

7537047-wartime-bonds-how-is-the-sovereign-investor-base-designed

SUMMARY: This study examines how Ukraine's government broadened its investor base during the 2022-2026 war by adding previously issued bonds to Diia, a government digital retail platform. The research finds that household-to-legal-entity holding odds for newly listed bonds increased by 33.87% compared to non-switching bonds. The study uses a structural participation model to link this response to retail access costs, bond characteristics, persistent bond heterogeneity, and dynamic demand shocks. The findings suggest that sovereigns can create domestic fiscal capacity by lowering retail participation frictions, and the welfare value depends on which balance sheets households displace.

METHOD: The study uses Ukraine's complete 2022-2026 war-bond holder history to analyze the staggered additions of already-issued bonds to Diia, a government digital retail platform. The researchers use a structural participation model to link the response to retail access costs, bond characteristics, persistent bond heterogeneity, and dynamic demand shocks. The sample consists of Ukraine's government bonds and the data comes from the National Bank of Ukraine monthly ISIN-by-holder archive.

KEY FINDINGS:

- Household-to-legal-entity holding odds for newly listed bonds increased by 33.87% compared to non-switching bonds.
- Persistent bond heterogeneity and stationary bond-specific demand shocks contribute to the persistence of household participation.
- The access effect is visible around the clean listing events, with newly listed bonds experiencing a 33.87% relative increase in household-to-legal-entity holding odds.
- The structural model shows how a lower retail participation cost can reallocate a fixed sovereign liability toward households.
- The financial-system value of reallocating the reallocation depends on the balance sheet displaced.

IMPLICATION FOR TRADING: The findings suggest that sovereigns can create domestic fiscal capacity by lowering retail participation frictions. Practitioners can use this information to understand how to mobilize domestic investors and potentially increase their own fiscal capacity. The study also highlights the importance of understanding the balance sheets that would otherwise carry the sovereign claim, which can inform investment strategies in government bonds and other financial instruments.

Wartime Bonds: How Is the Sovereign Investor Base Designed?

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Abstract

How should a sovereign broaden its investor base during war? Using Ukraine’s complete 2022–2026 war-bond holder history, we study staggered additions of already-issued bonds to Diia, the government’s digital retail platform. Newly listed bonds experience a 33.87% relative increase in household-to-legal-entity holding odds versus contemporaneous non-switching bonds. A structural participation model links this response to retail access costs, bond characteristics, persistent bond heterogeneity, and dynamic demand shocks. The results show how sovereigns can create domestic fiscal capacity by lowering retail participation frictions, while the welfare value depends on which balance sheets households displace.

Keywords: sovereign debt; banks; household finance; investor base; financial development; government bonds.

JEL codes: G11, G21, G18, G15, H63.

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1 Introduction

How should a government finance a war? Classic public-finance work studies the choice among taxes, debt, and money when military expenditure rises sharply and temporarily (Barro, 1979; Grossman and Han, 1993; Ohanian, 1997). Once debt is chosen, however, a second question remains: *who should hold it?* In normal times, the investor base can look like a secondary feature of debt management. In wartime it becomes a first-order financial constraint. Spending is urgent, borrowing less may be infeasible, foreign market access can weaken exactly when funding needs surge, and large-scale monetary finance can threaten inflation and credibility. The sovereign must therefore decide not only how much debt to issue, but which domestic balance sheets will absorb it.

This paper studies that domestic policy-design margin. The central idea is that wartime financial capacity depends on more than the stock of public debt. It also depends on the set of investors that can be mobilized quickly. When banks are the natural marginal buyers of government bonds, expanding direct access for households and firms can change the incidence of sovereign financing even if aggregate borrowing is unchanged. Digital distribution, lower minimum denominations, and easier account access can convert household savings into fiscal capacity; the economic value of doing so depends on how costly it is to mobilize those investors and on the balance sheets that would otherwise carry the sovereign claim.

Ukraine provides an unusually sharp laboratory. Before the full-scale invasion, the domestic government-securities market was bank centered: commercial banks held roughly 40.00% of government securities, while domestic institutional investors accounted for only about 8.00% and nonresidents about 5.00% (International Monetary Fund, 2022b). The invasion on 24 February 2022 created an immediate financing shock. The Ministry of Finance launched the first wartime-bond auction on 1 March, initially distributing the securities through primary-dealer banks. It then deliberately broadened retail access, reduced the effective minimum investment to UAH 1,000, and on 3 October 2022 made wartime bonds purchasable through Diia, Ukraine’s government digital-services application and retail bond-purchase

platform (Ministry of Finance of Ukraine, 2022; Diia, 2022). Later additions of individual bonds to Diia created repeated changes in the accessibility of already-outstanding securities.

Figure 1 shows why the household margin is quantitatively important. The descriptive total-reported household share—individual holdings divided by legal-entity, individual, and nonresident holdings—rose from 5.10% in March 2023 to 22.70% by September 2026, while the face-value holdings reported for individuals increased from about UAH 5.3 billion to UAH 54.2 billion. The change is not itself an estimate of the Diia effect; it establishes that households became a major wartime sovereign investor and motivates the security-level identification exercise.



Figure 1: Households became a major investor in Ukraine's wartime sovereign debt. The figure plots individuals' share of reported UAH military-bond holdings in the NBU monthly ISIN-by-holder archive. The share is individuals divided by reported UAH holdings of legal entities, individuals, and nonresidents.

The economic results are threefold. First, household participation is highly persistent across securities and over time, with persistent bond heterogeneity and stationary bond-specific demand shocks accounting for much of that persistence. Second, the access effect is visible directly around the clean listing events: newly listed bonds experience a 33.87% relative increase in the household-to-legal-entity holding-odds ratio versus contemporaneous bonds whose Diia status does not change. This event-window evidence isolates the access

margin before imposing the structural dynamics. Third, the structural model shows how a lower retail participation cost can reallocate a fixed sovereign liability toward households, while the financial-system value of that reallocation depends on the balance sheet displaced. Bank sovereign exposure mean-reverts strongly, but the public data do not identify the marginal bank-displacement share, so the paper reports an incidence and welfare frontier rather than an unsupported causal bank-displacement estimate.

The planner analysis therefore remains a conditional policy frontier. Broadening retail access is beneficial only while the marginal financial-system benefit of shifting sovereign financing away from costly balance sheets exceeds the marginal cost of attracting additional households. Under the illustrative calibration used below, the break-even marginal access cost is 1.42% per UAH when household demand fully displaces bank holdings. Because neither the bank-displacement share nor the complete social cost schedule is identified, the observed Ukrainian policy cannot be labeled socially optimal.

The paper contributes to three literatures. First, the classic war-finance literature explains why temporary wartime spending generates debt and studies the welfare consequences of alternative tax-debt-money mixes (Barro, 1979; Grossman and Han, 1993; Ohanian, 1997). We study the next margin: conditional on using debt, how should the sovereign design the creditor base that absorbs wartime issuance? Second, the sovereign-bank literature shows that domestic sovereign holdings can crowd out private investment, transmit sovereign risk, and interact with bank capital (Broner et al., 2014; Gennaioli, Martin, and Rossi, 2014; Acharya and Steffen, 2015; Crosignani, 2021). We move one step upstream and study whether market design can create alternative domestic buyers before sovereign exposure accumulates on bank balance sheets. Third, Fang, Hardy, and Lewis (2025) show that investor composition affects sovereign debt absorption and yields across countries, while Williams (2018) shows that an exogenous foreign inflow into Colombian government bonds releases domestic bank balance-sheet capacity. We study a distinct policy margin: whether a sovereign under acute financing stress can build *domestic* nonbank demand through access policy, and when that

domestically engineered investor base is socially valuable.

The remainder of the paper has five sections. Section 2 explains why wartime financing makes domestic investor-base design first-order, documents the prewar benchmark and the wartime access reforms, and describes the data. Section 3 develops the structural model and identification strategy. Section 4 reports the estimated household and bank mechanisms together with model fit and robustness. Section 5 presents fixed-debt counterfactuals and the welfare frontier. Section 6 concludes.

2 Wartime Financing and the Design of the Domestic Investor Base

2.1 Why wartime makes the investor-base margin first-order

War changes the sovereign financing problem in two ways. First, the quantity of near-term financing becomes unusually difficult to compress: defense, social protection, and essential state functions must be funded even when tax capacity falls. Second, the set of feasible financiers can shrink at the same time. External market access becomes costly or unavailable, and large-scale monetary financing creates inflation and credibility risks. Wartime therefore creates a setting in which the government may be unable to choose a materially smaller financing requirement but can still influence the balance sheets that absorb it. Investor-base design becomes a form of financial state capacity: the ability to mobilize private domestic balance sheets quickly without placing the entire financing shock on banks or the central bank.

At date t , let the UAH wartime-bond financing stock in the holder-allocation block be D_t . Holdings satisfy

$$D_t = B_t + H_t + F_t + N_t + C_t, \quad (2.1)$$

where B_t , H_t , F_t , N_t , and C_t are holdings by banks, households, domestic nonfinancial firms,

nonresidents, and the central bank/other residual holder class, respectively, all measured in UAH. Define the corresponding shares s_t^k for $k \in \{B, H, F, N, C\}$ and collect them in $\mathbf{s}_t$. Equation (2.1) separates the amount the state must finance from the financial system that finances it.

This distinction is particularly useful in war. If the government cannot immediately reduce D_t , investor-base policy acts on $\mathbf{s}_t$. A deeper domestic investor base can increase the state's financing capacity without relying on additional foreign inflows or additional central-bank purchases. But the policy is not free: the government must lower participation frictions, distribute securities, and attract progressively more marginal investors.

2.2 From the prewar sovereign market to wartime bonds

Military bonds have no prewar history because they were created after the invasion. The relevant prewar benchmark is therefore the overall domestic-government-bond market. IMF staff characterized that investor base as dominated by domestic commercial banks, which held about 40% of government securities; domestic institutional investors accounted for roughly 8% and nonresidents about 5.00% (International Monetary Fund, 2022b). Bank government-security exposure was also economically large: by the end of 2021, sovereign securities represented about one quarter of banking-system assets.

Russia's full-scale invasion on 24 February 2022 abruptly increased the financing requirement and impaired conventional financing channels. The Ministry of Finance announced wartime bonds on 28 February and held the first auction on 1 March, raising UAH 8.1 billion. Banks served as primary dealers and initially remained the largest holders. The setting therefore begins with exactly the financial structure in which investor-base design should matter most: a large, urgent sovereign financing need layered onto a bank-centered domestic debt market.

2.3 Domestic access as policy: from primary dealers to Diia

The government did not treat the wartime investor base as fixed. By late March 2022, households could buy bonds through primary dealers and licensed brokers with investments starting at UAH 1,000. On 22 March, the NBU began weekly publication of wartime-bond holder statistics. On 3 October 2022, the government launched direct wartime-bond purchase through the Diia application (Diia, 2022). The policy reduced search, account-opening, and transaction frictions by placing a sovereign-security purchase inside an application already used for digital public services.

The nationwide Diia launch changed the retail distribution technology for wartime bonds. The policy became still more useful for empirical identification when individual wartime-bond ISINs were subsequently added to Diia on different dates. Our source map identifies 18 bond-level additions across 10 listing dates between January 2024 and September 2026. Because these securities were already outstanding before appearing in Diia, the staggered additions separate a change in investor access from the original issuance decision. Section 3 uses this institutional variation to motivate the household-access block, while the replication archive documents every listing date and security.

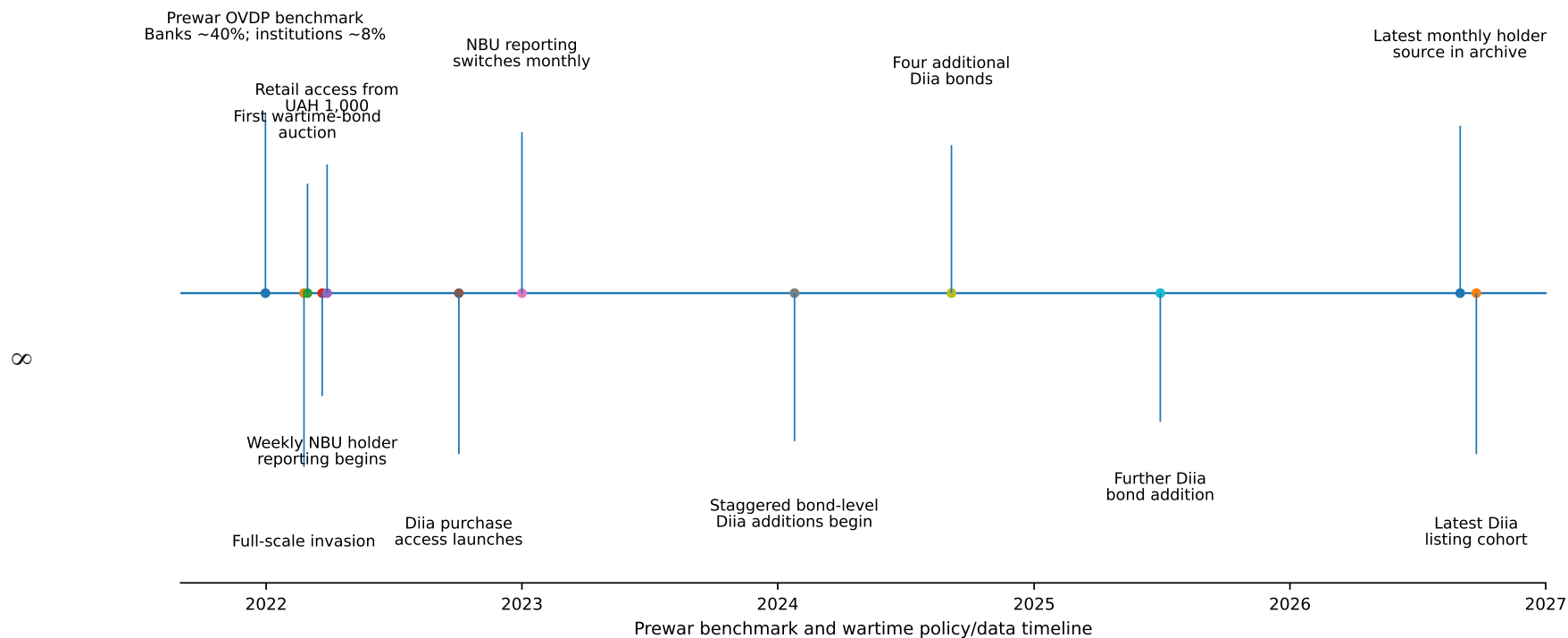


Figure 2: Wartime investor-base design and public-data coverage. The prewar benchmark refers to the overall OVDP market; military bonds begin only after the full-scale invasion. The public NBU holder archive begins in March 2022, switches from weekly to monthly reporting in 2023, and the source map extends through September 2026.

2.4 Data and the wartime reallocation of sovereign debt

The data architecture has four layers. First, the prewar benchmark uses aggregate OVDP investor composition and bank sovereign exposure. Second, the NBU public military-bond archive begins with weekly observations in March 2022 and changes to monthly observations at the beginning of 2023; the public source map runs through 1 September 2026. Third, Ministry of Finance announcements identify staggered Diia availability at the ISIN level. Fourth, the bank supervisory archive tracks assets, government securities, and customer loans by bank.

The public holder archive begins in March 2022. For structural estimation we use every recoverable monthly UAH ISIN-by-holder observation after the machine-readable workbooks begin in 2022: 622 interior-share security-month observations spanning 45 UAH military-bond ISINs from August 2022 through 1 September 2026. One additional UAH observation has exactly zero household holdings and is excluded from log-odds estimation rather than numerically clipped. The earlier March–July 2022 PDF releases remain in the replication archive and are used in the full ownership-history figure. The Diia access restriction uses 12 clean securities for which an adjacent monthly observation exists both before and after listing. Five issuance-adjacent additions are excluded because the security is absent from the immediately preceding monthly holder snapshot, and the September 2026 addition lacks a post-listing observation. The bank block uses 2,727 bank-month observations from January 2023 through August 2026.

Table 1: Data architecture and structural use

Data block	N	Period	Structural role
ISIN-month household holdings	622 obs., 45 UAH ISINs	Aug. 2022–Sep. 2026	Household participation/allocation SMM
Clean staggered Diia switches	12 ISINs	Jan. 2024–Jun. 2026	Access-cost identification
Bank-month panel	2,727 obs.	Jan. 2023–Aug. 2026	Inventory and lending SMM
NBU holder archive	85 source dates	Mar. 2022–Sep. 2026	Ownership history / validation
SMM simulations	80	Common random numbers	Simulated moments
Holder bootstrap	120 ISIN-cluster draws	Full panel	Moment covariance / weighting

Notes: One UAH ISIN-month observation has exactly zero household holdings and is excluded from log-odds estimation rather than clipped. The structural household block otherwise uses every recoverable monthly UAH ISIN-by-holder observation with positive reported domestic holdings. Earlier March–July 2022 PDF releases are used only in the descriptive ownership history.

The holder data reveal a substantial wartime change in who finances the sovereign. Households become a quantitatively important holder class while legal entities remain the dominant reported domestic category. This evolution is economically informative because the same sovereign liability can reside on balance sheets with very different functions. We use the holder series to measure the scale and timing of that reallocation, while the structural model separates household participation, bank portfolio adjustment, and lending responses. The full ownership history is reported in Internet Appendix OA.F.

3 Model, Identification, and Estimation

3.1 Household participation with an access cost

For UAH military bond j at monthly date t , let H_{jt} denote NBU-reported holdings by individuals and E_{jt} holdings by legal entities. Conditional on the domestic reported stock $Q_{jt}^D = H_{jt} + E_{jt}$, define the household allocation share

$$h_{jt} = \frac{H_{jt}}{H_{jt} + E_{jt}}. \quad (3.1)$$

The legal-entity category contains banks and other legal persons, so h_{jt} is a household share among reported domestic holders, not a household-versus-bank share and not the probability that a representative household owns a bond. One observation has $H_{jt} = 0$; because its log-odds are undefined, that observation is excluded from the log-odds structural sample rather than replaced by an arbitrary numerical floor.

Conditional on the observed domestic quantity Q_{jt}^D , index infinitesimal units of that quantity by $r \in [0, Q_{jt}^D]$. For each unit, a marginal household demand opportunity competes with the legal-entity outside option, normalized to zero. The unit is allocated to households when its household surplus is nonnegative. The normalized surplus difference is

$$\Delta U_{rjt} = V_{jt} - \kappa_{jt} + \xi_{rjt}, \quad (3.2)$$

where V_{jt} is the systematic household surplus from allocating that unit to households rather than legal entities, κ_{jt} is the retail participation cost, and ξ_{rjt} is iid logistic with scale normalized to one. By the law of large numbers, the fraction of the fixed domestic quantity allocated to households equals the choice probability. This makes the model a structural allocation problem for bond quantities; it does not reinterpret the holdings share as the fraction of Ukrainian households that own a bond. The access cost is

$$\kappa_{jt} = \kappa_0 - \kappa_D \text{Diia}_{jt}, \quad (3.3)$$

so $\kappa_D > 0$ is the primitive reduction in participation cost when an already-issued bond becomes purchasable through Diia. Aggregation over the logistic taste distribution gives

$$h_{jt} = \Pr(\Delta U_{rjt} \geq 0) = \Lambda(q_{jt}), \quad \Lambda(z) = (1 + e^{-z})^{-1}, \quad (3.4)$$

with $q_{jt} = V_{jt} - \kappa_0 + \kappa_D \text{Diia}_{jt}$. We parameterize the non-access component of normalized

household surplus as

$$\begin{aligned}
q_{jt} = & \mu + \gamma\tau_t + \beta_A \tilde{a}_{jt} + \beta_{A2} \tilde{a}_{jt}^{(2)} + \beta_{A3} \tilde{a}_{jt}^{(3)} + \beta_Q \tilde{q}_{jt}^Q \\
& + \alpha_j + u_{jt} + \kappa_D \text{Diia}_{jt}.
\end{aligned} \tag{3.5}$$

Here μ absorbs the common component $-\kappa_0$; τ_t is wartime calendar time in years; a_{jt} is time since the bond first appears in the machine-readable holder panel and is therefore an observed-age proxy rather than a claimed issuance date; and Q_{jt} is total reported holdings. Yield and remaining maturity are not present in the recovered monthly holder panel and are not fabricated; persistent bond type α_j absorbs time-invariant omitted security attributes. The centered characteristics used literally in estimation are $\tilde{a}_{jt} = a_{jt} - \bar{a}$, $\tilde{a}_{jt}^{(2)} = a_{jt}^2 - \bar{a}^2$, $\tilde{a}_{jt}^{(3)} = a_{jt}^3 - \bar{a}^3$, and $\tilde{q}_{jt}^Q = \log(Q_{jt}/\text{UAH 1 bn}) - \overline{\log(Q/\text{UAH 1 bn})}$. Persistent bond type is a two-point latent distribution. With probability π_H , $\alpha_j = \sigma_\alpha \sqrt{(1 - \pi_H)/\pi_H}$; otherwise $\alpha_j = -\sigma_\alpha \sqrt{\pi_H/(1 - \pi_H)}$. This normalization gives $E[\alpha_j] = 0$ and $\text{Var}(\alpha_j) = \sigma_\alpha^2$ while allowing persistent high-retail-attractiveness bonds. Bond-specific demand evolves as the stationary process

$$u_{jt} = \rho_u u_{j,t-1} + \sigma_u \varepsilon_{jt}, \quad |\rho_u| < 1, \quad \varepsilon_{jt} \sim N(0, 1), \tag{3.6}$$

with exact stationary initialization $u_{j0} \sim N(0, \sigma_u^2/(1 - \rho_u^2))$. This initialization is used literally in the simulator; there is no variance floor or near-unit-root approximation.

Equations (3.2)–(3.6) give the household block its structural interpretation. κ_D is a participation-cost primitive normalized by the logistic taste scale. The model is a conditional fixed-quantity allocation model: observed security quantities are held fixed while the household-versus-legal-entity allocation responds to access costs and bond attributes.

3.2 Clean identification of the Diia access effect

The structural parameter κ_D should not be asked to carry the entire empirical identification argument. Before estimating the dynamic model, we isolate the access effect in the narrow set of listing windows for which an already-issued bond is observed immediately before and immediately after becoming purchasable through Diia. For listing window e , define $q_{je} = \log(H_{je}/E_{je})$. We estimate

$$\Delta q_{je} = \alpha_e + \beta_D \text{Switch}_{je} + \nu_{je}, \quad (3.7)$$

where α_e absorbs every common change between the identical NBU holder snapshots and Switch_{je} equals one only for a security newly added to Diia. The comparison set contains securities observed over the same snapshot pair whose Diia status is unchanged. Thus aggregate wartime demand shocks, inflation news, and other common month-specific forces are differenced out rather than attributed to Diia. Listing timing is not randomized, however. The identifying assumption is that, conditional on the common listing-window effect and the requirement that the bond already be outstanding, newly listed bonds do not experience a simultaneous bond-specific demand innovation that would have changed household holdings even without Diia. We therefore treat Equation (3.7) as disciplined event-window evidence on the access mechanism rather than as a randomized experiment.

Across five clean listing windows, the sample contains 12 switching securities and 53 contemporaneous stable controls, for 65 transition observations. The estimated β_D is 0.291715. Because $q = \log(H/E)$, this corresponds to a 33.8721% increase in the household-to-legal-entity holding-odds ratio, $\exp(0.291715) - 1$. Table 2 reports the estimate and ISIN-clustered inference. This is the paper’s clean event-window estimate associated with the Diia access change. The structural parameter κ_D is conceptually different: it is the normalized participation-cost primitive estimated jointly with persistent heterogeneity and dynamic shocks and is used for the structural counterfactual.

Table 2: Clean identification of the Diia retail-access effect

	Diia switch effect
Change in household-to-legal-entity log holding odds	0.291715
ISIN-clustered standard error	0.124696
95% confidence interval	[0.047310, 0.536119]
Implied change in holding-odds ratio	33.8721%
Transition observations	65
Switching securities	12
Listing-event windows	5

Notes: The sample contains the 12 clean Diia switches and securities observed over the same pre/post snapshot pair whose Diia status does not change. The specification is $\Delta q_{je} = \alpha_e + \beta_D \text{Switch}_{je} + \nu_{je}$, where $q = \log[H/E]$ and α_e is a listing-window fixed effect. Standard errors are clustered by ISIN. The coefficient therefore compares newly accessible bonds with contemporaneous non-switching bonds over identical holder-snapshot intervals. It is a transparent event-window estimate of the access effect, not the structural participation-cost primitive κ_D .

3.3 Bank balance-sheet adjustment

For bank i at date t , let A_{it} denote assets, G_{it} government-security holdings, and L_{it} customer loans. Define $g_{it} = G_{it}/A_{it}$. The bank block is

$$\Delta g_{it} = a_G + \eta_{AG} g_{i,t-1} + \zeta_{it}, \quad (3.8)$$

and

$$\Delta \log L_{i,t+1} = a_L + \eta_{LG} \Delta g_{it} + e_{i,t+1}. \quad (3.9)$$

The intercepts are profiled out. The covariance restrictions implied by Equations (3.8)–(3.9), together with the cross-bank variance of g_{it} , identify the bank block.

3.4 SMM and identification

The structural parameter vector is

$$\Theta = (\mu, \gamma, \beta_A, \beta_{A2}, \beta_{A3}, \beta_Q, \sigma_\alpha, \pi_H, \rho_u, \sigma_u, \kappa_D, \eta_{LG}, \eta_{AG})'. \quad (3.10)$$

The holder panel contributes fifteen moments: the mean, variance, and skewness of log-odds; the mean and variance of h_{jt} ; adjacent-month persistence; covariances of log-odds with wartime time, bond age, and log reported stock; the mean and variance of adjacent changes; the clean-switch Diia change; the fraction with $h_{jt} > 0.20$; the between-ISIN variance of mean log-odds; and the between-date variance of mean log-odds. The bank block contributes three moments: $\text{Cov}(\Delta \log L_{i,t+1}, \Delta g_{it})$, $\text{Cov}(\Delta g_{it}, g_{i,t-1})$, and the mean monthly cross-bank variance of g_{it} .

Following the SMM architecture in Dou et al. (2021), let m^D denote the 18-vector of empirical moments and $\bar{m}^S(\Theta)$ the simulated moment vector. We estimate

$$\hat{\Theta} = \arg \min_{\Theta} [m^D - \bar{m}^S(\Theta)]' \mathcal{W} [m^D - \bar{m}^S(\Theta)]. \quad (3.11)$$

The holder-moment covariance is estimated by ISIN-cluster resampling and the bank block by bank-cluster resampling. The production holder simulator uses common random numbers and the exact stationary initial distribution in Equation (3.6). Table 3 summarizes local identification.

Table 3: Identification map for structural household parameters

Parameter	Three most informative moments
μ	Mean logit household share, Mean household share, Share above 20%
γ	Mean logit household share, Mean household share, Share above 20%
β_A	Covariance with bond age, Mean monthly change, Variance logit household share
β_{A2}	Covariance with bond age, Mean monthly change, Share above 20%
β_{A3}	Covariance with bond age, Mean monthly change, Share above 20%
β_Q	Skewness, Mean monthly change, Covariance with log reported stock
σ_α	Between-ISIN variance of mean logit share, Variance logit household share, Mean household share
π_H	Covariance with wartime time, Share above 20%, Between-ISIN variance of mean logit share
ρ_u	Between-ISIN variance of mean logit share, Variance logit household share, Share above 20%
σ_u	Variance logit household share, Between-ISIN variance of mean logit share, Share above 20%
κ_D	Excess change at Diia switch vs. controls, Share above 20%, Mean logit household share

Notes: Informativeness is ranked by the absolute Taylor-normalized local derivative. The scaled household Jacobian has rank 11/11 and condition number 301.6. No parameter lies on its imposed bound.

4 Structural Estimates and Model Fit

The repaired structural system is overidentified and is not rejected:

$$J = 6.67, \quad df = 5, \quad p = 0.247. \quad (4.1)$$

The holder Jacobian has numerical rank 11/11. No household parameter is estimated at a boundary. The stationary shock persistence is $\hat{\rho}_u = 0.890$, and the exact stationary initialization is used in every simulation. The latent-type estimate assigns probability $\hat{\pi}_H = 0.332$ to the high-retail-attractiveness bond type. The structural participation-cost primitive is $\hat{\kappa}_D = 0.101$. We do not use this noisier joint structural parameter as the headline estimate of whether Diia changes household demand; that question is answered by the transparent within-window estimate in Table 2. Instead, $\hat{\kappa}_D$ maps the access mechanism into the dynamic structural state and therefore governs the model’s no-Diia counterfactual. Its wider sampling interval is carried through that counterfactual rather than hidden.

Table 5: Structural parameter estimates

Parameter	Estimate	Std. error	p -value	95% CI
μ	-2.6705	0.4016	0.000	[-3.4576, -1.8834]
γ	0.0405	0.2081	0.846	[-0.3674, 0.4484]
β_A	5.1321	1.9600	0.009	[1.2906, 8.9737]
β_{A2}	-3.0018	2.9311	0.306	[-8.7466, 2.7431]
β_{A3}	0.3361	1.1704	0.774	[-1.9579, 2.6302]
β_Q	-0.4914	0.2509	0.050	[-0.9831, 0.0004]
σ_α	0.6374	0.1810	—	—
π_H	0.3321	0.1088	—	—
ρ_u	0.8899	0.1020	—	—
σ_u	0.2844	0.1296	—	—
κ_D	0.1006	0.1750	0.565	[-0.2425, 0.4437]
η_{LG}	-0.1426	0.1957	0.466	[-0.5262, 0.2410]
η_{AG}	-0.0331	0.0057	0.000	[-0.0443, -0.0219]

Notes: π_H is the probability of the high-retail-attractiveness latent bond type. The two-point type distribution is normalized to mean zero and standard deviation σ_α . κ_D is the reduction in household participation cost, normalized by the logistic taste scale, when a bond becomes purchasable through Diia. For scale, probability, and stationary persistence parameters, the table reports local standard errors but suppresses unconstrained symmetric p -values and confidence intervals that can leave the maintained parameter space.

Table 4: Model fit: structural holder-allocation SMM

Moment	Data	Model	Emp. SE	t
Mean logit household share	-2.4855	-2.5419	0.1609	0.35
Variance logit household share	1.6358	1.4229	0.2517	0.85
Skewness	0.1434	0.0862	0.2932	0.20
Mean household share	0.1220	0.1132	0.0212	0.41
Variance household share	0.0174	0.0142	0.0159	0.20
Lag correlation	0.9381	0.9495	0.0349	-0.33
Covariance with wartime time	0.1632	0.1327	0.2101	0.15
Covariance with bond age	0.1888	0.2251	0.0473	-0.77
Covariance with log reported stock	-0.4212	-0.2869	0.3870	-0.35
Mean monthly change	0.1382	0.1186	0.0207	0.95
Variance monthly change	0.1913	0.1387	0.1246	0.42
Excess change at Diia switch vs. controls	0.2710	0.2215	0.1354	0.37
Share above 20%	0.2090	0.1671	0.0414	1.01
Between-ISIN variance of mean logit share	0.9881	0.8251	0.1740	0.94
Between-date variance of mean logit share	0.1624	0.2071	0.0988	-0.45
Loan-growth / Δg covariance	-0.000181	-0.000181	—	—
Δg / lagged g covariance	-0.000810	-0.000810	—	—
Mean cross-bank variance	0.0239	0.0231	0.0047	0.18

Notes: The first fifteen moments are generated by the 2022–2026 household participation model. The final three are bank moments. The holder block gives $J_H = 6.63$ on 4 overidentifying restrictions ($p = 0.157$). The joint block-separable criterion is $J = 6.67$ on 5 overidentifying restrictions ($p = 0.247$).

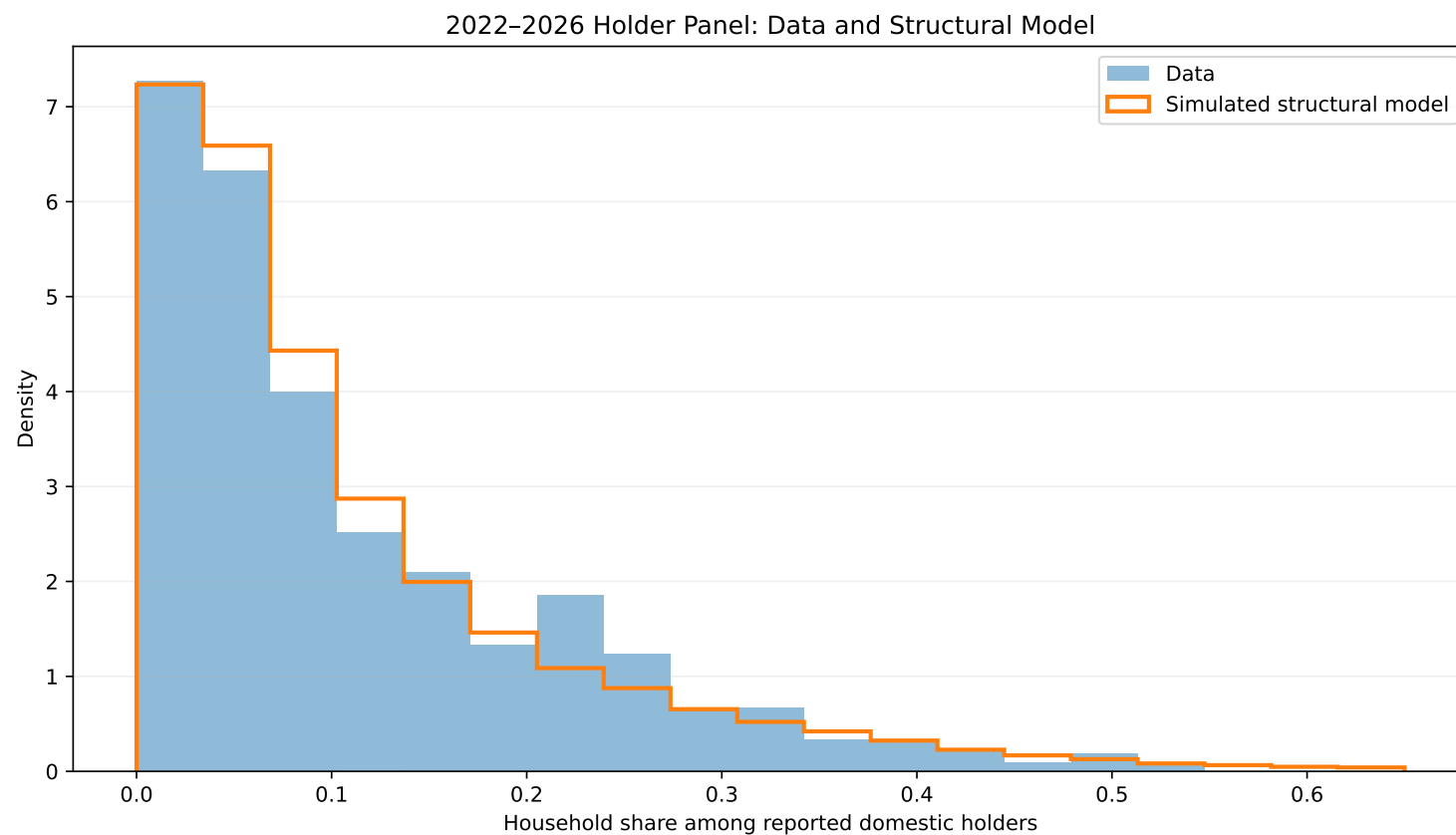


Figure 3: Full 2022–2026 holder panel: empirical and simulated household allocation distribution under the structural participation model.

The bank block continues to show sovereign-inventory mean reversion. The reproducible bank estimate is $\hat{\eta}_{AG} = -0.0331$. The lending semi-elasticity remains negative but imprecise at $\hat{\eta}_{LG} = -0.1426$. Thus the data identify bank portfolio adjustment much more strongly than the downstream lending response.

4.1 Specification discipline

The model repairs the three failures uncovered by the independent audit. First, the simulator now uses the exact stationary distribution implied by the shock law. Second, a cubic bond-age profile, reported stock size, and persistent bond heterogeneity enter the household choice problem directly. The two-type distribution is used because a single Gaussian bond effect cannot jointly reproduce the observed persistent cross-security dispersion and high-household-share tail; Table 6 reports the restricted alternatives rather than suppressing them. Because this richer heterogeneity specification was introduced after diagnosing the Gaussian model’s misspecification, the reported J probability is interpreted as a conditional specification check, not as a model-selection-adjusted probability. Third, κ_D is a primitive participation-cost reduction derived from the random-utility decision rather than a coefficient in an unexplained transformed-share process.

Table 6: Structural specification discipline

Specification	$\hat{\kappa}_D$	Holder $p(J)$	Rank	Condition no.
Preferred: two latent bond types + cubic age + persistent shock	0.101	0.157	11/11	301.6
Gaussian bond heterogeneity + cubic age + persistent shock	0.186	0.069	10/10	349.6
Gaussian bond heterogeneity + quadratic age + persistent shock	0.174	0.074	9/9	546.7

Notes: The preferred model is not rejected at conventional 10% or 5% levels. The restricted Gaussian-type specifications fail the 10% overidentification test and underfit persistent cross-ISIN dispersion and the high-household-share tail.

5 Counterfactuals and Welfare

5.1 Estimated no-Diia household counterfactual

The primary counterfactual removes only the estimated participation-cost reduction from securities purchasable through Diia while preserving each security’s observed domestic quantity and realized non-access state. For treated security j ,

$$h_j^{\text{NoDiia}} = \Lambda(\text{logit}(h_j) - \hat{\kappa}_D). \quad (5.1)$$

At the 1 September 2026 allocation, the point estimate lowers household war-bond holdings from UAH 54.230530 billion to UAH 52.256499 billion, a decline of UAH 1.974031 billion or 3.640073% of observed household holdings. Propagating the conventional 95% interval for κ_D yields effects ranging from a 9.25% increase to a 15.04% decline, so the sign of the no-access effect is not statistically pinned down. The paper therefore distinguishes the economically interpretable point estimate from its substantial sampling uncertainty.

5.2 Where would the displaced financing go?

The NBU holder workbooks report legal entities, individuals, and nonresidents; they do not split banks from nonbank firms at the ISIN level. The bank supervisory panel reports banks’ total OVDP holdings, but not the holder identity of each military-bond ISIN. Therefore the fraction of the point-estimate UAH 1.974031 billion household financing margin that would be absorbed by banks is not point identified.

Let $\lambda_B \in [0, 1]$ denote the fraction replaced by banks. At the August 2026 banking-system balance sheet,

$$\Delta(G/A) = \frac{\lambda_B 1.974031 \text{ bn}}{A}, \quad (5.2)$$

and the estimated lending equation implies

$$\Delta \log L \approx \hat{\eta}_{LG} \Delta(G/A). \quad (5.3)$$

Table 7 reports the complete admissible incidence range.

Table 7: No-Diia counterfactual and balance-sheet incidence

λ_B	Household loss (UAH bn)	Bank absorption (UAH bn)	Δ OVDP/assets (pp)	Δ loan growth (bp)	Δ loans (UAH bn)
0.00	1.974	0.000	0.000	-0.000	-0.000
0.25	1.974	0.494	0.011	-0.163	-0.021
0.50	1.974	0.987	0.023	-0.326	-0.041
0.75	1.974	1.481	0.034	-0.489	-0.062
1.00	1.974	1.974	0.046	-0.652	-0.082

Notes: The point-estimate no-access counterfactual removes the structural Diia participation-cost reduction from bonds accessible on 1 September 2026 while preserving observed domestic quantities. Household holdings fall by 3.640073% (UAH 1.974031 billion). λ_B is not identified; downstream effects are conditional sensitivity calculations.

5.3 Social planner and welfare analysis

Let s_R be the social shadow cost per UAH of bank sovereign exposure, s_L the social surplus per UAH of incremental bank lending, and $\mathcal{C}(x)$ the social cost of mobilizing x UAH of additional household financing. Conditional on λ_B , planner welfare is

$$\mathcal{V}(x) = \lambda_B x \left[s_R + s_L \frac{L}{A} (-\eta_{LG}) \right] - \mathcal{C}(x). \quad (5.4)$$

The break-even marginal access cost is

$$c^*(\lambda_B) = \lambda_B \left[s_R + s_L \frac{L}{A} (-\eta_{LG}) \right]. \quad (5.5)$$

With $s_L = 10\%$, $s_R = 1\%$, and the August 2026 loan-to-asset ratio, $c^*(1) = 1.416617\%$ per additional UAH of household financing. This threshold is unchanged by the smaller household point estimate because it is a marginal benefit per UAH, not a total-benefit calculation.

Proposition 1 (Conditional optimal retail access). *Let $x \in [0, \bar{x}]$ and define $b \equiv s_R + s_L(L/A)(-\eta_{LG})$. Suppose $b > 0$, $\mathcal{C}$ is twice continuously differentiable, and $\mathcal{C}''(x) > 0$. If $\mathcal{C}'(0) < \lambda_B b < \mathcal{C}'(\bar{x})$, there is a unique interior optimum x^* satisfying $\mathcal{C}'(x^*) = \lambda_B b$. Moreover, x^* increases with λ_B and s_R and, when $\eta_{LG} < 0$, with s_L .*

Thus the best policy is not universal retail ownership. It is the access level at which the marginal financial-system benefit equals the marginal mobilization and household-risk cost. Because s_R , s_L , λ_B , and the full access-cost schedule are policy inputs rather than identified structural parameters, the data do not establish that Ukraine’s observed access policy is the planner optimum.

Table 8: Welfare sensitivity for the point-estimate access-induced financing margin

λ_B	Break-even access cost (per UAH)	Gross benefit before access cost (UAH bn)	No-Diia bank absorption (UAH bn)
0.25	0.354%	0.007	0.494
0.50	0.708%	0.014	0.987
0.75	1.062%	0.021	1.481
1.00	1.416%	0.028	1.974

Notes: Illustration sets the social value of incremental lending to 10% per UAH and the shadow cost of bank sovereign exposure to 1% per UAH. These are conditional welfare thresholds, not estimates of social shadow values or of λ_B .

6 Conclusion

Ukraine’s wartime bond market shows that the sovereign investor base is not fixed. In the clean listing windows, bonds newly made purchasable through Diia experience a 33.87% relative

increase in the household-to-legal-entity holding-odds ratio versus contemporaneous non-switching bonds. The structural model then derives household allocation from a participation decision with an explicit access cost, bond characteristics, persistent bond heterogeneity, and stationary demand shocks. Because the structural no-access counterfactual is estimated less precisely than the event-window access effect, it is treated as supporting policy analysis rather than as the paper’s headline result.

The public data also impose a separate identification limit. Military-bond holder files do not separate banks from other legal entities security by security, so the fraction of marginal household financing that displaces bank holdings remains unidentified. Bank incidence, lending, and welfare are therefore reported over the admissible displacement range rather than as causal point estimates.

The broader contribution is a structural framework for investor-base design under acute sovereign financing stress: access policy changes the cost of mobilizing households, security characteristics and persistent heterogeneity shape demand, and the social value of additional retail financing depends on the balance sheet it replaces. The framework makes clear both what Ukraine’s public data identify and what richer institutional-holder data would be required to solve the planner’s problem quantitatively.

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Internet Appendix

Wartime Bonds: How Is the Sovereign Investor Base Designed?

OA.A Data Construction and Sample Audit

The replication archive contains the raw NBU military-bond releases from March 2022 through September 2026, the parsed monthly UAH holder panel, the bank supervisory panel, the structural-estimation scripts, simulated-moment outputs, moment covariance matrices, Jacobians, counterfactual files, and checksums. The structural household sample contains 622 interior-share ISIN-month observations for 45 UAH military bonds from August 2022 through September 2026. One additional UAH observation has exactly zero individual holdings and is excluded from log-odds estimation rather than clipped. Earlier 2022 PDF releases are retained and used in the descriptive full-history figure but are not mixed with the machine-readable monthly structural panel.

Household penetration is defined as individuals divided by individuals plus legal entities. The legal-entity category is not relabeled as “firms” or “banks.” This is essential because the NBU workbook does not separately identify banks at the ISIN level.

OA.B Moment Definitions and Simulation Algorithm

For each candidate parameter vector, the simulator follows the observed unbalanced ISIN-date structure. Common-random-number draws are held fixed across parameter evaluations. Persistent bond type is drawn once per ISIN from the estimated two-point distribution. For the stationary idiosyncratic shock, the first observation for each ISIN is drawn exactly from $N(0, \sigma_u^2/(1 - \rho_u^2))$ and subsequent observations follow Equation (3.6). No variance floor, clipping rule, or approximate initial condition is used.

The fifteen holder moments are the mean, variance, and skewness of log-odds; mean and

variance of household share; adjacent-month persistence; covariances with wartime time, bond age, and log reported stock; mean and variance of adjacent changes; clean-switch Diia change; fraction above 20%; between-ISIN variance of mean log-odds; and between-date variance of mean log-odds. The bank block adds two covariance restrictions and the mean cross-bank exposure variance. The full system has 18 moments and 13 structural parameters.

OA.C Identification Diagnostics

The household scaled Jacobian has numerical rank 11/11. No household parameter is at its imposed bound. The persistence parameter is estimated at $\hat{\rho}_u = 0.890$, inside the maintained stationary region. The preferred two-type latent-heterogeneity model has holder $J_H = 6.63$ on four overidentifying restrictions ($p = 0.157$); combined with the bank block, the joint statistic is $J = 6.67$ on five restrictions ($p = 0.247$). These are conditional specification checks: the two-type model was introduced after the Gaussian heterogeneity specification failed to reproduce persistent cross-ISIN dispersion and the high-share tail, so the reported probabilities are not model-selection-adjusted. Restricted Gaussian bond-type specifications fail the 10% overidentification test. The access-cost parameter is primarily disciplined by the within-security Diia-switch moment, while age, stock size, and persistent bond type absorb observable and persistent cross-security heterogeneity.

The bank-offset share is deliberately not estimated from public holder shares. Because the holder categories add up by construction and legal entities combine banks with other institutions, a bank-versus-household displacement elasticity cannot be recovered from the ownership identity. A separate projection using total bank OVDP holdings is unstable and yields an economically inadmissible point estimate with a confidence interval spanning the full feasible region. This failed identification exercise is retained in the replication archive as an audit, and the paper reports $\lambda_B \in [0, 1]$ sensitivity instead.

OA.D Frozen Notation Ledger

Table OA.1: Frozen notation ledger

Symbol	Definition	Domain	Units
t, j, i, r	Date, bond, bank, and potential-household indices	discrete	none
D_t	Conceptual UAH wartime-bond financing stock	$\mathbb{R}_+$	UAH
B_t, H_t, F_t N_t, C_t	Conceptual holdings by banks, households, nonfinancial firms, nonresidents, central bank/other	$\mathbb{R}_+$	UAH
E_{jt}, H_{jt}	NBU legal-entity and individual holdings for ISIN j	$\mathbb{R}_+$	UAH
h_{jt}	$H_{jt}/(H_{jt} + E_{jt})$	$(0, 1)$ in structural sample	share
q_{jt}	Net household participation surplus; equals $\text{logit}(h_{jt})$ for interior shares	$\mathbb{R}$	normalized utility
V_{jt}	Household surplus before retail access cost	$\mathbb{R}$	normalized utility
κ_{jt}	Retail participation cost	$\mathbb{R}$	normalized utility
κ_D	Diia-induced reduction in participation cost	$\mathbb{R}$	normalized utility
τ_t	Wartime calendar time	$\mathbb{R}_+$	years
a_{jt}	Time since first machine-readable appearance	$\mathbb{R}_+$	years
Q_{jt}	Total reported bond holdings used as size control	$\mathbb{R}_+$	UAH

Symbol	Definition	Domain	Units
$\tilde{a}_{jt}, \tilde{a}_{jt}^{(2)}, \tilde{a}_{jt}^{(3)}$	Centered age, squared-age, and cubic-age controls	$\mathbb{R}$	years / years ² / years ³
$\tilde{q}_{jt}^Q$	Centered log reported-stock control	$\mathbb{R}$	log UAH
α_j	Two-point persistent bond-specific household surplus	$\mathbb{R}$	normalized utility
σ_α	Cross-bond SD of α_j	$\mathbb{R}_+$	normalized utility
π_H	Probability of the high-retail-attractiveness latent bond type	$(0, 1)$	probability
u_{jt}	Stationary bond-specific demand shock	$\mathbb{R}$	normalized utility
ρ_u	Persistence of u_{jt}	$(-1, 1)$	none
σ_u	Innovation scale of u_{jt}	$\mathbb{R}_+$	normalized utility
A_{it}, G_{it}, L_{it}	Bank assets, government securities, customer loans	$\mathbb{R}_+$	UAH
g_{it}	G_{it}/A_{it}	$[0, 1]$	share
η_{AG}, η_{LG}	Bank inventory adjustment and lending semi-elasticity	$\mathbb{R}$	equation-specific
Θ	Structural parameter vector	$\mathbb{R}^{13}$ subject to bounds	mixed
$m^D, \bar{m}^S(\Theta)$	Data and simulated moment vectors	$\mathbb{R}^{18}$	moment-specific
λ_B	Fraction of marginal household financing replaced by banks	$[0, 1]$	share
x	Additional household financing in planner problem	$[0, \bar{x}]$	UAH

Symbol	Definition	Domain	Units
s_R, s_L	Social shadow values of bank exposure and lending	$\mathbb{R}_+$	welfare UAH/UAH
$\mathcal{C}(x), \mathcal{V}(x)$	Social access cost and planner welfare	convex / real	welfare UAH

OA.E Independent Equation and Proposition Derivations

Equation (2.1) follows from partitioning the conceptual wartime-bond stock across mutually exclusive holder classes, including the central-bank/other residual class C_t . Dividing by $D_t > 0$ yields shares summing to one. Equation (3.1) is instead a measurement equation based on the NBU categories and therefore uses E_{jt} rather than the conceptual F_t .

Equations (3.2)–(3.4) follow from a binary random-utility allocation problem applied to infinitesimal units of the fixed observed domestic bond quantity. Logistic heterogeneity implies that the fraction of units allocated to households is $h_{jt} = \Lambda(q_{jt})$. Equation (3.3) makes Diia a primitive reduction in participation cost, while Equation (3.5) parameterizes the non-access surplus using calendar time, a cubic observed-age profile, quantity controls, a two-point persistent bond type, and a stationary demand shock. The simulator initializes u_{j0} from the exact stationary distribution implied by Equation (3.6); hence the written model and numerical simulator coincide.

For the no-Diia counterfactual, setting the access-cost reduction to zero subtracts κ_D from the treated security’s normalized utility index while holding the realized non-access state and domestic quantity fixed. Applying Λ gives Equation (5.1).

For Equation (3.8), assume $\text{Cov}(\zeta_{it}, g_{i,t-1}) = 0$. Then

$$\text{Cov}(\Delta g_{it}, g_{i,t-1}) = \eta_{AG} \text{Var}(g_{i,t-1}).$$

For Equation (3.9), assume $\text{Cov}(e_{i,t+1}, \Delta g_{it}) = 0$. Then

$$\text{Cov}(\Delta \log L_{i,t+1}, \Delta g_{it}) = \eta_{LG} \text{Var}(\Delta g_{it}).$$

These are the bank covariance restrictions targeted by the SMM.

For the no-Diia incidence calculation, if banks replace fraction λ_B of a household financing shortfall x , bank government-security holdings rise by $\lambda_B x$. Holding aggregate assets fixed for the first-order mapping gives $\Delta(G/A) = \lambda_B x/A$, which yields Equation (5.2). Linearizing loan levels around the observed balance sheet and using Equation (3.9) gives $\Delta \log L \approx \eta_{LG} \Delta(G/A)$.

For the planner, one UAH of additional household financing that displaces banks by fraction λ_B avoids $\lambda_B s_R$ of bank-exposure cost. It also changes lending by $\lambda_B(L/A)(-\eta_{LG})$ UAH per UAH mobilized to first order, worth s_L per UAH. Subtracting $\mathcal{C}(x)$ yields Equation (5.4), and differentiation yields Equation (5.5).

Proof of Proposition 1. Let $b = s_R + s_L(L/A)(-\eta_{LG}) > 0$. From Equation (5.4),

$$\mathcal{V}'(x) = \lambda_B b - \mathcal{C}'(x), \quad \mathcal{V}''(x) = -\mathcal{C}''(x) < 0.$$

Strict concavity implies at most one interior maximizer. The inequalities $\mathcal{C}'(0) < \lambda_B b < \mathcal{C}'(\bar{x})$ and continuity of $\mathcal{C}'$ imply a unique $x^* \in (0, \bar{x})$ satisfying $\mathcal{C}'(x^*) = \lambda_B b$. Implicit differentiation gives

$$\frac{\partial x^*}{\partial \lambda_B} = \frac{b}{\mathcal{C}''(x^*)} > 0, \quad \frac{\partial x^*}{\partial s_R} = \frac{\lambda_B}{\mathcal{C}''(x^*)} > 0,$$

and, when $\eta_{LG} < 0$,

$$\frac{\partial x^*}{\partial s_L} = \frac{\lambda_B(L/A)(-\eta_{LG})}{\mathcal{C}''(x^*)} > 0.$$

This proves the statement and its comparative statics. □

OA.F Full Holder History

Figure OA.1 reports the full public NBU UAH military-bond holder archive from March 2022 through September 2026 using the NBU’s reported categories.

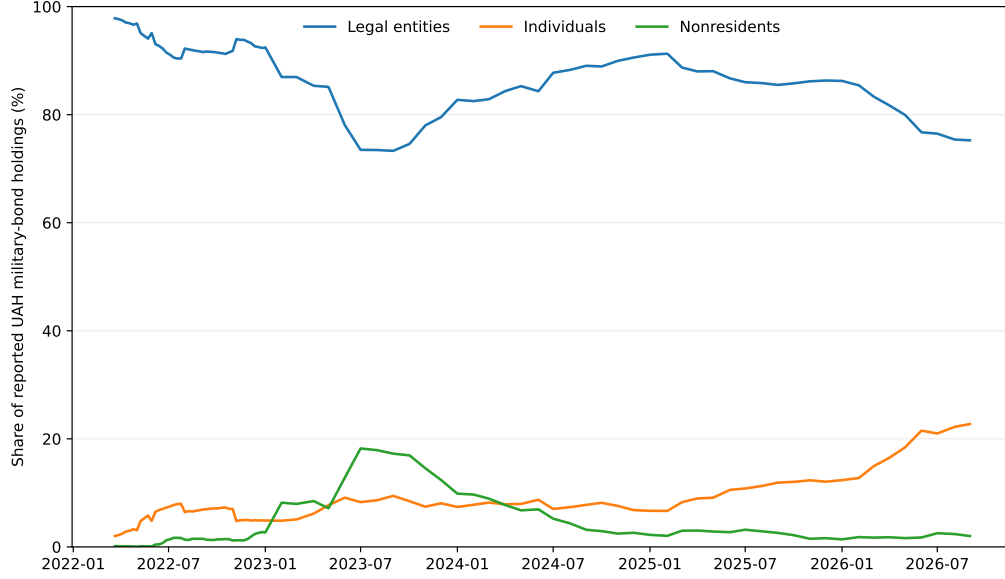


Figure OA.1: Full NBU UAH military-bond holder archive, March 2022–September 2026.

OA.G Counterfactual and Welfare Audit

The no-Diia counterfactual is calculated security by security from Equation (5.1). At 1 September 2026 observed individual holdings total UAH 54.230530 billion. Removing the point-estimate access-cost reduction lowers the counterfactual total to UAH 52.256499 billion, a 3.640073% decline. Using the conventional 95% interval for κ_D gives effects from a 9.25% increase to a 15.04% decline, so the counterfactual sign is not precisely identified.

The August 2026 banking system has approximately UAH 4.317 trillion in assets and UAH 1.261 trillion in customer loans in the supervisory panel. Table 7 maps the point-estimate UAH 1.974031 billion household financing margin into bank exposure and lending over $\lambda_B \in [0, 1]$. No value of λ_B is presented as estimated.

For welfare, Equation (5.4) is a transparent sufficient-statistic frontier. The social shadow values s_R and s_L and the incidence parameter λ_B are policy inputs. Consequently, the paper reports break-

even access costs and gross-benefit sensitivities rather than a fabricated consumption-equivalent welfare number.