

# Land and Mortgage Markets in Ukraine

Pre-War Performance, War Effects,  
and Implications for Recovery

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## Abstract

Almost throughout Ukraine's independent history, agricultural land sales were prohibited. Measures to allow them and make land governance more transparent in 2020/21 were expected to improve equity, investment, credit access, and decentralization. This paper draws on administrative data and satellite imagery to describe land market performance before and after the Russian invasion, assess changes in land use for transacted parcels, and analyze determinants of

land prices. Agricultural land market volume soon exceeded that of residential land and continued at a reduced level and with prices some 15–20 percent lower even after the invasion, with little sign of speculative land acquisition. Mortgage market activity and credit access remained below expectations. The paper discusses reasons and options for addressing them in a way that also factors in the needs of post-war reconstruction.

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# **Land and Mortgage Markets in Ukraine: Pre-War Performance, War Effects, and Implications for Recovery**

## **1. Introduction**

Legal reforms passed in 2020 to allow sale of agricultural land and establish the institutional basis for transparent operation of land and financial markets were intended to lay the basis for Ukraine's transition towards a modern market economy by (i) increasing trust in state registries and their capacity to maintain records properly without corruption, (ii) supporting financial market development by reducing the cost of registration and providing broad access to land price information, and (iii) fostering decentralization by empowering local governments to increase land values through planning and capturing part of the resulting benefits via property taxes and land lease fees. Although the key laws were by and large completed in 2020 and land markets operated since July 2021, it was clear that completing relevant regulations and institutional reforms would be a longer-term process.

The Russian invasion interrupted reform implementation in the short term and created challenges, the resolution of which hinges on expeditious reform implementation: Protecting rights to property despite destruction of physical registries in conflict-affected areas and loss of paper documents by displaced persons requires easy and reliable access to digital records and scanned copies of these documents. Compensation for lost land or property will be less arbitrary if based on objective price data and digital access to pre-war records. Distress sales will be less likely if information on land market values is publicly available or if any attempt to register transactions at prices that deviate too much from predicted prices can be flagged and subjected to scrutiny automatically. Reconstruction will be faster and more likely to maximize future economic potential if it leverages private finance and is informed by publicly available local land use plans that are based on and can be enforced using cadastral and registry information.

This paper uses administrative and remotely sensed data to assess performance of land and mortgage markets 18 months after the moratorium on agricultural land was lifted and uses this as the basis to assess the most expeditious ways of confronting the challenges ahead. Three main conclusions emerge:

First, after market opening, the volume of agricultural land markets soon eclipsed that of residential ones and exceeded it ever since. Prices for commercial agricultural land were more resilient to the invasion than residential land prices or land for personal farming and are in line with fundamentals, presumably because such land produces tradable goods. Neither registered transactions nor survey evidence raise concern about a potential wave of distress sales included in the registry.

Second, although fears about chaotic land markets were unfounded, expected increases in mortgage lending failed to materialize; with well below 1 percent of agricultural and residential land parcels mortgaged, it is unlikely that lifting of the remaining restrictions on agricultural land sales will make much of a difference. To address this constraint sustainably, there is need to (i) ensure that existing legislation mandating price reporting is fully implemented and move towards market-based mass valuation as a basis for land taxation; (ii) complete institutional reform of the registry and cadaster to establish a fully interoperable register of real property that includes land and structures (based on municipal records) in rural and urban areas; and (iii) reduce the cost of registering mortgages or foreclosing in case of default and ensure public land price information allows the National Bank to properly value collateral and increase loan-to-value ratios if land is pledged as collateral in line with Basel principles.

Third, although local planning and revenue collection have been superseded by more urgent priorities, the doubling of land values due to a mandated shift from in-person to transparent electronic auctions (Deininger *et al.* 2022) demonstrates the potential impact of land reform on local revenue. The destruction wrought by the invasion and the associated need to deal with a vast number of compensation or restitution claims swiftly and transparently create opportunities for rapid progress on the move towards electronic registries for residential real estate and decentralized land management by (i) digitizing historical property and cadastral records to use them as the basis for a seamless digital resolution and restitution processes; (ii) linking to the underlying cadastral records and recent high-resolution imagery for a fully integrated electronic register of real estate objects; (iii) publishing local land use plans digitally to streamline processes for enforcement as well as updating and approvals to facilitate expeditious reconstruction in a way that matches private investment with public services and avoids potentially irreparable damage to environmental and cultural assets; and (iv) eventually using market rather than outdated normative values as a basis for property taxation and establishing interoperability to support local efforts at better collection.

Our study links to three strands of literature. First, a large body of studies used land prices for hedonic analysis to make inferences on the value of specific attributes and the effect of market structure. Residential house prices have long been used to value size and incidence of benefits from public goods such as road maintenance (Gertler *et al.* 2022), broadband access (Ahlfeldt *et al.* 2017), trees (Han *et al.* 2021), coastal preservation (Severen & Plantinga 2018) or losses from hazards such as air pollution contamination (Chang & Li 2021), radon exposure (Pinchbeck *et al.* 2020), proximity to nuclear plants (Coulomb & Zylberberg 2021) earthquake risk (Singh 2019), exposure to sea-level rise (Goldsmith-Pinkham *et al.* 2021), or species extinction (Frank & Sudarshan 2022), zoning policies restricting on density (Hilber & Vermeulen 2016), congestion pricing (Tang 2021).

For agricultural land, hedonic analyses are complemented by studies that use data on land prices to analyze market structure and policy in several contexts. In Germany, the fact that institutional sellers achieve higher prices (Seifert *et al.* 2021) and that even for foreclosure, auctions lead to higher prices (Hüttel *et al.* 2014) points towards limited transparency, possibly warranting to consider measures such as mandatory price disclosure that reduced price dispersion in urban settings (Ben-Shahar & Golan 2019). Elimination of restrictions on outside buyers significantly increased land prices in Canada (Lawley 2018) while minimum parcel size regulation increased land values in Taiwan (Chang & Lin 2016). Analysis of the incidence of farm support between renters and owners point to monopsony power by renters (Kirwan 2009) who capture greater shares of such support in less competitive markets, especially if they are large and able to enter into long contracts (Kirwan & Roberts 2016). We add to this by showing that presence of unregistered land exerts a negative externality on transaction prices; that basing tax liability on the administrative ‘normative value’ rather than market values leads to public revenue loss. Once the current restriction of land transactions to physical persons is lifted, it will be important to also assess market competitiveness by using data on type, location, and size of buyers.

Second, while studies have explored the impact of implicit land price changes on the likelihood of conflict (Berman *et al.* 2021) and the effect of war-induced commodity price booms in the 1920s on credit expansion and bank failure in the US (Rajan & Ramcharan 2015, 2016; Jaremski & Wheelock 2020), evidence on the impact of inter-state war on agricultural land markets and prices is limited. Besley and Mueller (2012) use within-region variability in violent killings over time to assess the impact of such violence on residential house prices which are then used to infer the value of the ‘peace dividend’ in Northern Ireland’s civil war.

Studies in rural settings point towards behavioral responses such as higher levels of (within-group) altruism or risk-seeking and potential implications for savings and investments decisions (Voors *et al.* 2012) and farmers’ adjustment to conflict by reducing exposure to markets (Arias *et al.* 2019). They also highlight that conflict can be used strategically by elites to accumulate land at low cost, as documented by high levels of forced displacement and land loss to paramilitaries in municipalities with cultivation of land-intensive oil palm (Tellez 2022). While such issues are likely in areas outside of government control, land markets in locations controlled by government proved resilient; in fact, prices for commercial agricultural land that produces tradables declined only modestly, less than those for urban residential or personal farming land.

Finally, our study speaks to the institutional context for land governance in Ukraine, an issue the importance of which for global food supply chains (Ihle *et al.* 2022) and security (Lin *et al.* 2023) has come in relief with the invasion (Glauben *et al.* 2022). The country has long been subject to suppression of markets and entrepreneurship (Yaremko 2022) and Ukraine’s agricultural sector differs significantly from that of its neighbors (Deininger *et al.* 2018). Prohibition of land sales allowed political elites (Zadorozhna 2020) and

state institutions (Kvartiuk *et al.* 2022; Neyter & Nivievskyi 2022) to manipulate outcomes, exercise market power (Graubner *et al.* 2021) and in doing so reduce investment (Nizalov *et al.* 2016) and dent productivity and confidence in the state (Niviyevskyi *et al.* 2021). Documenting the components of land governance reform and the status of their implementation highlights differences in the extent of reform implementation and impact in practice, pointing to and suggests that improving land valuation, local planning, and links to mortgage lending, could help expand land reform benefits and support decentralization and reconstruction.

The rest of the paper is structured as follows: Section two provides context by describing legal reforms to improve land governance introduced together with the opening of the land sales market in June 2021 and briefly summarizes ways in which the invasion affected the sector. Section three describes the registry data used, discusses volume and prices for sales, rental, and mortgage transactions, and uses remotely sensed on post-transaction land use change to make inferences on potential speculative land acquisition. Section four provides results from parcel-level analysis of land transactions and compares market prices to ‘normative value’. Section five concludes with implications for policy and research.

## **2. Institutional context**

Legislation to allow agricultural land sales and to reform institutions to ensure transparency and reduce the transaction cost of market operation passed in Ukraine in 2020/21 was also expected to contribute to financial market development, investment, and decentralization. To appreciate potential impacts of this reform, we discuss the background for its adoption, the content of individual laws, and the way in which their implementation was affected by the unexpected outbreak of the Russian invasion of Ukraine in February 2022. While the invasion vindicated the need for reform, it also created new challenges, most importantly the need to transparently secure property rights for displaced people, especially in situations where physical offices and paper records have been destroyed, to counter distress sales, and eventually to expeditiously compensate for damages and aid private sector-led reconstruction.

### **2.1 Legal reforms to land governance in Ukraine**

With 41.5 million ha of some of the most fertile agricultural land globally, Ukraine has traditionally been a major source of food grains. Before the war, agriculture contributed about 10% to GDP and 42% of the country’s exports. After de-collectivization in the early 2000s, when some 7 million landowners were provided with land shares of about 4 ha each, the agricultural sector’s value added doubled. Some 20 million ha of Ukraine’s agricultural land is farmed by large farms, often by firms with links to foreign capital markets (Deininger *et al.* 2018); 12 million ha is cultivated by small and household farms. While about 9.2 million ha was state or communal land originally, repeated privatization is believed to have significantly reduced the size of this segment (Nivievskyi 2020).

Fears that market-induced land concentration might undermine equity led to a ‘moratorium’ on land sales in 2001. As the task of reforming land institutions to improve transparency and reduce corruption was too daunting, the moratorium was regularly extended (often by one or two years), together with measures aimed to deal with the symptoms of this situation, often introducing more distortions.<sup>1</sup>

Although there was agreement about the need to eventually lift this restriction, action was impeded by concerns that market imperfections and endemic corruption in the land sector, land markets might further exacerbate inequality. Allowing agricultural land sales, together with institutional reform to create the basis for transparent market operation was expected to support financial market development, encourage investment, and contribute to greater decentralization.

The scope for using agricultural land as a collateral for credit was expected to provide long term credit for the economy as a whole and, together with more secure land rights, support agricultural diversification away from the focus on producing land- and capital-intensive bulk commodities with limited value added or employment generation. It was anticipated to foster equity by improving land market transparency and competitiveness, increasing rent shares captured by landowners. Decentralization was to be improved by reforms that transferred all public land to local governments to provide them with a predictable stream of revenue for local service provision; by information sharing and interoperability to improve local bodies’ ability to collect local taxes (many indexed to land); and by allowing them to plan land use to increase the level of economic activity and land values in the medium to long term.

To address these issues, in 2019 and 2020, Parliament passed legislation to allow land sales from July 1, 2021, a move supported by Ukraine’s international partners and complemented by a package of seven additional laws to reform key institutions dealing with agricultural and urban land to level the playing field and increase the likelihood that desired impacts would materialize.<sup>2</sup> Although a major step, the law fell short of what was proposed by proponents in four respects, namely (i) land purchases by foreign natural persons or legal entities remain prohibited unless such a step is approved by public referendum;<sup>3</sup> (ii) a land ownership limit of 10,000 ha is established; (iii) until Jan. 1, 2024, land that had been in shares (i.e., land for commercial agriculture) can be purchased only by natural persons up to a limit

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<sup>1</sup> One example is legislation, passed in 2015, that prohibits registration of leases shorter than 7 years. See Kvartiuk and Herzfeld (2019) for a more detailed discussion.

<sup>2</sup> After prolonged and highly politicized discussion, Law 552-IX to this effect was passed on March 31, 2020.

<sup>3</sup> This provision was highly controversial and resisted by foreign land users who claimed to have made significant investments in land improvements and who feared to be left at a disadvantage especially with limited enforceability of lease contracts (renege and opportunistic behavior).



of 100 ha;<sup>4</sup> and (iv) public land cannot be sold but only leased. Partly to allay concerns about distress sales, a floor price for land sales is also set by a parcel's 'normative value'.<sup>5</sup>

Complementary laws aimed at institutional restructuring to increase transparency; decentralization; and operation of and access to financial markets especially by small producers. First, transparency, access to information, and competitiveness of markets was to be enhanced through laws (law 340 and law 554) that mandated price reporting and public access to relevant cadastral data. Also, legislation to reform the cadaster and registry was passed to ensure integrity of land ownership information, eliminate the scope for corruption in public and private land management, and reduce the transaction cost of registering land transactions through digital interoperability (law 1423).

Second, local self-governance and decentralization were to be supported by transferring ownership of all public land in within their boundaries from SGC to local governments (law 1423); providing local governments with the tools to rationally plan land use (law 711); empowering them, via taxes on land users and fees for public land leasing, to benefit from increased land values; and by mandating auctioning use rights to public land via competitive electronic auction together with the digital infrastructure to implement such auctions (law 1444).

Third, to improve access to finance by small producers whose inability to access foreign capital had earlier put them at a distinct disadvantage, a digital farmer registry was established to transparently target and transfer agricultural state support, serve as basis for a digital agricultural marketplace, and reduce transaction cost and increase competition in agricultural credit markets (law 985). This was complemented by establishment of an independent Partial Credit Guarantee Facility (PCGF) to reduce the risk of lending to producers who still had to establish a credit history (law 3205).

The mandatory shift from centralized in-person to fully electronic auctions run by local authorities for any transfer of use rights to public land (law 1444) was one of the first laws to be fully regulated. Analysis shows that this instantaneously doubled lease prices received by local governments (Deininger *et al.* 2022).<sup>6</sup> A simple count of the status of resolutions needed for individual reform laws as per Jan. 2023 suggests that progress with regulating other laws, especially those mandating institutional reform (law 1423) was less swift (see appendix table 1), creating a danger of far-reaching land sector reforms not being effective due to gaps in implementation.

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<sup>4</sup> From Jan. 1, 2024, legal persons will be able to purchase land up to a total limit of 10,000 ha. Moreover, even before 2024, current tenants hold a pre-emptive right that they can transfer in case legal restrictions do not allow them to exercise it themselves.

<sup>5</sup> This provision was highly controversial and resisted by foreign land users who often had made significant investments in land improvements and feared to be left at a disadvantage especially with limited de facto enforceability of lease contracts.

<sup>6</sup> Electronic auctions that had earlier been introduced without a proper regulatory framework were in fact less effective than in-person auctions.

## 2.2 Impacts of the war

Beyond leading to a shutdown of the cadaster and registry from end Feb. to end May for cyber-security reasons that made market transactions impossible, the war resulted in three changes.<sup>7</sup> The first and most immediate change was direct damage to farmers' land and structures and disruption of logistics by increasing the cost of seaborne grain exports and damaging grain storage infrastructure. Interpretation of high resolution satellite imagery suggests that about 16% of Ukraine's storage facilities had been damaged by mid-2022 (Khoshnood *et al.* 2022). At that point, 18.7% of village councils had sustained damage to cropland either through burning, shelling, or heavy vehicle movement (Deininger *et al.* 2023b). Aggregate assessments put the direct damage at that point at US\$ 4.29 billion for the agriculture sector alone (Neyter *et al.* 2022b).<sup>8</sup>

Second, reduced supply, damage to logistic structures, and war-related impediments that reduced the volume and increased the cost of seaborne grain exports and required use of more expensive overland routes (von Cramon-Taubadel 2022) significantly reduced output prices. Together with higher prices for inputs, this led to a marked reduction in farm profits. Data sourced from suppliers' catalogues and websites points towards significant increases in input prices with prices for fertilizer having almost doubled and those for ploughing and harvesting services increased by between 10% and 30%. Evidence from a survey of small and medium-scale farms (and households) highlights a drop in farmgate prices of 28% for barley, 23% for wheat, 18% for sunflower, 15% for maize, and 11% for soybean. Together, these factors reduced profits and output market participation compared to the pre-war situation. At the same time, willingness to sell land was very low and even for those interested in selling, the asking price was high. A possible explanation is that formal social support continued during the war period and informal safety nets remained strong (Deininger *et al.* 2023a), suggesting that, for the time being, the danger of registered distress sales of agricultural land seems to remain limited.

Third, by illustrating the importance of strong governance including IT systems that are up to par in terms of cybersecurity to ensure business continuity and the scope for shifting to a digital environment, the war reinforced the importance and benefits from quick implementation of reforms to help reform Ukraine's agriculture sector.<sup>9</sup> As a result, MAPF expedited implementation of a full digital State Agrarian Registry (SAR). The SAR was launched in August 2022 and successfully used to fully transfer, by Nov. 2022, € 50 million as cash grants to about 35,000 small producers (with less than 120 ha or fewer than 100 cows)

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<sup>7</sup> In addition to suspending land market activity, unharvested winter crops, 21% for machinery, 14% for stored products, 6% for storage facilities and the remainder for livestock, perennial crops and inputs.

<sup>8</sup> Of this total, about 50% is for land (mining pollution) and unharvested winter crops, 21% for machinery, 14% for stored products, 6% for storage facilities and the remainder for livestock, perennial crops and inputs.

<sup>9</sup> Key regulatory provisions to implement land sector reforms are included in the relevant chapter of the anti-corruption law (No. 2322) adopted in June 2022 to smooth the way towards EU accession.

whose eligibility had been checked digitally against state registries and crop maps derived from satellite imagery. This experience motivated MAPF to mandate that all state support, donor assisted programs, and banks that benefit from state funds via guarantees use this platform, a call already heeded by some organizations.<sup>10</sup>

### 3. Data and descriptive evidence

Registry data suggests that, following market opening, agricultural land markets quickly overtook those for residential land in terms of volume and maintained this advantage during the war period when a drop in volume was combined with a slight increase in the price of sold parcels. The potential of mortgage markets was not realized, most likely due to institutional reforms' incomplete nature. Changes in transacted parcels' land cover provide little basis for concerns about speculative sales and could be useful to monitor rural as well as urban land market activity in the future.

#### 3.1 Data sources and variable description

We use parcel-level data on registered sales or leases of agricultural and residential land,<sup>11</sup> prices for these where reported,<sup>12</sup> and mortgages, from the Registry of Rights of Ukraine to provide national and sub-national statistics on transaction volume and prices regularly published by Ukraine's State Geocadaster (SGC). Transacted parcels' cadastral numbers allow us to recover their location (either as a parcel shape or centroid) and use it to compute spatial characteristics such as land use at the time of transfer, distance to the next city, primary road, and park, a land quality index based on soil maps, altitude, and slope that are likely to affect agricultural profitability and thus land prices. Crop maps for 2019-22 elaborated using the methodology described in Kussul *et al.* (2017); Shelestov *et al.* (2017), and Shelestov *et al.* (2020) are then used to obtain information on parcels' land use before, at, and after the time of transfer.<sup>13</sup>

As a proxy for local institutional quality, we use the share of unregistered but cropped land at the village level. We obtain this by subtracting the area included in the cadaster in 2021 (as a precondition for registering rights) from the total area cultivated with crops in a village in the same year. Experts believe that such informality differs between private and public land. For private land, failure to register is often attributed to general distrust of the state or fears that registration might incur additional tax liabilities. In

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<sup>10</sup> Following the PSG, the SAR has been used to manage distribution of short-term grain storage by FAO, for distribution of emergency support (e.g., generators) by MAPF and programs to use it to distribute seeds and fertilizer for the 2023 spring planting season have just been launched. SAR is also intended to provide the platform for farmers' application for partial credit guarantees to be provided by an independent agency.

<sup>11</sup> In addition to residential land, transfers and mortgages are reported for recreational and industrial land which are relatively minor (1,526 recreational and 1,991 industrial land sales were observed during the period). We include these figures in the number of land transactions but report prices only for residential land to allow comparability and avoid issues with outliers.

<sup>12</sup> Despite a legal obligation to register prices, prices are reported only for about 50% for sales and lease transactions (see appendix table 2). Although ensuring compliance with the law is important to obtain reliable figures and for banks to accurately value land pledged as collateral, below we use prices without adjusting for selection. Values of mortgages reported in the registry are not credible and are thus not analyzed.

<sup>13</sup> Crop maps are available at <https://ukraine-cropmaps.com/> and files for transactions at <https://land.gov.ua/monitorynh-zemelnykh-vidnosyn/>.

the case of public land, informality is more likely to be linked to corrupt practices that local authorities either endorse or are unable to resist. While we lack the data to distinguish between these two,<sup>14</sup> we note that, irrespective of the ultimate reason, the presence of cropped land to which rights cannot be registered may create negative external effects on registered land by reducing the scope for counting on local authorities for contract enforcement and increasing the likelihood of contracts being disputed, challenged, or reneged on.

### **3.2 Transaction volumes and price trends in land markets**

Daily transaction volumes from July 1, 2021, when the agricultural land sales market opened to Feb. 25, 2022, when transfers were no longer possible as registries were taken offline for security purposes and from May 31, 2022, to Dec. 31, 2022 are displayed in figure 1, separately for agricultural (panel A) and residential (panel B) land.<sup>15</sup> For agricultural land sales, we note a gradual increase from less than 200 to more than 900 daily transactions in at year-end in Dec. 2021 followed by a drop to about 200 daily sales during the war. Residential land sales volume was more stable at about 300 daily transactions before Dec. 2021 when a similar year-end blip is observed, stabilizing at about 150 daily transactions with the war.

Table 1 provides monthly averages of registered land sales and leases, prices, and the number of mortgages for agricultural (panel A) and residential land (panel B). After a modest start in July 2021 when agricultural land sales (5,041) numbered about half of those for residential land (9,831), they accounted for almost three times residential (28,448 vs. 11,890) in December 2021. With the war, the volume of agricultural land sales dropped: number and area of monthly sales after June amount to 44% and 34%, respectively, of the pre-war level, a decline that is slightly more modest (50% for number and area) for residential land.

Markets for new leases are thinner and more seasonal than those for sales: compared to 173,606 and 97,545 sales, only 43,609 and 1,948 new leases were entered over the entire period for agricultural and residential land, respectively. Low liquidity in the formal lease markets may be due to three factors, namely (i) most agricultural enterprises locked in long-term leases (mostly for the legal maximum of 49 years) on favorable terms in the early 2000s when land was perceived to have little value; (ii) measures such as an automatic renewal of expiring leases for one growing season were introduced soon after the start of the war to maintain agricultural production with the imposition of martial law (Kvartiuk & Martyn 2022);<sup>16</sup> and (iii) the legal prohibition on registering leases with less than 7 years creates additional uncertainty and instead of entering

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<sup>14</sup> Records on the nature of unregistered land are only available in paper form at the local level and efforts to systematically gather these were interrupted by the outbreak of the war.

<sup>15</sup> The suspension of land transactions during the initial phase of the war (from Feb. 25 to May 31, 2022) when the registry was taken offline for security reasons to prevent cyber-attacks or manipulation of information, making land transactions impossible, is marked by a black bar.

<sup>16</sup> Note that this measure was repealed, restoring pre-war rules for lease contracting, on Nov. 19, 2022.

into long-term leases on what might later turn out to be unfavorable terms, land owners might prefer short-term informal arrangements.

Table 1 also highlights that mortgage markets have been extremely thin not only for agricultural but also for residential land with only 708 and 2,704 registered mortgages for both types, respectively, in the entire period. While unfinished institutional arrangements (including absence of historical land prices), remaining constraints on land market liquidity such as the ability to transfer only to natural persons, and banks' risk aversion or lack of familiarity with the market could explain this for agricultural land, the low number of mortgages for residential land where such restrictions are absent suggests the transaction cost of using land as collateral remains high. Issues such as complex and costly procedures for mortgage registration and difficulties in executing collateral in case of default should be explored as a matter of priority if the scope for financial market development to catalyze a private sector led reconstruction is to be realized.

Information on prices is needed to provide parties with an accurate picture of land market conditions, for institutions including the central bank to properly value land pledged as collateral to secure their loan portfolios, and for aggregate analysis. While legislation to make price registration mandatory for all sales and leases was passed early in the reform process, appendix table 2 points to weak enforcement even before the war when prices were reported for 57% (54%) of sales for agricultural and residential land. Enforcement worsened with the war; after June 1, 2022, prices are reported only for 24% and 26% of agricultural and residential land transactions, respectively.

Registered price data show that, in contrast to the drop in transaction numbers, agricultural sales and lease prices were slightly higher (by 11% and 5%) during the war than in the pre-war period. Although surprising at first, especially in light of the drop in agricultural profits, the average post-war price of land (US\$ 1,369) would be consistent with expectations under a standard capitalization formula (Deaton & Lawley 2022) even under the assumption that such low prices would persist with any future increases in profits likely resulting in appreciation of prices for agricultural land.

Agricultural land comprises two types, namely (i) land for personal farming (formerly household plots) that is normally located close to owners' house or the settled area of the village and used to provide crops for home consumption (Kvartiuk & Martyn 2021) and (ii) land for commercial agriculture, located at greater distance and farmed in larger fields, often based on rental. Figures by category of land in appendix table 2 show that mean reported prices increased during the war for the former and slightly decreased for the latter. To properly interpret these data, analysis that controls for parcel-level characteristics is needed to adjust for compositional effects (i.e., land entering the market being of higher quality or with structures).

To illustrate regionally differentiated war effects on transaction numbers, we regress volume of agricultural and residential sales and total mortgages on regional indicators,<sup>17</sup> interacted with a post-war dummy (see appendix table 3).<sup>18</sup> Coefficients are graphically illustrated in figure 2 which displays the pre-(blue) and post-war (red) number of monthly transactions and associated 95% confidence interval for agricultural land (panel A), residential land (panel B) and mortgages (panel C). For agricultural land, the pre-war volume of transactions was highest in the Center, followed by the North, the South, the West, and the East. The war significantly reduced transaction volumes everywhere except in the West, eliminated markets completely in the East and nearly in the South, while triggering a more severe decline in the North than the Center. The pattern of residential land sales is similar but characterized by a lower level of transactions in all regions. Mortgage markets, though very modest, were most active before the war in the North.

Figure 3 illustrates pre- and post-war transaction volumes at the oblast level.<sup>19</sup> The size of each pie chart is proportional to transaction volume while blue and yellow segments indicate the distribution of registered sales between the pre-war and the war period. In line with minimal market activity in the East and South, no or very few registered land sales were reported during the war in Kherson, Luhansk, Donetsk, Kharkiv, and Zaporizye.<sup>20</sup> Agricultural land sales remained at less than a quarter of their pre-war level in Mykolaiv, Sumy, Chernihiv, and Kyiv city. By contrast, the (limited) pre-war sales volume was exceeded during the war in Ivano-Frankivsk, possibly reflecting a westward shift of producers displaced in the East.

### 3.3 Changes in transacted parcels' land cover

While opening of agricultural land markets was expected to encourage investment via increased demand (tenure security) and credit supply (mortgages), there was also concern of speculative land acquisition whereby purchasers would acquire land in anticipation of land price increases and leave it idle, potentially giving rise to negative external effects. Although fiscal measures such as a land tax that will encourage more productive land use are a preferable policy response to more crude administrative measures that are more costly to implement and prone to manipulation or corruption at local level, information on changes in land use for all the 83,852 parcels transacted in 2021 based on remotely sensed imagery provides an opportunity to test this empirically. To do so, we drop forest and water and collapse all crops into one 'cropland' category (Kussul *et al.* 2022).

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<sup>17</sup> Oblasts are assigned to regions as follows: The Center includes Cherkasy, Dnipro, Khmelnytsky, Kropyvnytsky, Poltava, Vinntsyia, and Zhytomyr; the East includes Donetsk, Kharkiv, and Luhansk; the North includes Chernihiv, Kyiv, and Sumy; the South includes Kherson, Mykolayiv, Odessa, and Zaporizhje; and the West includes Chernivtsi, Ivano-Frankivsk, Lviv, Rivne, Ternopil, Volyn, and Zakarpattia.

<sup>18</sup> Before the war, agricultural land markets were most active in the Center (with 1,285 weekly sales), followed by the North (941), South (546), East (405), and West (388).

<sup>19</sup> Oblasts are first-level administrative divisions equivalent to states or districts. There are a total of 24 oblasts in Ukraine (including Crimea).

<sup>20</sup> Conflict-affected oblasts are Cherihiiv, Sumy, Kharkiv, Luhansk, Donetsk, Zaporzhje, and Kherson.

Table 2 presents summary results for all as well as personal and commercial farmland in panels A, B, and C for the entire country (cols. 1 and 2) and oblasts with and without conflict in cols. 3 and 4 or 5 and 6, respectively. At the national level, a more than 50% increase in built up parcels is combined with a slight reduction (-4%) in parcels under crops and a slight increase (+3%) in those covered by grass or weeds. The notion of transacted parcels being used more intensively is reinforced by disaggregating parcels by conflict status: in oblasts not affected by conflict, there is no change in the number of parcels under crops but a significant increase in those with structures and a significant drop in those under grassland. By contrast, in conflict-affected oblasts, there is still an increase in built up parcels but a reduction in cropped ones together with an increase in the share of those under grass or uncultivated.

Distinguishing by type of land suggests that most of the shift from crop to grassland in conflict affected oblasts is observed on commercial farmland and that in oblasts unaffected by conflict, a slight increase in cultivated area on land for personal farming matches a slight decrease of commercial farmland. Appendix table 4 presents transition matrices with land use in 2021 and 2022 for agricultural parcels transacted in the sales market in 2021 at the national level (panel A) and separately for areas affected by conflict (panel B) and those unaffected by conflict (panel C).

This suggests that any changes in transferred parcels' cultivation status from cropped to uncultivated land between the 2021 and 2022 cropping seasons were more likely due to conflict conditions than to speculation. It also implies that continued monitoring of land cover in rural areas will be useful and could possibly be extended to urban areas using high resolution imagery to assess war-related damages (Mueller *et al.* 2021) and possibly also monitor progress with reconstruction.

#### **4. Parcel-level land price analysis**

Construction of a hedonic land price index allows us to obtain an index of intertemporal price changes net of parcel attributes and to quantify how parcel characteristics affect market prices for agricultural land. Comparing market price to administratively set 'normative' value points towards sizeable discrepancies that limit the value of the normative value as a floor price to prevent distress sales even if it were enforced. Use of predicted market prices to value land for administrative purposes could thus offer many advantages.

##### **4.1 Evolution of land prices over time**

The evolution of raw prices for (commercial) agricultural and residential land, normalized to equal 100 in February 2022 as illustrated in figure 4 shows that, as indicated in table 1, the post-war decrease in prices for residential land was more pronounced than that for commercial agriculture. Although data intensive (Hill 2013), the potential of hedonic price indexes to control for a host of factors is a distinct advantage

(Diewert *et al.* 2020) that led to their widespread adoption in statistical agencies (Gouriéroux & Laferrère 2009) and research (Diewert & Shimizu 2022).

While lack of data on the nature of residential land sales (e.g., if structures were transferred together with the land) precludes construction of a hedonic price index for this type of land, remotely sensed data on land use and open-source information on infrastructure access construction of such an index for agricultural land. To do so, we regress sale or lease prices for transacted parcels on their characteristics and rayon and month fixed effects, overall and separately for land designated for personal and commercial farming. Indexing parcels by  $i$ , and months by  $t$ , the equation to be estimated is

$$Y_{it} = \alpha_i + \delta X_{it} + \lambda_t + \varepsilon_{it} \quad (1)$$

where  $Y_{it}$  is the sales or lease price for parcel  $i$  sold in month  $t$ ;  $X_{it}$  is a vector of time invariant parcel characteristics including area, slope, and altitude, land use at the time of transfer (crops, forest, built up or grass/uncultivated), a land quality index, the distance to the next city and national or regional park, and the share of unregistered land at village level.<sup>21</sup>  $\alpha_i$ s are rayon fixed effects;  $\lambda_t$ s are month fixed effects; and  $\varepsilon_{it}$  is a random error term. Standard errors are adjusted for clustering at rayon level throughout.

Descriptive statistics for the regression sample of 71,779 sold parcels with and 79,997 ones without prices in appendix table 5 (panel A) and the 10,854 leased ones with and 15,994 without prices (panel B) point towards vast differences between parcels for personal and commercial farming: the former are smaller (1.1 vs. 3.6 ha) and more valuable (US\$10,775 vs. 1,178 per ha), possibly due to presence of structures. Land use also differs between these groups: with 92.5% (43.2) of land for commercial (personal) farming covered by crops; 5.6% (28.9%) covered by grass and 1.8% (22.2%) by forest; and little (5.8%) built up. Differences between transferred parcels for which prices are or are not reported are comparatively small, we report rayon and month fixed effects regression results below.<sup>22</sup>

Regressions for sales prices are presented in table 3, overall (col. 1) and separately for personal (col. 2) and commercial (col. 3) farmland with the first set of (12) coefficients focusing on parcel characteristics. Col. 1 suggests that market prices for land in commercial agriculture are 31% higher than for those in personal agriculture once parcel characteristics are controlled for. We discuss results separately for commercial and personal farming land. For the former, a significant premium is estimated for larger parcels (coefficient of 0.106) at higher elevations (0.143) and those covered with crops (0.285) or trees (0.146). A one-point increase of the land quality index is estimated to increase the sales price by 0.5%. While distance to the next city is insignificant, access to roads matters, with the coefficient (-0.013) suggesting that doubling the

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<sup>21</sup> As (Kvartiuk & Martyn 2021) explain, land used for personal farming refers to house and garden plots and was not subject to the moratorium.

<sup>22</sup> Results from a Heckman-type specification are not significantly different and included in the appendix/available on request.



distance to roads reduces prices for commercial farmland by 1.3%. A positive estimated coefficient on distance to parks is consistent with the notion that, whether due to environmental regulations, a greater number of odd-shaped parcels, or congestion externalities, proximity to a park reduces prices of commercial farmland. Also, the coefficient on the share of unregistered village land is significant and negative (-0.124), possibly reflecting a discount for the higher risk of rights being challenged in such a setting.

By comparison, for personal farmland coefficients of -0.464 on land size, -0.006 on slope, and -0.039 on altitude indicate that smaller parcels of land for personal use fetch higher prices, consistent with a ‘small parcel premium’ in US agriculture (Brorsen *et al.* 2015). Partly non-agricultural use of such land is in line with premia for built up or forested land (with point estimates of 0.286 and 0.218) and highly significant and large coefficients on distance to the next city and road (-0.021 and -0.024). The level of unregistered land at village level is insignificant, in line with the notion that rights to land close to the homestead are often secured through personal presence.

Conditional on controlling for other factors (parcel and time-invariant characteristics), the  $\lambda_t$ s provide an estimate of a quality-adjusted monthly price index. Using July 2021 as the base month, we note that this index almost halved over the period, a phenomenon driven by a drop in the value of land used for personal farming. As can be seen in table 3 and figure 5, quality-adjusted prices for such land declined by 21% and 31% from their July 2021 value in Jan. and Feb. 2022 and bottomed out in Oct 2022, 62.2% below this value. By comparison, commercial farmland prices were stable in the pre-war period (with a 5-7% gain in Oct. and Nov. 2021) but dropped by about 15% after the start of the war.

Table 3 col. 4-6 report coefficients for lease price regressions where, given the thin and seasonal market (with less than 11,000 valid transactions concentrated in July/August of each year as per table 1), we focus primarily on commercial farmland (col. 6) compared to the sales regressions. Estimated coefficients on land quality and road distance are much larger than in the sales regression, indicating the short-term impact of these variables. Also, the coefficient on the share of unregistered land at village level is much larger (-0.320 for commercial and -0.513 for personal farmland) than for sales. This provides micro-level support for the notion, first raised and tested in a cross-country context by Casas-Arce and Saiz (2010) that, if enforcement via the legal system is costly, ownership rights are preferred. Given the seasonal nature of the lease market, we only include an indicator variable for leases concluded during the war. Estimated coefficients on this variable are slightly smaller in absolute terms than those for sales (-0.422 for personal farming and -0.155, significant only at 10% for commercial farming land), but they are consistent in terms of a larger and more significant war effect on prices for land under household plots than commercial farmland.

## 4.2 Comparing market prices to normative values

As registry data include the normative value for each transacted parcel,<sup>23</sup> we can assess the relationship between normative and registered sales price (market value) at parcel level. Deviations of this ratio from unity are policy relevant as all land-related taxes, including those on presumed profits by commercial farms, are linked to the normative value, any mismatch will affect the amount of tax revenue local governments are able to obtain. Moreover, to prevent distress sales, the law prohibits land sales with prices below a parcel's normative value; and given its ready availability, the normative value may well be used as a basis for compensation in the future.

As a first check, figure 6 presents scatterplots of normative value vs. market price (in logs) with each dot representing a transaction, separately for commercial (panel A) and personal farmland (panel B) together with the 45-degree line that should be the locus for all transactions if normative value and market price coincide. Two observations stand out: First, although correlated with normative values, parcels' sales prices are often significantly above it. The simple correlation between normative value and sales price is 0.69 for commercial farming while only 0.28 for personal farming, partly because the normative value is capped at about US\$ 2,500/ha ( $e^{7.8}$ ) whereas many transactions far exceed this value (see figure 6 panel B). Appendix table 5 reinforces this by showing that, with 20%, the difference between sales price and normative value remains modest for commercial farmland but, with mean market prices more than 6 times the normative value, is vast for land in personal farms, suggesting that use of the normative value rather than market values reduces revenue for local governments, similar to use value assessment in the US (Bigelow & Kuethe 2023). Interestingly, a relatively large share of land sales for the latter is at a price well below normative value, implying that legislation establishing this as a minimum purchase price is widely ignored.

As we have information on current land use of transferred parcels including land cover from satellite imagery, we can assess the extent to which the gap between normative and market value can be explained by such attributes (vs. other dummies). To do so, we regress the ratio of the sales price to normative value on parcel characteristics as well as oblast dummies and their interaction with a war dummy. Interacting dummies for administrative units with a war dummy provides an indication whether with the war, the normative value-to-price gap widened, implying an increase in the incidence of distress sales.

Table 4 reports results for commercial (col. 1 and 2) and personal farmland (col. 3 and 4). Constants of 0.986 for commercial and 0.675 for personal farmland confirm that sales prices for the latter are quite close

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<sup>23</sup> The 'normative value' which, by law, provides the basis for taxation and leasing out of public land, is based on the presumed rental income that can be obtained from the parcel from effective use for its intended purpose. For agricultural parcels it accounts for land quality, distance to infrastructure, parcel shape, and other environmental conditions. It is indexed to inflation with annual updates that adjust for inflation in the previous year made on Jan. 15 of every year by State Geocadaster (SGC).

to normative values on average and that easily observable attributes (size or crop cover) increase the ratio while attributes that are more difficult to measure such as distance to infrastructure, slope, or altitude (and whether a parcel of farmland for personal use is built up) reduce it. This provides support to the notion that, despite recent updates normative values continue to be based on a concept of productivity in terms of physical output rather than economic value.

A second conclusion emerging from table 4 is that normative values seem to be updated without accounting for changes in land use such as building of new structures. This implies that shifting from normative value to market values, possibly determined using an equation such as (1) above would be preferable to increase local government's land revenue. It also implies that use of the normative value as a floor price may not be the most effective way to address distress sales. Instead, flagging observations that deviate significantly from market prices after controlling for observable attributes and singling them out for attention (e.g., in terms of automatically informing the seller about market prices and/or establishing a waiting period) might be a more effective approach that would be less open to manipulation.

## **5. Conclusion and policy implications**

Our analysis shows that fears of land market opening causing havoc did not materialize and that even under war conditions, the positive results associated with moves to transparent and digital service delivery, via mandatory e-auctions and the SAR, support the general approach taken to reforms. At the same time, the war caused interruptions, especially to institutional reforms, that prevented the realization of benefits in terms of financial market development and decentralization. Evidence on the resilience of markets, especially for commercial agricultural land, suggests that fast-tracking institutional reforms, including whatever regulations are needed on the financial and safeguards side to prevent exacerbating the impact of war-related disturbances, can provide a basis for realizing these benefits, especially with full opening of agricultural land markets around the corner.

The impact of land reforms in rural areas can be multiplied by expanding these reforms to urban areas, where constraints to clear property records and data interoperability are more severe and potential benefits even larger than in rural ones. Recent legal initiatives suggest that the challenge of re-building large parts of Ukraine's urban areas decimated by the war may provide an opportunity to extend property reform benefits to urban areas. Reform initiatives include (i) moving towards a fully digital register of real property objects; (ii) moving towards market-based mass valuation of land and associated property to provide a buoyant tax base for urban governments; and (iii) planning land use in ways that maximize local revenue, allow effective service provision, and respect social and environmental safeguards.

**Table 1: Monthly volume of registered sales, leases, and mortgages for agricultural and residential land Jul. 2021-Dec. 2022**

	Land sales			Land leases			No. of Mortgages
	No. of Sales	Area (ha)	Price (US\$/ha)	No. of Leases	Area (ha)	Price (US\$/ha)	
<b>Panel A: Agricultural land</b>							
July 21	5,041	5,922	4,146	13,830	34,852	70	
Aug 21	9,934	18,303	1,493	10,143	26,884	76	
Sep 21	14,523	32,763	1,311	3,191	7,801	56	
Oct 21	17,054	41,514	1,309	983	2,261	64	19
Nov 21	21,159	52,194	1,233	498	1,370	76	144
Dec 21	28,448	71,229	1,165	4,596	11,364	82	145
Jan 22	12,190	29,661	1,114	75	294	63	109
Feb 22	16,794	43,437	1,124	67	284	46	91
Jun 22	4,261	6,857	1,601	131	288	53	35
July 22	6,978	10,966	1,528	4,809	9,116	84	8
Aug 22	7,740	12,289	1,375	3,264	6,487	68	18
Sep 22	6,104	12,167	1,214	20	102	N/A	17
Oct 22	7,511	13,400	1,367	1,837	3,863	68	31
Nov 22	7,695	15,059	1,524	127	341	33	32
Dec 22	8,174	16,760	1,164	38	195	53	59
Before war	15,643	36,878	1,228	4,173	10,639	73	101.6
After war	6,923	12,499	1,369	1,461	2,913	77	28.6
Ratio	0.44	0.34	1.11	0.35	0.27	1.05	0.28
Total	173,606	382,521		43,609	105,502		708
<b>Panel B: Residential land</b>							
July 21	9,831	1,206	33,071	619	73	7,009	
Aug 21	8,908	1,089	34,187	364	135	8,427	
Sep 21	8,868	1,141	32,536	122	24	6,756	
Oct 21	9,111	1,344	31,771	47	17	18,551	140
Nov 21	9,121	1,188	30,250	36	7	10,825	364
Dec 21	11,890	1,603	29,309	140	17	7,139	514
Jan 22	5,176	654	33,807	5	2	7,332	275
Feb 22	5,046	647	29,915	14	2	27,149	328
Jun 22	2,788	369	24,807	8	7	27,147	64
July 22	4,543	596	22,408	304	25	13,806	132
Aug 22	4,987	668	21,612	132	10	7,905	152
Sep 22	3,958	537	20,898	6	1	9,941	187
Oct 22	4,551	597	17,202	118	13	3,786	136
Nov 22	4,604	679	16,918	21	4	12,886	201
Dec 22	4,163	549	17,792	12	1	21,880	211
Before war	8,494	1,109	31,676	168	35	7,869	324.2
After war	4,228	571	20,033	86	9	9,737	154.7
Ratio	0.50	0.51	0.63	0.51	0.26	1.24	0.48
Total	97,545	12,867		1,948	338		2,704

Source: Own computation based on parcel-level statistics from Ukraine registry of rights.

Note: Data on mortgages for July-Sept. 2021 are not available. Transaction prices are median prices for cases where prices are reported.

**Table 2: Changes in land cover for transacted parcels**

	Entire country		Oblasts with no conflict		Oblasts with conflict	
	2021	2022	2021	2022	2021	2022
<b>Panel A: All farmland</b>						
Built up	2,779	4,377	2,271	3,625	508	752
Cropland	58,720	56,539	36,613	36,655	22,107	19,884
Grassland	22,353	22,936	16,525	15,129	5,828	7,807
No. of obs. (parcels sold 2021)	83,852	83,852	55,409	55,409	28,443	28,443
<b>Panel B: Personal farmland</b>						
Built up	2,762	4,314	2,255	3,573	507	741
Cropland	19,710	19,992	13,750	14,341	5,960	5,651
Grassland	19,553	17,719	15,214	13,305	4,339	4,414
<b>Panel C: Commercial farmland</b>						
Built up	17	63	16	52	1	11
Cropland	39,010	36,547	22,863	22,314	16,147	14,233
Grassland	2,800	5,217	1,311	1,824	1,489	3,393

*Source:* Own computation from 2021 and 2022 crop maps (available on <https://ukraine-cropmaps.com>) using field coordinates for 83,852 agricultural parcels sold between July and December 2021 as summarized in the transition matrices in appendix table 5.

*Note:* For all included parcels, the table provides the total number of parcels in each land use class in 2021 and 2022.

**Table 3: Land price determinants at parcel level**

	Sales			Leases		
	All	Personal	Comm.	All	Personal	Comm.
Parcel area in ha	-0.343*** (0.003)	-0.464*** (0.005)	0.106*** (0.003)	0.100*** (0.008)	0.006 (0.015)	0.115*** (0.009)
Commercial agriculture	0.309*** (0.008)			-0.017 (0.019)		
Used for crops at time of transfer	0.148*** (0.009)	0.071*** (0.012)	0.285*** (0.010)	0.133*** (0.019)	0.149*** (0.027)	0.132*** (0.025)
Built up at time of transfer	0.645*** (0.020)	0.286*** (0.023)				
Forested at time of transfer	0.367*** (0.012)	0.218*** (0.014)	0.146*** (0.018)	-0.074** (0.033)	0.003 (0.053)	-0.086** (0.041)
Land quality index	-0.001 (0.001)	-0.001 (0.001)	0.005*** (0.000)	0.009*** (0.001)	0.010*** (0.003)	0.011*** (0.001)
Dist. to next city (km)	-0.038*** (0.003)	-0.021*** (0.003)	0.001 (0.003)	-0.048*** (0.010)	-0.089*** (0.015)	0.014 (0.014)
Dist. to primary road (km)	-0.022*** (0.003)	-0.024*** (0.004)	-0.013*** (0.002)	-0.006 (0.008)	-0.010 (0.013)	-0.034*** (0.010)
Dist. to next park (km)	0.005* (0.003)	-0.003 (0.005)	0.018*** (0.002)	0.017** (0.007)	-0.007 (0.011)	0.038*** (0.008)
Village share of unregistered land	-0.205*** (0.031)	-0.053 (0.046)	-0.124*** (0.025)	-0.534*** (0.089)	-0.513*** (0.150)	-0.320*** (0.109)
Slope (%)	-0.012*** (0.002)	-0.006** (0.003)	-0.011*** (0.001)	-0.007** (0.004)	-0.009 (0.006)	-0.003 (0.004)
Altitude (m)	0.070*** (0.010)	-0.039*** (0.015)	0.143*** (0.009)	0.170*** (0.036)	-0.232*** (0.061)	0.219*** (0.045)
War dummy				-0.269*** (0.059)	-0.422*** (0.081)	-0.155* (0.085)
August 2021	-0.036* (0.021)	0.008 (0.028)	0.035* (0.019)			
September 2021	-0.099*** (0.020)	-0.044 (0.027)	0.029 (0.018)			
October 2021	-0.079*** (0.020)	-0.030 (0.027)	0.068*** (0.018)			
November 2021	-0.176*** (0.020)	-0.110*** (0.027)	0.047*** (0.018)			
December 2021	-0.231*** (0.019)	-0.190*** (0.026)	0.002 (0.018)			
January 2022	-0.255*** (0.021)	-0.216*** (0.029)	-0.000 (0.019)			
February 2022	-0.277*** (0.020)	-0.314*** (0.028)	0.018 (0.018)			
June 2022	-0.387*** (0.031)	-0.412*** (0.042)	-0.060** (0.027)			
July 2022	-0.426*** (0.028)	-0.520*** (0.039)	-0.096*** (0.024)			
August 2022	-0.521*** (0.028)	-0.603*** (0.038)	-0.165*** (0.024)			
September 2022	-0.518*** (0.029)	-0.601*** (0.042)	-0.191*** (0.024)			
October 2022	-0.522*** (0.029)	-0.622*** (0.040)	-0.148*** (0.024)			
November 2022	-0.501*** (0.028)	-0.544*** (0.039)	-0.185*** (0.025)			
December 2022	-0.463*** (0.043)	-0.491*** (0.064)	-0.167*** (0.032)			
Constant	7.072*** (0.059)	7.738*** (0.084)	5.660*** (0.051)	3.066*** (0.187)	5.301*** (0.324)	2.477*** (0.231)
Number of observations	71,779	37,244	34,535	10,854	3,819	7,035
Within R-squared	0.237	0.318	0.121	0.048	0.041	0.065

Note: Rayon fixed effects included throughout. Standard errors in parentheses, \* p<0.10, \*\* p<0.05, \*\*\* p<0.010.

**Table 4: Median regression for ratio of normative value to sales price:**

	Land for personal farming		Commercial farmland	
		War dummy interaction		War dummy interaction
Log area in ha	0.0874*** (0.0033)		0.0004*** (0.0001)	
Value of land quality, index	0.0032*** (0.0003)		0.00004*** (0.00001)	
Crop	0.0307*** (0.0074)		0.0075** (0.0032)	
Built up	-0.2818*** (0.0233)			
Forest and low trees	-0.0201* (0.0107)		-0.0933** (0.0449)	
Log distance to the nearest city in km	0.0066*** (0.0024)		-0.00003*** (0.0000)	
Log distance to primary road in km	-0.0002 (0.0026)		-0.00003*** (0.0000)	
Log distance to parks in km	0.0003 (0.0019)		0.00002* (0.00001)	
Share of unregistered land at village level	-0.0636** (0.0256)		-0.0006*** (0.0002)	
Log slope	-0.0026* (0.0016)		-0.00002*** (0.0000)	
Log altitude meters	0.0203*** (0.0074)		-0.0002*** (0.00004)	
Vinntsyia	-0.1216*** (0.0243)	-0.4634*** (0.0687)	-0.0224 (0.0238)	0.0194 (0.0772)
Rivne, Volyn	-0.0232 (0.0152)	0.0061 (0.0213)	0.0049 (0.0149)	0.0002 (0.1093)
Dnipropetrovsk	0.0057 (0.0218)	-0.0255 (0.0465)	0.0045** (0.0023)	-0.0001 (0.0000)
Donetsk	-0.0417 (0.0260)		0.0045* (0.0023)	
Zhytomyr	-0.0260 (0.0209)	-0.4405*** (0.1263)	0.0042** (0.0022)	-0.4908*** (0.1244)
Zaporozhje	0.0474** (0.0218)	2.2062*** (0.1173)	0.0047** (0.0023)	-0.0003 (0.0002)
Chernivtsi, Ivano-Frankivsk, Zakarpatie	-0.3976*** (0.0311)	0.0498 (0.0426)	0.0004 (0.0056)	0.0030 (0.0060)
Kiev	-0.5336*** (0.0165)	-0.0573** (0.0250)	-0.1638*** (0.0210)	0.1588*** (0.0253)
Kirovohrad	-0.0357* (0.0185)	0.0323 (0.0452)	0.0044* (0.0023)	0.0000 (0.0001)
Luhansk	-0.0097 (0.0556)		0.0048** (0.0023)	
Lviv	-0.5934*** (0.0242)	0.0314 (0.0278)	-0.2915*** (0.0647)	0.1827** (0.0845)
Mykolayiv	0.0226 (0.0225)	-0.5432*** (0.0591)	0.0046** (0.0023)	-0.0002 (0.0002)
Odessa	-0.2431*** (0.0202)	0.1749*** (0.0357)	0.0043* (0.0023)	-0.0000 (0.0001)
Poltava	-0.0116 (0.0163)	0.0444 (0.0304)	0.0041* (0.0023)	-0.0029** (0.0012)
Sumskaya	-0.0040 (0.0159)	0.0050 (0.0894)	-0.0078 (0.0056)	0.0022 (0.0300)
Ternopil	-0.4843*** (0.0445)	0.0580 (0.1107)	0.0005 (0.0035)	-0.2764*** (0.0615)
Kharkiv	0.0086 (0.0180)	-0.0351 (0.0934)	0.0044* (0.0023)	-0.0001 (0.0021)
Kherson	0.0946*** (0.0248)		0.0047** (0.0023)	

Khmelnysky	-0.1524*** (0.0173)	0.0992*** (0.0247)	0.0043* (0.0023)	-0.0002 (0.0021)
Cherkasy	-0.0562*** (0.0196)	0.0170 (0.0322)	0.0041* (0.0023)	-0.0001 (0.0005)
Chernihiv		0.1556** (0.0713)		0.0055** (0.0023)
Constant		0.6747*** (0.0379)		0.9864*** (0.0044)
N		10,729		21,128

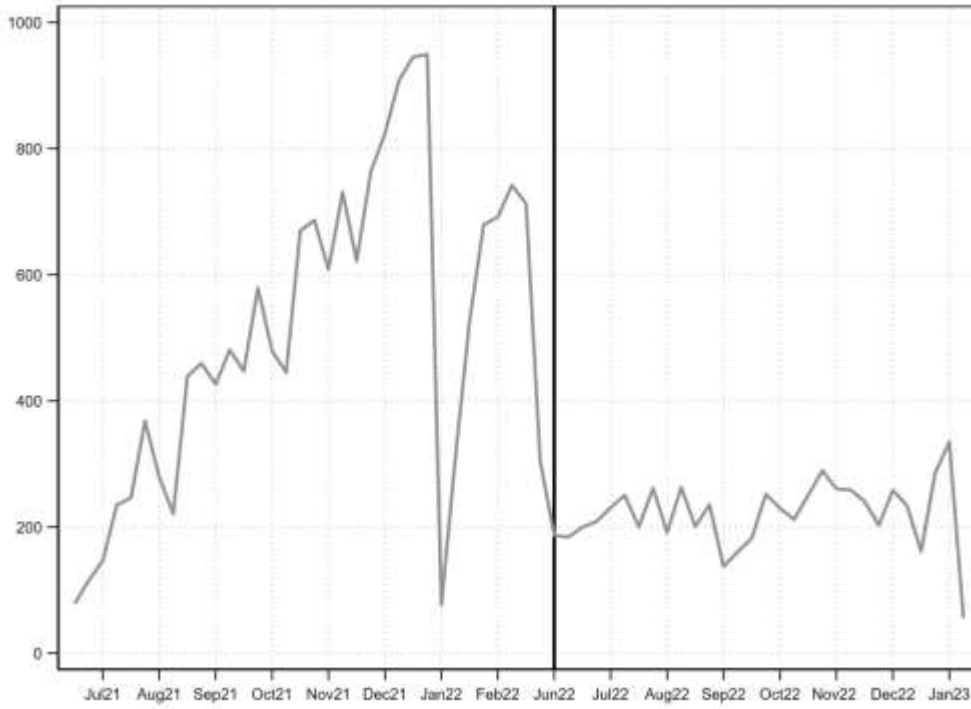
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Standard errors in parentheses. \* p<0.10, \*\* p<0.05, \*\*\* p<0.010

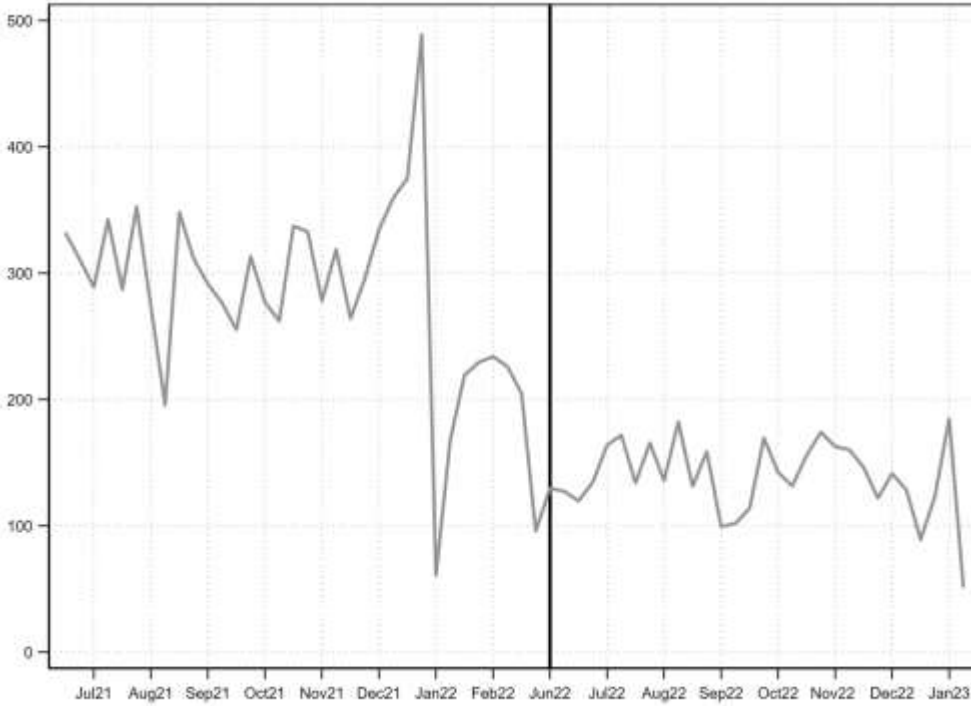


**Figure 1: No. of daily land sales**

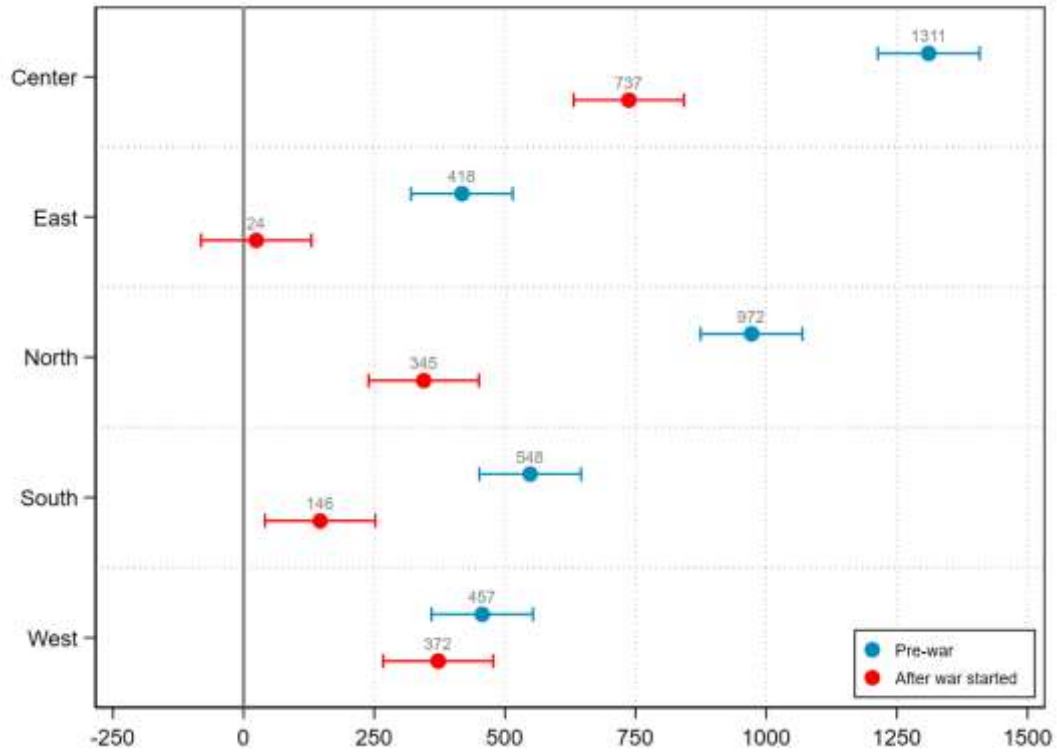
**Panel A: Agricultural land**



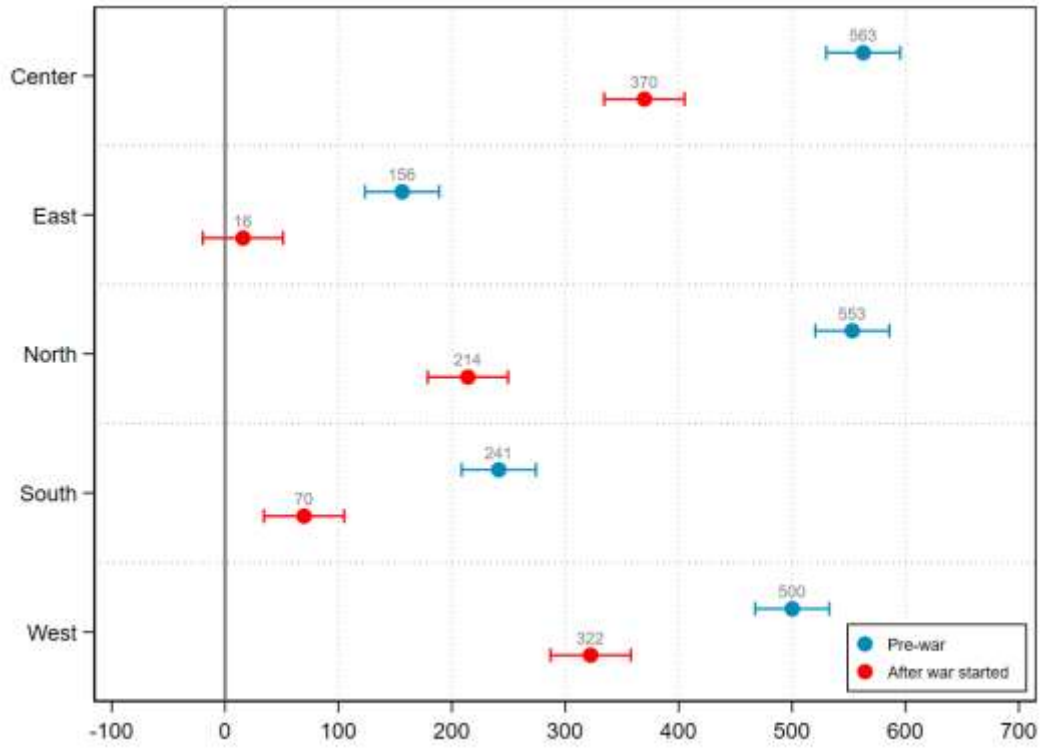
**Panel B: Residential land**



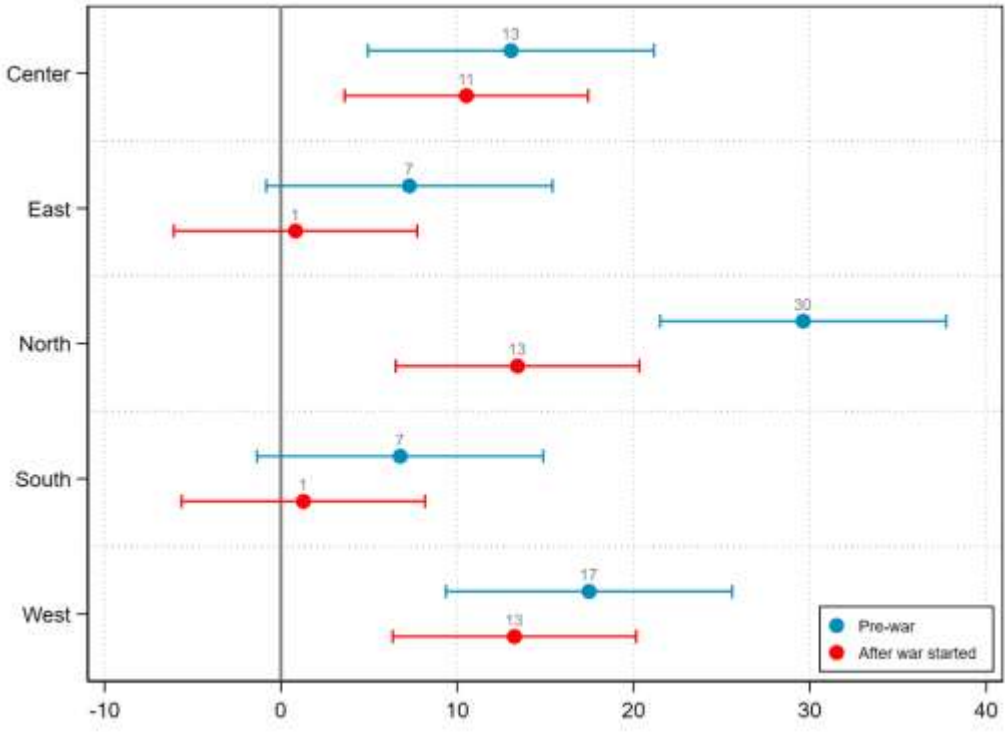
**Figure 2: Coefficients (and confidence intervals) from total and regional regressions for land market activity**  
 Panel A: No. of registered sales of agricultural land



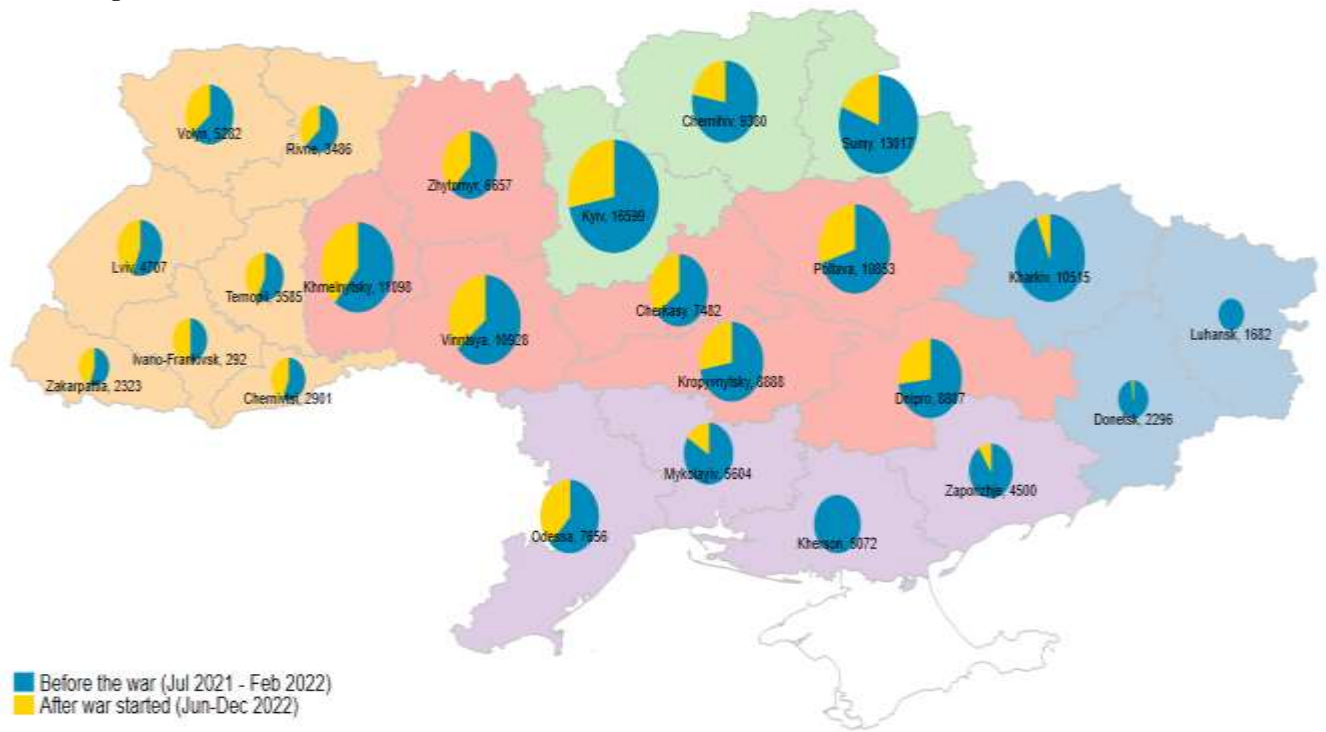
Panel B: No. of registered sales of residential land



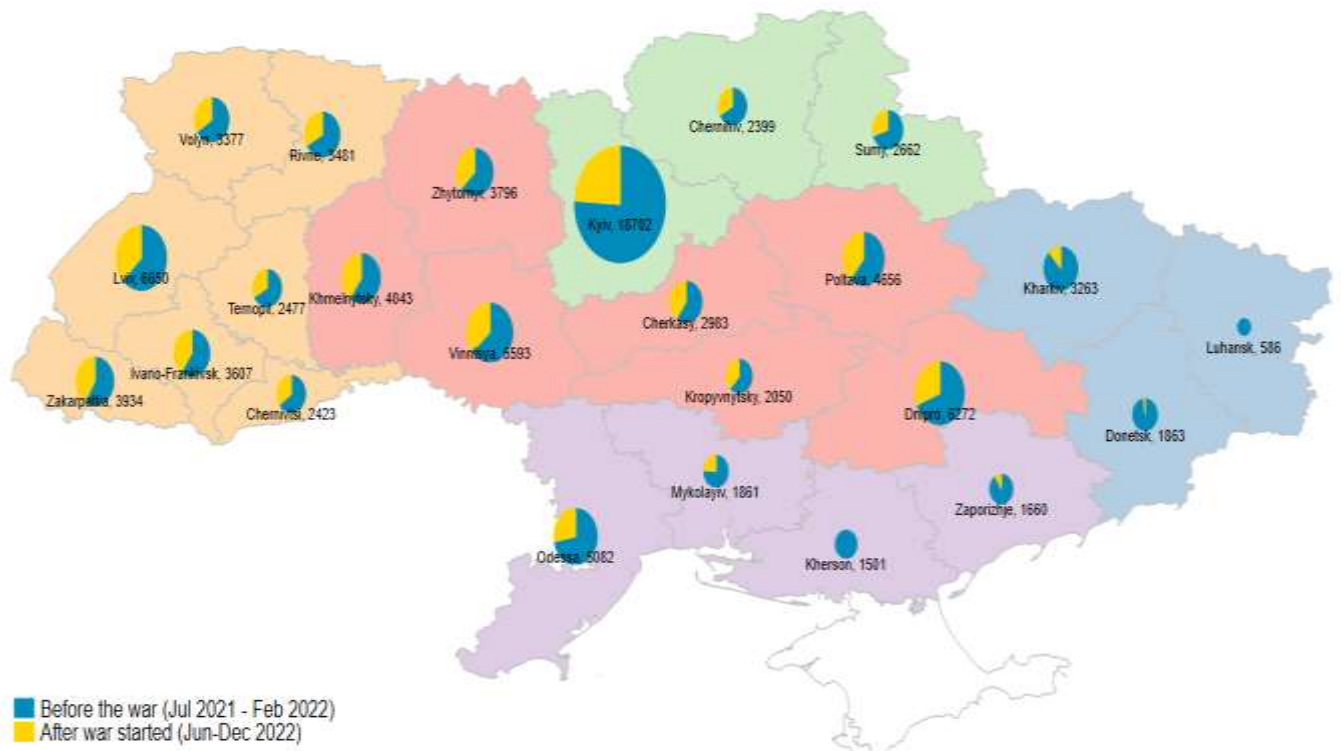
Panel C: No. of registered mortgages (agric. & residential)



**Figure 3: No. of monthly registered sales in pre-war and war periods by oblast**  
**Panel A: Agricultural**



**Panel B: Residential**



*Note:* Colors indicate how oblasts are mapped into regional groupings used in the paper.

Figure 4: National sales price index for agricultural land (for commercial use) and residential land

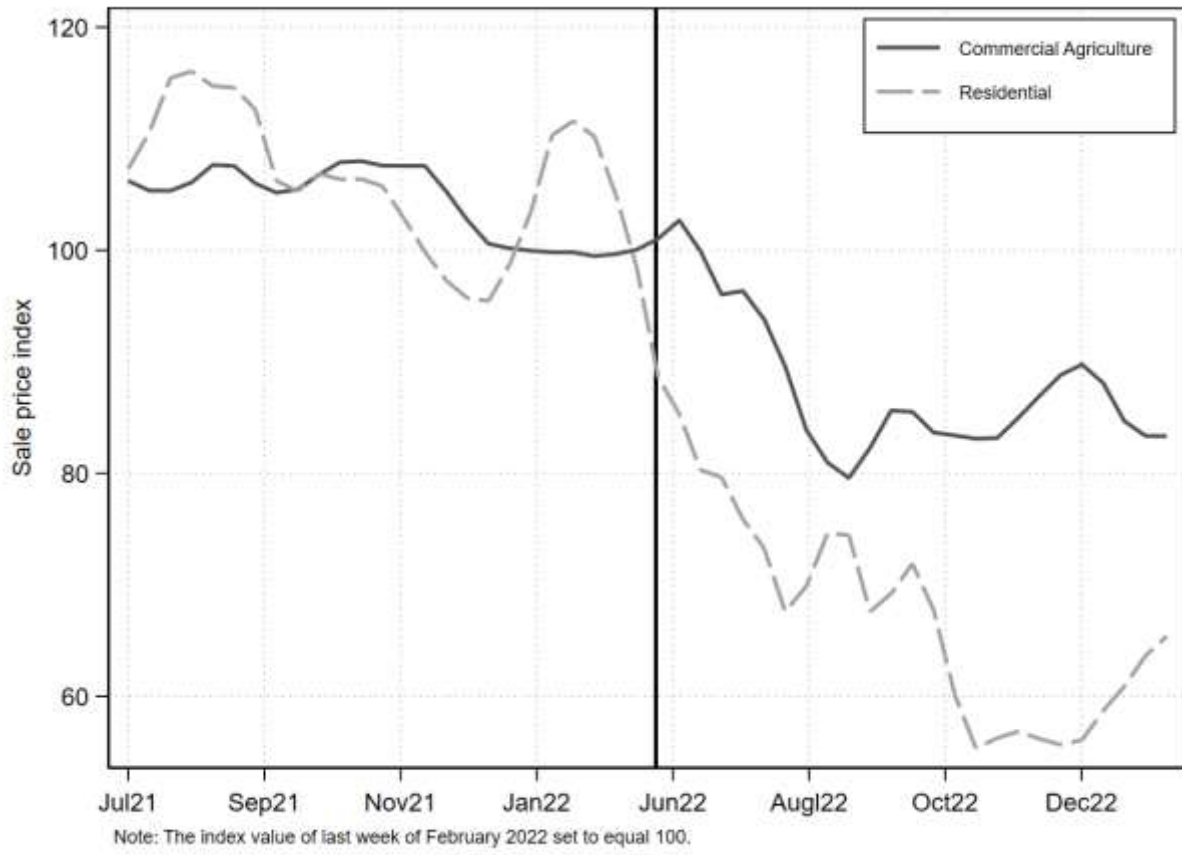


Figure 5: Hedonic log sales price series net of observed characteristics and Rayon fixed effects

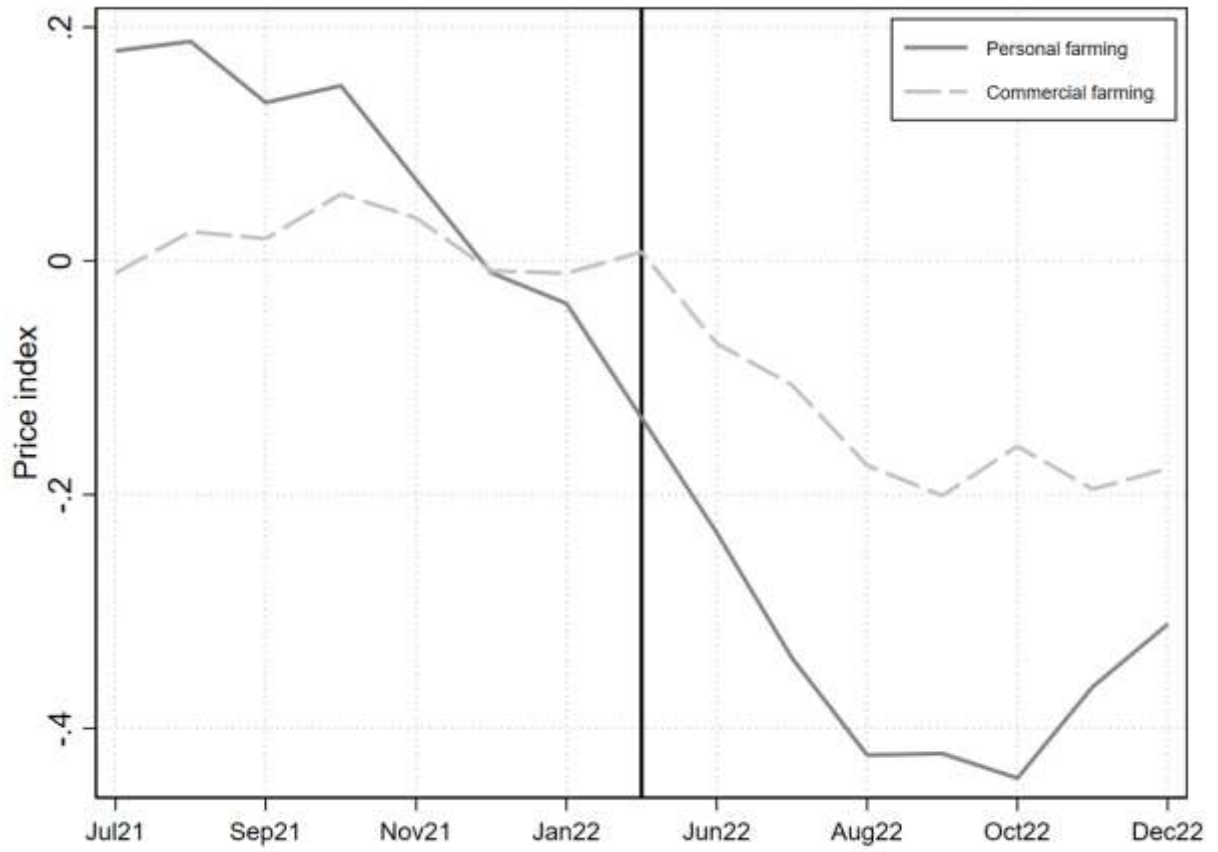
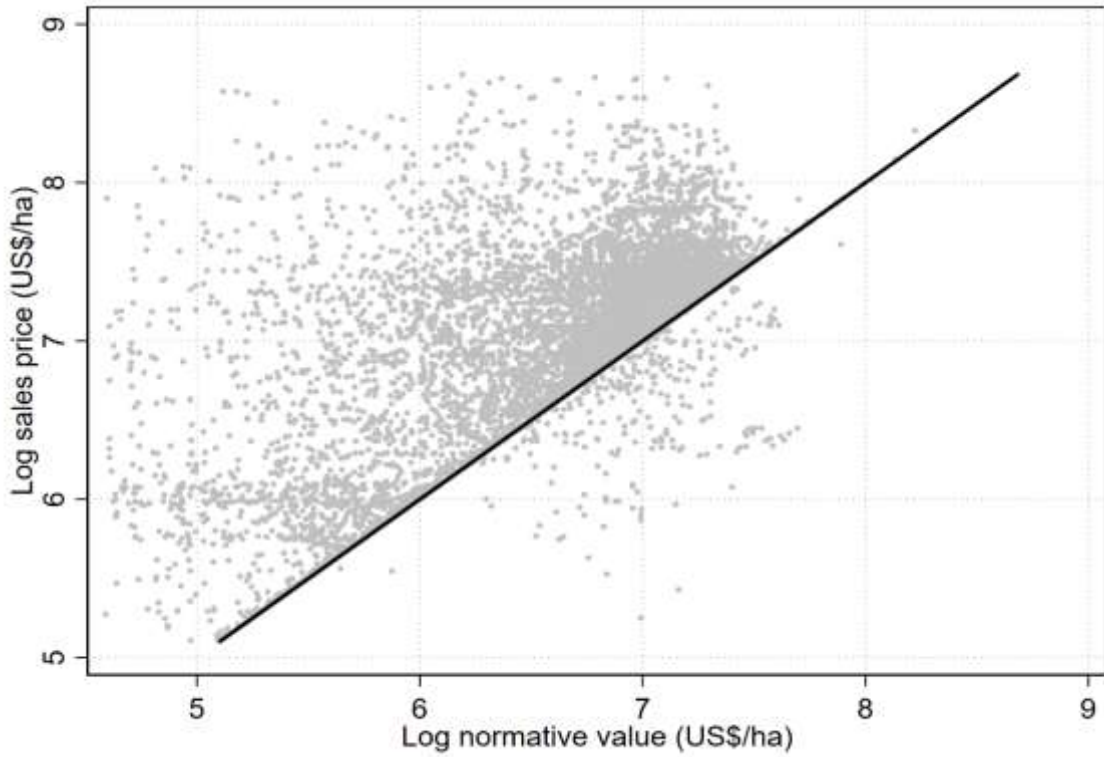
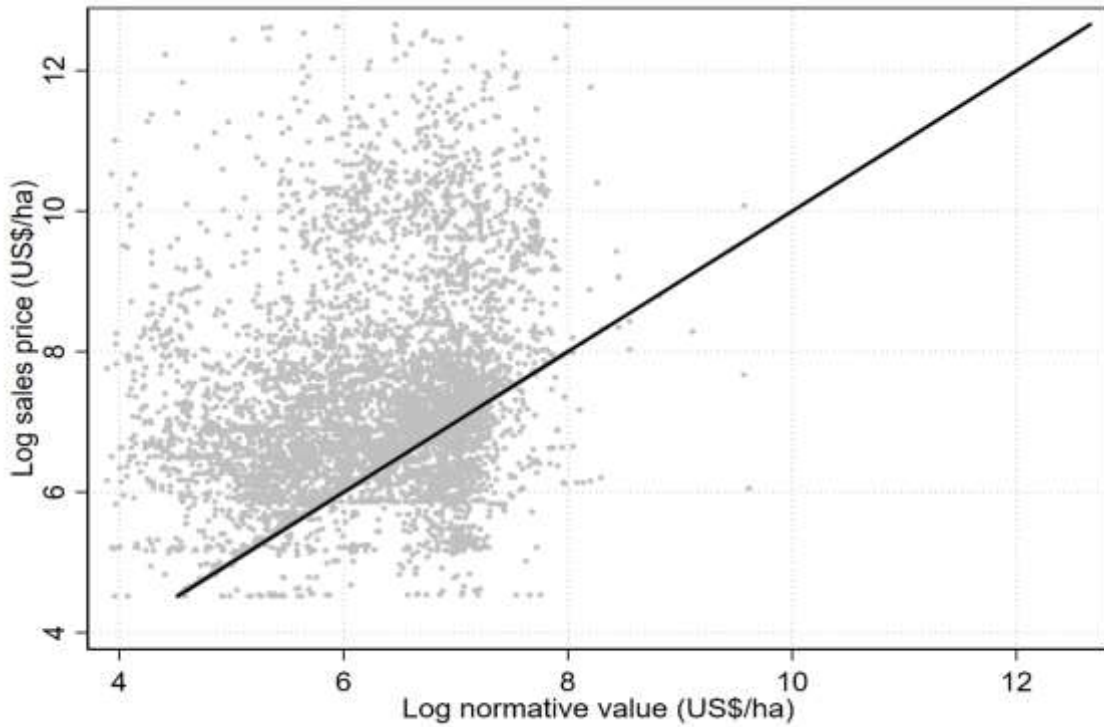


Figure 6: Scatterplot of normative against market value for agricultural land parcels sold  
Panel A: Land for commercial agriculture



Panel B: Land for personal farming



Note: Each dot corresponds to a transaction

**Appendix table 1: Status of subsidiary regulation for major reform laws**

Law #	Topic	No. regulations required	No. of regulations by status in the process		
			Not started	Drafting	Adopted
552	Turnover law	4			4
340	Anti-raider	5			5
711	Planning	10			9
554	Spatial data interoperability	3			3
985	State support	6		1	5
1423	Institutional reform (SGC )	23	12		7
1444	E-auctions for public land	1			1
3205	Part. Credit Guarantee Fac.	9		2	7

*Source:* Own elaboration based on monitoring by legal reform working group

*Note:* Status is as of Jan. 26, 2023. Empty cells mean 0.



**Appendix table 2: Monthly volume of registered sales, leases, and mortgages for agricultural and residential land Jul. 2021-Dec. 2022**

	2021						2022						Relative to invasion				
	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Before	After
<b>Agricultural land</b>																	
No of sales registered	5,041	9,934	14,523	17,054	21,159	28,448	12,190	16,794	4,261	6,978	7,740	6,104	7,511	7,695	8,174	15,643	6,923
Total area (ha)	5,922	18,303	32,763	41,514	52,194	71,229	29,661	43,437	6,857	10,966	12,289	12,167	13,400	15,059	16,760	36,878	12,499
Share reporting price	0.50	0.60	0.59	0.59	0.57	0.56	0.58	0.56	0.28	0.25	0.25	0.26	0.22	0.22	0.21	0.57	0.24
Median sale price (US\$/ha)	4,146	1,493	1,311	1,309	1,233	1,165	1,114	1,124	1,601	1,528	1,375	1,214	1,367	1,524	1,164	1,228	1,369
No of new leases	13,830	10,143	3,191	983	498	4,596	75	67	131	4,809	3,264	20	1,837	127	38	4,173	1,461
Total lease area in ha	34,852	26,884	7,801	2,261	1,370	11,364	294	284	288	9,116	6,487	102	3,863	341	195	10,639	2,913
Share reporting price	0.47	0.49	0.43	0.37	0.41	0.41	0.48	0.36	0.24	0.50	0.41	0.15	0.47	0.41	0.34	0.46	0.46
Median lease price (US\$/ha)	70	76	56	64	76	82	63	46	53	84	68	N/A	68	33	53	73	77
No. of mortgages registered				19	144	145	109	90	35	8	18	17	31	32	59	101	29
<b>Personal farm</b>																	
No of parcels sold	3,413	5,559	7,393	7,897	9,480	12,936	5,579	6,676	2,394	3,875	4,186	3,105	3,902	3,958	3,923	7,367	3,620
Total sale area in ha	2,282	5,289	9,897	10,280	11,524	16,879	7,812	9,370	2,123	3,069	3,241	3,447	3,067	3,581	3,484	9,167	3,144
Share reporting price	0.47	0.61	0.59	0.60	0.59	0.57	0.58	0.56	0.29	0.23	0.26	0.27	0.23	0.25	0.22	0.58	0.25
Median sale price (US\$/ha)	5,536	2,400	1,518	1,553	1,209	1,152	1,031	1,052	2,410	2,317	2,084	1,777	2,394	2,030	1,781	1,316	2,071
No of new leases	4,610	3,215	1,063	328	116	1,628	29	9	53	1,423	1,047	5	548	22	5	1,375	443
Share reporting price	0.47	0.51	0.45	0.38	0.48	0.47	0.62	0.78	0.19	0.52	0.41	0.40	0.53	0.50	0.60	0.48	0.48
Total lease area in ha	7,206	5,205	1,776	488	202	2,684	56	10	113	1,900	1,566	7	756	34	7	2,204	626
Median lease price (US\$/ha)	73	91	84	79	116	109	101	111	112	93	68	N/A	68	55	N/A	84	78
No. of mortgages registered				6	32	47	42	79	32	6	15	8	9	25	36	41	19
<b>Commercial farm</b>																	
No of parcels sold	970	3,466	6,101	8,141	10,415	13,559	5,800	9,418	1,480	2,505	2,898	2,526	3,064	3,188	3,729	7,234	2,770
Total sale area in ha	3,494	12,488	22,038	30,204	38,594	50,234	20,305	32,745	4,043	6,899	8,168	7,226	8,736	9,521	11,007	26,263	7,943
Share reporting price	0.55	0.57	0.57	0.57	0.54	0.54	0.58	0.56	0.23	0.24	0.21	0.24	0.19	0.16	0.18	0.54	0.26
Median sale price (US\$/ha)	1,173	1,198	1,192	1,210	1,207	1,133	1,119	1,124	1,189	1,079	921	940	938	958	959	1,164	969
No of new leases	8,656	6,533	2,017	575	359	2,657	40	54	67	3,295	2,098	15	1,228	101	33	2,611	977
Total lease area in ha	24,368	19,066	5,631	1,506	1,125	7,495	176	262	152	7,032	4,540	95	2,854	251	188	7,454	2,159
Share reporting price	0.46	0.49	0.41	0.35	0.37	0.36	0.40	0.30	0.30	0.50	0.40	0.07	0.45	0.40	0.30	0.45	0.45
Median lease price (US\$/ha)	70	70	49	67	60	73	38	43	35	80	70	N/A	75	33	71	68	76
No. of mortgages registered				1	102	81	45	5	0	0	0	1	17	2	17	47	5
<b>Residential property</b>																	
No of properties sold	9,831	8,908	8,868	9,111	9,121	11,890	5,176	5,046	2,788	4,543	4,987	3,958	4,551	4,604	4,163	8,494	4,228
Total sale area in ha	1,206	1,089	1,141	1,344	1,188	1,603	654	647	369	596	668	537	597	679	549	1,109	571
Share reporting price	0.53	0.54	0.56	0.56	0.55	0.53	0.55	0.55	0.31	0.27	0.26	0.26	0.24	0.26	0.24	0.54	0.26
Median sale price (US\$/ha)	33,071	34,187	32,536	31,771	30,250	29,309	33,807	29,915	24,807	22,408	21,612	20,898	17,202	16,918	17,792	31,676	20,033
No of new leases	619	364	122	47	36	140	5	14	8	304	132	6	118	21	12	168	86
Total lease area in ha	73	135	24	17	7	17	2	2	7	25	10	1	13	4	1	35	9
Share reporting price	0.52	0.54	0.61	0.64	0.61	0.56	0.80	0.50	0.88	0.56	0.53	0.83	0.59	0.52	0.33	0.54	0.56
Median lease price (US\$/ha)	7,009	8,427	6,756	18,551	10,825	7,139	7,332	27,149	27,147	13,806	7,905	9,941	3,786	12,886	21,880	7,869	9,737
No. of mortgages registered				124	311	438	236	270	53	92	133	149	113	173	211	276	132

Source: Own computation from Registry of Rights of Ukraine, January 2023

Note: The columns “Before” and “After” refers to the months before and after the Russian invasion on February 24, 2022. In these columns, number and area of transactions are, for comparison purpose, monthly averages. Median prices are not computed for months with very few reported prices.

**Appendix table 3: Mean war effects on no. of registered transactions & prices per ha of transferred land by region**

	No of transactions			Prices (US\$/ha)	
	Agric. land	Resid. land	Mortgages	Agric. land	Resid. land
Center	1310.824*** (49.468)	562.706*** (16.604)	13.048*** (4.119)	1496.940* (856.664)	16053.249*** (3496.674)
Center # War	-573.617*** (72.912)	-192.982*** (24.472)	-2.530 (5.409)	-360.524 (1262.646)	-7354.489 (5153.786)
East	417.676*** (49.468)	156.088*** (16.604)	7.286* (4.119)	2793.398*** (856.664)	25613.209*** (3496.674)
East # War	-393.470*** (72.912)	-140.295*** (24.472)	-6.458 (5.409)	2509.741* (1287.637)	21815.248*** (5203.217)
North	971.765*** (49.468)	553.088*** (16.604)	29.619*** (4.119)	5089.350*** (856.664)	46782.731*** (3496.674)
North # War	-627.110*** (72.912)	-339.019*** (24.472)	-16.205*** (5.409)	868.517 (1262.646)	-17570.138*** (5153.786)
South	548.265*** (49.468)	241.324*** (16.604)	6.762 (4.119)	2050.455** (856.664)	27645.946*** (3496.674)
South # War	-401.885*** (72.912)	-171.703*** (24.472)	-5.486 (5.409)	-13.245 (1262.646)	-2989.776 (5153.786)
West	456.559*** (49.468)	500.118*** (16.604)	17.476*** (4.119)	2784.245*** (856.664)	34340.177*** (3496.674)
West # War	-84.386 (72.912)	-177.842*** (24.472)	-4.235 (5.409)	33.248 (1262.646)	-5656.125 (5153.786)
No obs.	315	315	250	313	314
R-squared	0.844	0.935	0.340	0.335	0.706

Standard errors in parentheses. \* p<0.10, \*\* p<0.05, \*\*\* p<0.010.

Note: Regressions are for 315 week-region observations for land sales except for mortgages where the no. of obs. is 250 and for prices where no prices are reported for 1 or 2 weeks, respectively.

**Appendix table 4: Land cover transition matrix for parcels transacted in 2021**

2021	2022						
	Built up	Crop	Grass	Garden/parks	Total	%	
<b>I: All agricultural land</b>							
<b>Panel A: National</b>							
Built up	2,131	77	73	498	2,779	3.31	
Crop	246	52,259	5,289	926	58,720	70.03	
Grass	1,198	3,646	9,658	999	15,501	18.49	
Garden/parks	802	557	1,209	4,284	6,852	8.17	
Total	4,377	56,539	16,229	6,707	83,852		
%	5.22	67.43	19.35	8.00			
<b>Panel B: Areas not directly affected by conflict</b>							
Built up	1,747	76	63	385	2,271	4.10	
Crop	205	33,594	2,228	586	36,613	66.08	
Grass	1,022	2,509	6,888	708	11,127	20.08	
Garden/parks	651	476	1,045	3,226	5,398	9.74	
Total	3,625	36,655	10,224	4,905	55,409		
%	6.54	66.15	18.45	8.85			
<b>Panel C: Conflict-affected areas only</b>							
Built up	384	1	10	113	508	1.79	
Crop	41	18,665	3,061	340	22,107	77.72	
Grass	176	1,137	2,770	291	4,374	15.38	
Garden/parks	151	81	164	1,058	1,454	5.11	
Total	752	19,884	6,005	1,802	28,443		
%	2.64	69.91	21.11	6.34			
<b>II. Land used for commercial agriculture</b>							
2021	2022						
	Built up	Crop	Grass	Garden/parks	Total	%	
<b>Panel A: National</b>							
Built up	10	2	3	2	17	0.04	
Crop	12	35,716	3,040	242	39,010	93.27	
Grass	33	761	1,468	93	2,355	5.63	
Garden/parks	8	68	114	255	445	1.06	
Total	63	36,547	4,625	592	41,827		
%	0.15	87.38	11.06	1.42			
<b>Panel B: Areas not directly affected by conflict</b>							
Built up	9	2	3	2	16	0.07	
Crop	7	21,903	881	72	22,863	94.51	
Grass	30	355	587	36	1,008	4.17	
Garden/parks	6	54	68	175	303	1.25	
Total	52	22,314	1,539	285	24,190		
%	0.21	92.24	6.36	1.18			
<b>Panel C: Conflict-affected areas only</b>							
Built up	1				1	0.01	
Crop	5	13,813	2,159	170	16,147	91.55	
Grass	3	406	881	57	1,347	7.64	
Garden/parks	2	14	46	80	142	0.81	
Total	11	14,233	3,086	307	17,637		
%	0.06	80.70	17.50	1.74			

### III. Land used for personal farming

	2021	2022					
		Built up	Crop	Grass	Garden/parks	Total	%
<b>Panel A: National</b>							
Built up		2,121	75	70	496	2,762	6.57
Crop		234	16,543	2,249	684	19,710	46.90
Grass		1,165	2,885	8,190	906	13,146	31.28
Garden/parks		794	489	1,095	4,029	6,407	15.25
Total		4,314	19,992	11,604	6,115	42,025	
%		10.27	47.57	27.61	14.55		
<b>Panel B: Areas not directly affected by conflict</b>							
Built up		1,738	74	60	383	2,255	7.22
Crop		198	11,691	1,347	514	13,750	44.04
Grass		992	2,154	6,301	672	10,119	32.41
Garden/parks		645	422	977	3,051	5,095	16.32
Total		3,573	14,341	8,685	4,620	31,219	
%		11.44	45.94	27.82	14.80		
<b>Panel C: Conflict-affected areas only</b>							
Built up		383	1	10	113	507	4.69
Crop		36	4,852	902	170	5,960	55.15
Grass		173	731	1,889	234	3,027	28.01
Garden/parks		149	67	118	978	1,312	12.14
Total		741	5,651	2,919	1,495	10,806	
%		6.86	52.30	27.01	13.83		

Source: Own computation from 2021 and 2022 crop maps (available on <https://ukraine-cropmaps.com>) using field coordinates for parcels transacted in the agricultural land sales market between July and December 2021.

Note: Grass includes bare and uncultivated land.

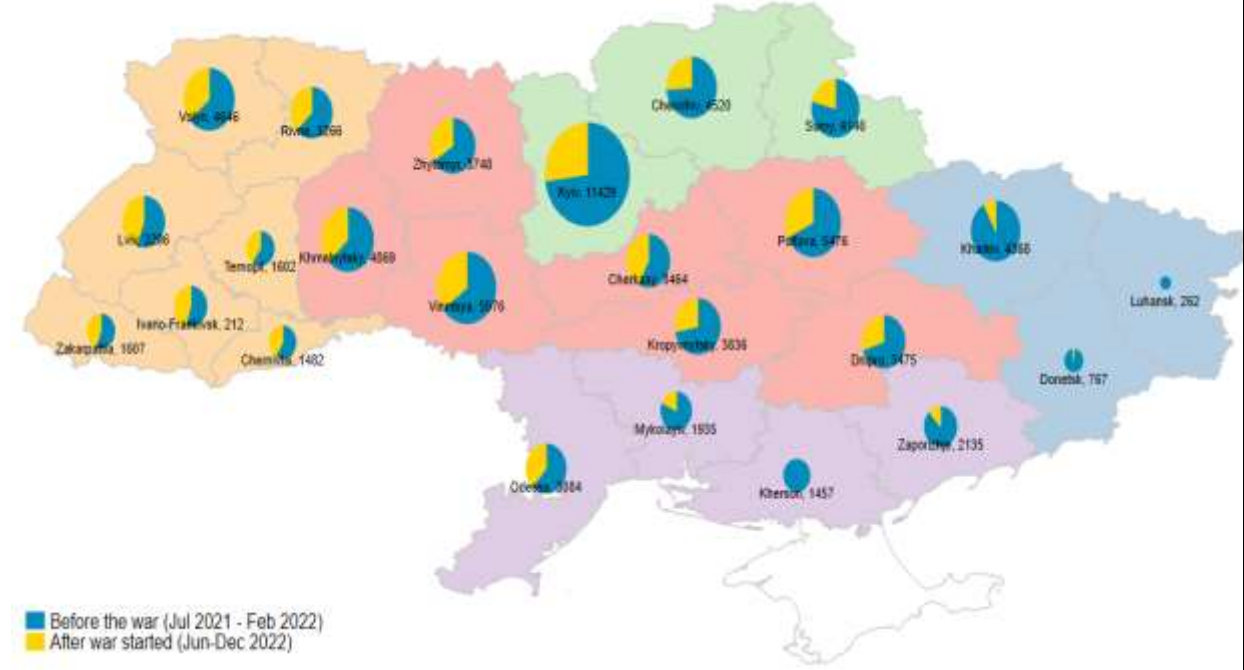
**Appendix table 5: Characteristics of parcels transferred in the July 2021 – Dec. 2022 period**

	Price reported			Price not reported		
	Total	Personal	Commercial	Total	Personal	Commercial
<b>Panel A: Sales</b>						
Price (US\$/ha)	6,157.7	10,774.7	1,178.5			
Parcel area (ha)	2.285	1.096	3.568	2.198	1.051	3.415
Normative value (US\$/ha)	1,205.4	1,650.9	978.9	1,092.7	1,465.1	909.7
Commercial agric.	0.481	0.000	1.000	0.485	0.000	1.000
Used for crops at transfer	0.669	0.432	0.925	0.684	0.450	0.921
Built up at transfer	0.030	0.058	0.000	0.031	0.061	0.000
Forested at transfer	0.123	0.221	0.018	0.111	0.200	0.020
Grassland at of transfer	0.177	0.289	0.056	0.174	0.289	0.059
Land quality index	40.490	37.933	43.247	39.883	38.346	41.440
Dist. to next city (km)	13.117	11.338	15.035	13.766	11.760	15.799
Dist. to prim. road (km)	7.353	6.105	8.700	8.148	6.833	9.481
Dist. to parks (km)	29.167	27.695	30.754	29.253	28.058	30.463
% unreg. cropland in village	0.204	0.218	0.190	0.205	0.213	0.196
Slope (%)	2.592	2.939	2.219	2.513	2.878	2.144
Altitude (m)	172.118	177.124	166.720	166.234	174.648	157.706
Transacted during war	0.113	0.131	0.094	0.377	0.408	0.344
Number of parcels	71,779	37,244	34,535	79,997	41,178	38,819
<b>Panel B: Leases</b>						
Price (US\$/ha)	91.115	94.655	89.193			
Parcel area (ha)	2.478	1.665	2.919	2.262	1.491	2.635
Normative value (US\$/ha)	680.7	623.5	717.6	665.1	501.9	728.0
Commercial agric.	0.648	0.000	1.000	0.673	0.000	1.000
Used for crops at transfer	0.772	0.704	0.809	0.760	0.667	0.806
Built up at transfer	0.000	0.000	0.000	0.000	0.000	0.000
Forested at transfer	0.053	0.051	0.054	0.056	0.069	0.050
Grassland at of transfer	0.175	0.246	0.137	0.184	0.265	0.144
Land quality index	36.579	36.740	36.492	35.913	33.573	37.077
Dist. to next city (km)	14.631	14.537	14.682	17.088	16.008	17.625
Dist. to prim. road (km)	8.538	8.143	8.753	9.848	9.109	10.215
Dist. to parks (km)	32.051	28.118	34.185	30.976	27.382	32.762
% unreg. cropland in village	0.225	0.213	0.232	0.234	0.219	0.241
Slope (%)	2.241	2.409	2.150	2.260	2.418	2.181
Altitude (m)	173.310	175.759	171.981	171.789	176.108	169.641
Transacted during war	0.018	0.021	0.016	0.262	0.248	0.269
Number of parcels	10,854	3,819	7,035	15,994	5,227	10,767

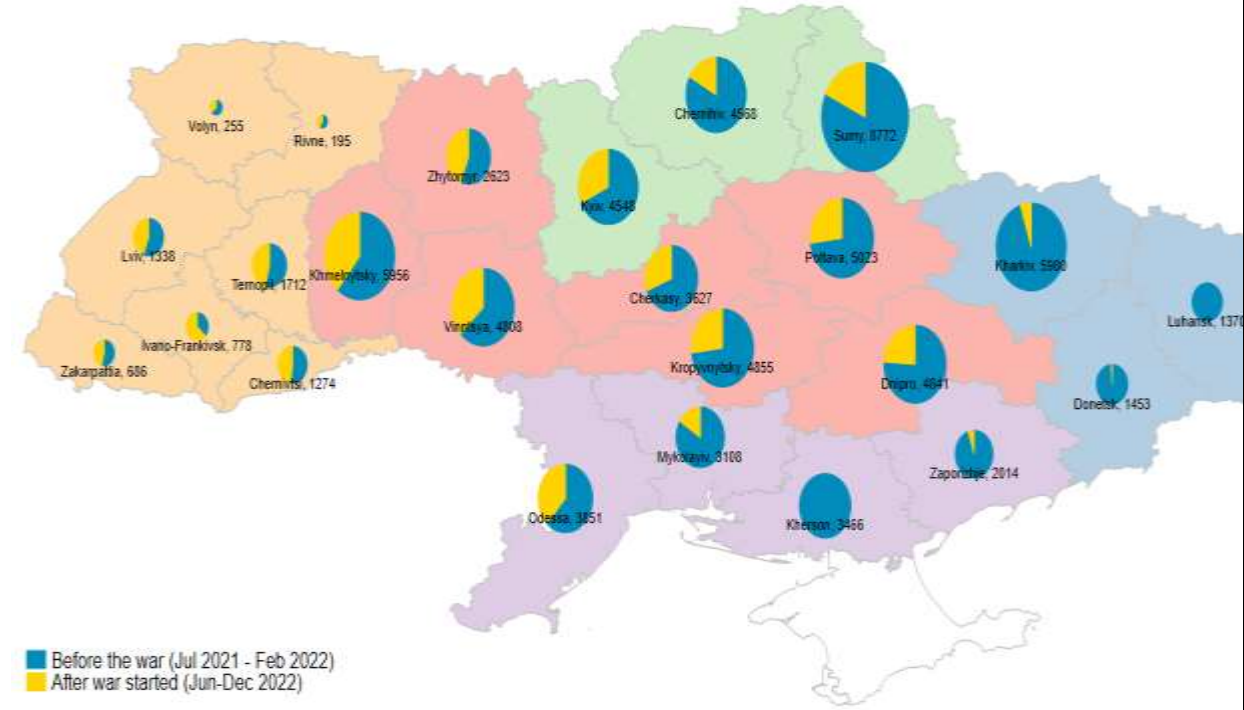
Source: Own computation using Registry of Rights of Ukraine (Jan. 2023); State Statistics of Ukraine (Form 50); Crop cover estimates based on remotely sensed data; Open Street map. Note: Col. 1-3 are for observation used in the regression analysis.

**Appendix figure 1: No. of daily agricultural land sales per week and oblast, before and after the start of the war**

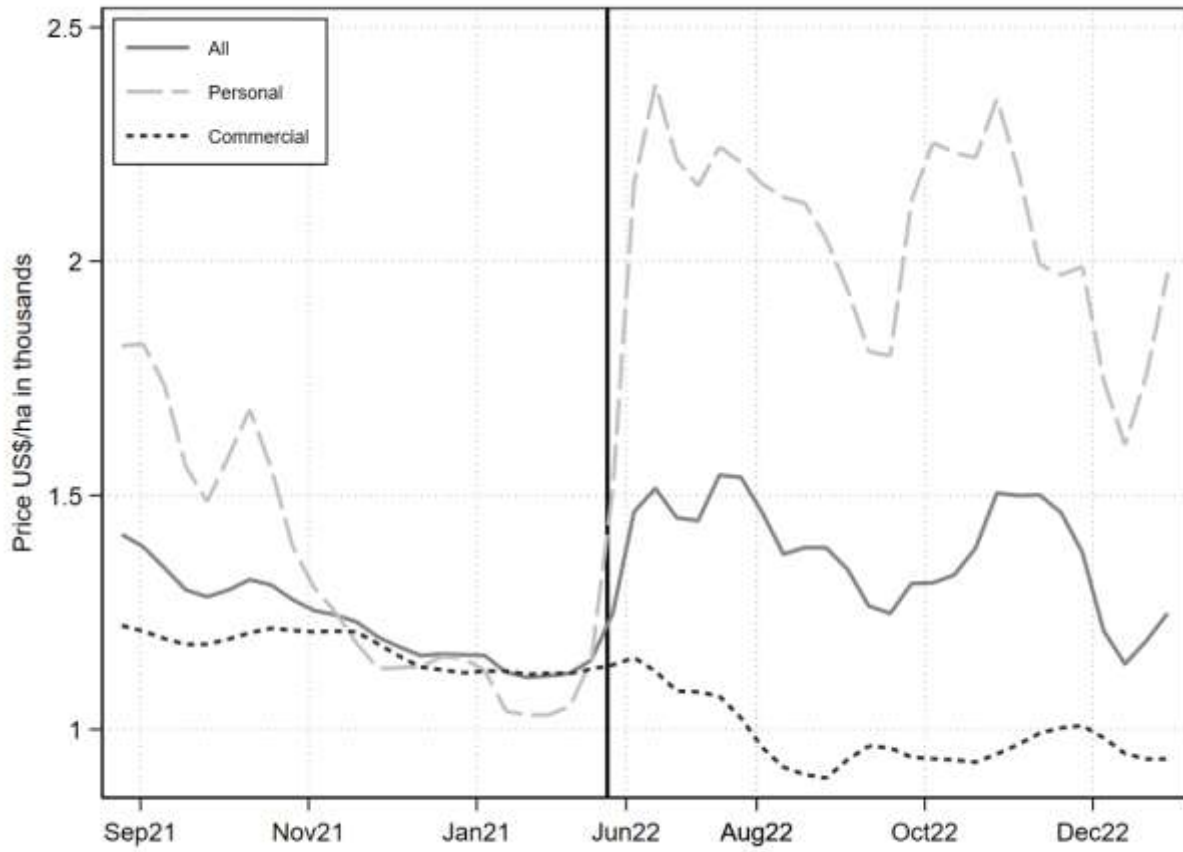
**Panel A: Agricultural for personal farming**



**Panel B: Agricultural for commercial farming**



Appendix figure 2: Land sales price of agricultural land per ha



Note: Excluding the first five weeks after the opening of the agricultural land sales market due to the very erratic nature of the price information.

## References:

- Ahlfeldt, G., Koutroumpis, P., Valletti, T., 2017. Speed 2.0: Evaluating Access to Universal Digital Highways. *Journal of the European Economic Association* 15, 586-625
- Arias, M.A., Ibáñez, A.M., Zambrano, A., 2019. Agricultural production amid conflict: Separating the effects of conflict into shocks and uncertainty. *World Development* 119, 165-184
- Ben-Shahar, D., Golan, R., 2019. Improved information shock and price dispersion: A natural experiment in the housing market. *Journal of Urban Economics* 112, 70-84
- Berman, N., Couttenier, M., Soubeyran, R., 2021. Fertile Ground for Conflict. *Journal of the European Economic Association* 19, 82-127
- Besley, T., Mueller, H., 2012. Estimating the Peace Dividend: The Impact of Violence on House Prices in Northern Ireland. *American Economic Review* 102, 810-833
- Bigelow, D.P., Kuethe, T., 2023. The Impact of Preferential Farmland Taxation on Local Public Finances. *Regional Science and Urban Economics* 98
- Brosen, B.W., Doye, D., Neal, K.B., 2015. Agricultural Land and the Small Parcel Size Premium Puzzle. *Land Economics* 91, 572-585
- Casas-Arce, P., Saiz, A., 2010. Owning versus Renting: Do Courts Matter? *Journal of Law and Economics* 53, 137-165
- Chang, H.-H., Lin, T.-C., 2016. Does the Minimum Lot Size Program Affect Farmland Values? Empirical Evidence Using Administrative Data and Regression Discontinuity Design in Taiwan. *American Journal of Agricultural Economics* 98, 785-801
- Chang, Z., Li, X., 2021. How Regulation on Environmental Information Disclosure Affects Brownfield Prices in China: A Difference-in-Differences (DID) Analysis. *Journal of Environmental Planning and Management* 64, 308-333
- Coulomb, R., Zylberberg, Y., 2021. Environmental Risk and the Anchoring Role of Mobility Rigidities. *Journal of the Association of Environmental and Resource Economists* 8, 509-542
- Deaton, B.J., Lawley, C., 2022. A survey of literature examining farmland prices: A Canadian focus. *Canadian Journal of Agricultural Economics* 70, 95-121
- Deininger, K., Ali, D., Niviyevskiy, O., 2023a. Changes in Ukrainian Farm Profitability 2021 to 2022: Farm Survey Evidence In: Policy Research Working Paper. World Bank, Washington DC
- Deininger, K., Ali, D.A., Kussul, N., Shelestov, A., Lemoine, G., Yailimova, H., 2023b. Quantifying war-induced crop losses in Ukraine in near real time to strengthen local and global food security. *Food Policy* 115, 102418
- Deininger, K., Ali, D.A., Neyter, R., 2022. Impacts of Transparent Online Auctions on Public Land Lease Revenue: Evidence from Legal and Administrative Changes in Ukraine. In: Policy Research Working Paper 10201. World Bank, Washington DC
- Diewert, W.E., Shimizu, C., 2022. Residential Property Price Indexes: Spatial Coordinates versus Neighborhood Dummy Variables. *Review of Income and Wealth* 68, 770-796
- Diewert, W.E., Shimizu, C., Watanabe, T., Nishimura, K.G., 2020. Property Price Index: Theory and Practice. Springer, Tokyo.
- Frank, E.G., Sudarshan, A., 2022. The Social Costs of Keystone Species Collapse : Evidence From The Decline of Vultures in India. University of Warwick, Department of Economics, The Warwick Economics Research Paper Series (TWERPS)
- Gertler, P.J., Gonzalez-Navarro, M., Gracner, T., Rothenberg, A.D., 2022. Road Maintenance and Local Economic Development: Evidence from Indonesia's Highways. University of California, Berkeley
- Glauben, T., Svanidze, M., Gotz, L., Prehn, S., Jamali Jaghdani, T., Duric, I., 2022. The War in Ukraine, Agricultural Trade and Risks to Global Food Security. *Review of European Economic Policy* 57, 157-163
- Goldsmith-Pinkham, P., Gustafson, M.T., Lewis, R.C., Schwert, M., 2021. Sea Level Rise Exposure and Municipal Bond Yields Yale University, New Haven, CT
- Gouriéroux, C., Laferrère, A., 2009. Managing hedonic housing price indexes: The French experience. *Journal of Housing Economics* 18, 206-213
- Graubner, M., Ostapchuk, I., Gagalyuk, T., 2021. Agroholdings and Land Rental Markets: A Spatial Competition Perspective. *European Review of Agricultural Economics* 48, 158-206
- Han, L., Heblich, S., Timmins, C., Zylberberg, Y., 2021. Cool Cities: The Value of Urban Trees\*.
- Hilber, C.A.L., Vermeulen, W., 2016. The Impact of Supply Constraints on House Prices in England. *Economic Journal* 126, 358-405
- Hill, R.J., 2013. Hedonic Price Indexes for Residential Housing: A Survey, Evaluation and Taxonomy. *Journal of Economic Surveys* 27, 879-914
- Hüttel, S., Jetzinger, S., Odening, M., 2014. Forced Sales and Farmland Prices. *Land Economics* 90, 395-410
- Ihle, R., Bar-Nahum, Z., Nivievskiy, O., Rubin, O.D., 2022. Russia's Invasion of Ukraine Increased the Synchronisation of Global Commodity Prices. *Australian Journal of Agricultural and Resource Economics* 66, 775-796
- Jaremski, M., Wheelock, D.C., 2020. Banking on the Boom, Tripped by the Bust: Banks and the World War I Agricultural Price Shock. *Journal of Money, Credit & Banking* 52, 1719-1754
- Kirwan, B.E., 2009. The Incidence of U.S. Agricultural Subsidies on Farmland Rental Rates. *Journal of Political Economy* 117, 138-164
- Kirwan, B.E., Roberts, M.J., 2016. Who Really Benefits from Agricultural Subsidies? Evidence from Field-Level Data. *American Journal of Agricultural Economics* 98, 1095-1113



- Kussul, N., Deininger, K., Shumilo, L., Lavreniuk, M., Ali, D.A., Nivievskiy, O., 2022. Biophysical Impact of Sunflower Crop Rotation on Agricultural Fields. *Sustainability* 14, 3965
- Kvartiuk, V., Herzfeld, T., 2019. Welfare effects of land market liberalization scenarios in Ukraine: Evidence-based economic perspective. In: Discussion paper 2019 # 186. Leibniz Institute of Agricultural Development in Transition Economies (IAMO), Halle/Saale
- Kvartiuk, V., Herzfeld, T., Bukin, E., 2022. Decentralized public farmland conveyance: Rental rights auctioning in Ukraine. *Land Use Policy* 114, 105983
- Kvartiuk, V., Martyn, A., 2021. Ukraine's Agricultural Land Sales Market: First Outcomes and Monitoring Challenges. In: *Agro Policy Report APD/APB/11/2021*. German-Ukrainian Agricultural Policy Dialogue, Kyiv
- Kvartiuk, V., Martyn, A., 2022. Ukraine's agricultural land sales market: An update and the effect of Russian war against Ukraine. In: *Agro Policy Report APD/APB/20/2022*. German-Ukrainian Agricultural Policy Dialogue, Kyiv
- Lawley, C., 2018. Ownership Restrictions and Farmland Values: Evidence from the 2003 Saskatchewan Farm Security Act Amendment. *American Journal of Agricultural Economics* 100, 311-337
- Lin, F., Li, X., Jia, N., Feng, F., Huang, H., Huang, J., Fan, S., Ciaias, P., Song, X.-P., 2023. The impact of Russia-Ukraine conflict on global food security. *Global Food Security* 36, 100661
- Mueller, H., Groeger, A., Hersh, J., Matranga, A., Serrat, J., 2021. Monitoring war destruction from space using machine learning. *Proceedings of the National Academy of Sciences* 118, e2025400118
- Neyter, R., Nivievskiy, O., 2022. Local versus central public land governance: Evidence from spatial analysis of land auctions in Ukraine. *Kyiv School of Economics, Center for Food and Land Use Research, Kyiv*
- Nivievskiy, O., 2020. Where state agricultural land disappears to. URL <https://www.epravda.com.ua/columns/2020/06/4/661385/>
- Nizalov, D., Thornsbury, S., Loveridge, S., Woods, M., Zadorozhna, O., 2016. Security of property rights and transition in land use. *Journal of Comparative Economics* 44, 76-91
- Pinchbeck, E.W., Roth, S., Szumilo, N., Vanino, E., 2020. The Price of Indoor Air Pollution: Evidence from Radon Maps and the Housing Market. In: *IZA DP No. 13655*, Bonn
- Rajan, R., Ramcharan, R., 2015. The Anatomy of a Credit Crisis: The Boom and Bust in Farm Land Prices in the United States in the 1920s. *American Economic Review* 105, 1439-1477
- Rajan, R., Ramcharan, R., 2016. Local Financial Capacity and Asset Values: Evidence from Bank Failures. *Journal of Financial Economics* 120, 229-251
- Seifert, S., Kahle, C., Hüttel, S., 2021. Price Dispersion in Farmland Markets: What Is the Role of Asymmetric Information? *American Journal of Agricultural Economics* 103, 1545-1568
- Severen, C., Plantinga, A.J., 2018. Land-use regulations, property values, and rents: Decomposing the effects of the California Coastal Act. *Journal of Urban Economics* 107, 65-78
- Singh, R., 2019. Seismic risk and house prices: Evidence from earthquake fault zoning. *Regional Science and Urban Economics* 75, 187-209
- Tang, C.K., 2021. The Cost of Traffic: Evidence from the London Congestion Charge. *Journal of Urban Economics* 121, 103302
- Tellez, J.F., 2022. Land, Opportunism, and Displacement in Civil Wars: Evidence from Colombia. *American Political Science Review* 116, 403-418
- Voors, M.J., Nillesen, E.E.M., Verwimp, P., Bulte, E.H., Lensink, R., Van Soest, D.P., 2012. Violent Conflict and Behavior: A Field Experiment in Burundi. *American Economic Review* 102, 941-964
- Yaremko, V., 2022. The Long-Term Consequences of Blacklisting: Evidence from the Ukrainian Famine of 1932-33. *University of California, Berkeley, CA*
- Zadorozhna, O., 2020. Clientelism and Land Market Outcomes in Ukraine. *Eastern European Economics* 58, 478-496