on February 24, 2022, transformed Ukraine into a unique quasi-natural experiment, exposing newly formed institutions to an extreme stress test. The operating environment rapidly changed from stable development to chaos, with resource shortages and logistical disruption. In these conditions, the attributes that theoretically made hromadas "efficient", like resource centralization and more extensive geographical coverage, potentially become vulnerabilities.

Researchers in crisis management warn that efficiency often comes at the cost of spare resources, which are considered wasteful in peace but could be essential for survival in a shock (Boin and Lodge 2016). Furthermore, standard bureaucratic procedures, which form the basis of local government functioning, can fail in crises, where rapid improvisation is required (Boin and Lodge 2016).

A larger territorial size created by amalgamation complicates hromada performance during wartime. Consolidated units might provide services cheaply, but delivering them to the periphery costs more as the distance increases (Fox and Gurley 2006; Byrnes and Dollery 2002). In peacetime, this can be a manageable trade-off, but it can convert into diseconomies of scale in wartime conditions, which are characterized by restricted transport, heavily damaged roads, and other disrupted logistics. In this context, theoretical efficiency benefits that might be obtained through consolidation are offset by the exponential rise in the cost of reaching remote settlements, potentially making the bigger amalgamated unit less efficient than smaller councils.

Initial research on Ukraine's response to the invasion is largely focused on broad institutional resilience (Rabinovych et al. 2024). However, it remains empirically unverified if the fiscal strength and strategic capacity created by the decentralization and amalgamation reform continue to deliver better fiscal returns during the economic shock of war. The defining challenge in Ukrainian local governance today is the potential change from economies of scale to diseconomies of scale, as administrative advantages of larger consolidated units are traded off against the increasing marginal costs of service delivery in a conflict environment.

To the best of our knowledge, there is still limited empirical evidence in the literature on whether the fiscal gains expected from amalgamation persist under wartime conditions and whether more institutionally mature hromadas are better able to withstand the wartime shock. This thesis addresses this gap by combining pre-war analysis of amalgamation effects with wartime analysis of fiscal outcomes and institutional maturity. This thesis seeks to resolve these tensions by analyzing the performance of Ukrainian hromadas. It asks:

To what extent did territorial amalgamation generate economies of scale in Ukrainian hromadas, as reflected in key fiscal outcomes, and how were these outcomes affected by wartime exposure?

This thesis is organized as follows: Chapter 2 presents a literature review of existing studies on the economies-of-scale gains from the amalgamation and local government resilience. In Chapter 3, we state the research question and the hypotheses, and explain our econometric framework in detail. In Chapter 4, we describe the composition of the dataset and the construction of the main variables and present descriptive statistics. In Chapter 5, we present empirical results and discuss them. In Chapter 6, we summarize the main findings.

Chapter 2

LITERATURE REVIEW

2.1 Theoretical foundations of decentralization and territorial amalgamation

Over the past decades, decentralization and amalgamation have become the main instruments of public sector reforms in both developing and developed countries. The literature usually justifies these reforms by expecting that larger territorial units would achieve economies of scale, increase efficiency of public service delivery and proficiency of administrative staff (Tavares 2018), while decentralization would make decision-making more transparent and bring it closer to citizens (Oates 1999; Tiebout 1956). Although these objectives are often considered complementary, the literature shows that decentralization and amalgamation often target partially conflicting goals.

Decentralization concentrates on responsiveness and accountability, which may be harder to maintain in larger local units that can become distant from citizens (Oates 1999; Tavares 2018). The classical theory of decentralization originates in the fiscal federalism literature. Tiebout in his model of "voting with one's feet," which states that decentralization increases efficiency of public good allocation by allowing citizens to choose jurisdictions that better align with their preferences (Tiebout 1956). Oates, in his decentralization theorem, argues that public services should be provided by the lowest level of local government because smaller administrative units are better informed about heterogeneous local preferences (Oates 1999).

Territorial amalgamation is usually justified by a more specific efficiency argument. When several smaller jurisdictions are merged, the reform is expected to remove duplicated administrative offices and spread fixed administrative costs over a larger population (Tavares 2018). In this sense, the expected economy of scale is not necessarily a reduction in all local spending, but primarily a reduction in the per-

capita cost of administration. Larger hromadas may also be able to employ more specialized administrative staff, while small local councils often lack enough personnel to divide administrative tasks among separate specialists (Byrnes and Dollery 2002; Andrews and Boyne 2009).

At the same time, the literature states that economies of scale tend to improve efficiency only to a limited extent. Larger local governments may reduce duplicated administrative functions, but after a certain point, size can also make administration more costly, especially when the number of services provided increases or settlements become dispersed (Byrnes and Dollery 2002; Fox and Gurley 2006). Existing studies suggest tensions between these concepts gain additional significance under stress conditions, such as economic crises or internal and external conflicts, when assumptions about efficiency-oriented reforms no longer hold (Boin and Lodge 2016).

2.2 Economies of scale in municipal amalgamation: international empirical evidence

Despite the theoretical expectation that amalgamation should reduce local government costs, empirical studies do not provide clear support for this claim. First, administrative expenditures are generally considered a category where economies of scale are most likely. However, they usually represent only a limited part of the local budget. Given this, even if amalgamation leads to cost reduction, in that distinct category of spending, the effect can be offset by higher spending in other service areas. This pattern is supported by international empirical evidence. Similar results are found in other European contexts, especially Finland and the Netherlands (Moisio and Uusitalo 2013; Allers and Geertsema 2016).

Second, large-scale reviews generally find that municipal size alone is a weak predictor of efficiency (Holzer et al. 2009; Swianiewicz 2010; Tavares 2018). One

of the theoretical reasons is that the scale effect is different across service types. Capital-intensive services may benefit from a larger scale because their fixed costs can be spread over a larger population. At the same time, most public services, such as education, healthcare, and social protection, are relatively labor-intensive, so operational costs tend to increase with population. The overall results are mixed because of the opposite nature of these effects (Fox and Gurley 2006; Holzer et al. 2009).

The findings of Blom-Hansen et al. (2016) on the Danish reform partially support the previous statement. The reform reduced administrative expenditures and expenditures on roads, but these savings were offset by higher spending on labor market activities. At the same time, most service areas such as schools, daycare, elder care, culture, and children with special needs showed no systematic change. The authors explain this by distinguishing between the size of the local government jurisdiction and the scale of the actual service-production units. Amalgamation can reduce costs in firm-level administrative functions, but it does not automatically reduce costs in plant-level services delivered through schools, care facilities, or other local service units.

Another explanation of the mixed amalgamation result is related to the territorial dimension. Consolidation increases the area over which the services must be delivered. This means that larger municipalities' spending can be driven up by service-delivery costs to more dispersed territories. This is especially relevant for services that depend on local facilities and regular contact with residents, such as schools, social services, or basic local infrastructure (Fox and Gurley 2006).

Overall, empirical literature suggests that a more realistic expectation from amalgamation is that fiscal effects appear unevenly across budget categories. A decrease in costs, driven by the optimization of administrative structures or by spreading fixed costs over a wider population, can be outweighed by an increase in

other spending due to expanded service obligations and higher service-delivery costs. This distinction is important for the Ukrainian case, where the reform was not only a territorial merger but also a transfer of fiscal and administrative responsibilities to newly formed hromadas.

2.3 The Ukrainian decentralization reform pre-war evidence

Ukraine's decentralization reform is an interesting and, in some ways, unique empirical setting that combines several mechanisms that are often studied separately in the literature. First, newly formed hromadas not only increased in scale, but they also received a larger revenue base, including a share of PIT revenues; at the same time, they became responsible for financing a wider range of local services (Nivievskyi et al. 2021; OECD 2018). A second important feature is the staggered timing of the reform, as from 2015 to 2019, communities could decide whether and with whom to amalgamate, while the remaining units were consolidated through a mandatory stage in 2020 (Nivievskyi et al. 2021; Wright and Slukhai 2021).

It is important to understand that both fiscal decentralization and staggered amalgamation are not specific to the Ukrainian case. For example, gradual municipal mergers are also studied in the Dutch case by Allers and Geertsema (2016). What makes the Ukrainian case analytically important is that these mechanisms unfolded after the political and security shock of 2014, following the annexation of Crimea and the beginning of the conflict in Donbas (Wright and Slukhai 2021; OECD 2022). Therefore, the Ukrainian reform combines territorial consolidation, fiscal decentralization, and institutional adjustment under external pressure.

The Ukrainian pre-war evidence does not support the simple expectation that amalgamation should reduce local spending. OECD assessments describe the

decentralization and amalgamation reform as generally positive, but with uneven results. Problems with strategic planning, limited human capacity, and weak coordination between different levels of government meant that gains in administrative capacity and service provision were not equally distributed across hromadas (OECD 2018, 2022).

These broader assessments are partly supported by the more applied fiscal evidence of Nivievskyi et al. (2021). Using local budget data for 2012–2018, they estimate the effect of voluntary amalgamation on several fiscal indicators, including own and land-related revenues, recurrent administrative and capital expenditures, special grant-related and salary-related expenditures, and the revenue-expenditure ratio. Their results do not show a simple cost-saving effect. Revenues increased after amalgamation, but expenditures increased as well, while the revenue-expenditure ratio declined over time. This suggests that the reform strengthened the fiscal scale of hromadas, but did not make them cheaper to operate. Another interesting, suggestive result is a possible learning-curve effect: earlier cohorts and hromadas with more years after amalgamation show stronger revenue effects and some signs of more efficient expenditure management. However, they stress that longer post-reform data are needed for stronger conclusions.

More skeptical assessments argue that the reform's main instruments had clear limits. The voluntary phase still left many small and financially weak local units, inter-municipal cooperation remained too limited to compensate for this problem, and fiscal incentives increased revenues without making all hromadas financially sustainable (Wright and Slukhai 2021).

Therefore, the Ukrainian literature gives a cautious interpretation of the reform. It suggests that amalgamation strengthened local fiscal capacity, but did not guarantee lower expenditures or equal capacity across hromadas. Existing empirical evidence is also limited by the period it covers, focusing on the early voluntary phase and

stressing that longer post-reform data are needed for stronger conclusions, especially about possible learning effects. Also, its effect should be separated across different fiscal outcomes. This is important for this research because only examining different fiscal outcomes, representing the spending and revenue sides of local budgets, can give a full picture of amalgamation results.

2.4 Resilience, crisis governance, and wartime local government performance

The full-scale invasion placed Ukraine's newly formed hromadas under conditions very different from those assumed in the pre-war decentralization reform. By 2020, these hromadas had already become larger and more institutionally responsible local units. The war, therefore, tested not only whether larger local governments could operate more efficiently, but also whether these newly empowered institutions could preserve basic fiscal and administrative functions under external military pressure.

Ukraine differs from the cases usually discussed in the literature on decentralization during conflict or state weakness. Much of this literature focuses on internal conflict, weak state capacity, or contested domestic authority. Ukraine's case is different: local governments had to operate during a full-scale interstate invasion, where fragility was created mainly by external military aggression rather than by the collapse of domestic institutions. For this reason, the wartime period changes the analytical question. The issue is no longer only whether amalgamation generated economies of scale before the war, but whether hromadas could maintain revenue capacity and expenditure functions when exposed to direct hostilities, occupation, or wartime risk.

Crisis-governance literature helps explain this shift. Crises not only reduce available resources but they also change what public organizations are required to do. Boin and Lodge (2016) argue that extreme events test the ability of institutions to

preserve critical functions, coordinate across actors, and adapt beyond routine administrative procedures. Boin and Hart (2003) similarly emphasize that crisis response cannot rely only on hierarchical command, because large crises create multi-actor response networks that require lateral coordination. Applied to hromadas, this means that the same territorial and administrative scale that may be useful in peacetime can become more difficult to manage under wartime conditions, especially when revenues are disrupted, service needs change, and coordination problems become more severe.

The Ukrainian wartime literature supports this interpretation. Hromadas' resilience during the first months of the invasion was shaped by geographical, politico-administrative, and economic factors, including characteristics linked to decentralization such as hromada size, type, resources, and institutional capacity (Rabinovych et al. 2024). Their findings suggest that resilience was not only a matter of having a larger budget. It also depended on proximity to the front line, local networks, preparedness, and the ability to maintain basic services under threat.

The ICLD/KSE study shows that hromadas were actively involved in civilian crisis response, including support for internally displaced people, infrastructure repair, emergency communication, and continuity of basic services during the full-scale invasion (Keudel et al. 2024). These functions required not only financial resources but also an effective administrative structure, capable of coordinating with state and non-state actors and adjusting existing administrative routines to new wartime conditions. This may be relevant for the institutional-maturity argument of this thesis: hromadas that had existed longer before the full-scale invasion may have had more time to gain experience in self-government, organize internal procedures, and develop practical crisis-response capacity.

Overall, existing wartime studies mainly examine resilience, governance practices, and crisis response, while the fiscal dimension of local wartime resilience remains

less developed. It is still unclear how wartime pressure affected hromadas' budget capacity and whether pre-war institutional experience changed their ability to withstand this fiscal pressure.

2.5 Research gap and hypotheses development

The reviewed literature points to a more conditional fiscal mechanism behind economies of scale from amalgamation. If cost savings exist, they are most likely to appear in administrative expenditures, where fixed administrative costs can be spread over a larger population. However, this effect depends on a variety of factors, such as territorial or service type structure, and institutional context (Tavares 2018; Fox and Gurley 2006). A reduction in one expenditure category can also be offset by an increase in other categories of spending. This creates the first gap for this thesis: the effect of amalgamation should be tested separately for administrative expenditures and broader types of expenditures rather than treated as a single aggregate cost-saving effect.

The literature on Ukrainian amalgamation reform narrows this gap. Existing studies suggest that decentralization and voluntary amalgamation increased local fiscal capacity before the full-scale invasion, but they do not show a simple reduction in spending. Revenues increased, but expenditures increased as well, and earlier cohorts may have benefited from a learning process over time. However, this evidence is still limited in two ways. First, it mainly covers the early voluntary phase of the reform; there is limited understanding of how the effects evolved over time after the voluntary amalgamation. Second, suggestive results about the possible learning curve effects in local budgets are understudied.

The wartime literature on Ukraine addresses local resilience in crisis response, concentrating on the role of hromadas in maintaining basic services during the invasion. However, it mostly studies governance practices and resilience

mechanisms rather than fiscal outcomes. It remains unclear how wartime exposure affected local fiscal capacity. It is also unclear whether hromadas with longer pre-war experience as amalgamated units were better able to manage wartime fiscal pressure.

This thesis addresses these gaps by connecting the pre-war fiscal effects of voluntary amalgamation with the wartime fiscal performance of hromadas. It first revisits the economies-of-scale argument using data covering the voluntary phase up to 2019 and separates the fiscal effects across own-source revenues, administrative expenditures, and broader expenditure categories. This allows the analysis to distinguish between revenue-capacity effects and possible expenditure reduction effects, rather than treating amalgamation as a single cost-saving effect. The analysis is extended to the wartime period by examining whether wartime exposure after 2022 was associated with changes in fiscal outcomes. Finally, it tests whether the pre-war institutional maturity of hromadas moderated these wartime fiscal effects.

Chapter 3

METHODOLOGY

3.1 Hypotheses and Empirical Design

We decompose the research question into the main empirical mechanisms to address it. It includes economies of scale after amalgamation, wartime effects on fiscal outcomes, and the role of institutional maturity in moderating this effect. Thus, we may suggest three hypotheses based on existing literature:

H1: Voluntary territorial amalgamation during the initial phase of reform (2015-2019) was expected to generate economies of scale, reflected in stronger own-source revenue capacity and lower per-capita expenditure levels, particularly administrative expenditures. This hypothesis is based on policy and theoretical logic of territorial amalgamation reforms, which are commonly justified by expectations of improved efficiency, lower costs, and stronger local-government capacity (Tavares 2018; Allers and Geertsema 2016). However, this expectation should be treated cautiously. Existing empirical studies show that amalgamation cost savings usually appear in administrative expenditures, while broader expenditure categories often show mixed results depending on the type of service and local context (Holzer et al. 2009; Tavares 2018). Thus, the general cost decrease is not guaranteed.

H2: After 2022, wartime exposure weakened the fiscal performance of hromadas by increasing expenditure pressure and shrinking their own-source revenues. This hypothesis is based on the crisis-governance literature, which argues that crises disrupt administrative systems, forcing public authorities to shift towards emergency responses, coordination, and adaptation (Boin and Hart 2003; Boin and Lodge 2016). In the Ukrainian wartime context, this placed additional responsibilities on local governments, such as to support displaced populations,

affected residents, and repair infrastructure (Keudel et al. 2024). At the same time, occupation, destruction, and displacement caused by war may weaken local own-source revenue (Keudel et al. 2024; Rabinovych et al. 2024).

H3: Institutional maturity, measured as the duration of the hromada's existence as an amalgamated unit before the full-scale invasion, mitigates the negative effect of war exposure on fiscal outcomes. This hypothesis is motivated by pre-war Ukrainian evidence suggesting a possible learning curve effect in revenues of local budgets after amalgamation, although it is suggestive and requires further research (Nivievskyi et al. 2021). If institutional capacity develops over time, hromadas that had existed longer as amalgamated units before 2022 may have had more time to build administrative experience, budgeting routines, and local capacity. During wartime, these created capacities may become important for local governments to respond to war-related shocks. For this reason, institutional maturity is expected to reduce the negative fiscal effect of wartime exposure (Rabinovych et al. 2024).

In this study, we use a panel dataset of Ukrainian hromadas to test these hypotheses. The analysis is based on three connected but different specifications. Economies of scale in this thesis are estimated through key fiscal outcomes that represent expenditure pressure, administrative burden, and local revenue capacity.

3.2 Data Structure and Sample Construction

In our research, we use an unbalanced panel of Ukrainian hromadas with observations at the hromada-year level covering the period 2013-2025. The main reasons for this are the timing of amalgamation, wartime disruptions, and full or partial occupation, which lead to missing fiscal records in some years. Thus, the unbalanced structure of the dataset partly reflects the institutional and wartime environment under study. An extremely small number of hromada-year observations with zero values across all main fiscal variables were treated as

missing, since such records more likely reflect incomplete budget reporting than the absence of local fiscal activity.

We use separate specifications to estimate the effect of amalgamation and war exposure. To avoid mixing identification logics, we split the main dataset into two subsets to test different hypotheses. The first one captures the period of voluntary amalgamation and the pre-reform period (2013-2019). The second subset (2020-2025) includes 2020-2021 as a pre-war baseline and 2022-2025 as the period of full-scale war.

In the wartime sample used for H2 and H3, we exclude observations under full occupation, because such observations may not reflect regular local budget operations. After this, we classify remaining cases as indirect exposure, risk exposure, or no exposure. Direct exposure refers to hromada-year observations that were either in an active combat zone or partially occupied. Risk exposure refers to hromada-years, which are territories of possible hostilities, but currently there are no direct military clashes or partial occupation at that time.

Consistent annual hromada-level data are not available for the full period of analysis, so we used extrapolated population values to construct per capita variables. For the pre-war period, we extrapolated the 2022 population backward to 2013 using oblast-level population growth rates. Also, as a robustness check, we construct an alternative denominator based on each hromada's share in the corresponding oblast population in 2022. For the period after the beginning of the full-scale invasion, the 2022 population of hromadas is extrapolated forward using nighttime lights. Because post-2022 population estimates are uncertain, we also construct lower- and upper-bound population variants based on 95% confidence intervals and use them as robustness checks. Since population values are estimated, per-capita outcomes may partly reflect uncertainty in the population denominator,

especially after 2022. The extrapolation procedure is explained in the data section and Appendix E.

3.3 Outcome Variables and Measurement of Economies of Scale

Based on international and Ukrainian empirical evidence, we consider two main fiscal channels through which amalgamation may affect hromadas: the expenditure channel and the revenue channel (Blom-Hansen et al. 2014; Nivievskyi et al. 2021). On the expenditure side, administrative expenditures are the main outcome where economies of scale are expected to appear, since larger hromadas may reduce duplicated administrative functions and spread fixed administrative costs over a larger population. At the same time, it is important to check whether possible administrative savings are offset by changes in other expenditure categories. On the revenue side, own-source revenues are used to capture whether amalgamation strengthened the fiscal capacity of hromadas.

Therefore, the analysis uses three main outcomes: own-source revenues per capita, administrative expenditures per capita, and comparable total expenditures per capita. Administrative expenditures are expressed per capita because the expected economies-of-scale mechanism is population-based: larger hromadas may spread fixed administrative costs over a larger number of residents. For the other outcomes, per-capita normalization makes fiscal outcomes comparable across hromadas of different population sizes and shows changes in average fiscal capacity or expenditure burden. The exact construction of these outcomes is described in the data section; some revenue and expenditure categories are excluded to keep the variables comparable across synthetic pre-amalgamation hromadas and post-amalgamation hromada budgets.

3.4 Empirical Models

We use a dynamic difference-in-differences framework to test the first hypothesis because treatment is heterogeneous in time, so it cannot be estimated with classical TWFE DID models. Hypotheses 2 and 3 are estimated as fixed effect models with hromada and year fixed effects.

3.4.1 Hypothesis 1: Pre-war Effects of Voluntary Amalgamation

Different hromadas voluntarily amalgamated in different years in the period from 2015 to 2019, which means staggered adoption of the reform. The classical two-way fixed-effect DiD models give a biased estimate in such cases due to model comparing units treated in later periods with already treated ones. To deal with this problem, we decided to use the Difference-in-Differences model developed by Callaway and Sant'Anna, which enables estimation of group-time average effects working correctly with staggered treatments (Callaway and Sant'Anna 2021). The specification of the model is presented in equations (1) and (2).

$$ATT(g,t) = E[\, Y_{it}(g) - Y_{it}(0) \mid G_i = g \,] \tag{1}$$

$$ATT(e) = \sum_{g \in G_e} w_{g,e}\, ATT(g, g+e) \tag{2}$$

Where i denotes hromada, and t year. Y_{it} denotes the fiscal outcome in the year t for the hromada i. The year when hromada i was first treated is G_i, the treatment group is voluntarily amalgamated hromadas, and the control group is hromadas that are not yet treated at the respective period. $Y_{it}(g)$ represents the outcome for

the hromada i in year t if became treated in year g, and $Y_{it}(0)$ represents the potential outcome for the same hromada in year t in the absence of treatment.

$ATT(g,t)$ is the average treatment effect for hromadas that were treated in year g and evaluated in calendar year t. Identification of these effects is based on the conditional parallel trend assumption, which implies that without treatment, all units would have similar dynamics of outcomes after conditioning on the included covariates.

$ATT(e)$ is dynamic effects obtained by aggregating these group-time treatment effects by event time $e = t - g$, , where e measures the number of years before or after amalgamation. This allows us to estimate not only the average effect of voluntary amalgamation, but also how the effect changes over time. This dynamic perspective is important because the fiscal effects of amalgamation may not appear immediately. Newly amalgamated hromadas may need time to reorganize administration, adjust budgeting routines, and use the larger institutional scale more effectively (Tavares 2018; Nivievskyi et al. 2021). The baseline specification controls for the logarithm of area and hromada type, and group-time effects are estimated using the doubly robust procedure. Standard errors are clustered at the hromada level using bootstrap inference.

3.4.2 Hypothesis 2: The fiscal effects of wartime exposure

We tested the second hypothesis on the wartime subset (2020-2025). Its main goal is to test whether different types of war exposure reduce the fiscal performance of the hromada. Treatment in this case is not the amalgamation but exposure to wartime conditions. The model distinguishes between direct exposure and risk exposure. Direct exposure refers to hromada-years affected by active hostilities or

partial occupation, while risk exposure refers to territories of possible hostilities without direct combat or partial occupation in the same year.

To check this, we use the TWFE model with hromada and year fixed effects. The first one captures all hromada geographical and historical features which do not differ in time, while the second accounts for general macroshocks which affect all hromadas. The specification of the model is presented in equation (3).

$$Y_{it} = \beta_1 DirectExposure_{it} + \beta_2 RiskExposure_{it} + \alpha_i + \gamma_t + \varepsilon_{it} \quad (3)$$

In this model, Y_{it} denotes fiscal outcome in year t for hromada i, $DirectExposure_{it}$ is a binary variable equal to 1 if hromada was affected by active hostilities or partial occupation. $RiskExposure_{it}$ is an indicator equal to 1 if the hromada was a territory of possible hostilities, but there was no direct combat or partial occupation there in the same year, α_i is the hromada fixed effect, and γ_t is the year fixed effect, ε_{it} is the error term. The war effects in this model are captured by the coefficient, β_1 and β_2 which shows the change in outcome value associated with the corresponding type of exposure relative to non-exposed hromada-years. Standard errors are clustered at the hromada level to account for serial correlation within hromadas over time. Since wartime exposure is not randomly assigned, we interpret coefficients in this model as fixed-effects associations rather than fully causal effects.

This model choice follows empirical conflict studies that compare local units with and without conflict exposure and link exposure status to local or household outcomes (Odozi and Oyelere 2021; Abay et al. 2023). We do not use staggered-adoption design because wartime exposure is a changing hromada-year condition rather than a one-time reform, and most hromadas with direct exposure were first

exposed in 2022, leaving little meaningful variation in first-exposure timing as given in the Appendix A, Table 15.

3.4.3 Hypothesis 3: Institutional maturity and wartime exposure

The third hypothesis tests whether institutional maturity mitigates the negative war effect on fiscal outcomes. It evaluates how the magnitude of war shock differs relative to the time the hromada existed as a united unit before the beginning of full-scale war in 2022. We check these effects by extending the baseline TWFE model with the interaction of two types of war exposure and institutional maturity. Specification of the model is given in equation (4):

$$\begin{aligned} Y_{it} = \beta_1 DirectExposure_{it} + \beta_2 RiskExposure_{it} + \\ + \beta_3 (DirectExposure_{it} \times Maturity_i) + \\ + \beta_4 (RiskExposure_{it} \times Maturity_i) + \\ + \alpha_i + \gamma_t + \varepsilon_{it} \end{aligned} \quad (4)$$

Where $DirectExposure_{it}$ is an indicator of direct war exposure $RiskExposure_{it}$ is the risk exposure variable, and $Maturity_i$ is centered institutional maturity of hromada i, measured by the number of years between the hromada's creation and 2022. α_i is the hromada fixed effect, γ_t is the year fixed effect, and ε_{it} is the error term.

In this model, coefficients show the effect of direct and risk exposure on the hromada with average institutional maturity, while represents how these effects change with each additional year of institutional maturity. If the interaction terms are statistically significant, it means that the fiscal effect of wartime exposures differs between younger and more mature hromadas. So, the model is assessing the heterogeneity of the war effect dependent on institutional maturity. Standard errors

are clustered at the hromada level. Since wartime exposure is not randomly assigned, the coefficients are interpreted as fixed-effects associations rather than fully causal effects.

3.5 Robustness Checks

To check if the main results of the models are robust, different specifications and alternative samples are used. The main goal of these tests is to ensure that the results are not dependent on specific transformations of data, covariates, the definition of treatments, or wartime sample restrictions in the case of the second and third hypotheses.

3.5.1 Robustness checks for Hypothesis 1

To check the robustness of the results for the first hypothesis, we use several different verifications. First is an alternative level of winsorization at 2nd–98th percentiles to test the sensitivity to extreme values. Second, we estimate the model without covariate variables to check if estimates are dependent on conditioning on area and type. In the third, we use alternative population values in per-capita terms to exclude estimates' dependence on the method of normalization of fiscal outcomes. Also, we re-estimate the H1 using fiscal outcomes normalized per square kilometer instead of per capita, to check whether the results depend on population-based normalization. It may also account for the territorial dimension of hromadas, since larger administrative areas may create additional service-delivery and administrative burdens. The results are reported in the Appendix B, Table 16 and Figure 14.

Additionally, pre-treatment dynamics are assessed using the CS-DiD pre-test p-value reported in the main results table, and a placebo test is used as a weak

diagnostic check, since the available pre-reform period covers only two years. Finally, the main results are compared to the alternative Sun and Abraham specification (Sun and Abraham 2021). This specification is used in a similar empirical context of economies of scale in Ukrainian hromadas (Nivievskyi et al. 2021).

3.5.2 Robustness checks for Hypotheses 2 and 3

For the second and third hypotheses, the robustness check focuses on whether the estimates are dependent on the definition of war exposure and the structure of the wartime sample. For H2, first we check if hromadas that later became exposed to direct or risk wartime conditions already had different fiscal outcomes before the full-scale invasion, so we conduct short pre-trend for 2020-2021 years. Second, we split direct exposure into two components: active hostilities and partial occupation. This checks whether the baseline variable mixes two different effects. Third, we estimate models with continuous exposure durations measured in ten-day units instead of binary exposure indicators.

In our baseline wartime sample, we exclude all hromada-year observations with any full occupation, so to test results sensitivity to occupation, we use a less strict exclusion rule and leave hromadas that were fully occupied for less than a full year in the sample. As the fifth, we use an alternative population denominator for the per-capita fiscal outcomes. This is important because the population for 2023-2025 was extrapolated using nighttime lights, which may affect per-capita measures. Finally, we exclude 2022 to test whether the results are driven mainly by the first year of the full-scale invasion.

Most of these tests are common for H2 and H3 because both hypotheses use the same wartime sample and the same definitions of direct and risk exposure. However, we conduct additional tests for H3 because it includes the interaction

between wartime exposure and institutional maturity. We check if results are dependent on the way institutional maturity is measured, and we estimate specification with maturity groups instead of a continuous centered maturity variable. As the second test, we use age at first direct or risk exposure as an alternative maturity measure. We also re-estimate H2 and H3 with fiscal outcomes normalized per square kilometer; the results are given in Appendix C, Table 20, and Appendix D, Table 21.

Chapter 4

DATA

4.1 Data sources and panel construction

We use an unbalanced panel dataset of Ukrainian hromadas covering the period from 2013 to 2025. The unit of observation is hromada-year. Final dataset combines several types of information: local budget data, territorial characteristics of hromadas, estimated population values, and data about the type and amalgamation of hromadas, war exposure data.

Primary data on the local budget level were obtained from two main sources of information: World Bank BOOST Ukraine for financial data from 2013 to 2017, and the Open Budget web portal for executed local budget data of hromadas in the period from 2018 to 2025 (World Bank n.d.; Ministry of Finance of Ukraine n.d.). Data are structured according to the World Bank (BOOST) methodology, which includes classifications at administrative (budget name and code), functional (category of expenditure), and economic (category of income) levels. The raw financial datasets consist of annual nominal values in Ukrainian hryvnia (UAH).

We used the most recent available version of the official "List of territories where hostilities are/were conducted or temporarily occupied by the Russian Federation" available at the time of data collection to identify hromadas affected by wartime exposure. The list was accessed in March 2026 and was published under the Order of the Ministry for Communities and Territories Development of Ukraine No. 376 dated February 28, 2025, registered by the Ministry of Justice of Ukraine on March 11, 2025, under No. 380/43786 (Ministry for Communities and Territories Development of Ukraine 2025).

Data on hromada characteristics, amalgamation status, amalgamation date, area, and hromada type were taken from the KSE-Loc-Data-Hub GitHub repository (Kyiv School of Economics n.d.). The repository contains hromada-level datasets and derived files for research on Ukraine's decentralization reform.

Oblast-level annual population data for 2013–2021 were taken from the official database of the State Statistics Service of Ukraine through the Statistical Data Explorer (State Statistics Service of Ukraine n.d.-a). These data are used to calculate oblast-level population growth rates. Hromada-level population values for the beginning of 2022 were taken from the KSE-Loc-Data-Hub dataset, which reports these values based on official State Statistics Service of Ukraine population data (Kyiv School of Economics n.d.). Since direct annual hromada-level population data were not available for 2013–2021, the 2022 hromada population is extrapolated backward using the corresponding oblast-level population growth rates.

Old KOATUU and new KATOTTG codifiers were used to harmonize administrative identifiers and settlement names across pre- and post-amalgamation administrative structures (Kyiv School of Economics n.d.). This harmonization is necessary to link fiscal records reported for old local councils to contemporary hromada units.

We used NASA Earthdata nighttime lights data as the primary data source for nighttime-light intensity (NASA n.d.). It is used to estimate population values after the full-scale invasion, using nighttime-light-based extrapolation.

The inflation adjustment is based on the Consumer Price Index from the State Statistics Service of Ukraine (State Statistics Service of Ukraine n.d.-b). Since local budget values are reported in nominal Ukrainian hryvnias, CPI data were used to convert all monetary fiscal variables into constant prices of 2021, which we use as a base year.

We made several steps to construct the final dataset and make it comparable across years of observations. First, local budget records were harmonized across pre- and post-amalgamation administrative structures. Fiscal data before amalgamation were reported for old local councils and cities of oblast significance. Using KOATUU and KATOTTG identifiers, old local councils and settlements were matched to contemporary hromada units. The accuracy of this matching procedure was checked manually. Then, in pre-amalgamation years, we summed the budgets of local councils that were later amalgamated into the same hromadas, creating synthetic hromada budgets for years when these hromadas did not yet legally exist. This makes it possible to compare fiscal outcomes before and after amalgamation using a consistent territorial unit.

After aggregating fiscal data, we added population estimates and information about hromadas' area, year of amalgamation, and wartime exposure indicators. Fiscal data were converted to 2021 prices. The final panel was then used to construct separate samples to estimate models, and the main outcomes: own-source revenues per capita, administrative expenditures per capita, and comparable total expenditures per capita.

4.2 Analytical samples and key variables

We use two separate data samples in our empirical analysis. The first one covers the period 2013-2019, and we use it to estimate the pre-war voluntary amalgamation effect. Treatment is defined by the year of voluntary amalgamation. The 2020-2025 period is used to estimate the second and third hypotheses; in this sample, treatment is defined as exposure to wartime conditions. This allows the analysis to treat amalgamation and wartime exposure as distinct empirical mechanisms.

Table 1 presents the composition of the analytical samples. The H1 pre-war sample includes 10,051 hromada-year observations and 1,438 unique hromadas.

Table 1 Composition of analytical samples

Sample	Years	Empirical use	Hromada-year observations	Unique hromadas
H1 pre-war sample	2013-2019	H1: amalgamation effects	10,051	1,438
H2/H3 wartime sample	2020-2025	H2/H3: wartime exposure effects	8,262	1,438

Note: H1 includes 859 voluntary amalgamated hromadas and 579 comparison hromadas. H2/H3 include 329 direct/risk exposed hromadas and 1,109 non-exposed hromadas.

The wartime exposure sample used for H2 and H3 includes 8,262 hromada-year observations. In this sample, hromadas are classified as directly exposed, risk-exposed, or non-exposed. Also, we exclude hromada-year observations with any full occupation, because such fiscal records may not reflect local budget regular operations.

After organizing samples, we constructed the main fiscal variables from revenue and expenditure categories and war exposure variables. Table 2 summarizes the construction of the main variables used in the empirical analysis.

Own-source revenues are calculated as total revenues excluding personal income tax and official transfers. Official transfers are excluded because they reflect intergovernmental redistribution rather than locally generated fiscal capacity. Income tax is excluded because of the synthetic hromada budget composition. Synthetic hromada budgets are constructed from the lowest level of local budgets, which received 25% of PIT before the reform. During the decentralization reform, the allocation of PIT across local and higher budget levels changed to 60% for amalgamated hromadas. Therefore, if personal income tax is included, changes in

own-source revenues could partly reflect new PIT-sharing rules and differences in budget-level assignment rather than changes in comparable local fiscal capacity.

Table 2 Construction of main variables

Variable	Construction	Used in
Own-source revenues per capita	(Total revenue - personal income tax - transfers) / population	H1, H2, H3
Administrative expenditures per capita	Administrative expenditures / population	H1, H2, H3
Comparable total expenditures per capita	(Total expenditures - healthcare - education - social protection) / population	H1, H2, H3
Direct exposure	Indicator equal to 1 if active hostilities or partial occupation are recorded in a hromada-year	H2, H3
Risk exposure	Indicator equal to 1 for territories of possible hostilities without active hostilities or partial occupation	H2, H3
Institutional maturity	Number of years between hromada creation and 2022	H3

Following the same comparability logic, the next main variable, comparable total expenditures, is constructed. It is calculated as total expenditures excluding healthcare, education, and social protection. These categories were often reported at the rayon or other higher budget levels before the reform. Excluding them reduces the risk that changes in expenditures reflect reassignment of budget responsibilities rather than changes in local fiscal activity.

The last main variable, administrative expenditures, is reported in the BOOST data as a high-level functional expenditure category, coded as 0100; we use this category directly. We normalize all mentioned outcomes by population to get own-source revenues per capita, administrative expenditures per capita, and comparable total expenditures per capita.

Wartime exposure variables are constructed based on the type of exposure. Direct exposure variable combines the effects of active combat in the hromada or partial occupation. Risk exposure captures hromada-years classified as territories of possible hostilities, where direct exposure is absent. These effects are studied separately because they are expected to differently affect the fiscal outcomes of hromadas. Institutional maturity is calculated as the number of years between amalgamation and the beginning of the full-scale invasion. This variable captures how long the hromada had existed as an amalgamated administrative unit before the full-scale war. In the interaction model, it is centered around its sample mean to make the main exposure coefficients interpretable for hromadas with average institutional maturity.

Since consistent annual hromada-level population data are not available for the full period, the observed 2022 hromada population is used as the baseline, and population values for years without direct hromada-level data are estimated. For the 2013-2021 period, these values are estimated backward using oblast-level population growth rates. We use urban and rural population growth rates for corresponding types of hromadas to account for differences in potential population growth trends between them. For each hromada, population in the previous year was calculated as population in the current year divided by one plus the corresponding oblast-level population growth rate. This estimation approach is also used in similar amalgamation literature (Nivievskyi et al. 2021). As an alternative population denominator, we used a fixed-share extrapolation method. For each hromada, we calculated its share in the corresponding oblast population in 2022 and then multiplied it by the oblast population in the year being estimated.

For 2023–2025, hromada population is extrapolated from the 2022 population baseline using changes in nighttime-light intensity. The 2021 nighttime-light value is used as the pre-war baseline, and population in each wartime year is estimated by scaling the hromada population as of January 1, 2022, by the change in

nighttime-light intensity relative to 2021, adjusted by the estimated population–nighttime-light elasticity. These values are used as approximate wartime population denominators. The full extrapolation procedure, including the nighttime-light regression and estimated coefficient, is reported in Appendix E.

4.3 Transformations and descriptive statistics

Figure 1 presents annual median values in the three main fiscal outcomes from 2013 to 2025. We can see that all fiscal outcomes generally increased, although the growth had a different pace across outcomes.

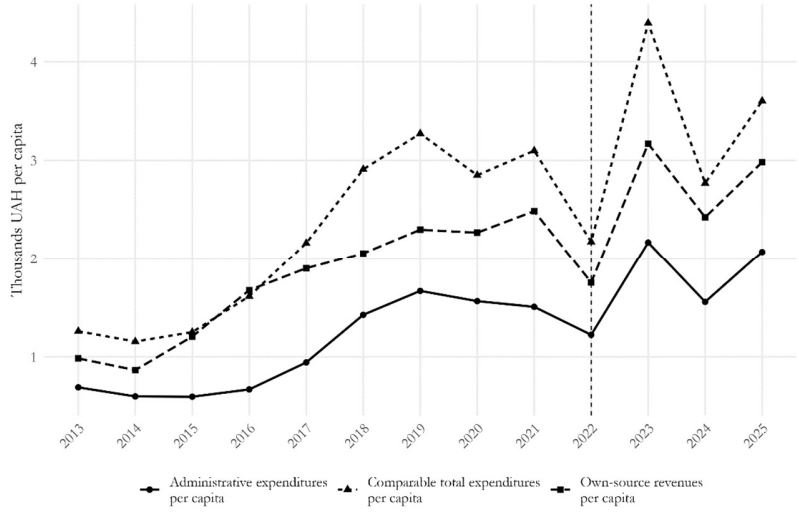


Figure 1 Annual median values of the three main fiscal outcomes, 2013–2025

From this figure we can see that administrative and comparable total expenditures were growing intensively in the period from 2016, while own-source revenues showed more gradual dynamics. In 2022, we can see a sharp decline associated with the beginning of the full-scale invasion. The following years show high volatility of

outcomes, but this pattern should be treated cautiously because wartime per-capita values rely on extrapolated population denominators.

Figures 5–7 in Appendix A show trends by amalgamation status. All three fiscal outcomes follow a similar pattern: after the start of voluntary amalgamation, the groups began to differ in trends, especially in administrative and comparable total expenditures. Appendix Figure 8 provides additional descriptive evidence on the aggregate revenue and expenditure structure of voluntary and non-voluntary hromadas during 2013–2019. These figures are used only as descriptive background and not as evidence of treatment effects. Formal pre-trend tests for the main variables are reported in the results section.

Observations with zero total revenue or zero total expenditure were treated as missing, since a fully zero annual budget is unlikely to be a valid fiscal record. Negative own-source revenues were also treated as missing because they result from the construction of the variable after subtracting personal income tax and transfers. The number of such observations is extremely small. In Table 3, we report descriptive statistics for the pre-war samples.

Table 3 H1 pre-war sample (2013-2019)

Variable	N	Mean	SD	Median	Min	Max
Own-source revenues per capita (UAH)	10,051	1,844.52	1,665.56	1,488.84	6.79	38,419.46
Administrative expenditures per capita (UAH)	10,051	1,129.35	1,003.02	811.38	28.57	15,912.07
Comparable total expenditures per capita (UAH)	10,051	2,325.18	1,975.51	1,731.64	51.46	29,085.88
Population (thousands)	10,051	24.96	72.80	12.02	1.82	1,481.47
Area (sq. km.)	10,051	385.14	298.86	296.80	2.40	2,497.10

Note: Fiscal outcomes are in 2021 prices.

The H1 pre-war sample includes 10,051 hromada-year observations. Mean own-source revenues per capita equal 1,844.52 UAH, while mean administrative expenditures per capita equal 1,129.35 UAH. Comparable total expenditures are higher, with a mean of 2,325.18 UAH per capita. All three fiscal outcomes have large standard deviations, which shows substantial heterogeneity across hromadas even before the full-scale invasion. The median values are lower than the means, especially for comparable total expenditures, which suggests a right-skewed distribution, where a smaller number of hromadas have much higher fiscal values than the typical hromada in the sample. The mean population is 24.96 thousand, while the median is 12.02 thousand, showing that the sample includes many relatively small hromadas and a smaller number of much larger units. Table 4 reports descriptive statistics for the H2/H3 wartime sample, which covers 2020–2025.

Table 4 H2/H3 wartime sample (2020-2025)

Variable	N	Mean	SD	Median	Min	Max
Own-source revenues per capita (UAH)	8,255	3,178.42	3,382.31	2,432.11	2.08	106,705.67
Administrative expenditures per capita (UAH)	8,259	2,232.46	2,714.70	1,626.30	158.81	131,446.33
Comparable total expenditures per capita (UAH)	8,259	4,347.17	5,670.84	3,053.82	234.42	296,492.04
Population (thousands)	8,262	22.06	59.66	11.05	1.09	1,450.02
Area (sq. km.)	8,262	379.22	297.17	292.60	2.40	2,497.10
Institutional maturity (years)	8,262	3.84	1.81	3.00	2.00	7.00
Active war exposure (days)	8,262	5.28	39.18	0.00	0.00	366.00
Partial occupation (days)	8,262	7.31	48.79	0.00	0.00	366.00
Potential exposure (days)	8,262	22.99	84.30	0.00	0.00	366.00

Note: Fiscal outcomes are in 2021 prices; exposure variables are measured in days per year.

We can see that fiscal outcomes are higher in the wartime sample. Mean own-source revenues per capita increase to 3,178.42 UAH, administrative expenditures per capita increase to 2,232.46 UAH, and comparable total expenditures per capita increase to 4,347.17 UAH. At the same time, the standard deviations are large, especially for own-source revenues and comparable total expenditures, which indicates strong variation across hromadas during the wartime period. The number of observations differs slightly across fiscal outcomes because some fiscal records were treated as missing after data-quality checks. The mean population in the wartime sample is 22.06 thousand, while the median is 11.05 thousand, which again shows that the sample is dominated by relatively small hromadas.

Wartime exposure is highly concentrated. Active war exposure and partial occupation have mean values of 5.28 and 7.31 days per year, but their medians are zero. Potential exposure is more common, with a mean of 22.99 days, but its median is also zero. This means that most hromada-year observations are not exposed in a given year, while a smaller group experiences high wartime exposure. The mean institutional maturity is 3.84 years, meaning that the average hromada in the wartime sample had existed for almost four years before the full-scale invasion. The difference in mean area between the pre-war and wartime samples reflects sample restrictions rather than changes in hromada boundaries, since area does not change over time.

The fiscal variables used in the analysis are highly skewed because Ukrainian hromadas differ strongly in population size, area, economic capacity, and wartime exposure. To reduce the influence of extreme observations, we winsorized the main fiscal variables at the 1st and 99th percentiles. After winsorization, we use a natural logarithmic transformation to mitigate the right-skewness of the data. After the transformations, the estimated coefficients are approximately interpretable as a percentage change. Figure 2 shows the distribution of administrative expenditures per capita before and after winsorization and log transformation.

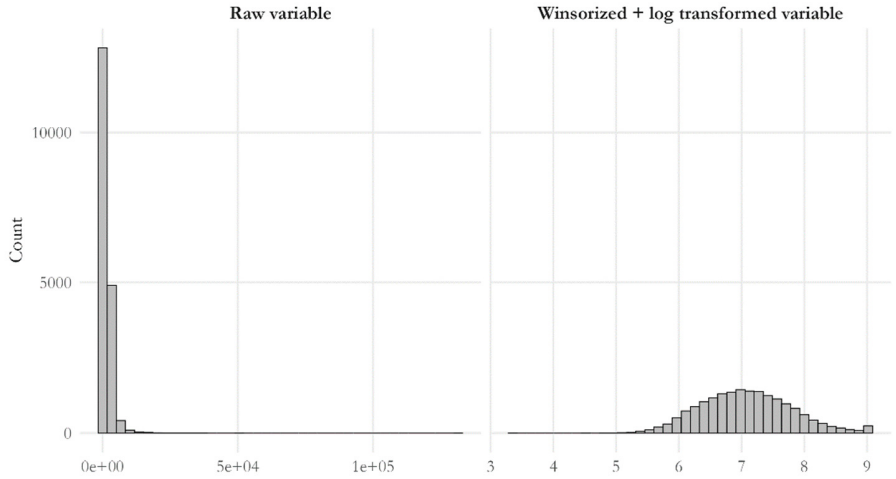


Figure 2 Distribution of administrative expenditures per capita before and after transformation

After transformation, the distributions become more bell-like and more suitable for regression analysis. The figures showing the distribution of own-source revenues per capita and comparable total expanditures per capita before and after the transformation are given in the Appendix A Figures 10 and 11.

Chapter 5

RESULTS

5.1 Hypothesis 1: Pre-war effects of voluntary amalgamation

5.1.1 Average treatment effects

We use average treatment effects for key fiscal outcomes to check if amalgamation was associated with systematic changes in three main outcome variables: own-source revenues per capita, administrative expenditures per capita, and comparable total expenditures per capita. The estimated effects are given in Table 5.

Table 5 Average treatment effects of voluntary amalgamation

VARIABLES	**(1) Own-source revenues per capita**	**(2) Administrative expenditures per capita**	**(3) Comparable total expenditures per capita**
ATT	0.044***	0.437***	0.362***
	(0.014)	(0.015)	(0.016)
CS-DiD pre-test p-value	0.718	0.019	0.244
Observations	10051	10051	10051

Note: Clustered standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Outcomes are winsorized at the 1st and 99th percentiles and transformed using the natural logarithm.

Considering that the main variables are log-transformed, the coefficients should be interpreted approximately as a percentage change; for the exact percentage interpretation, the coefficient is first exponentiated, then one is subtracted from this value, and the result is multiplied by 100. Therefore, ATT shows changes on the relative scale, not in monetary values.

As we can see from the table, all main coefficients show a positive average effect of voluntary amalgamation. The expenditure-side effects are much larger than the revenue-side effect. Administrative expenditures per capita have the largest estimate of 0.437, which is approximately equal to a 54.8% increase. Comparable total expenditures per capita show a slightly smaller but still substantial ATT coefficient of 0.362, which corresponds to approximately a 43.6% increase. Own-source revenues per capita are also positive but noticeably lower, with an estimate of 0.044, which indicates approximately a 4.5% increase in own-source revenues. Average amalgamation effects are highly statistically significant ($p < 0.01$). The table also shows CS-DiD pre-trend test p-values, which indicate that evidence on pre-treatment trends is not equally strong for all outcomes. For own-source revenues and comparable total expenditures, the p-values are 0.718 and 0.244 ($p > 0.05$), so there is no clear evidence that treated and comparison hromadas had different trends before amalgamation. However, for administrative expenditures, the p-value is 0.019, so this outcome does not pass the CS-DiD pre-trend test and should be interpreted more cautiously.

The results show that voluntary amalgamation can be associated with higher average values in expenditures and revenues of local governments. This may suggest that the average effect has been more pronounced in the change of expenditure volumes than in the increase of the income base. At the same time, a large positive coefficient for administrative expenditures should be interpreted carefully, as treated and comparison hromadas may already have had different trends before the reform, and the effect may partially reflect pre-existing differences rather than only the effect of voluntary amalgamation.

Thus, the ATT estimates do not provide full support for H1 because the results are mixed. While own-source revenues per capita have a positive effect, which was stated in the hypothesis, both administrative expenditures per capita and comparable total expenditures also have a positive effect, which is inconsistent with

the expected direction of the hypothesis. In addition, the estimates do not show when the effect emerged after amalgamation or its persistence over time. Because of this, we look at dynamic treatment effects in the next subsection.

5.1.2 Dynamic treatment effects

To make a more precise analysis of the first hypothesis, we estimated the dynamic treatment effects of voluntary amalgamation. These effects show how the main fiscal outcomes changed before and after hromada unification. Figure 3 presents the results on the expenditure side of the main variables.

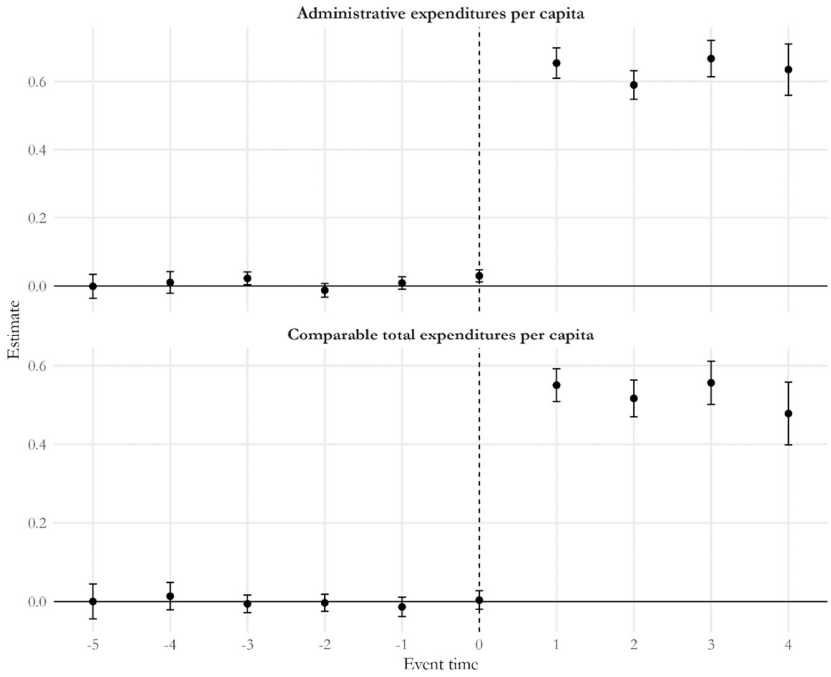


Figure 3 Event-study estimates of voluntary amalgamation effects on expenditure outcomes

In the two panels, we can see that after the treatment, the expenditure variables show strong positive changes. For administrative expenditures per capita, dynamic effects become strongly positive in the first year after the unification and stay positive throughout the post-treatment horizon. The value of the coefficients ranges from 0.590 to 0.667, which shows that this type of expenditure has increased substantially. Similar dynamics can be seen for comparable total expenditures per capita. Post-treatment effect is also significantly higher and stays in the range of 0.48 - 0.56. Therefore, both expenditure variables are associated with an increase in expenditure burden after amalgamation. We show the dynamic effect on own revenues in Figure 4.

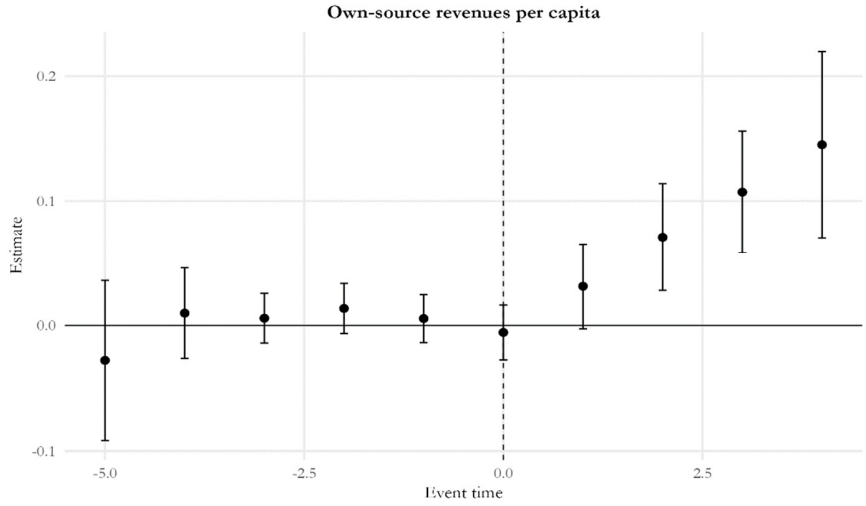


Figure 4 Event-study estimates of voluntary amalgamation effects on own-source revenues per capita

Own-source revenues per capita show a different dynamic of coefficients. In the first year after the amalgamation, the effects stay weak and gradually increase in the next years. Four years after amalgamation, the effect reaches 0.15, which may

suggest that the positive effect of amalgamation on the own income base of hromadas appears more gradually than the expenditure increase. This pattern may be consistent with a gradual learning or adjustment process: newly amalgamated local governments may need time to adapt their administrative capacity, improve revenue collection, and make better use of the expanded local revenue base. However, this interpretation should be treated cautiously, since the event-study estimates show the timing of the effect but do not directly identify the specific administrative mechanism behind it.

Taken together, the dynamic treatment effects additionally support the mixed results from the previous specification. On the one hand, own-source revenues show a positive dynamic, which aligns with the hypothesis and suggests a gradual strengthening of local revenue capacity. On the other hand, the expenditure side shows strong positive effects, which is not supported by the expected cost-saving mechanism. Therefore, neither the dynamic nor the average effects fully support H1. This means that voluntary amalgamation may have strengthened fiscal capacity, but it did not generate clear expenditure savings in the observed period.

5.1.3 Robustness checks for H1

Since the estimates consistently show positive effects for all main outcomes, but administrative expenditures do not pass the pre-trend test, this subsection checks whether the main pattern remains stable under alternative specifications. To check the robustness of the main H1 results, we run several additional tests. Table 6 shows average treatment effects with different winsorization levels, an alternative per capita population denominator, a specification without covariates, and an additional placebo test.

Table 6 Robustness checks for average treatment effects

VARIABLES	(1) Own-source revenues per capita	(2) Administrative expenditures per capita	(3) Comparable total expenditures per capita
Main specification	0.044***	0.437***	0.362***
	(0.014)	(0.015)	(0.016)
Alternative winsorization 2-98	0.040***	0.434***	0.362***
	(0.014)	(0.015)	(0.015)
Alternative population denominator	0.043***	0.436***	0.361***
	(0.015)	(0.014)	(0.016)
No covariates	0.062***	0.427***	0.369***
	(0.014)	(0.014)	(0.015)
Placebo	0.021*	0.034***	-0.014
	(0.012)	(0.010)	(0.013)

Note: Clustered standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

As we can see from Table 6, the average treatment effects remain positive and highly significant across all main robustness specifications. For own-source revenues per capita coefficients stay in the range of 0.040-0.062. Coefficients on the expenditure side also remain stable in narrow ranges of 0.427-0.437 for administrative expenditures per capita and in the range from 0.361 to 0.369 for comparable total expenditures. This shows that the main ATT results are not dependent on changes in variable transformations, the set of controls, or the population denominator.

Placebo coefficients are significant for administrative expenditures and own-source revenues, which suggests that treated and comparison hromadas may have followed different pre-treatment dynamics. However, placebo coefficients are much smaller than the main ATT estimates. For example, the administrative expenditures placebo coefficient is 0.034, compared with the main ATT of 0.437.

Thus, the placebo test does not overturn the main result, but it weakens the causal interpretation, especially given the short 2013–2014 pre-amalgamation period.

Table 7 compares the event-study estimates from the Callaway and Sant'Anna DiD specification with the Sun and Abraham DiD specification.

Table 7 Comparison of dynamic treatment effects: Callaway & Sant'Anna vs Sun & Abraham

	Own-source revenues per capita		**Administrative expenditures per capita**		**Comparable total expenditures per capita**	
Event time	**CS-DiD**	**SA-DiD**	**CS-DiD**	**SA-DiD**	**CS-DiD**	**SA-DiD**
-5	-0.028	-0.064**	-0.001	-0.024	0.000	0.026
	(0.031)	(0.028)	(0.018)	(0.027)	(0.023)	(0.030)
-4	0.010	-0.073***	0.010	-0.025	0.014	0.014
	(0.018)	(0.020)	(0.016)	(0.019)	(0.018)	(0.021)
-3	0.006	-0.050***	0.022**	-0.002	-0.006	0.022
	(0.010)	(0.015)	(0.010)	(0.015)	(0.011)	(0.016)
-2	0.013	-0.020**	-0.013	-0.009	-0.003	0.013
	(0.009)	(0.010)	(0.010)	(0.010)	(0.011)	(0.011)
-1	0.005	—	0.009	—	-0.014	—
	(0.009)		(0.009)		(0.013)	
0	-0.006	0.005	0.030***	0.030***	0.004	0.007
	(0.011)	(0.011)	(0.009)	(0.009)	(0.012)	(0.011)
1	0.031*	0.053***	0.654***	0.648***	0.550***	0.558***
	(0.016)	(0.016)	(0.023)	(0.020)	(0.021)	(0.020)
2	0.071***	0.101***	0.590***	0.577***	0.517***	0.523***
	(0.022)	(0.021)	(0.021)	(0.020)	(0.024)	(0.022)
3	0.107***	0.149***	0.667***	0.644***	0.556***	0.562***
	(0.026)	(0.025)	(0.027)	(0.026)	(0.028)	(0.027)
4	0.145***	0.204***	0.635***	0.614***	0.478***	0.506***
	(0.041)	(0.041)	(0.038)	(0.037)	(0.041)	(0.038)

Note: Clustered standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

From Table 7, we can see that post-treatment effects for administrative expenditures and comparable total expenditures are positive and statistically significant in the first year after amalgamation. The coefficients in both specifications are similar. For administrative expenditures, the post-treatment coefficients range from 0.590 to 0.667 in the CS-DiD specification and from 0.577 to 0.648 in the Sun and Abraham specification. A similar pattern is observed for comparable total expenditures: the coefficients range from 0.478 to 0.556 in the CS-DiD specification and from 0.506 to 0.562 in the Sun and Abraham specification. This shows that the expenditure-side result does not depend on the choice of the event-study model. In both specifications, voluntary amalgamation is followed by a rapid and persistent increase in expenditure outcomes rather than by expenditure savings.

For own-source revenues per capita, the Sun and Abraham specification shows statistically significant negative coefficients before amalgamation at event times -5, -4, -3, and -2. This provides weaker support for the parallel trends assumption for this variable, and it is consistent with the placebo test results, which also indicate caution for the revenue outcome. Therefore, the positive post-treatment increase should be interpreted cautiously. It may be partially related to pre-existing differences between amalgamated hromadas and the comparison group.

As an additional robustness check, Appendix B, Table 16 reports the H1 estimates using fiscal outcomes normalized by area instead of population. The expenditure-side results remain very similar: administrative expenditures per square kilometer and comparable total expenditures per square kilometer are both positive and statistically significant. However, the effect on own-source revenues per square kilometer is positive but no longer statistically significant. This suggests that the expenditure-side findings are more robust to alternative normalization, while the revenue effect is weaker and more sensitive to how fiscal outcomes are scaled.

5.2 Hypothesis 2: Wartime change of fiscal outcomes

5.2.1 Main war exposure specification

This subsection reports results for H2 based on the baseline wartime exposure specification. Table 8 presents estimates for the three main fiscal outcomes, with direct exposure and risk exposure included as separate variables.

Table 8 Main wartime exposure specification

VARIABLES	(1) Administrative expenditures per capita	(2) Comparable total expenditures per capita	(3) Own-source revenues per capita
Direct exposure	-0.104**	-0.208***	-0.863***
	(0.043)	(0.046)	(0.082)
Risk exposure	0.238***	0.265***	0.061*
	(0.032)	(0.032)	(0.035)
Hromada FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Observations	8259	8259	8255
Within R2	0.021	0.035	0.118

Note: Clustered standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. All outcomes are winsorized at the 1st and 99th percentiles and transformed using the natural logarithm.

As we can see from Table 8, most exposure coefficients are highly statistically significant; at the same time, we can observe different patterns between direct and risk exposure. Direct exposure is associated with a decrease in fiscal outcomes. Own-source revenues per capita show the strongest effect with a coefficient of -0.863, which means that the exposed hromada has approximately 57.8% lower own revenues than non-exposed. On the expenditure side, direct exposure is associated with milder negative effects, with administrative expenditures -0.104 and

comparable total expenditures -0.208 being 9.9% and 18.8% lower compared to non-exposed hromadas.

Risk exposure is associated with higher fiscal outcomes, especially on the expenditure side. It is associated with approximately 26.9% higher administrative expenditures per capita and 30.3% higher comparable total expenditures per capita. The coefficient for own-source revenues is also positive, but much smaller and only weakly significant: 0.061, or approximately 6.3%.

Overall, the baseline results provide partial support for H2. The negative effect of direct exposure on own-source revenues is consistent with the hypothesis that war exposure weakens local fiscal capacity. However, the expenditure results are more mixed. Direct exposure is associated with lower expenditures, while risk exposure is associated with higher expenditures. Therefore, the results suggest that the effects of wartime exposure are linked to different fiscal patterns based on type of exposure. Direct exposure is associated with a reduction in both revenues and expenditures, while risk exposure is associated with increased expenditure needs and slightly higher own-source revenues.

5.2.2 Robustness check specifications

In Table 9, we show the results of three robustness specifications. First, we estimate the model with a less strict exclusion rule for hromada-year observations with full occupation. For the second test, we exclude the year of the beginning of the full-scale invasion. Finally, we test variables with alternative population denominators. The key robustness question is whether the two main baseline patterns remain stable: direct exposure is associated with lower fiscal outcomes, while risk exposure is associated with higher expenditure outcomes.

Table 9 Robustness summary for direct and risk exposure effects

Specification	Administrative expenditures per capita		Comparable total expenditures per capita		Own-source revenues per capita	
	Direct	**Risk**	**Direct**	**Risk**	**Direct**	**Risk**
Baseline	-0.104**	0.238***	-0.208***	0.265***	-0.863***	0.061*
	(0.043)	(0.032)	(0.046)	(0.032)	(0.082)	(0.035)
Less strict occupation exclusion	-0.228***	0.247***	-0.340***	0.276***	-0.876***	0.076**
	(0.036)	(0.032)	(0.037)	(0.032)	(0.059)	(0.035)
Excluding 2022	0.166**	0.277***	-0.071	0.307***	-1.480***	0.086**
	(0.068)	(0.034)	(0.074)	(0.033)	(0.139)	(0.037)
Alternative population denominator	-0.104**	0.251***	-0.207***	0.278***	-0.861***	0.073**
	(0.044)	(0.033)	(0.047)	(0.033)	(0.083)	(0.036)

Note: Clustered standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. All specifications include hromada and year fixed effects. The alternative population denominator robustness uses upper-bound fixed-oblast-share population estimate and applies to all per capita outcomes.

From Table 9, we can see that direct exposure remains negatively associated with own-source revenues in all specifications. The coefficients are -0.876 under the less strict occupation-exclusion rule, -0.861 when the alternative population denominator is used, and both estimates are close to the baseline estimate. When 2022 is excluded, the negative direct-exposure effect on own-source revenues becomes even larger with a coefficient of -1.480 corresponding to approximately a 77% decrease. This suggests that the negative association between direct exposure and own-source revenues is robust across the tested specifications.

On the expenditure side, robustness tests show more mixed results. Alternative population denominator specifications show almost identical estimates for both outcomes. Using a less strict occupation-exclusion rule leads to larger negative effects. At the same time, after excluding 2022, the coefficient of -0.071 becomes statistically insignificant for comparable total expenditures, and the coefficient 0.166 changes sign to the opposite for administrative expenditures. Therefore, the

expenditure-side effect of direct exposure is less stable than the revenue effect and appears more sensitive to the treatment period and sample composition.

Risk exposure shows a more consistent pattern, remaining positively associated with fiscal outcomes in all specifications. The coefficients also stay close to baseline estimates, but effects are smaller for own-source revenues. This supports the interpretation that risk exposure is associated with higher fiscal activity, especially on the expenditure side.

In Table 10, direct exposure is decomposed into active hostilities and partial occupation to check how the result is driven by this component. In addition, we estimated the same specification with continuous days variables instead of binary indicators; the results are given in Appendix C, Table 17.

Table 10 Decomposed direct exposure specification

VARIABLES	(1) Administrative expenditures per capita	(2) Comparable total expenditures per capita	(3) Own-source revenues per capita
Active hostilities	-0.062	-0.071	0.008
	(0.053)	(0.050)	(0.072)
Partial occupation	-0.143**	-0.281***	-1.218***
	(0.068)	(0.073)	(0.117)
Risk exposure	0.233***	0.261***	0.072**
	(0.032)	(0.032)	(0.035)
Hromada FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Observations	8259	8259	8255
Within R2	0.023	0.040	0.153

Note: Clustered standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. This specification decomposes direct exposure into active hostilities and partial occupation.

Table 10 shows that the negative direct-exposure effect is mainly driven by partial occupation. The coefficients for active hostilities are not statistically significant for any of the three main outcomes. In contrast, partial occupation is associated with lower administrative expenditures and comparable total expenditures, and especially lower own-source revenues. The coefficient for own-source revenues under partial occupation is -1.218, corresponding to approximately a 70.4% decrease, which indicates a very large decline in local revenue capacity. Risk exposure remains positive and statistically significant in this specification.

Appendix C provides additional H2 diagnostics. The short pre-trend test in Table 19 shows no significant pre-2022 coefficients for expenditure outcomes, while own-source revenues have a weakly significant coefficient. The continuous exposure-duration specification in Table 17 shows that partial occupation remains negatively associated with own-source revenues, but the expenditure-side results are less stable: partial occupation duration is not statistically significant for administrative expenditures, while both partial occupation and active hostilities duration are significant for comparable total expenditures. Under area-based normalization in Table 20, the risk-exposure coefficient for own-source revenues changes from positive to negative, so this revenue-side result should be interpreted cautiously.

Overall, the robustness checks support the main H2 conclusion that wartime exposure produces different fiscal patterns depending on exposure type. Direct exposure is consistently associated with a strong decline in own-source revenues, while risk exposure is consistently associated with higher expenditures. However, the expenditure effects of direct exposure are less stable across specifications, and the revenue effect of risk exposure is sensitive to normalization. The weak pre-trend result means that future exposed hromadas may already have differed in own-source revenues before the full-scale invasion.

5.3 Hypothesis 3: Institutional maturity and wartime exposure

5.3.1 Main interaction specification

The interaction specification examines whether the effect of wartime exposure on fiscal outcomes changes with the institutional maturity of the hromada. The results are given in Table 11.

Table 11 Main interaction specification

VARIABLES	(1) Administrative expenditures per capita	(2) Comparable total expenditures per capita	(3) Own-source revenues per capita
Direct exposure	-0.105**	-0.207***	-0.861***
	(0.042)	(0.045)	(0.083)
Risk exposure	0.229***	0.253***	0.059
	(0.032)	(0.032)	(0.036)
Direct exposure × maturity	-0.012	0.003	0.017
	(0.022)	(0.025)	(0.048)
Risk exposure × maturity	-0.036**	-0.046**	-0.005
	(0.017)	(0.018)	(0.020)
Hromada FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Observations	8259	8259	8255
Within R2	0.023	0.038	0.119

Note: Clustered standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Maturity is measured as years between hromada creation and 2022 and centered around the sample mean. Main exposure coefficients refer to hromadas with average maturity.

Table 11 shows that the model uses two interaction terms: direct exposure with maturity and risk exposure with maturity. We can see that the coefficients for direct exposure interaction are statistically insignificant for the main fiscal outcomes. In contrast, risk exposure interaction coefficients are statistically significant on the

spending side, with coefficients of -0.036 for administrative expenditures and -0.046 for comparable total expenditures. This may suggest that each additional year of institutional maturity before the full-scale invasion is associated with a smaller expenditure increase under risk exposure: approximately 3.5% lower for administrative expenditures and 4.5% lower for comparable total expenditures.

5.3.2 Robustness checks for H3

To assess whether the moderating role of institutional maturity is sensitive to alternative sample restrictions and maturity definitions, Table 12 reports robustness checks for the interaction terms. The table focuses on the interaction coefficients, because the main question is whether maturity systematically changes the fiscal effect of direct and risk exposure.

Table 12 Robustness summary for maturity interactions

Specification	Administrative expenditures per capita		Comparable total expenditures per capita		Own-source revenues per capita	
	Direct × maturity	Risk × maturity	Direct × maturity	Risk × maturity	Direct × maturity	Risk × maturity
Baseline	-0.012	-0.036**	0.003	-0.046**	0.017	-0.005
	(0.022)	(0.017)	(0.025)	(0.018)	(0.048)	(0.020)
Excluding 2022	-0.075**	-0.041**	-0.049	-0.055***	-0.018	-0.012
	(0.032)	(0.018)	(0.037)	(0.018)	(0.082)	(0.021)
Less strict occupation exclusion	-0.020	-0.036**	0.001	-0.046**	0.020	-0.007
	(0.018)	(0.017)	(0.020)	(0.018)	(0.033)	(0.020)
Alternative population denominator	-0.013	-0.038**	0.002	-0.048**	0.017	-0.007
	(0.023)	(0.018)	(0.025)	(0.019)	(0.048)	(0.020)
Age at first wartime exposure	0.022	-0.037***	0.041*	-0.053***	0.057	0.002
	(0.021)	(0.014)	(0.023)	(0.014)	(0.046)	(0.015)

Note: Clustered standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. All specifications include hromada and year fixed effects.

Table 12 shows that the interaction between direct exposure and maturity is mostly not statistically significant across robustness checks. The main exception is for administrative expenditures when 2022 is excluded, where the coefficient becomes statistically significant at -0.075. The age-at-first-exposure specification also gives a marginally significant coefficient for comparable total expenditures, but this pattern is not repeated across other specifications. Therefore, the evidence that maturity moderates direct exposure remains weak.

The interaction between risk exposure and maturity is more stable on the expenditure side. For administrative expenditures, the coefficients remain negative and statistically significant across all specifications, ranging from -0.036 to -0.041. For comparable total expenditures, the coefficients are also consistently negative and statistically significant, ranging from -0.046 to -0.055. In contrast, the interaction for own-source revenues remains statistically insignificant in all specifications. This suggests that institutional maturity is more consistently associated with a smaller expenditure increase under risk exposure than with revenue resilience.

In Table 13, we report an additional robustness check using three maturity bins instead of a continuous hromada maturity measure. This check tests whether the results change when maturity is grouped into categories rather than measured year by year. This is important because the moderating role of maturity may not change linearly with each additional year. In this specification, hromadas are classified as young if they existed for 2–3 years, middle-maturity if they existed for 4–5 years, and old if they existed for 6 or more years before the full-scale invasion as an amalgamated unit. Young hromadas are treated as the reference group.

Table 13 Maturity bins robustness

VARIABLES	(1) Administrative expenditures per capita	(2) Comparable total expenditures per capita	(3) Own-source revenues per capita
Direct exposure, young/reference	-0.082	-0.217***	-0.963***
	(0.067)	(0.069)	(0.106)
Direct exposure × middle maturity	-0.066	0.010	0.388**
	(0.090)	(0.101)	(0.170)
Direct exposure × old maturity	-0.033	0.034	0.069
	(0.091)	(0.105)	(0.218)
Risk exposure, young/reference	0.279***	0.326***	0.056
	(0.042)	(0.041)	(0.041)
Risk exposure × middle maturity	-0.095	-0.148**	0.021
	(0.075)	(0.072)	(0.088)
Risk exposure × old maturity	-0.097	-0.136	-0.017
	(0.080)	(0.084)	(0.095)
Hromada FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Observations	8259	8259	8255
Within R2	0.022	0.037	0.122

Note: Clustered standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Young maturity group is the reference category. Interaction coefficients for middle and old groups show differences relative to the young group.

Table 13 shows that, for young hromadas, direct exposure is associated with a substantial decline in own-source revenues. The coefficient is -0.963, which corresponds to approximately a 61.8% decrease in own-source revenues per capita. The interaction for middle-maturity hromadas is also statistically significant but positive, suggesting that direct exposure may be associated with a smaller revenue decline for this group than for young hromadas. However, the interaction for older hromadas is not statistically significant. For risk exposure, results show that risk exposure is associated with higher administrative and comparable expenditures for young hromadas. Coefficients for middle-maturity and old hromadas are negative,

but only the middle-maturity interaction for comparable total expenditures is statistically significant. This again suggests that institutional maturity may reduce the expenditure response to risk exposure, although the evidence is weaker in older maturity groups. Table 14 further checks whether the direct-exposure results are driven by active hostilities or partial occupation.

Table 14 Split direct exposure robustness

VARIABLES	(1) Administrative expenditures per capita	(2) Comparable total expenditures per capita	(3) Own-source revenues per capita
Active hostilities	-0.067	-0.076	0.003
	(0.054)	(0.051)	(0.071)
Partial occupation	-0.155**	-0.293***	-1.247***
	(0.063)	(0.069)	(0.117)
Risk exposure	0.224***	0.250***	0.072**
	(0.031)	(0.032)	(0.036)
Active hostilities × maturity	0.006	0.018	0.004
	(0.029)	(0.027)	(0.038)
Partial occupation × maturity	-0.051	-0.056	-0.092
	(0.033)	(0.037)	(0.067)
Risk exposure × maturity	-0.036**	-0.046***	-0.006
	(0.017)	(0.017)	(0.019)
Hromada FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Observations	8259	8259	8255
Within R2	0.025	0.043	0.155

Note: Clustered standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. This specification decomposes direct exposure into active hostilities and partial occupation. Maturity is centered around the sample mean.

From Table 14, we can see that the negative effect is mainly driven by partial occupation, while active hostilities remain statistically insignificant for all main outcomes. Maturity interactions for both components of direct exposure stay statistically insignificant, which is consistent with the main H3 interaction results and supports the conclusion that institutional maturity does not clearly moderate the effects of direct exposure. At the same time, interaction between risk exposure and maturity remains negative and statistically significant for administrative expenditures and comparable total expenditures.

Overall, the H3 robustness checks give conditional support for the hypothesis. Institutional maturity does not consistently mitigate the negative effects of direct exposure. The clearest result is observed for risk exposure: more mature hromadas are associated with a smaller increase in administrative and comparable total expenditures under wartime risk. However, this pattern is weaker in the maturity-bin specification and does not extend to own-source revenues.

Chapter 6

CONCLUSIONS AND POLICY RECOMMENDATIONS

6.1 Main conclusions

This thesis examines whether Ukraine's decentralization and territorial amalgamation reform generated economies of scale in local public finance and how these fiscal outcomes changed under wartime conditions. It focuses on two expected fiscal effects: lower expenditure levels and stronger own-source revenue capacity. These expectations are based on the theoretical and policy literature on municipal amalgamation; at the same time, empirical studies show that larger local governments do not automatically generate expenditure savings. Ukrainian pre-war studies on voluntary amalgamation also find that decentralization increased both local revenues and expenditures after reform (Nivievskyi et al. 2021). This thesis extends that discussion by asking whether these fiscal changes translated into greater fiscal resilience under wartime pressure. To answer this question, we analyze three related mechanisms: the pre-war fiscal effect of voluntary amalgamation, the effect of wartime exposure on local fiscal outcomes, and the role of institutional maturity in moderating wartime fiscal pressure.

The pre-war model results align with existing Ukrainian empirical literature. Voluntary amalgamation is associated with higher own-source revenues per capita, which supports the fiscal-capacity part of the hypothesis. However, it is also associated with higher administrative and comparable total expenditures. Furthermore, the expenditure effect is larger and appears earlier compared to the revenue effect.

The dynamic model results add an important timing dimension to the previous conclusion. Expenditure effects appear almost immediately after the amalgamation and remain high during the post-treatment period. In contrast, the effect on own-

source revenues appears more gradual over time. This pattern may suggest a possible adjustment process; newly amalgamated hromadas may need time to adapt to their expanded fiscal base and to improve the revenue collection process. At the same time, hromadas received broader administrative and service-delivery responsibilities previously associated with a higher rayon administrative level, which may be the reason for such rapid growth of expenditures. However, this interpretation should remain cautious, since the event-study estimates show the timing of the effect but do not directly identify the administrative mechanism behind it. To get a better understanding of these mechanisms, we need further research on the types of services and their delivery in the new hromadas.

The wartime models show that war effects vary based on the type of exposure. Direct exposure, which combines partial occupation and active hostilities, is associated with a strong decline in own-source revenues per capita. This result may support theoretical claims that war weakens local fiscal capacity because of disrupted administrative functioning, tax collection, and population outflow. At the same time, direct exposure is also associated with lower administrative and comparable total expenditures. This may indicate that exposed hromadas also face fiscal disruptions, making them less able to maintain normal service provision and regular administrative functions.

Hromadas exposed to potential wartime risk, but not direct hostilities or partial occupation, experience higher administrative and comparable total expenditures, which is the opposite pattern. This is more aligned with the wartime pressure mechanism we expected. This may suggest that such hromadas face higher spending needs related to emergency response preparedness. Therefore, the second hypothesis is partially supported by the negative revenue effect of direct exposure and by the positive expenditure effect under risk exposure, but it is not supported as a uniform war effect.

The interaction between direct exposure and maturity is statistically insignificant for the main fiscal outcomes, which suggests that longer pre-war experience as an amalgamated hromada does not protect local governments from the fiscal consequences of active hostilities or partial occupation. However, institutional maturity interaction with risk exposure is negative and statistically significant for spending. This suggests that more mature hromadas experience a slightly lower increase in spending under risk exposure. This result may suggest that institutional experience may help local governments manage wartime fiscal pressure when the shock is serious but not directly destructive.

Overall, the results suggest that territorial amalgamation did not generate economies of scale expressed as a cost-saving effect; instead, it is associated with stronger local fiscal capacity in both revenues and expenditures. Wartime exposure affected this capacity through two types of effects. Direct exposure is associated with decreases in all fiscal outcomes, especially own-source revenues, while risk exposure is associated with higher expenditure outcomes. Institutional maturity played a limited role, mainly by reducing the expenditure increase associated with risk exposure. Therefore, the fiscal consequences of amalgamation should be assessed not only through expected cost savings but also through changes in revenue capacity, expenditure responsibilities, and fiscal responses to wartime pressure.

6.2 Limitations

Several limitations should be considered when interpreting the results of this thesis. First, the analysis relies on estimated population denominators, especially after the beginning of the full-scale invasion, when reliable annual hromada-level population data are not available. Post-2022 population values are extrapolated using nighttime-light intensity, which may reflect not only population changes but also

displacement, blackouts, infrastructure damage, occupation, and changes in economic activity. Although alternative population-denominator specifications are used as robustness checks, wartime per-capita outcomes should still be treated as approximate fiscal indicators, because the population estimates may either overstate or understate the true population of hromadas

Second, synthetic pre-amalgamation hromada budgets are constructed from the budgets of local councils and separate cities that later became part of the same hromada, but they may not fully capture functions financed at the rayon or other higher budget levels before the reform. This may understate pre-reform fiscal activity and may partly bias estimated post-amalgamation increases upward. The main variables partly reduce this problem by excluding PIT and major expenditure categories whose financing shifted between rayon and hromada budget levels during the reform. However, pre-reform synthetic budgets should still be interpreted as approximations of comparable local fiscal activity rather than full consolidated local-government budgets.

Third, the wartime specifications are limited by the structure of exposure timing. For direct exposure, the first exposure is highly concentrated in 2022, which leaves limited meaningful variation in treatment timing for a staggered-adoption design. For this reason, H2 and H3 use standard TWFE models with hromada and year fixed effects. These models control for permanent hromada differences and common yearly shocks, but they cannot fully account for time-varying local wartime factors correlated with both exposure and fiscal outcomes. This limits the strength of causal interpretation.

Additionally, the diagnostic tests used to check pre-treatment trends are limited. For H1, the placebo test covers only 2013–2014, so it provides only a weak check of differences before voluntary amalgamation. For H2 and H3, the pre-trend check is also limited because the post-reform pre-war baseline covers only 2020–2021.

6.3 Policy Implications

The first policy implication is that territorial amalgamation should not be evaluated only through aggregate expenditure savings. The results of this thesis show that voluntary amalgamation was associated with higher administrative and comparable total expenditures, which is contrary to the expected cost-saving mechanism. However, this does not necessarily mean that efficiency gains were absent at the hromada level. Higher expenditures may reflect broader service responsibilities, changes in the scale of local administration, or the expansion of functions previously performed at higher administrative levels. Future evaluations of amalgamation should therefore examine not only whether expenditures increased or decreased, but also whether the structure of services provided by hromadas became more efficient. In particular, further research should distinguish between economies of scale in administrative functions at the hromada level and economies of scale in specific service-production units, such as schools, hospitals, and other local facilities.

Second, wartime fiscal support should take into account that direct exposure and risk exposure are not the same fiscal condition. The results suggest that direct exposure is associated with lower own-source revenues and lower expenditure levels. However, this should not be interpreted as evidence of lower spending needs. The decomposition of direct exposure shows that the negative effect is mainly driven by partial occupation, where fiscal data may reflect disrupted budget execution rather than normal local-government adjustment. Therefore, policy support for directly exposed hromadas should focus not only on compensating revenue losses, but also on restoring basic budget execution. This may include flexible operating grants, temporary emergency transfers when local revenues collapse, technical support for restoring budget-execution procedures, and simplified procedures for urgent spending on basic services. Such support is especially relevant for partially occupied or recently de-occupied hromadas, where

lower expenditures may reflect disrupted budget execution rather than lower spending needs.

Third, risk-exposed hromadas may require a different type of fiscal support. In contrast to direct exposure, risk exposure is associated with higher administrative and comparable expenditures. This suggests that hromadas located in areas of potential hostilities may remain administratively functional, but face additional spending pressure. Such pressure may be related to emergency preparedness, civil protection, support for displaced persons, infrastructure protection, and other wartime responsibilities. Therefore, support for risk-exposed hromadas should focus on financing additional operating costs rather than restoring disrupted budget execution. This may include targeted transfers for civil protection, temporary accommodation and services for displaced persons, maintenance of reserve infrastructure, and emergency coordination capacity.

Finally, the results suggest that institutional experience may matter, but this implication should be treated cautiously. The H3 results do not show that institutional maturity protects hromadas from the fiscal effects of direct exposure. However, more mature hromadas appear to experience a smaller expenditure increase under risk exposure. This may suggest that administrative experience helps local governments manage fiscal pressure when the shock is serious but not directly destructive. One practical implication is that wartime governance experience should be transferred from hromadas that have already operated under wartime exposure to hromadas that are currently non-exposed or less exposed but may face similar conditions later.

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APPENDIX A. ADDITIONAL DESCRIPTIVE EVIDENCE AND DATA STRUCTURE

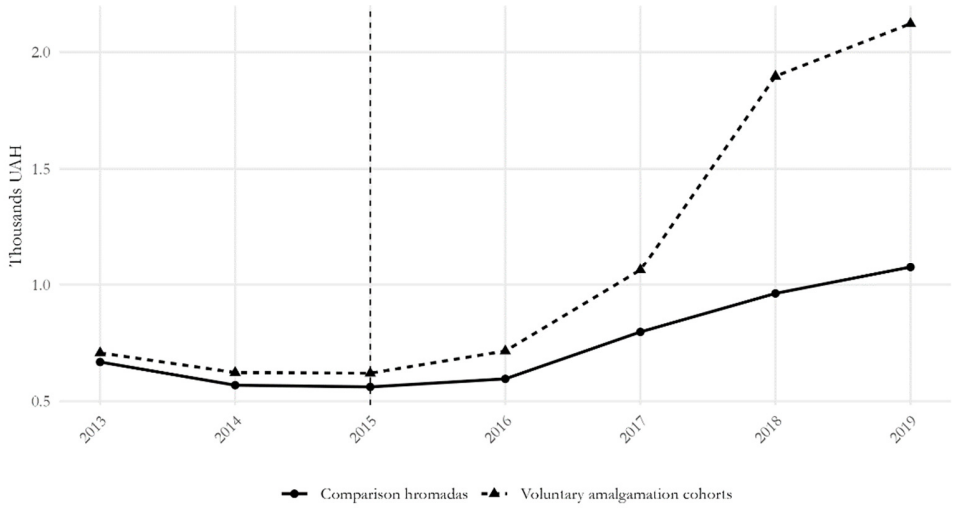


Figure 5 Pre-war median trends in administrative expenditures per capita by amalgamation status, 2013–2019

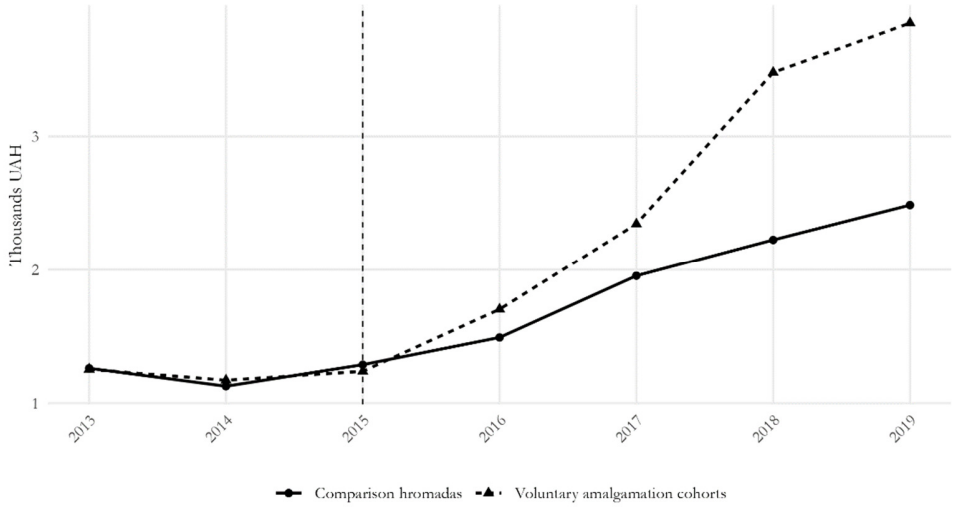


Figure 6 Pre-war median trends in comparable total expenditures per capita by amalgamation status, 2013–2019

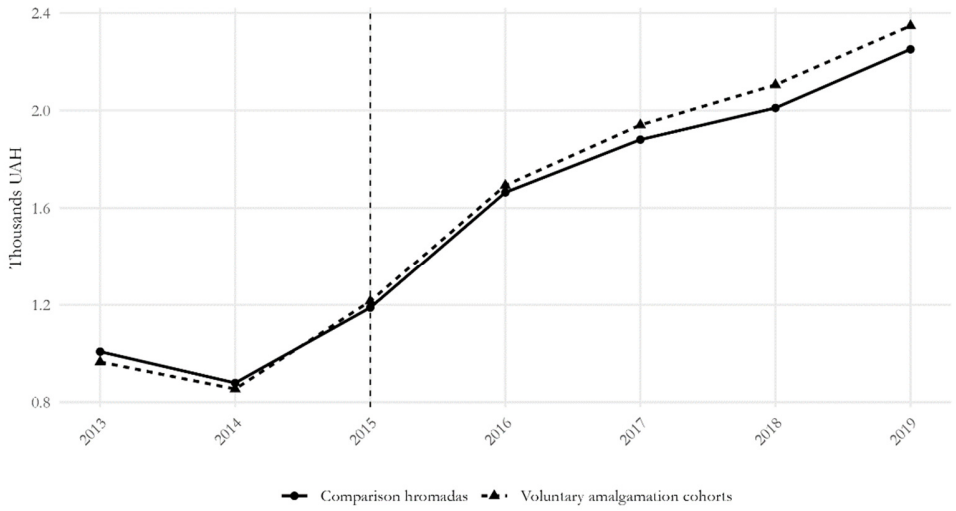


Figure 7 Pre-war median trends in own-source revenues per capita by amalgamation status, 2013–2019

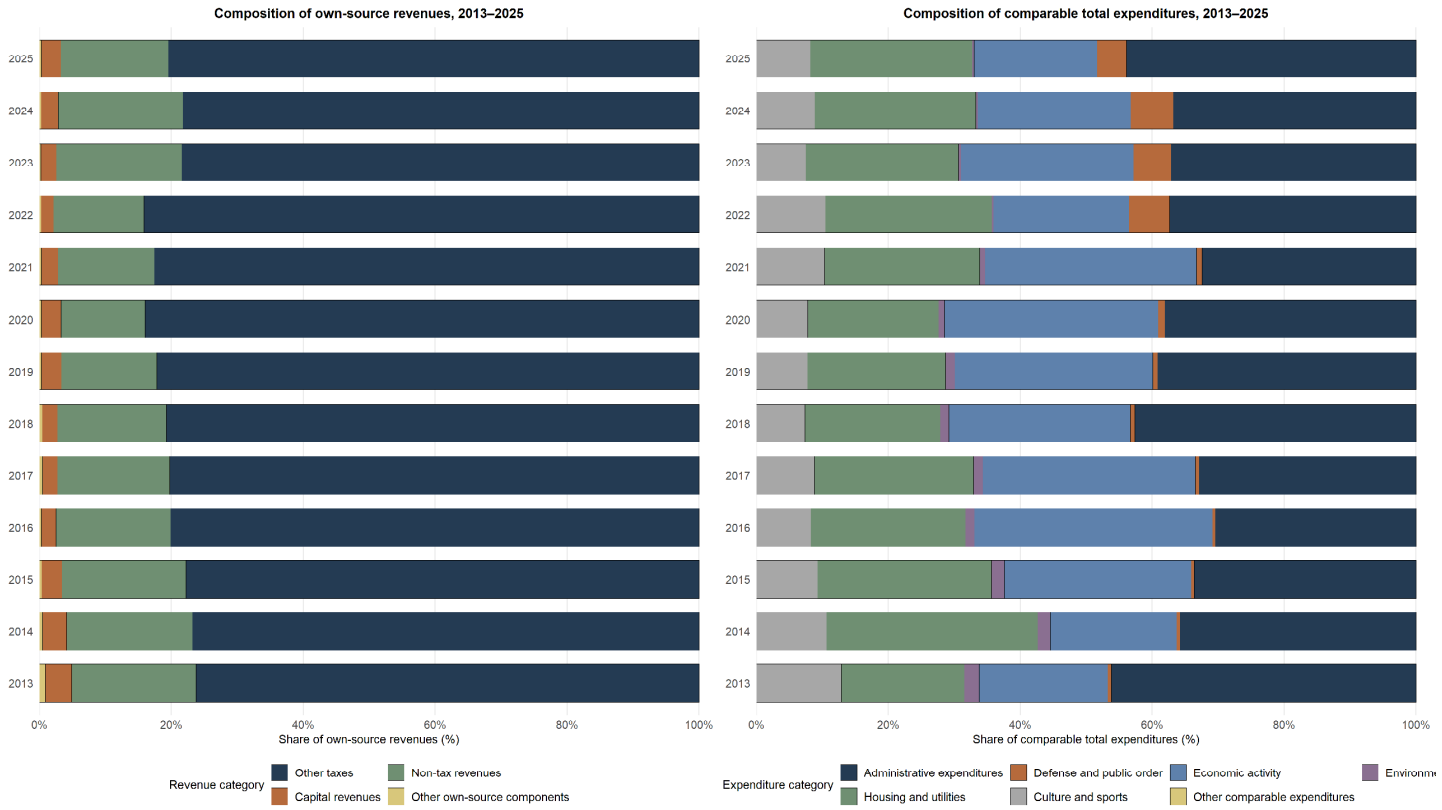


Figure 8 Composition of constructed fiscal outcomes, 2013–2025

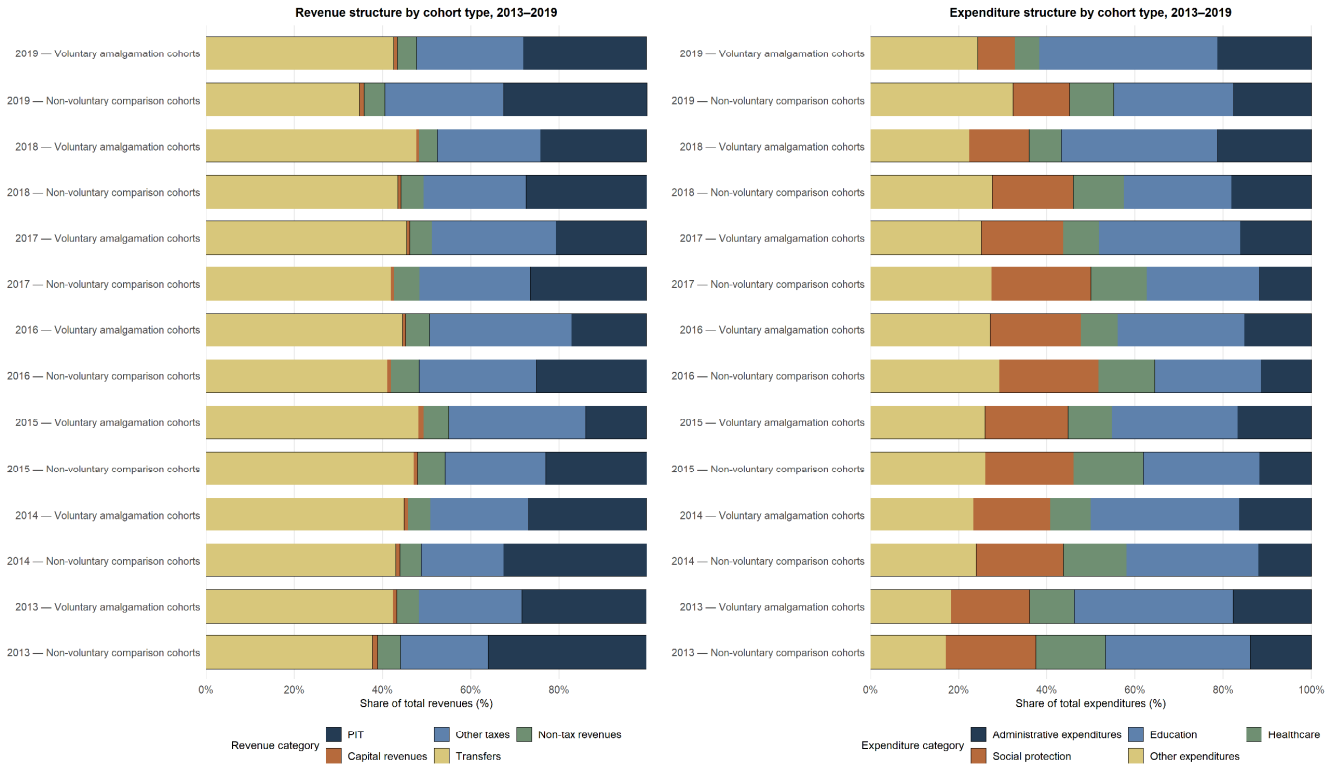


Figure 9 Revenue and expenditure structure by cohort type, 2013–2019

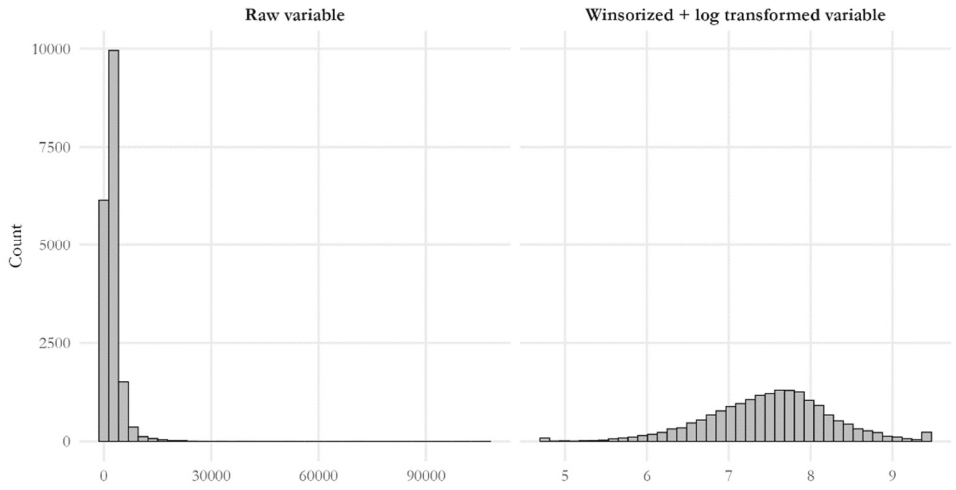


Figure 10 Distribution of own-source revenues before and after transformation

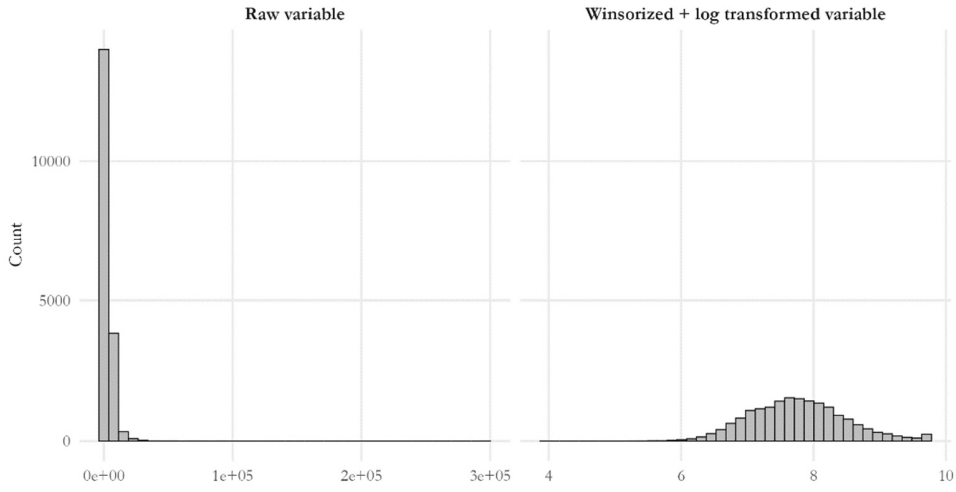


Figure 11 Distribution of comparable total expenditures before and after transformation

Table 15 First observed exposure year by exposure type

First exposure year/status	First direct exposure	First risk exposure, all hromadas	First risk exposure among never-direct hromadas
2022	146	72	64
2023	3	79	39
2024	5	13	6
2025	5	62	61
Total exposed	159	226	170
Never exposed	1,279	1,212	1,109

Note: This table reports the number of hromadas by first observed wartime exposure year in the H2/H3 wartime sample. Direct exposure is defined as active hostilities or partial occupation. Risk exposure is defined as potential exposure in a hromada-year without direct exposure. The final column restricts risk exposure to hromadas that never experience direct exposure.

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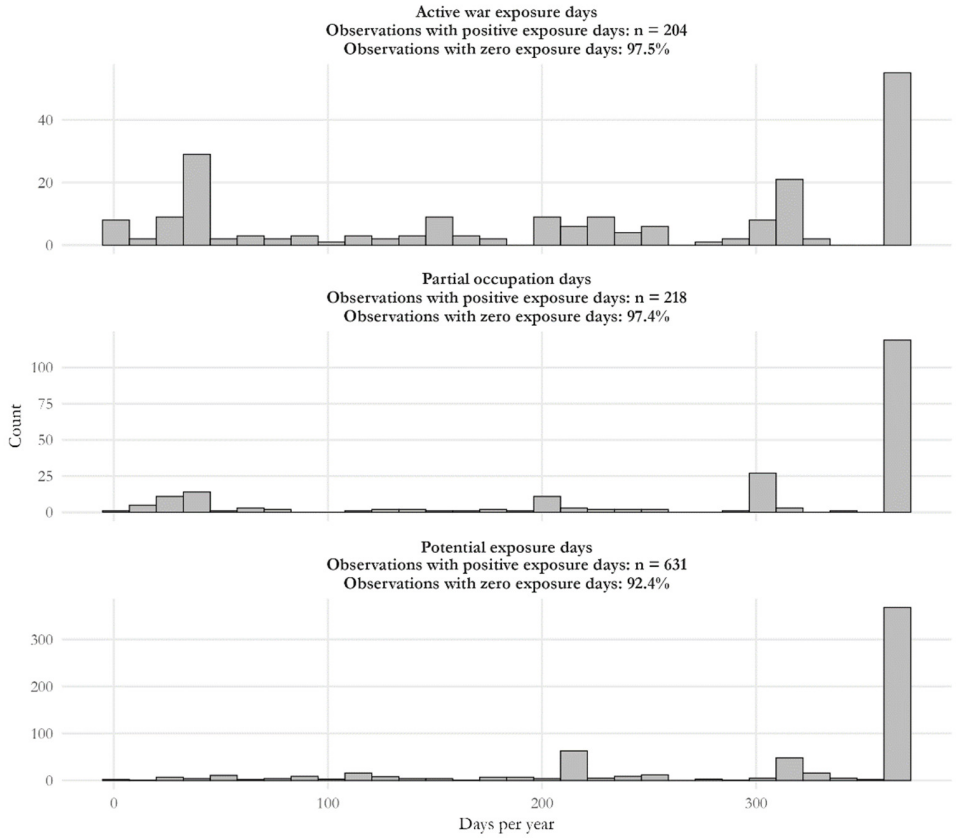


Figure 12 Distribution of annual wartime exposure days by exposure type, 2020–2025

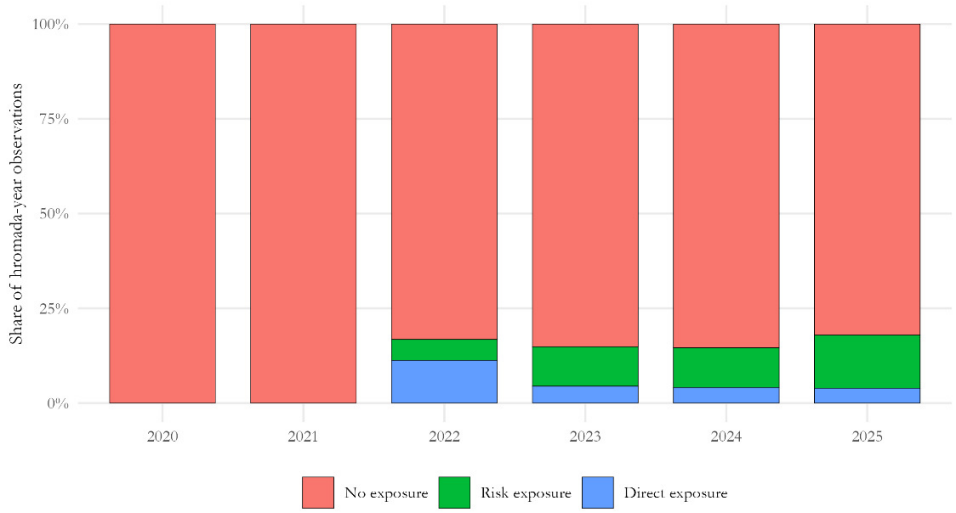


Figure 13 Composition of wartime exposure status by year, 2020–2025

APPENDIX B. ADDITIONAL EVIDENCE FOR HYPOTHESIS 1

Table 16 Alternative area-based normalization of H1 average treatment effects

VARIABLES	(1) Own-source revenues per sq. km.	(2) Administrative expenditures per sq. km.	(3) Comparable total expenditures per sq. km.
ATT	0.024	0.422***	0.348***
	(0.017)	(0.017)	(0.018)
CS-DiD pre-test p-value	0.956	0.195	0.306
Observations	10051	10051	10051

Note: Clustered standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Outcomes are winsorized at the 1st and 99th percentiles and transformed using the natural logarithm.

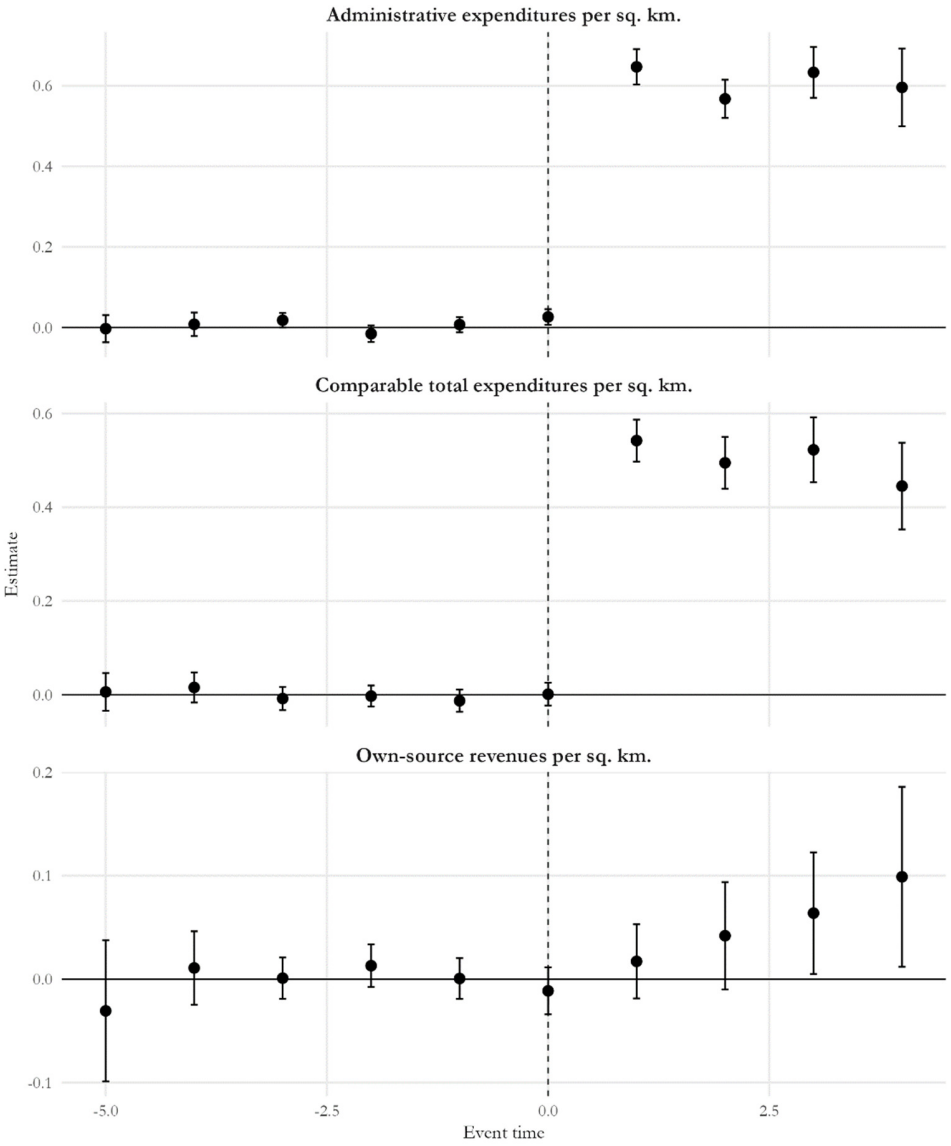


Figure 14 Dynamic treatment effects of voluntary amalgamation using area-based outcomes

APPENDIX C. ADDITIONAL EVIDENCE FOR HYPOTHESIS 2

Table 17 Continuous exposure-duration specification

VARIABLES	(1) Administrative expenditures per capita	(2) Comparable total expenditures per capita	(3) Own-source revenues per capita
Active hostilities, per 10 days	-0.003	-0.005**	-0.004
	(0.002)	(0.002)	(0.003)
Partial occupation, per 10 days	-0.002	-0.009***	-0.053***
	(0.003)	(0.003)	(0.003)
Risk exposure, per 10 days	0.009***	0.010***	0.003***
	(0.001)	(0.001)	(0.001)
Hromada FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Observations	8259	8259	8255
Within R2	0.026	0.050	0.230

Note: Clustered standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Exposure duration variables are measured in 10-day units.

Table 18 Sensitivity to alternative population denominators

	Oblast growth-rate extrapolation			Oblast fixed-share extrapolation		
VARIABLES	**Lower**	**Baseline**	**Upper**	**Lower**	**Baseline**	**Upper**
Panel A. Administrative expenditures per capita						
Direct exposure	-0.085*	-0.104**	-0.103**	-0.086*	-0.104**	-0.104**
	(0.044)	(0.043)	(0.044)	(0.044)	(0.043)	(0.044)
Risk exposure	0.261***	0.238***	0.252***	0.260***	0.237***	0.251***
	(0.032)	(0.032)	(0.033)	(0.032)	(0.032)	(0.033)
Observations	8259	8259	8259	8259	8259	8259
Within R2	0.024	0.021	0.022	0.024	0.021	0.022
Panel B. Comparable total expenditures per capita						
Direct exposure	-0.189***	-0.208***	-0.207***	-0.189***	-0.208***	-0.207***
	(0.046)	(0.046)	(0.047)	(0.046)	(0.046)	(0.047)
Risk exposure	0.288***	0.265***	0.278***	0.288***	0.265***	0.278***
	(0.032)	(0.032)	(0.033)	(0.032)	(0.032)	(0.033)
Observations	8259	8259	8259	8259	8259	8259
Within R2	0.039	0.035	0.036	0.039	0.035	0.036
Panel C. Own-source revenues per capita						
Direct exposure	-0.844***	-0.863***	-0.860***	-0.844***	-0.863***	-0.861***
	(0.082)	(0.082)	(0.083)	(0.082)	(0.082)	(0.083)
Risk exposure	0.085**	0.061*	0.074**	0.084**	0.060*	0.073**
	(0.035)	(0.035)	(0.036)	(0.035)	(0.035)	(0.036)
Observations	8255	8255	8255	8255	8255	8255
Within R2	0.120	0.118	0.114	0.120	0.118	0.114

Note: Clustered standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. This table reports sensitivity of per capita outcomes to alternative population denominators.

Table 19 Short Pre-War Diagnostic for Future-Exposed Hromadas, 2020–2021

VARIABLES	(1) Administrative expenditures per capita	(2) Comparable total expenditures per capita	(3) Own-source revenues per capita
Future exposed × 2021	0.010	-0.015	-0.025*
	(0.024)	(0.020)	(0.015)
Hromada FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Observations	2874	2874	2874
Within R2	0.000	0.000	0.002

Note: Clustered standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. This short pre-trend diagnostic uses only 2020-2021 and tests whether hromadas that later became exposed to wartime conditions already experienced different fiscal changes before the full-scale invasion. The coefficient shows whether future-exposed hromadas changed differently from non-exposed hromadas between 2020 and 2021.

Table 20 Alternative area-based normalization of H2 wartime exposure estimates

VARIABLES	(1) Own-source revenues per sq. km.	(2) Administrative expenditures per sq. km.	(3) Comparable total expenditures per sq. km.
Direct exposure	-0.860***	-0.113***	-0.220***
	(0.079)	(0.035)	(0.039)
Risk exposure	-0.079***	0.104***	0.133***
	(0.026)	(0.022)	(0.023)
Hromada FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Observations	8255	8259	8259
Within R2	0.143	0.009	0.024

Note: Clustered standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Outcomes are winsorized at the 1st and 99th percentiles and transformed using the natural logarithm.

APPENDIX D. ADDITIONAL EVIDENCE FOR HYPOTHESIS 3

Table 21 Alternative area-based normalization of H3 interaction estimates

VARIABLES	(1) Own-source revenues per sq. km.	(2) Administrative expenditures per sq. km.	(3) Comparable total expenditures per sq. km.
Direct exposure	-0.857***	-0.115***	-0.220***
	(0.079)	(0.034)	(0.039)
Risk exposure	-0.078***	0.101***	0.127***
	(0.026)	(0.022)	(0.023)
Direct exposure × maturity	0.033	-0.019	-0.001
	(0.044)	(0.018)	(0.021)
Risk exposure × maturity	0.011	-0.017	-0.023*
	(0.014)	(0.012)	(0.013)
Hromada FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Observations	8255	8259	8259
Within R2	0.144	0.010	0.025

Note: Clustered standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Outcomes are winsorized at the 1st and 99th percentiles and transformed using the natural logarithm. Maturity is centered around the sample mean.

APPENDIX E. NIGHTTIME-LIGHT POPULATION EXTRAPOLATION

Because official annual hromada-level population data are not available for the full wartime period, post-2022 population values were estimated using nighttime-light intensity. Previous studies use nighttime lights to approximate population distribution and concentrated human activity when demographic data are limited (Elvidge et al. 1999; Huang et al. 2016). These estimates are used as approximate denominators for per-capita fiscal outcomes and should not be interpreted as exact demographic measurements.

We use 2021 nighttime lights as the baseline because 2022 may contain a war-induced downward shock in nighttime light intensity caused by blackouts, infrastructure damage, displacement, military activity, and disrupted economic activity in the first month of full-scale invasion. In the ratio-based extrapolation, an artificially decreased 2022 light baseline would mechanically increase the ratio between later nighttime lights and the baseline value, which could lead to systematically higher post-2022 population estimates.

To estimate the relationship between population and nighttime lights, we use a cross-sectional log-log regression at the hromada level depicted in equation (5):

$$\ln(popl_i) = \beta_1 + \beta_2 \ln\left(NTL_{i,2021}\right) + \beta_3 \ln(Area_i) + \beta_4 Type_i + \varepsilon_i \quad (5)$$

In this specification $popl_i$ is hromada i population as of January 1, 2022, $NTL_{i,2021}$ is total nighttime-light intensity in 2021 for the same hromada, $Area_i$ is hromada area, and $Type_i$ controls for hromada type (urban, settlement, or rural), with urban hromadas used as the reference category. The coefficient β_2 is

interpreted as the elasticity between the population and nighttime-light intensity. We also extend this specification with number of settlements to test sensitivity for additional controls. Table 22 reports the regression results.

Table 22 Nighttime-light population extrapolation and elasticity sensitivity variants

VARIABLES	Baseline model	Extended specification
Log nighttime lights, 2021	0.341***	0.338***
	(0.018)	(0.017)
Log area	0.101***	0.167***
	(0.017)	(0.033)
Log number of settlements	—	-0.083*
		(0.036)
Settlement hromada	-0.743***	-0.745***
	(0.035)	(0.035)
Rural hromada	-1.161***	-1.173***
	(0.036)	(0.037)
Observations	1469	1469
R2	0.734	0.737
Adjusted R2	0.734	0.736

Note: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Dependent variable: log hromada population as of January 1, 2022. Urban hromadas are the reference category for hromada type.

Estimation results show that the extended specification changes the nighttime-light elasticity only slightly and increases R-squared marginally. Therefore, we use the baseline model to construct the population denominator. Thus, $\beta = 0.341$

Post-2022 population is then extrapolated using the relative change in nighttime-light intensity compared with the 2021 baseline, as shown in equation (6):

$$popl_{i,t} = popl_{i,jan\ 1\ 2022} \times \left(\frac{NTL_{i,t}}{NTL_{i,2021}}\right)^{\beta} \quad (6)$$

Where t refers to wartime years after 2022 and $\beta = \beta_2$, $popl_{i,jan\ 1\ 2022}$ is hromada population as of January 1 2022

To account for uncertainty in the estimated elasticity, we also construct lower—elasticity β = 0.306 and upper-elasticity β = 0.376 variants based on the approximate 95% confidence interval of beta. These variants are used in robustness checks to test whether the empirical results are sensitive to uncertainty in the post-2022 population denominator. They are combined with two pre-war hromada-level population extrapolations to get 6 population-denominator variants: the central, lower-bound, and upper-bound variants of the oblast-growth population estimate, and the central, lower-bound, and upper-bound variants of the fixed oblast-share population estimate.

The resulting population estimates should be treated as approximate denominators for fiscal normalization rather than as direct demographic estimates. Therefore, all per-capita wartime fiscal results are interpreted with caution and checked against alternative population-denominator specifications.