Why did Ukraine become a Key Player on the World Agri-Food Markets? An Enterprise-Level Perspective

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Abstract

Over the past decades, Ukraine has built an increasingly dynamic agricultural sector, characterized by growing export engagement in various commodities. Whether the country can quickly regain its status of a key player on the world agri-food markets amid and after Russian invasion is extremely important for international food security. However, the to-date understanding of the recovery potential remains elusive due to the lack of systematic and objective insights into the major drivers of recent growth. Scarce evidence suggests that Ukraine's agriculture has been successfully modernized mainly due to the efforts of private sector actors operating in the context of generally inconsequent policies typical of a transition country. The following factors have been reported to contribute to recent modernization and development of the sector: a) improvement of efficiency and productivity, especially in crop production; b) structural change involving a rapid development of large-scale agroholdings; and c) relatively positive public acceptance of modern technologies and organizational forms of agricultural production. The present paper reviews these trends in greater detail by addressing the role of professional farm management, digital technologies, ongoing optimization of the size of production operations (including horizontal and vertical integration through merger and acquisitions) as well as farm engagement in sustainability and legitimation activities as the main enterprise-level drivers of growth and resilience in Ukrainian agriculture.

Keywords

agricultural enterprises; financial strength; digitalization; resilience; structural change; Ukraine

1 Introduction

During the last 15 years, Ukraine has built an increasingly dynamic agricultural sector, characterized by growing productivity and export engagement in various commodities, such as grains, oilseeds and poultry. Before the recent invasion by Russia, Ukraine was expected to account for about 50 percent of global vegetable oil exports and 14 percent of global grain exports (FAO, 2022).

Whether or not this development keeps up and translates into a quick recovery of agricultural production and export amid and after Russian invasion is increasingly important for international agricultural market participants. On the one hand, recovery largely depends on how quickly international community and domestic policymakers respond by providing respective support to meet the security and economic needs of agricultural producers and exporters. The sector has already experienced huge losses and is in an urgent need of demining of fields, lifting of the blockade of Ukrainian ports for exports, reduction of the outflow of workers and recovery of supplies of necessary inputs, such as fuel and fertilizer (NEYTER et al., 2022). On the other hand, it is evident that Ukraine successfully resists Russian aggression not least because of a high degree of concerted horizontal cooperation and resilience among citizens and private sector actors (BIELIESKOV, 2022; VON NOLCKEN, 2022). Therefore, one can expect a strong engagement of the domestic private sector in agricultural recovery as well.

The latter would generally replicate the manner, in which the country's agriculture has been modernized in recent years. Apart from positive developments on the world agricultural markets, factors such as ongoing structural change, implementation of modern technologies and the dismantlement of labor-intensive production by agricultural enterprises have contribut-

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ed to superior performance of the sector on the background of very limited state support (BALMANN et al., 2013; NIVYEVSKYI et al., 2015). Local agricultural enterprises, particularly large agroholdings and their subsidiaries, have been (and are) developing unique internal capabilities that help to establish efficient and resilient enterprise systems and build infrastructures filling particular institutional voids present in Ukraine as a transition country (GAGALYUK and VALENTINOV, 2019).

By assuming that availability of these capabilities helped Ukrainian agricultural enterprises to navigate through earlier crises, the present paper aims to scrutinize the enterprise resilience factors during the 2007-2008 global financial crisis and the 2013-2014 conflict with Russia in order to understand which enterprises will have most chances to survive the ongoing turmoil. We assess a unique 2005-2016 enterprise-level data from Ukraine using the logistic regression method to clarify which production and financial performance indicators are associated with enterprise survivability.

The paper is structured as follows. We first provide a more detailed account of the recent development of Ukrainian agriculture. We follow by a description of external and internal factors of the sector's rise to prominence with a particular focus on the evolution of large-scale agroholdings. Subsequently, the data, method and results of empirical analysis are presented. We conclude by discussing the results and presenting an outlook on possible enterprise-level developments in the context of Russian invasion.

2 Recent Performance of Ukrainian Agriculture

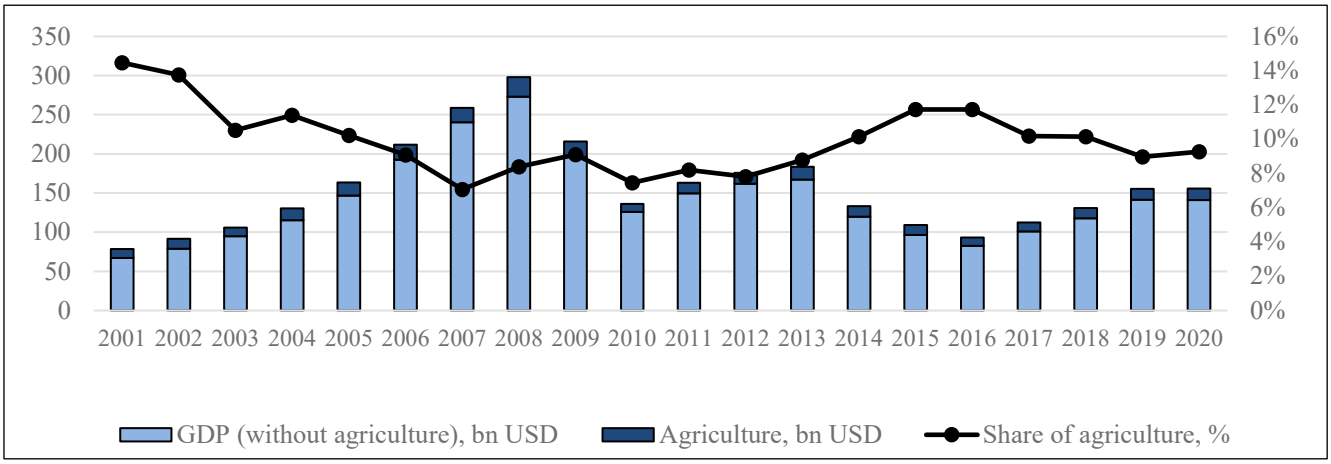
2.1 Agricultural Production

Fertile soils, favorable geographic and climatic conditions have provided Ukraine with a huge potential for agricultural production. Agriculture has been contributing 9-10% to Ukraine's GDP in recent years (Figure 1). Also, agriculture employs 14% of economically active population in Ukraine (OECD, 2022a).

After the collapse of the Soviet Union in 1991, Ukraine started the transition to a market economy. Agricultural and land reforms were introduced in 1990's in order to foster transition to individual farming via transfer of ownership of farm assets from state to collective and, ultimately, individual or family farm ownership. However, contrary to expectations, the reform did not result in the development of strong European-like family farming. Given disrupted supply chains, growing input prices and declining output prices, about 90% of collective agricultural enterprises turned out to be unprofitable and accumulated large debts (LERMAN et al., 2007). The agricultural sector faced a drastic reduction of production. In 1991-2000, gross agricultural production decreased by 65% while animal production declined by astonishing 83% (Figure 2).

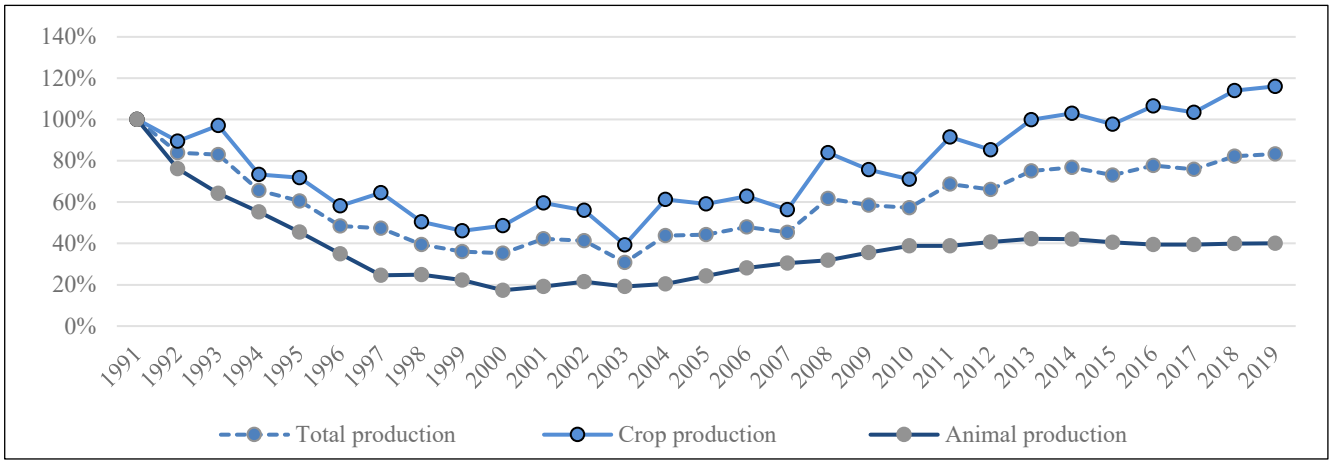
An upward trend in agricultural production has been observed since early 2000's although crop and livestock sectors have shown different dynamics. In particular, due to significant productivity improvements (Figure 3), crop production recovered to the

Figure 1. Contribution of agriculture to GDP of Ukraine



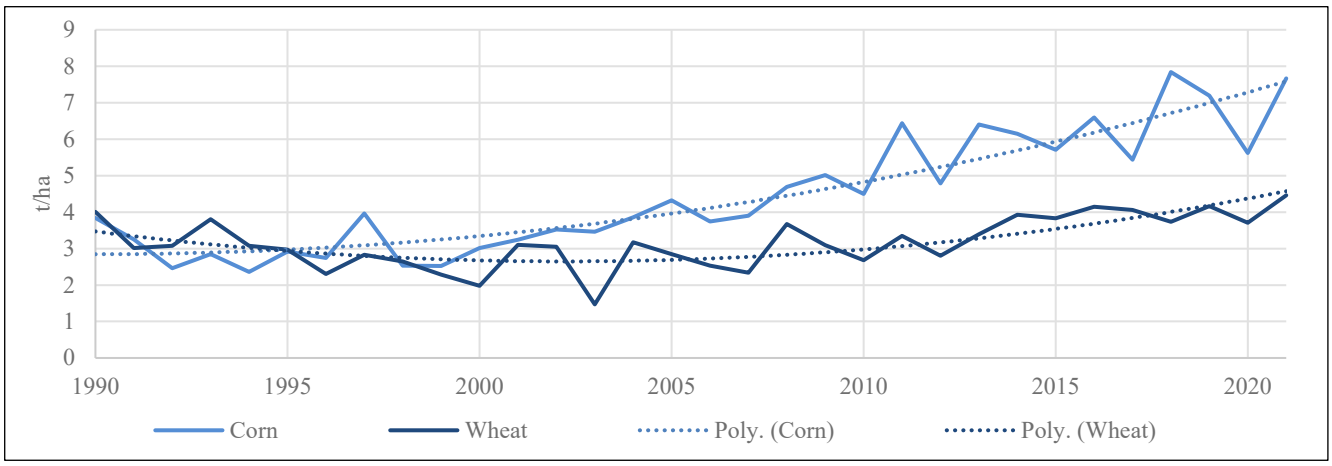
Note: GDP in current prices. The conversion from UAH to USD was performed using official exchange rates of the National Bank of Ukraine, which fluctuated between 5.37 UAH per 1 USD in 2001 and 26.96 UAH per 1 USD in 2020.
Source: STATE STATISTICS SERVICE OF UKRAINE (multiple years)

Figure 2. Agricultural production value in Ukraine, 1991 = 100%



Source: STATE STATISTICS SERVICE OF UKRAINE (multiple years)

Figure 3. Corn and wheat productivity in Ukraine, 1990-2020



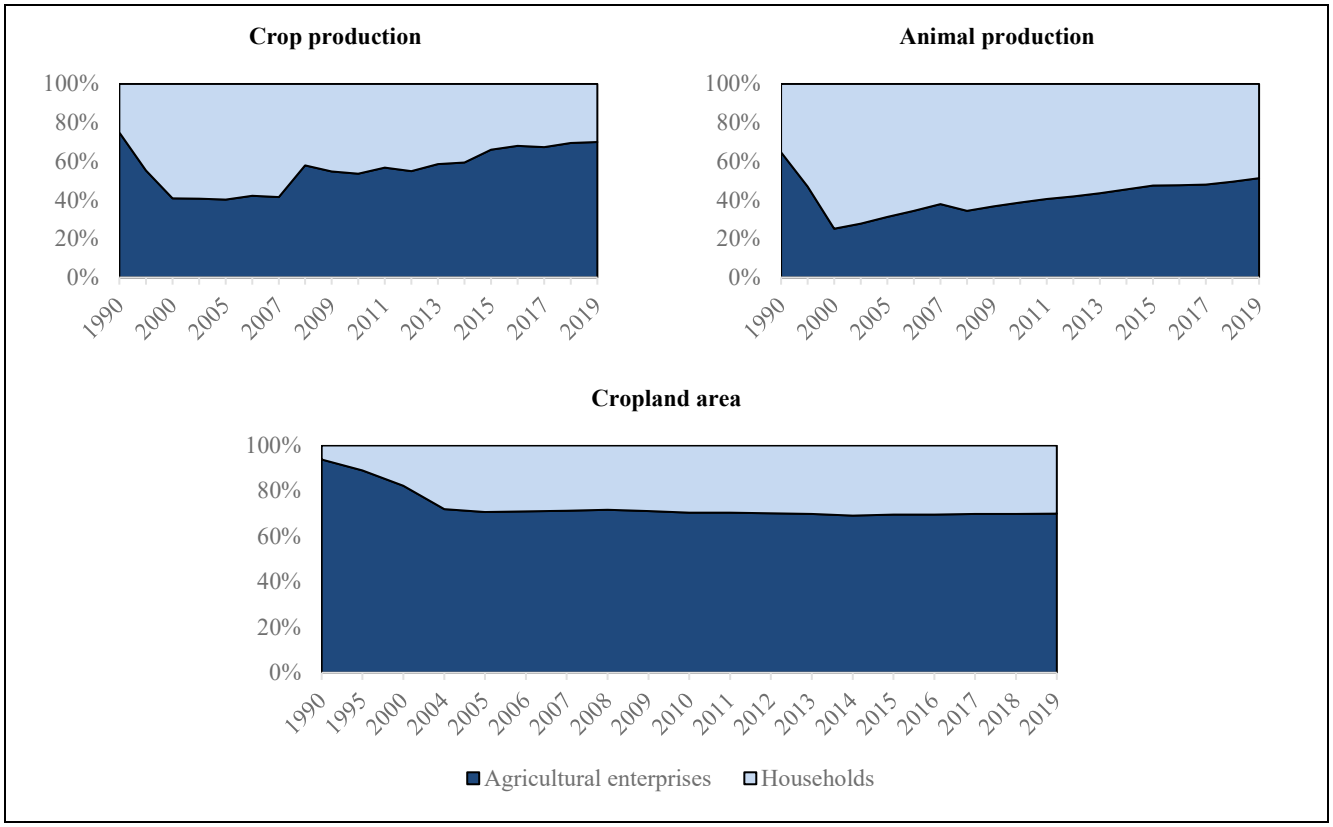
Source: own calculations based on FAOSTAT (2021)

1991 level in 2013 and exceeded it by about 16% in 2019. At the same time, the volume of animal production remained far below the level of 1991, primarily due to the lack of performance-enhancing investments caused by relatively long payback periods associated with capital- and labor-intensive livestock production.

Contrary to growing production, state support of agriculture in Ukraine has declined over time and accounts for a rather small share of farm receipts today. Moreover, after entering the World Trade Organization (WTO) in 2008, Ukraine has bound itself to limit direct support of agricultural production. As a result, agriculture in Ukraine receives generally modest levels of direct support and generous tax benefits (NIVYEVSKYI et al., 2015). In 2019-2021, state support, measured by the producer support estimate (PSE), fluctuated around zero, averaging 1.7% of gross farm receipts. At the same time, total support amounted to an average of 0.59% of the GDP in 2019-2021, which is low compared to other countries (OECD, 2022b).

In the view of the failed attempt to transform the agricultural sector in 1990's, the Ukrainain government decided to reconsider the path of the agricultural reforms in early 2000's. Existing collectively owned enterprises were reorganized into corporate and cooperative forms of production organization. The Land Code of Ukraine was adopted in 2001 and legally recognized private farmland ownership. Approximately 7 million rural inhabitants-members of former Soviet kolkhozes and sovkhozes became owners of land plots with an average of 4.2 hectares per person (GAGALYUK et al., 2018).

Figure 4. Structure of agricultural production and cropland use by major types of agricultural producers in Ukraine



Source: STATE STATISTICS SERVICE OF UKRAINE (multiple years)

Nevertheless, the moratorium on buying and selling of land has been introduced and then prolonged until 2021[1]. The Land Code also banned the investment of agricultural land in the equity capital of newly created businesses to preclude landowners from losing their legal rights to land via transfer of ownership of their land plots to corporate farms. Instead, landowners obtained the possibility to either establish their own farms or to earn from renting out their plots to agricultural enterprises. The latter were not allowed to own land and, thus, lease was the only way for them to use land. However, the majority of smallholder landowners faced limited access to production inputs and could not produce efficiently. They were, therefore, impelled to rent out their land plots to agricultural enterprises that were in a better position with regard to input procurement. The government did not restrict the duration of land leases and, consequently, long-term land leases led to a de facto accumulation of land in the hands of agricultural enterprises.

As a result, agricultural output of Ukraine is generated by two major groups of producers today: i) relatively large commercial agricultural enterprises (including family farms) and ii) small-scale quasi-commercial rural households. The decline of agricultural production in early post-Soviet years took place mainly due to a continuous reorganization, financial and economic distress of agricultural enterprises. On the opposite, rural households succeeded to maintain livestock production on a relatively stable level and managed to substantially raise crop production (Figure 4). The share of agricultural enterprises in crop production started to recover in late 2000's while their share in animal production became equal to that of rural households only recently. Thus, the remarkable productivity growth of 2000-2020 occurred for the most part due to the improvements achieved by commercial agricultural enterprises.

[1] Only in early 2021, the amended Land Code provided for lifting of the moratorium on land sales. Since July 2021, private individuals in Ukraine have been allowed to buy and sell agricultural land up to a maximum of 100 hectares. Legal entities, including agricultural enterprises, will be granted the right to purchase up to 10,000 hectares only from January 2024 onwards. However, according to Ukrainian legislation, foreign individuals and legal entities are not and will not be allowed to acquire farmland in Ukraine (OSTAPCHUK and GAGALYUK, 2022).

2.2 Agriculture and Rural Development

Agriculture and rural development were and are closely intertwined in Ukraine. Moreover, agriculture remains the major income source for rural dwellers. Analysis of the structure of agricultural employment in rural areas shows that approximately 20% are working at agricultural enterprises while about 80% are self-employed farming households. However, in general, the share of rural household income that comes from sales of agricultural production is rather low (around 11-12%) and diminishing. The share of labor cost in the structure of production cost of agricultural enterprises has been continuously decreasing and amounted to, e.g., 7% in 2014 as compared to 34% in 1990 and 11% in 2008 (GAGALYUK and SCHAFT, 2016). The average number of agricultural employees per 1,000 hectares tends to decrease and nowadays amounts to 18 workers (ibid.) while the most modernized agricultural enterprises employ between 7 and 10 workers per 1,000 hectares (LATIFUNDIST, 2021). In combination with ongoing technological progress, these developments resulted in higher labor productivity: production volume per worker has increased by factor of 6.6 over the last two decades (STATE STATISTICS SERVICE OF UKRAINE, multiple years).

At the same time, agriculture contributes to rural unemployment at a much lower rate than in early 2000's. For example, the agricultural sector was responsible for only 3.4% of layoffs in the economy in 2012 compared to 17.1% in 2002 (GAGALYUK and SCHAFT, 2016). Moreover, agricultural enterprises experience huge deficits of qualified labor due to population aging and outmigration caused by inadequate socioeconomic conditions in rural areas. Along with unemployment and outmigration, Ukrainian rural areas have faced a decline of household incomes, deterioration of housing conditions and lack of social, cultural and entertainment services (FAO, 2012). The poor socioeconomic situation resulted in part due to inconsistent rural development policies. The reforms of early 2000's transferred the tasks of providing social and servicing facilities, which had been the responsibility of agricultural enterprises since Soviet times, to local authorities (GAGALYUK and SCHAFT, 2016). This step was not bad in itself but, due to a significant government centralization in Ukraine, local authorities lacked necessary funds and, therefore, could not accomplish those tasks properly (KEYZER et al., 2013). The result for the agricultural sector was a growing deficit of qualified and loyal farm workers that the majority of farms faced (KOESTER et al., 2010).

Some positive developments are expected from the so-called decentralization reform, which started in 2014 and set out to transform the regional administrative structure and give additional power and resources to local authorities. The latter obtained more responsibilities and possibilities to dispose of and spend larger volumes of locally collected taxes for own needs. As a result of these transformations, revenues of local communal budgets have initially grown while the share of transfers from the central government in the structure of revenues of local communities has declined. However, local governments' revenue is still limited – as is autonomy in revenue generation and management – with local governments controlling only about 30% of their resources. This affects their ability to meet 'exclusive' responsibilities, such as infrastructure maintenance and provision of municipal services and amenities (cf. OECD, 2018: 16).

2.3 Investments in Agriculture

As regards private investments in agriculture, both domestic and foreign investment have increased in absolute terms over the past decade. From 2007 to 2015, the share of agriculture in total inflows of foreign direct investment (FDI) rose to a maximum of 2.3% in 2009 (HOROVETSKA et al., 2017). In 2015-2019, agricultural investment as a share of total FDI amounted to 1.1-1.4% (NBU, 2020). Thus, Ukrainian agriculture has higher shares in total FDI than EU member states such as Germany (not more than 0.03%) and Poland (approximately 0.5%). However, these countries are in a better position to invest in their own agricultural sectors and benefit from EU subsidies as well (cf. HOROVETSKA et al., 2017: 12). However, further significant investment would be needed in Ukraine to improve the availability and quality of physical infrastructure, including transportation, storage, energy and irrigation infrastructure (OECD, 2015).

European countries represent the main source of FDI in Ukraine. Investors from China and the Gulf countries are also investing actively in the sector (ibid.). Noteworthy, the largest portion of FDI is still inflowing from Cyprus where most Ukrainian corporations are registered (NBU, 2021). While investors are attracted by the country's enormous agricultural potential, they still may face significant uncertainties in Ukraine. The country's rapidly changing political environment leads to short-term and volatile policies

and unpredictable regulatory changes hindering long-term investment (LOVE and RACHINSKY, 2015). However, since 2012, Ukraine has considerably improved its rank in business climate rankings, such as the corruption perception index (CPI). Ukraine is among the 26 countries that have recorded statistically significant CPI growth over the 10-year perspective. This improvement is due to the changes that occurred immediately after the Revolution of Dignity in 2014. Yet, since 2018, Ukraine's steady CPI growth has almost stopped. Despite the positive changes, there is a perception in the business community that the judiciary in Ukraine is subject to political interference and corruption, which outweighs anti-corruption achievements (cf. TRANSPARENCY INTERNATIONAL, 2022).

2.4 Development of Agri-Food Trade

Exports of agricultural products generate significant inflows of foreign currency into the Ukrainian economy. In most recent years, export revenues have exceeded USD 22 billion, which is equivalent to 45% of the country's total export earnings. Figure 5 demonstrates that crops are the major source of export growth as they have been continuously generating more than a half of agricultural export revenues for the last decade, followed by the export of fats and oils with 21-27% in the structure of export revenues. These developments allowed Ukraine to become a major player on the global markets for crops and vegetable oil. Particularly, domestic exporters supplied about 9% of wheat, 13% of corn, 14% of barley, 15% of rapeseed and 44% of sunflower oil exports globally in the most recent years (FAOSTAT, 2021).

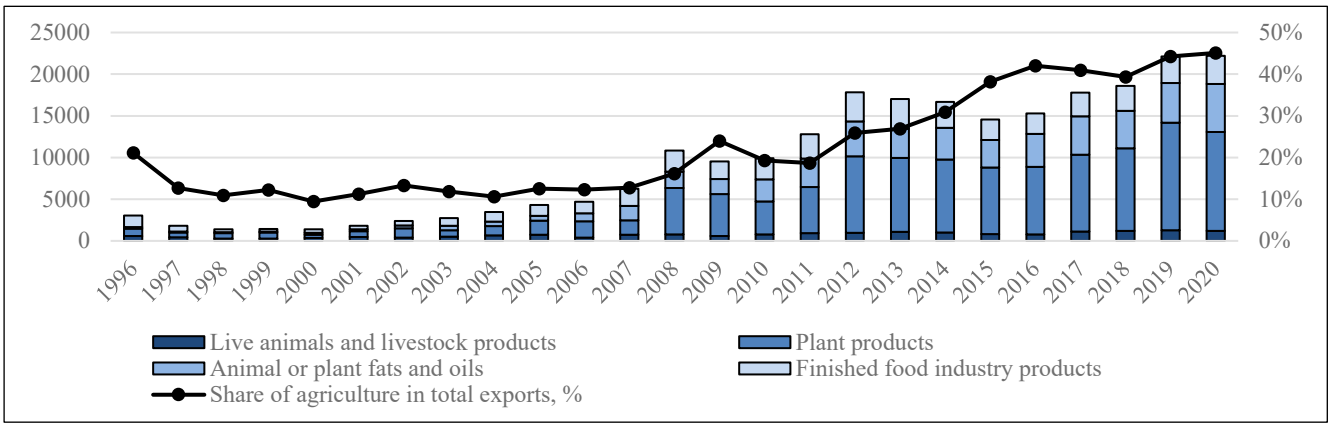
Noteworthy, a remarkable diversification of Ukrainian export destinations has occurred after 2014 when the Deep and Comprehensive Free Trade Agreement (DCFTA) between Ukraine and the EU has been applied. In the structure of total agricultural exports from Ukraine, the share of CIS countries decreased from 29.5% in 2014 to 10.7% in 2021 while the share of the EU increased from 31.8% to 38.6% within the same period. Agri-food exports to the EU fluctuated around the average of 31.5% in the structure of total exports in 2017-2021 while agri-food exports to the CIS countries were on average 6.6% of the total exports from Ukraine. The share of agri-food exports to Asian countries in total Ukraine's exports grew from 44.7% in 2017 to 50.3% in 2021. Ukraine's surplus from trade with agricultural goods has increased from USD 1.6 billion in 2005 to USD 20.1 billion in 2021 (STATE STATISTICS SERVICE OF UKRAINE, 2021).

3 Development of Ukrainian Agroholdings

The recovery and growth of the Ukrainian agricultural sector is often associated with the development of a particular type of commercial agricultural enterprises, so-called agroholdings (OSTAPCHUK et al., 2021b). Generally, an agroholding is any entity consisting of a mother company that controls dozens or hundreds of farms and operates dozens or even hundreds of thousands of hectares of farmland (cf. OSTAPCHUK et al., 2021a: 594). Nowadays, agroholdings play a prominent role in agricultural production and land use in Ukraine (see Table 1).

The number of agroholdings of above 10,000 hectares of size grew from zero to about 120 in 2005-2019. During the major period of land accumulation

Figure 5. Agricultural exports by major groups of products, million USD



Source: UN COMTRADE (2020)

Table 1. Farm structure in Ukraine[1], 2017

Farm type	N, thousand	Farmland, million ha	Share in total production, %
Agricultural enterprises	14.0	30.4	48.3
of them: state enterprises	0.2	5.7	1.9
private enterprises	13.8	24.7	46.4
of them: agroholding-affiliated farms	0.9	5.8	22.3
standalone farms	12.9	18.9	24.1
of them: JSCs, LTDs, etc.	12.2	18.1	n/a
agricultural cooperatives	0.7	0.8	n/a
Farmers (peasant) enterprises	33.7	4.6	8.7[2]
Individual entrepreneurs	29.6	n/a	n/a
Private household farms	4,100.0	6.3	43.0
Total	4,177.3	41.3	100.0

Notes: [1]including Crimea; [2]including individual entrepreneurs. Separate data on this figure for individual entrepreneurs are not available.
Source: GAGALYUK et al. (2021b)

in 2007-2013, these agroholdings increased their operated land area 3.5 times to about 6 million hectares or 27% of the total farmland in the use of agricultural enterprises (see Figure 6).

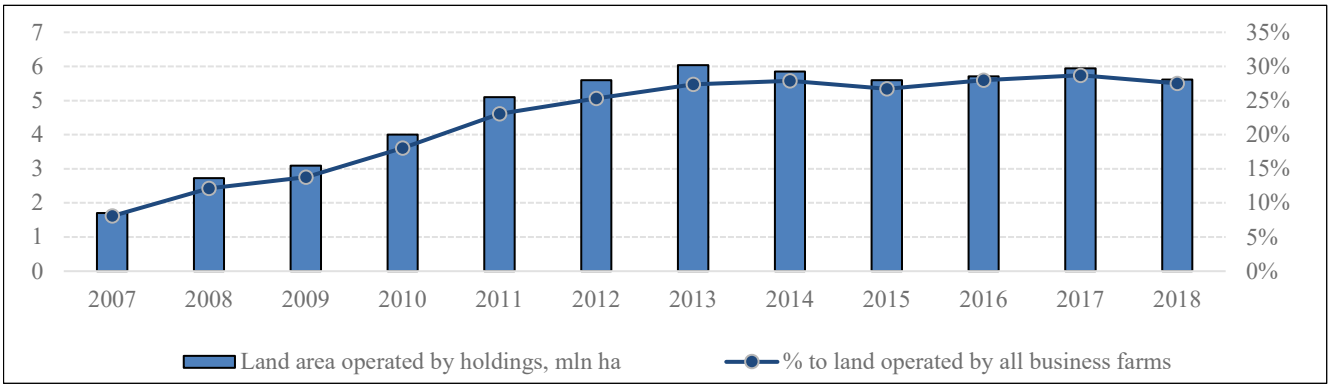
The development of large-scale agroholdings was driven by a number of factors including some global or external trends as well as local or internal capabilities that these agroholdings developed over time to primarily address the peculiarities of the transitional institutional environment surrounding them in Ukraine.

3.1 Global Factors of Agroholding Development

Among the global factors, the developments on the world market were particularly conducive to proliferation of agroholdings. Driven by growing global demand for food, feed and fiber, prices for agricultural commodities doubled over the period of 2006-2008 and increased again to this high level after the financial crisis until 2013 (FAO, 2020). The rising prices allowed for high profitability, particularly, in crop production. For instance, the average profitability of sunflower production in Ukraine has been consistently above 20% over the last two decades while it reached 80% in some years (Figure 7). In turn, high profitability has raised the interest of outside investors in agriculture, which allowed for favorable access to capital and, consequently, investments in modern production technologies and business enlargement to benefit from economies of size. Larger enterprise sizes and access to capital have also enabled the concentration of market power and favorable access to land as additional drivers of growth of agroholdings (LAPA et al., 2015; GRAUBNER et al., 2021).

Another global factor of the development of agroholdings was the institutional environment in

Figure 6. Land area operated by agroholdings in Ukraine



Source: UCAB (2019)

Ukraine. The moratorium on farmland sales along with prevailing smallholder land ownership enabled the development of agroholdings in several ways. First, it restricted the growth of land rent prices and thus made it possible to accumulate large areas although only via lease agreements. Second, the absence of the formal land lease duration limitations (until 2015) allowed for very long-term leases that led to lease-based land accumulation in corporate structures (cf. GAGALYUK et al., 2018: 683). This way, the moratorium made it possible to accumulate land through a direct lease of land plots from individual landowners and/or acquisition of other farms with existing long-term lease contracts between them and individual landowners (NIVIEVSKYI et al., 2015). Furthermore, indirect state support via preferential, hectare-based taxation and refunds of value added tax (VAT) for purchase of production inputs by agricultural enterprises were (and some of them still are) driving large farm sizes. Even recently, some of the agroholdings have been among the main recipients of public support in Ukraine (cf. GAGALYUK, 2017: 262).

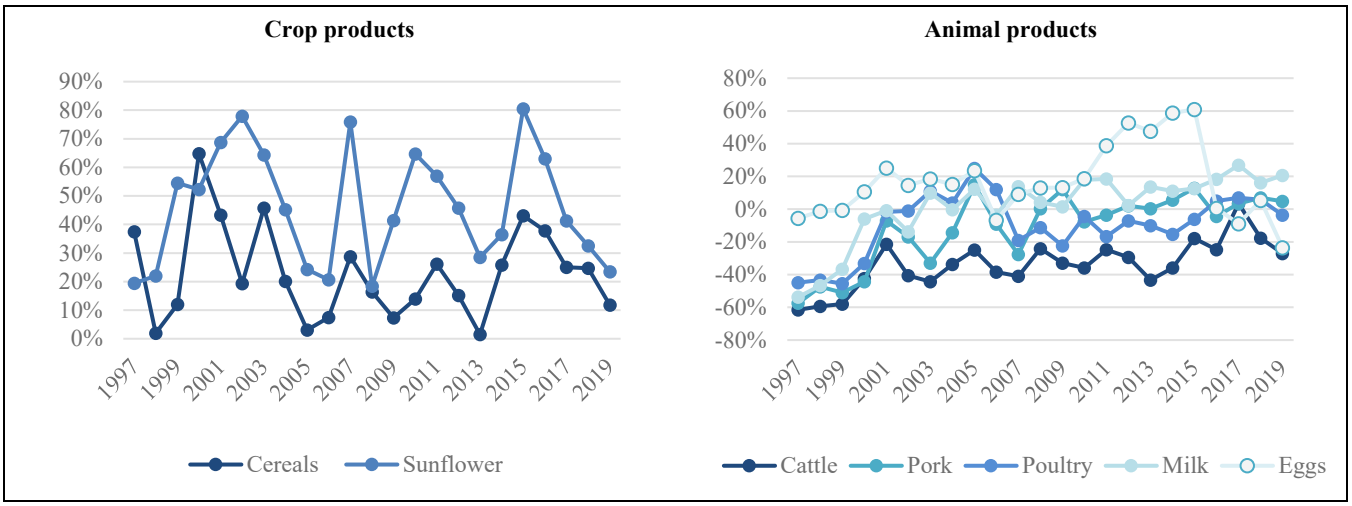
3.2 Internal Capabilities as Factors of Agroholding Development

Favorable external opportunities for large-scale farming operations could have been foregone if there had been no internal capabilities to capitalize on them. More specifically, based on previous research, we maintain that agroholdings were able to develop a number of internal capabilities that not only enabled them to grow but also helped them to address existing bottlenecks of the institutional environment they operate in. We further review some of these capabilities.

Investor Relations / Fundraising Capability

In Ukraine, the stock market is underdeveloped while commercial banks are providing loans under very restrictive refinance rates (GAGALYUK et al., 2018). However, agroholdings have demonstrated the ability to attract outside capital from a number of alternative sources. For instance, over the period from 2005 to 2013, twenty-one Ukrainian agroholdings have successfully made initial public offerings (IPO) of their shares on international stock exchanges and thereby raised more than USD 1.5 billion of additional investments (UCAB, 2012). In addition to international listings on stock markets like Frankfurt Stock Exchange, London Stock Exchange and Warsaw Stock Exchange, many agroholdings received loans from international financial institutions such as European Bank for Reconstruction and Development (EBRD) and International Finance Corporation (IFC). The concerned loans were and are targeted at financing of working capital, land lease rights, expansion of processing lines and storage capacities, and are often complemented by technical assistance and advisory services from the donors (cf. GAGALYUK and VALENTINOV, 2019: 487). Apart from growth financing and technical assistance, access to the international capital sources entails changes in business models, as it requires new approaches to corporate governance and transparency (GAGALYUK, 2017). Diverse boards of directors, independent auditing and disclosure of information about owners and financials serve as safeguards for publicly listed agroholdings against opaque business practices typical of a transition economy. Adherence to these requirements have been found to contribute to the resilience of the publicly listed agroholdings, as not only investors and shareholders but

Figure 7. Profitability of production of major crop and animal products, %



Source: STATE STATISTICS SERVICE OF UKRAINE (multiple years)

also other stakeholder groups became addressed via more transparent business models (GAGALYUK and VALENTINOV, 2019).

Growth Management Capability

The rapid growth of agroholdings was largely possible through quick acquisitions of other, standalone farms as well as of enterprises located up- and downstream in the food chain. While this process itself became possible due to favorable access to outside capital, its successful implementation required strong restructuring and reorganization capabilities. In this context, OSTAPCHUK et al. (2021b) show that farm acquisitions by agroholdings in Ukraine positively affected growth and productivity of acquired farms while agroholdings used various resource allocation, resource redeployment and investment/divestment instruments for the post-acquisition integration of farms. In particular, agroholdings re-orientated farm specialization to focus predominantly on crop production and thereby benefit from favorable world market situations; significantly improved crop productivity of farms via application of high-quality inputs; divested outdated assets and resorted to some outside crop-tending services; and strengthened storage and marketing infrastructure of acquired farms. Moreover, in terms of their continuous acquisition activity, most agroholdings took over mainly poorly performing farms (OSTAPCHUK et al., 2021a) and were, nevertheless, capable of bringing those farms' performance to the above-average level already three years after an acquisition (OSTAPCHUK et al., 2021b). Importantly, agroholdings were generally able to change their strategic orientation from extensive acquisitive growth toward more organic, efficiency-based growth over time, e.g. by substantially increasing yields per hectare, especially during various economic and political crises (ibid.).

Along with a specialization in primary agriculture, agroholdings include elements of vertical integration, such as the distribution of inputs, logistics, exports, food manufacturing and even food retail. For instance, of the ten largest agroholdings in terms of land use in Ukraine, each is vertically integrated in some way (GAGALYUK, 2018). Apart from the economies of scope rationale (Balmann et al., 2013), vertical integration helps agroholdings to address high transaction costs associated with problems of frequent supply disruptions, access to quality inputs and mistrust among food chain actors in transition economies (SWINNEN, 2006).

Technology Adoption Capability

Agroholdings bear a lion's share of responsibility for the fact that already 4.5 million hectares of Ukraine's total of 32 million hectares of cropland are being supervised by unmanned aerial vehicles (UAVs), also known as drones (AGROHUB, 2019). Moreover, satellite monitoring of fields, precision farming tools, navigation systems, and digital sensor technologies are being increasingly used. In addition, agroholdings deploy various IT solutions to integrate the obtained data into enterprise management systems and enable data analysis with modern analytical tools.

Modern digital technologies assist agroholdings in overcoming several problems. First, they help to manage and administer thousands of land lease agreements with individual smallholder landowners. A number of agroholdings are already using cloud software, data from satellite and UAV monitoring as well as artificial intelligence (AI)-based analytics for cadastral purposes (ibid.). Second, the use of precision farming technologies not only supports efficiency improvements but is also conducive to levelling out the effects of heterogenous farming practices and weather conditions within an agroholding, thus helping to fill existing yield gaps, typical of Ukraine (SCHIERHORN et al., 2021). Third, introduction of modern digital technologies by agroholdings bears the potential of improving existing institutional environment through building of shared and open institutional infrastructures, such as real-time kinematic stations, online trade platforms and data sharing with food chain actors (AGROHUB, 2019). Last but not least, tools such as digital sensor technologies and input application methods help to reduce high farm-internal transaction costs associated with the need to monitor labor and operations on a large scale (LISSITSA, 2018).

Stakeholder Management Capability

Previous studies have shown that Ukrainian agroholdings are able to address the strategic-legitimacy conflict between management and stakeholders and thereby improve public acceptance of own operations (BALMANN et al., 2016). For the most part, this conflict arises from existing institutional bottlenecks in Ukraine. For example, agroholdings face high uncertainty regarding security of land-based investments. Due to the long-lasting moratorium on land sales, agroholdings predominantly operate on leased land and are under a constant threat of losing it if, e.g., a significant number of lessors / landowners withdraws

from lease contracts for some reason (GAGALYUK, 2017). Another serious threat is the exodus of qualified employees from rural areas due to poor living conditions (GAGALYUK et al., 2021a).

In response to these problems, agroholdings introduced various corporate social responsibility (CSR) programs. The necessity to maintain the commitment of landowners and employees requires them to develop rural communities by means of charitable giving, support of local technical and social infrastructure, provision of advisory services, investments in smallholder entrepreneurial initiatives and promotion of cooperation among rural smallholders (GAGALYUK et al., 2018).

Importantly, the above described internal capabilities of agroholdings not only establish institutional arrangements for the achievement of higher efficiency (along the lines of transaction cost theory), but also seem to contribute to higher organizational resilience in a turbulent institutional environment (GAGALYUK and VALENTINOV, 2019). Moreover, these developments have notable spillover effects. Farms of sizes and organizational forms other than those of agroholdings engage in CSR activities (GAGALYUK and SCHAFT, 2016), implementation of precision farming technologies (HRYNEVYCH et al., 2022) and capital raising from international financial institutions (EBRD, 2021a; EBRD, 2021b; IFC, 2012). We, therefore, maintain that availability of these capabilities is important to consider when addressing economic factors of enterprise survivability amid crises (such as the Russian invasion of Ukraine). The paper further proceeds with testing this proposition by analyzing empirically post-crisis developments in agricultural enterprises of Ukraine.

4 Analysis of Post-Crisis Exit and Recovery of Agricultural Enterprises

Undoubtedly, the consequences of the economic recession caused by the Russian invasion of Ukraine are and will be extremely negative. In order to understand how the agriculture of Ukraine can respond to the ongoing and imminent economic crisis, we draw attention to the aspect of resilience of agricultural enterprises. In particular, we try to clarify, which enterprises will have more chances to survive the crisis by analyzing the factors of survival of agricultural enterprises during previous crises and post-crisis periods.

Over recent decades, there have been two widely recognized crisis periods in the agricultural sector of Ukraine. The first one occurred in 2007-2008 due to a significant drought in Ukraine and the global financial crisis that significantly negatively affected national economy. The second crisis took place in 2013-2014 as a result of negative global market conditions for grain and oil crops as well as due to the 2014 Russian aggression in the eastern part of Ukraine and annexation of Crimea followed by large inflation and devaluation of the national currency. By using the data on pre-crisis performance indicators of enterprises as well as the information on farm exits during and after these crises, we try to make projections regarding the characteristics of agricultural enterprises that may be conducive to their survival amid the ongoing crisis.

4.1 Data

In this study, we scrutinize the effects of the pre-crisis production and financial performance indicators of agricultural enterprises on the likelihood of their exit or survival during and after crisis events. We use the information from two databases for analysis:

- The Spark Interfax database (SPARK INTERFAX, 2019) or *financial database*, which includes the data from financial reports, i.e. balance sheets and profit-loss reports of Ukrainian agricultural enterprises. The total number of observations in this database is about 116 thousand for the years 2005-2016.
- The database of Ukrainian Agribusiness Club (UCAB, available to the authors) or *production database*, which includes the data of statistical reporting on the production indicators of agricultural enterprises in Ukraine. It contains about 105,000 observations for 2005-2016.

The descriptive statistics on the numbers of enterprise exits are presented in Appendix 1. The data from the first crisis period suggests that many agricultural enterprises have been exiting before 2008 and 2009, thus pointing to a possible larger detrimental effect of the drought of 2007 and other unidentified factors as compared to the effects of the 2008 global financial crisis. With regard to the second crisis period, we observe the peak of enterprise exits in 2014. This suggests that the 2014 Russian aggression may have exerted an additional negative impact on the agricultural enterprises trying to cope with the effects of the unfavorable pricing situation that had occurred on global agricultural markets a year before.

4.2 Methodology

We use logistic regressions to identify the characteristics of enterprises that increase or decrease the likelihood of enterprise exit from business in the post-crisis period. In our models, the dependent variable is binary, where 1 stands for the exit of an enterprise in the periods 2009-2012 and 2013-2016, and 0 indicates that the enterprise continued to exist/operate in the respective period. The dependent variable is regressed upon the financial and production performance indicators of the enterprises in the preceding period, i.e., the variable of enterprise exit in 2009-2012 is regressed upon the financial and production indicators of 2005-2008 while the variable of enterprise exit in 2013-2016 is regressed upon the respective indicators of 2009-2012.

We tested eight models, i.e. four models per each post-crisis period (2009-2012 and 2013-2016, respectively) using data from both financial and production databases. Thus, our analysis included four "production models" and four "financial models". Given significant change in the number of reporting enterprises from the annexed Crimea and the conflict areas of the Donetsk and Luhansk oblasts, we tested the models that included and did not include the enterprises from these regions.

For a more detailed analysis of the impact of changes in the production and financial indicators on enterprise exit, we used the average values of the respective indicators for the relevant period, as well as absolute change of an indicator, i.e. the difference between the value of an indicator at the beginning and the end of the relevant period. In addition, we considered the variation in an indicator for some selected indicators. All variables expressed in monetary terms were deflated using the 2005 price levels. We also divided certain indicators into quartile groups. In some cases, another approach to indicator grouping was used. For example, in the case of the "Debt-to-asset ratio" indicator, grouping was carried out on the basis of normative values of indebtedness adopted in the literature on enterprise finance (LI and ZHANG, 2017), i.e. 0-20%, 20-40%, 40-60%, 60-100%, >100%. The indicator "Biological (non-current) assets" was divided into 5 groups, of which the group with the code "0" denoted the enterprises that do not have biological assets on the balance sheet while the groups coded from "1" to "4" were constructed for the enterprises with available biological assets based on quartiles of non-zero values of this indicator. To code the absolute change/growth of any indicator, we used a binary variable, which takes the value of 1 if there was a greater than zero change of the indicator in the respective period, and 0 – if this change was less than or equal to zero.

4.3 Results

We further present the results of model assessment separately for each of the two post-crisis periods, i.e. 2009-2012 and 2013-2016, respectively. For a more detailed information about the results, see Appendix 2.

4.3.1 Factors of Enterprise Exit and Survival in 2009-2012

Factors of Enterprise Exit

The results of the financial models' assessment, i.e. based on the data of the financial database, demonstrate that the enterprises that primarily did not survive the 2007-2008 crisis were small in size. Similarly, the models based on the indicators of the production database show that the enterprises that failed to achieve scale effects, i.e. small-size enterprises with high and growing material costs, were more likely to exit.

According to the findings of the financial models, the enterprises that exited from business were financially unstable and weak. In the pre-crisis period, such enterprises experienced a high variation in the cost of fixed assets and sales revenue, large indebtedness and growing volume of receivables. The enterprises that were characterized by the low level of sales, general and administrative costs (SG&A) pointing, among other things, to infrastructural weakness of an enterprise were also likely to exit. In line with these results, the findings of the production models' assessment show that the enterprises that sold a larger share of their production still in the harvest year had a higher likelihood of exit implying that poor storage infrastructure could be one of the reasons for the enterprise exit.

Regarding the organizational and legal forms of exited enterprises, the results of the financial models indicate that production cooperatives and public joint-stock companies had the highest likelihood of exit in 2009-2013. Our smaller sample model based on the production data shows that also private joint-stock companies were at risk during the same period. Both financial and production models show that unitary enterprises were the most stable with the lowest likelihood of exit. Altogether these results suggest that the enterprises with hired management navigated the 2007-2008 crisis sub-optimally. In addition, the crisis

highlighted general weakness of the cooperative business model in Ukraine (SWINNEN, 2006).

Factors of Enterprise Survival

According to the results obtained from the assessment of both financial and production models, the factors that reduced the risk of enterprise exit in 2009-2012 included growing sales revenues as well as high and growing enterprise profits. Our findings suggest that the effects of these factors were due in particular to the high level of crop productivity and economies of scale achieved via the increase of the farmland area under cultivation by an enterprise. The risk of exit was particularly lower for the enterprises specialized in the cultivation of commercial crops, such as wheat, barley, corn, sunflower, soybeans and rapeseed. Furthermore, the enterprises with relatively large livestock numbers were less likely to disappear in 2009-2012. Most probably, availability of animal production, associated with low production seasonality compared to crop production, enabled the enterprises of mixed, i.e. crop- and animal-production specialization to level out own cash flows throughout the year and thus to achieve a better financial standing.

Larger numbers of workers at an enterprise were also associated negatively with enterprise exit, suggesting that the ability of an enterprise to hire additional or seasonal workers may play a positive role, e.g., during harvesting. In addition, the enterprises with better investment opportunities that managed to increase equity and depreciate fixed assets at a higher rate were found to be less susceptible to negative effects of the crisis. The volume of subsidies received by an enterprise had also a negative effect on the enterprise exit likelihood.

We also observed some regional peculiarities with regard to farm exits as a consequence of the 2007-2008 crisis. The lowest likelihood of exits was among the enterprises registered mostly in the southern regions of the steppe agro-climatic zone. Since the Ukrainian steppe has long been considered a risky farming zone, it is possible that the enterprises in these areas are better prepared to deal with the effects of adverse weather conditions, such as drought. Our data suggests that they have lower material costs and cultivate more drought-resistant crops, such as sunflower, than the enterprises located in other regions. In addition, the enterprises in the south of Ukraine have the advantage of geographical proximity to ports, which lowers the cost of logistics of their exported products.

4.3.2 Factors of Enterprise Exit and Survival in 2013-2016

Factors of Enterprise Exit

Similar to the 2007-2008 crisis period, small farm size and poor financial performance were among the major factors of enterprise exposure to the 2013-2014 crisis. Growing variation in sales revenue and high (and growing) share of receivables increased the likelihood of farm exits in this period. The positive impacts on enterprise exit of the cost of outside services obtained by an enterprise and a low number of employees per enterprise suggest that a lack of competent in-house management made enterprises more vulnerable to the crisis.

In contrast to the 2009-2012 results, a growing share of commercial crops in the structure of production was positively associated with enterprise exit in 2013-2016. This finding points to the negative effect of dropping global prices of grain and oilseeds in 2013. Noteworthy, agroholding affiliation of an enterprise increased the likelihood of the enterprise exit in both financial and production models. In 2014, many export-oriented agroholdings faced financial problems due to currency devaluation, which were further aggravated by high levels of indebtedness of agroholdings. It was during this period that the rate of expansion of farmland area by agroholdings slowed down considerably. Accordingly, many enterprises that were part of the agroholdings' structures were liquidated or reorganized. Our results also show that production cooperatives again had the highest exposure to the crisis among organizational and legal forms of enterprises. At the same time, we did not find any significant differences between the regions of enterprise registration regarding their impact on enterprise exit likelihood.

Factors of Enterprise Survival

Like in 2009-2012, the enterprises with a steady growth of revenues were exposed to a lower risk of liquidation. In addition, higher profitability, which is associated with lower dependence on loan capital, had a negative impact on the enterprise exit likelihood. The negative effect of the value of fixed assets and SG&A costs on enterprise exit underscores again the important role of own infrastructure, e.g. logistics and warehouses, in navigating through crises. In addition, the possibility of achieving scale economies through an increase of farmland under cultivation was a significant factor of enterprise survival also after the 2013-2014 crisis. Furthermore, a negative impact of higher

wages on enterprise exit suggests that well-established incentive systems help to attract qualified personnel, which can be another strong factor of enterprise survival.

5 Discussion and Outlook

In this paper, we aimed to understand which agricultural enterprises in Ukraine will have most chances to survive during and after the crisis caused by the Russian invasion. For this purpose, we engaged with the assessments of the enterprise resilience factors during previous disruptive events, i.e. the 2007-2008 and 2013-2014 crises. Undoubtedly, the ongoing crisis will have a much more negative impact not only on Ukrainian agriculture but also on practically all sectors of the local and global economy that is still coping with the consequences of the Covid-19 pandemic. Furthermore, the war-related problems, such as the threat to global food security posed by the blockade of Ukrainian harbors or lacking supplies of fertilizer, require solutions that are rather outside everyday agenda of economic or trade policies.

The ongoing crisis, however, may include some of the features of both the 2007-2008 and 2013-2014 crises. For example, it is clear now that the macroeconomic recovery may overwhelm the financial capacities of the Ukrainian government and partly those of international development institutions. Therefore, it is important to support the resilience of the private sector and to attract private capital to address the economic consequences of the ongoing war (INTERFAX-UKRAINE, 2022). In this context, our results contribute to the understanding of the types of private sector actors that, on the one hand, may be most vulnerable to the crisis and, on the other hand, may be subject to quick post-crisis recovery.

Our research findings suggest that small-size agricultural enterprises are particularly endangered by huge disruptive events and, therefore, they may require special policy support during and after the crisis. Small enterprises with poor financial indicators and lack of resources and competences are the most vulnerable. Lack of storage and logistics capacities exerts additional pressure on them to sell products immediately after harvesting, most often at a lower price. Existing problems with grain exports hit such enterprises at most.

On the contrary, highly productive, profitable, less indebted and infrastructurally strong enterprises are most capable of overcoming the economic problems. Financial strength of an enterprise not only helps to maintain the current level of production but is also conducive to getting quick access to outside capital, which becomes particularly important in the view of imminent problems with cash. However, a so far unaddressed issue is access to financial resources in the amounts that would, among other issues, make it possible to pay timely land rental payments, since most of farmland in the use of Ukrainian agricultural enterprises is still leased-in. Moreover, salaries need to be paid in time, particularly given the increasing shortage of qualified labor. If there are not enough funds for these obligations, at least some portion of agricultural enterprises may face the threats of losing farmland or employees, or of even social unrest in the areas of their operations. It is probably just about the time when the stakeholder management capability of enterprises may complement other capabilities and pay off at most. CSR engagement and care of rural communities do facilitate landowner loyalty as well as cooperation with international financial institutions and commercial banks (GAGALYUK et al., 2021a).

Another factor that may be particularly conducive to maintaining land lease relationships and applying for external funds is digitalization. The use of digital cadaster systems may reduce enterprise transaction costs of accounting of land lease contracts and enable, e.g., targeted restructuring or postponement of lease payments in case of financial problems. Furthermore, the use of satellite monitoring and drones helps enterprises to make a more precise assessment of the losses incurred due to warfare. Some agroholdings are already using this opportunity to prepare lawsuits for loss compensation by Russian Federation while they can also use this data to apply for restructuring funds (UCAB, 2022). Furthermore, given limited access to inputs, agroholdings are using precision farming tools to more evenly apply scarce inputs across fields (AGROPORTAL, 2022).

Interestingly, although larger farm sizes are found to be the factor of anti-crisis resilience, our results suggest that the farms affiliated with large-scale agroholdings are not necessarily the most robust ones. Moreover, liquidation of a subsidiary enterprise of an agroholding may not necessarily be caused by its enormous underperformance. Agroholdings have previously shown a strong ability for continuous restructuring and adaptation, especially during crises. Therefore, liquidation of an agroholding-affiliated subsidiary may point to its involvement in some re-

structuring activities, e.g., enlargement of affiliates within an agroholding's structure with the aim to streamline the management processes or reduce agroholding-internal transaction costs (OSTAPCHUK et al., 2021b).

The development of Ukrainian agriculture during the past 15 years has to be seen as a success story given that agricultural exports as wells the share of agricultural exports in total Ukrainian exports quadrupled. This development was based on access to finance, modern technology and public acceptance of agricultural development. Whether these drivers will work again after an end to the war will very much depend on access to financial means (most likely private finance), investment perspectives for private actors and potentials for earning profits. Moreover, these determinants will heavily depend on the political, institutional and economic conditions after the war, such as functioning infrastructure and open harbors. The Lugano International Ukraine Recovery Conference held on July 4-5, 2022 indicated that donors are aware of the need for enormous investments and considered agriculture to be particularly in need for recovery investments. These insights may provide a suitable ground for investments not only in assets such as machinery and buildings but also in the improvement of the financial status of farms, farming businesses and agroholdings.

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Appendix 1. Descriptive statistics

Table 1A. Descriptive statistics of enterprise exits and revenues based on financial database, 2005-2016

Year	N observations		N exited		Share of exited		Deflated revenue, UAH billion	
	Whole sample	Excl. Crimea, Donetsk and Luhansk	Whole sample	Excl. Crimea, Donetsk and Luhansk	Whole sample	Excl. Crimea, Donetsk and Luhansk	Whole sample	Excl. Crimea, Donetsk and Luhansk
2005	11011	9844	-	-	-	-	21.6	18.7
2006	10970	9798	710	651	6.5%	6.6%	23.4	20.5
2007	10590	9445	892	810	8.4%	8.6%	26.6	23.1
2008	10267	9178	668	588	6.5%	6.4%	29.1	25.3
2009	10063	8582	519	495	5.2%	5.8%	32.1	28.3
2010	9605	8210	555	458	5.8%	5.6%	33.8	29.8
2011	9731	8274	808	677	8.3%	8.2%	43.2	38.8
2012	9709	8250	452	380	4.7%	4.6%	53.6	48.2
2013	9568	8489	445	407	4.7%	4.8%	53.4	48.5
2014	8596	8151	1050	1044	12.2%	12.8%	62.1	59.1
2015	8256	7801	500	487	6.1%	6.2%	68.6	65.9
2016	8020	7543	461	451	5.7%	6.0%	63.3	60.4

Source: own calculations based on SPARK-Interfax database

Table 1B. Descriptive statistics of enterprise exits and revenues based on production database, 2005-2016

Year	N observations		N exited		Share of exited		Deflated revenue, UAH billion	
	Whole sample	Excl. Crimea, Donetsk and Luhansk	Whole sample	Excl. Crimea, Donetsk and Luhansk	Whole sample	Excl. Crimea, Donetsk and Luhansk	Whole sample	Excl. Crimea, Donetsk and Luhansk
2005	8498	7620	-	-	-	-	19.6	17.2
2006	7593	6789	1292	1183	17.0%	17.4%	22.5	19.9
2007	8259	7359	1145	1040	13.9%	14.1%	22.9	20.0
2008	9234	8182	766	690	8.3%	8.4%	31.2	27.4
2009	9196	8115	694	637	7.5%	7.8%	36.9	32.7
2010	9127	8029	696	630	7.6%	7.8%	35.1	31.1
2011	9462	8316	568	522	6.0%	6.3%	39.5	35.3
2012	9077	7975	776	670	8.5%	8.4%	46.8	41.8
2013	9034	7933	536	458	5.9%	5.8%	48.0	43.6
2014	8492	8063	1031	433	12.1%	5.4%	53.8	50.8
2015	8421	7926	715	676	8.5%	8.5%	58.7	55.1
2016	8236	7747	324	304	3.9%	3.9%	54.1	50.8

Source: own calculations based on UCAB database

Appendix 2. Results of logistic regressions

Table 2A. Odds ratios of liquidation of agricultural enterprises in post-crisis years, based on financial database, 2005-2016

Variables		2009-2012		2013-2016	
		Incl. Crimea, Donetsk and Luhansk	Excl. Crimea, Donetsk and Luhansk	Incl. Crimea, Donetsk and Luhansk	Excl. Crimea, Donetsk and Luhansk
Revenue	Growth (binary, 1 = growth)	0.711***	0.720***	0.676***	0.651**
	Average - groups				
	1	0.926	0.929	2.782***	2.128**
	2	0.897	0.901	1.773***	1.376
	3	1.166	1.145	1.375*	1.082
	4	Benchmark			
	Variation	1.010***	1.009***	1.004	1.008**
Debt-to-assets	Growth	1.000	1.000	1.002	1.001
	Average - groups				
	1	0.947	0.942	0.890	1.069
	2	Benchmark			
	3	0.955	0.949	1.000	1.156
	4	1.216*	1.221	0.970	0.982
	5	1.643***	1.651***	0.727	0.757
	Variation	1.001	1.001	1.003	1.003
Fixed assets	Growth	1.000	1.000	0.99996***	0.9999***
	Variation	1.003*	1.003*	1.001	1.002
Net profit margin	Growth (binary, 1 = growth)	0.703***	0.661***	0.606***	0.539***
	Average - groups				
	1	Benchmark			
	2	0.714***	0.650***	1.098	1.296
	3	0.650***	0.603***	1.117	1.037
	4	0.564***	0.536***	1.072	1.178
Return on assets	Growth	1.001	1.001	0.998*	1.000
	Average	1.022	1.088	0.750	0.874
	Variation	1.000	1.000	1.000	1.000
Working capital ratio	Average	0.999	0.999	0.996	0.996
	Variation	1.000	1.00004*	1.000	1.000
Current liquidity ratio	Growth	1.000	1.000	1.000	1.000
	Average - groups				
	1	1.375**	1.436**	1.011	1.101
	2	1.200*	1.234*	1.053	1.016
	3	Benchmark			
	4	0.863	0.839	0.848	0.684*
SG&A costs	Growth (binary, 1 = growth)	0.882	0.904	0.630***	0.606***
	Average - groups				
	1	1.838***	1.848***	-	-
	2	1.197*	1.224*	-	-
	3	Benchmark		-	-
	4	0.955	0.925	-	-
	Average	-	-	0.99998***	0.99997**
Small-size enterprise (binary)		1.588***	1.568***	0.947	0.799
Biological assets	Average - groups				
	0	Benchmark			
	1	1.016	1.004	0.730	0.599*
	2	1.135	1.123	0.694**	1.077
	3	1.028	0.996	0.599***	0.798
	4	0.828	0.857	0.670**	0.910
Receivables-to-assets ratio	Growth	3.632***	3.751***	2.226**	1.769
	Average	1.567	1.211	3.227**	3.932**
Inventory turnover ratio	Growth (binary, 1 = growth)	1.138*	1.140	1.156	0.900
	Average - groups				
	1	1.109	1.082	1.092	1.333
	2	1.067	1.030	1.063	1.360
	3	Benchmark			
	4	1.127	1.143	1.083	1.166

Variables		2009-2012		2013-2016	
		Incl. Crimea, Donetsk and Luhansk	**Excl. Crimea, Donetsk and Luhansk**	**Incl. Crimea, Donetsk and Luhansk**	**Excl. Crimea, Donetsk and Luhansk**
Equity capital	Growth (binary, 1 = growth)	0.663***	0.698***	0.759*	0.586***
	Average	1.000	1.000	1.000003*	1.000
Fixed asset turnover	Growth (binary, 1 = growth)	1.199**	1.191**	1.244*	1.174
	Average - groups				
	1	Benchmark			
	2	1.052	1.061	0.886	0.943
	3	1.268**	1.236*	0.841	0.888
	4	1.373**	1.338*	0.778	0.960
Agroholding affiliation (binary)		0.804*	0.860	1.730***	2.783***
Organizational / legal form	Agricultural production cooperative	1.720***	1.687***	2.070***	2.264***
	Private (closed) joint stock company	0.707	0.729	0.544*	0.648
	Public (open) joint stock company	1.612***	1.547**	2.526***	1.536
	Service cooperative	1.205	1.297	-	-
	Peasant (family) farm	0.767	0.789	0.319**	0.279
	Limited liability company	Benchmark			
	Unitary	0.780***	0.831**	1.088	1.040
	Other	1.278	1.306*	0.864	0.611
Region	1 – Crimea	0.453***	-	19.594***	-
	2 – Cherkasy	0.630**	0.644**	0.641	0.733
	3 – Chernihiv	0.792	0.798	1.259	1.138
	4 – Chernivtsi	0.624*	0.620*	-	-
	5 – Dnipro	0.226***	0.233***	0.569*	0.907
	6 – Donetsk	0.503***	-	5.260***	
	7 – Ivano-Frankivsk	0.897	0.905	0.875	0.852
	8 - Kharkiv	0.549***	0.559***	0.492*	0.685
	9 – Kherson	0.325***	0.333***	0.514	0.671
	10 – Khmelnytskyi	1.202	1.204	-	-
	11 – Kropyvnytskyi	0.355***	0.364***	0.630	0.814
	12 – City of Kyiv	0.433**	0.449**	1.928	2.315*
	13 – Kyiv Oblast	0.329***	0.335***	0.773	0.836
	14 – Luhansk	0.543***	-	6.805***	-
	15 – Lviv	0.566***	0.560***	-	-
	16 – Mykolaiv	0.520***	0.526***	0.343**	0.448
	17 – Odesa	0.379***	0.393***	-	-
	18 – Poltava	Benchmark			
	19 – Rivne	0.689	0.689	2.361*	2.735**
	21 – Sumy	0.654**	0.664*	0.762	0.861
	22 – Ternopil	0.920	0.899	0.656	0.777
	23 – Vinnytsia	0.565***	0.574***	0.569	0.864
	24 – Volyn	0.651*	0.661*	0.763	0.814
	26 – Zaporizhzhia	0.360***	0.375***	0.303***	0.539
	27 – Zhytomyr	0.928	0.910	1.071	1.120
Constant		0.338***	0.352***	0.146***	0.113***
Obs		6663	5973	4202	3476
Prob > chi2		0.000	0.000	0.000	0.000
Pseudo R2		0.189	0.191	0.335	0.174

Note: *, ** and *** denote 10%, 5% and 1% significance level, respectively.
Source: own calculations based on data of SPARK-Interfax

Table 2B. Odds ratios of liquidation of agricultural enterprises in post-crisis years, based on production database, 2005-2016

Variables		2009-2012		2013-2016	
		Incl. Crimea, Donetsk and Luhansk	Excl. Crimea, Donetsk and Luhansk	Incl. Crimea, Donetsk and Luhansk	Incl. Crimea, Donetsk and Luhansk
Revenue	Growth (binary, 1 = growth)	0.564***	0.558***	0.531***	0.540***
	Average – groups				
	1	6.190***	5.561***	4.669***	4.384***
	2	3.338***	2.919***	2.330**	2.043*
	3	1.778***	1.654**	1.302	1.216
	4	Benchmark			
Crop production value per hectare	Growth	1.120	1.164	0.979	0.971
	Average – groups				
	1	Benchmark			
	2	0.543***	0.524***	1.075	1.116
	3	0.515***	0.479***	1.050	0.966
	4	0.542**	0.486***	1.135	1.012
Material cost	Growth	1.0001***	1.0001***	1.000	1.000
	Average – groups				
	1	0.862	0.839	1.349	1.584*
	2	Benchmark			
	3	1.605**	1.534**	0.974	0.944
	4	2.242***	1.996**	0.968	1.038
Cost of outside services / cost of services of third-party organizations	Growth	1.000	1.000	1.0002***	1.0002***
	Average	1.000	1.000	1.000	1.000
Asset depreciation	Growth	0.999**	0.999**	1.000	1.000
	Average	0.998***	0.999***	0.999***	0.999*
Profit	Growth (binary, 1 = growth)	0.716***	0.735***	0.943	1.020
	Average	0.9997***	0.9996***	0.9999**	1.000
Number of workers	Growth	0.996***	0.996**	1.000	1.000
	Average – groups				
	1	1.173	1.179	1.398**	1.353*
	2	Benchmark			
	3	1.110	1.084	0.934	0.841
	4	1.060	1.021	0.904	0.864
Wages	Growth	1.006	1.008	0.984*	0.974***
	Average – groups				
	1	Benchmark			
	2	1.071	1.047	0.774*	0.917
	3	1.038	1.042	0.840	0.919
	4	0.969	0.936	0.888	1.124
Farmland area operated	Growth	0.9999*	0.9999**	0.9998**	0.9997***
	Average – groups				
	1	0.811	0.884	0.683*	0.644**
	2	Benchmark			
	3	0.841	0.904	1.301	1.110
	4	0.723	0.754	1.399	1.004
Land rental payments	Growth	1.243	1.349	0.811	1.377
	Average	1.303	1.370	0.623	1.897
Ratio of harvested to total arable land operated	Growth (binary, 1 = growth)	1.003	1.025	0.930	0.887
	Average – groups				
	1	Benchmark			
	2	0.739**	0.807	0.864	0.842
	3	1.123	1.230	1.033	1.100
	4	0.873	0.972	1.065	0.994
Share of crop production in total production	Growth	0.768	0.823	1.560	0.958
	Average – groups				
	1	1.116	1.049	-	-
	2	0.662*	0.701	-	-
	3	0.892	0.909	-	-
	4	Benchmark		-	-
	Average (binary, 1 = 100% crop production)	-	-	1.042	1.184

Variables		2009-2012		2013-2016	
		Incl. Crimea, Donetsk and Luhansk	Excl. Crimea, Donetsk and Luhansk	Incl. Crimea, Donetsk and Luhansk	Incl. Crimea, Donetsk and Luhansk
Share of cash / commercial crops in total crop production	Growth	0.529**	0.466***	1.960**	1.883*
	Average – groups				
	1	Benchmark			
	2	0.887	0.890	1.007	0.959
	3	0.887	0.881	0.827	0.899
	4	0.594**	0.598**	0.879	0.811
Share of production sold in the current harvesting year	Growth	2.641***	2.914***	1.086	1.105
	Average – groups				
	1	Benchmark			
	2	1.345**	1.285*	0.872	0.811
	3	1.242	1.191	1.023	0.820
	4	1.326	1.245	0.956	0.923
Number of cows	Growth	1.000	1.000	0.999	0.999
	Average – groups				
	0	Benchmark			
	1	1.198	1.146	0.965	1.007
	2	0.834	0.777	0.984	1.116
	3	0.571***	0.550***	1.098	1.191
	4	0.596*	0.610*	0.575*	0.720
Ratio of subsidies to revenue	Growth	0.798	0.868	0.856	0.850
	Average – groups				
	0	Benchmark			
	1	0.735*	0.769	1.775*	1.429
	2	0.523***	0.557***	1.235	1.198
	3	0.488***	0.533***	1.371	1.459
	4	0.427***	0.433***	1.797*	1.779*
Agroholding affiliation (binary, 1 = agroholding)		2.139***	2.282***	3.759***	4.706***
Organizational / legal form	Private (closed) joint stock company	1.833*	1.960**	1.158	1.321
	Public (open) joint stock company	0.807	0.739	0.966	1.108
	Peasant (family) farm	1.169	1.333	1.079	1.793***
	Limited liability company	Benchmark			
	Unitary	0.731***	0.744**	0.799*	0.912
	State-owned	-	-	1.872	2.270
	Other	0.864	0.931	0.829	0.864
Region	Crimea	0.813	-	-	-
	Vinnytsia	0.825	0.878	0.616	0.727
	Volyn	1.187	1.203	1.098	1.329
	Dnipro	0.200***	0.192***	0.716	0.744
	Donetsk	0.211***	-	4.899***	-
	Zhytomyr	0.695	0.737	0.603	0.676
	Zakarpattia	1.752	2.027	-	-
	Zaporizhzhia	0.206***	0.200***	0.297***	0.325***
	Ivano-Frankivsk	2.087	2.253	0.304	0.282
	Kyiv Oblast	0.335***	0.342***	0.638	0.677
	Kropyvnytskyi	0.186***	0.185***	0.466**	0.489*
	Luhansk	0.283***	-	2.820***	-
	Lviv	0.971	1.008	0.927	1.095
	City of Kyiv	-	-	7.607**	7.484*
	Mykolaiv	0.489**	0.475**	0.405***	0.442**
	Odesa	0.534**	0.533**	0.641	0.783
	Poltava	Benchmark			
	Rivne	1.580	1.610	1.699	1.737
	Sumy	0.296***	0.296***	0.375***	0.425**
	Ternopil	0.966	0.999	0.535	0.597
	Kharkiv	0.217***	0.214***	0.452**	0.446**
	Kherson	0.236***	0.245***	0.318***	0.349**
	Khmelnytskyi	1.558	1.636*	1.243	1.427
	Cherkasy	0.851	0.884	0.543	0.578
	Chernivtsi	0.621	0.683	1.211	1.416
	Chernihiv	0.516**	0.530**	0.585	0.718
Constant		1.241	1.154	0.215***	0.150***
Obs		3474	3116	3850	3528
Prob > chi^2		0.000	0.000	0.000	0.000
Pseudo R2		0.225	0.223	0.177	0.160

Note: *, ** and *** denote 10%, 5% and 1% significance level, respectively.
Source: own calculations based on data of UCAB