ENABLING VALUE, NOT JUST PROCESSING: INSIGHTS FROM EUROPEAN AND UKRAINIAN AGRI-FOOD CHAINS

by

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LIST OF ABBREVIATIONS

ABF – Associated British Foods plc

AD – Ahold Delhaize N.V.

AGCO – AGCO Corporation

AST – Astarta Holding N.V.

B4B – Metro AG ticker symbol

BAS – BASF SE ticker symbol

BAYN – Bayer AG ticker symbol

BMI – Business Monitors International agency

CA – Carrefour S.A.

CAP – Common Agricultural Policy

CEVA – Creation or Destruction of Economic Value Added

CNHI – CNH Industrial N.V. ticker symbol

COGS – Cost of Goods Sold

CVGW – Calavo Growers Inc. ticker symbol

EVA – Economic Value Added

IMC – IMC S.A.

KER – Kernel Holding S.A.

KSE – Kyiv School of Economics

KSG – KSG Agro S.A.

KWS – KWS Saat SE & Co. KGaA

LND – BrasilAgro (ticker symbol)

LPM – Linear Probability Model

MEVA – Modified Economic Value Added

MHPC – MHP SE

NESN – Nestlé S.A. ticker symbol

NOA – Net Operating Assets

NOPAT – Net Operating Profit After Tax

NYSE – New York Stock Exchange

OECD – Organisation for Economic Co-operation and Development

OSE – Oslo Stock Exchange

OVO – Ovostar Union N.V.

PEVA – Persistence of Economic Value Added

PLC – Public Limited Company

R&D – Research and Development

Re – Cost of Equity

Rd – Cost of Debt

SBM – Sustainable Business Model

SANW – S&W Seed Company ticker symbol

SHV – Select Harvests Limited ticker symbol

SSSU – State Statistical Service of Ukraine

SZU – Südzucker AG ticker symbol

TBM – Technology-based Business Model

TSCO – Tesco PLC ticker symbol

ULVR – Unilever PLC ticker symbol

USA – United States of America

VAT – Value Added Tax

WACC – Weighted Average Cost of Capital

WHO – World Health Organization

WSE – Warsaw Stock Exchange

YAR – Yara International ASA ticker symbol

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CHAPTER 1. INTRODUCTION

The Russian invasion in February 2022 has significantly disrupted the agricultural sector of Ukraine. The damages are estimated at over $10.3 billion and agricultural land available reduced by 26% (Neyter et al, 2024). This has significant consequences in Ukraine and abroad. Before the war, agriculture accounted for about 10% of Ukraine's gross domestic product or around 20% including upstream and downstream industries and accounted for over 40% of all exports from Ukraine (Nivievskyi, 2024). Therefore, agriculture is one of the most important areas for the recovery of the Ukrainian economy. Furthermore, Ukraine is critically important for food security in the world as it is the largest exporter of sunflower oil in the world and is one of the top five suppliers of corn, wheat and barley to Asia, Africa and Europe.

As Ukraine plans recovery and moves towards European integration, the question of priority in reconstruction is important. The Ukraine Recovery Plan aims to increase processing volume by 85% by 2030. It is based on the belief that by processing and moving into downstream activities, the country moves up the value chain and automatically generates more economic value than primary production. This assumption drives significant policy decisions about resource allocation, but it lacks robust empirical validation for Ukrainian agricultural systems. Historical experience with forced processing policies, such as Ukraine's sunflower seed export tariffs, suggests the relationship between value chain position and value creation may be more complex than commonly believed (Nivievskyi, 2016).

In order to make evidence-based reconstruction decisions we need to understand where economic value is actually created along agricultural value chains. While many studies have been conducted to develop agricultural value chains, a major methodological gap still exists with respect to quantifying these value-creation patterns. Most studies have relied either on qualitative organizational case studies or on simple profitability figures that do not take into account the full cost of capital used. Cucagna and Goldsmith (2018) developed an Economic Value Added (EVA) methodology for measuring the creation of value across agricultural chains but limited their analysis to the National and South American markets. No similar quantitative analysis was done on European and Ukrainian agricultural systems leaving the field open for further investigation.

Therefore, this research fills a gap by using EVA methodology to analyze value creation in Europe's and Ukraine's agricultural value chains. It examines how economic value is created, what factors influence it, and how patterns differ across different stages of the chain. The findings will help us understand Ukraine's agricultural reconstruction and provide broader insights into how value is created in agricultural systems.

The analysis tests three major hypotheses about value creation in agriculture. First, that value creation can vary greatly due to different levels of capital intensity, competition and buyer relationships among the four stages of the value chain (inputs, production, processing, retail). Second, that downstream value chain stages (processing and retailing) generate higher economic value than upstream stages (inputs and production), testing the assumption which is used in current policy preferences.

But aside from the question of where value is created along this value chain, it may be equally important how businesses create value in their respective stages. Third, the analysis hypothesizes that innovation and product differentiation are the key drivers of value creation, that firms engaged in R & D and product differentiation will be more productive and improve their performance relative to those who compete primarily through cost efficiency. This would suggest that value creation will depend not only upon the chain position but also on firm strategies and capabilities.

The methodology utilizes a panel regression analysis of 28 firms, over 4 stages of the value chain, over the period 2015-2024, using four complementary measures: EVA, Modified EVA (MEVA), Creation or Destruction of EVA (CEVA), and Persistence of EVA (PEVA). This sample includes 6 Ukrainian, 17 European and 5 global agricultural companies, which provides approximately 280 firm-year observations.

The empirical analysis reveals interesting patterns that challenge conventional assumptions. Agricultural production (Stage 2) shows the highest capital efficiency after accounting for firm size, costs, and innovation. Yet this efficiency is highly volatile, as fewer than half of production observations create positive value in any year, but they rarely maintain such good performance during multiple years in a row. This "feast or famine" pattern reflects producers' significant exposure to weather, biological risks, and commodity price volatility, which makes it impossible for them to sustain consistent value creation.

In contrast, retail (Stage 4) shows negative capital efficiency, but it achieves exceptional consistency in positive value creation across observations and high persistence over time. This apparent paradox illustrates fundamentally different value creation models: retailers earn modest but predictable returns, while producers achieve high efficiency inconsistently. Processing (Stage 3) occupies an intermediate position with moderate efficiency, high consistency, and strong persistence. Input suppliers (Stage 1) achieve the strongest capital efficiency, which is persistent, but with substantial year-to-year variability.

Also, product differentiation appears to play a very important part as measured by the relationship of COGS ratio. Companies, who operate with lower COGS, and therefore higher value added, create significantly more value than those with high COGS ratios. This suggests that additional value comes not merely from a company's position in the value chain, but from how effectively it deals with innovation and differentiation at that stage.

The key message from this analysis is that value creation in agricultural systems appears more complex than simple assumption "moving up the value chain" suggests. Each stage faces distinct opportunities and constraints, and optimal strategies likely involve complementary specialization rather than universal approaches. For Ukraine's reconstruction efforts, this implies that strengthening the entire value chain system, accounting for their specialties, rather than favoring particular stages, may bring superior economic outcomes.

CHAPTER 2. INDUSTRY OVERVIEW AND RELATED STUDIES

2.1 European Agricultural Sector

The agricultural sector is of great importance to the EU economy. According to the European Commission (2025), the sector produced a value added of €234.1 billion and represented 1.3% of the total GDP in 2024. The agriculture sector produced an output of €532.4 billion in 2024, which is approximately the output of the whole Greek economy. The income of the sector has increased by 37.8% over the past decade since 2015. This indicates that the productivity and profitability of the sector keep increasing.

However, the agricultural sector in the EU and in Ukraine differs in their structural aspects and economic significance. Agriculture in Ukraine plays a much greater economic role in agriculture than in the EU. Agriculture in the EU contributes only 1.3% of the GDP and employs only 3.8% of the work force. In Ukraine these figures are 10.6% and 14.7% respectively. Agricultural exports in Ukraine account for about 40.6% of total exports as compared to only 8.9% in the EU (Nivievskyi, 2024).

The farm structure shows considerable differences as well. The EU contains approximately 10.5 million farms with an average size of 37 hectares of area, but more than half of them is smaller than 5 hectares. The Ukrainian farms, on the other hand, are much larger with an average farm size of 514 hectares (European Commission, 2025; Nivievskyi, 2024). These size differences indicate that each region has evolved its own unique production systems and experienced different patterns of historical development.

Production orientation shows noticeable differences between the two regions as well. Both sectors are primarily crop-based, but crops dominate significantly more in Ukraine, consisting of 82% of the total agricultural production, as against 61% in the European Union, livestock producing only 18% in Ukraine, as against 39% in the European Union (Nivievskyi, 2024). Also, agricultural land in the Ukraine territory constitutes 71% of total land area, as against only 41% in the European Union. Arable land out of agricultural area amounts to 80% in the Ukraine, against 58% in the European Union (Nivievskyi, 2024).

Four countries represent most European agriculture, these being France at €89.4 billion, Germany at €75.5 billion, Italy at €75.4 billion and Spain at €67.5 billion, representing nearly 58% of total EU agricultural output. The addition of the Netherlands, Poland and Romania brings this to 76% of total agricultural output (European Commission, 2025).

According to a separate European Commission analysis (2022), EU is self-sufficient in cereal (108%), dairy and meat production, but less in the case of oilseeds (59%) and oils and fats (70%). Agricultural workers number 7.6 million full-time equivalent positions, with most (5.3 million) being farm operators and their families working on their own farms, rather than hired workers (2.3 million). The agricultural workforce is also in decline, by 2.5% per annum since 2009, due to the trend of mechanization of farms towards greater efficiency and productivity.

The Common Agriculture Policy has provided €387 billion in financial assistance between 2021 and 2027, concentrating on environmental sustainability and rural development. New policies being implemented are setting targets for agriculture, including a 50% reduction in pesticide and nutrient losses and 25% of farming land under organic production by 2030 (European Commission, 2022).

However, the sector faces considerable challenges. The EU faces pressures from climate change, labour supply shortages, higher demand for sustainable and plant-based foods, and increasingly demanding environmental regulations under the European Green Deal and its Farm to Fork and Biodiversity Strategies. To the reconstruction challenge, in the case of Ukraine, is added another complicating factor, whereas the EU agricultural sector is concerned with the sustainability transition, Ukraine must at the same time rebuild its war-damaged infrastructure, modernise its production processes and prepare its institutional capacities for possible EU membership (Nivievskyi 2024).

2.2 Ukrainian Agriculture Sector

While the EU agricultural sector operates within a mature, highly regulated framework with diversified production across member states, Ukraine's agricultural sector has followed a distinctly different trajectory. The structural differences outlined above, particularly in farm size, production orientation, and economic significance, reflect Ukraine's unique position as a major global agricultural exporter operating under fundamentally different conditions than its European counterparts.

It is essential, however, to consider the situation which existed before the war, in order to note that the period of development which the sector had attained prior to the full-scale invasion has changed everything. The development of the agricultural sector of Ukraine has undergone a most remarkable transformation in the 30 years of independence, evolving from a struggling post-Soviet system into a globally competitive player.

A significant indicator of agricultural development was Ukraine's emergence as a major exporter. The share of agricultural products in total exports dramatically increased from 9.4% in 2000 to 45.1% in 2020, making agriculture the backbone of Ukraine's export economy. Labour productivity in agriculture also increased from 50 thousand hryvnias per employee in 1990 to 857 thousand hryvnias per employee in 2020, more than 17-fold increase (Ukrainian Agribusiness Reference Guide, 2020/2021).

Also, agriculture's share of GDP lowered from 24.4 percent in 1990 to 9.3 percent in 2020, reflecting the diversification of the economy overall, not the decline of agriculture, while the absolute values of agricultural production increased significantly: grain production increased by 29%, sunflower production grew by 448%, and other oilseeds expanded greatly during this period (Ukrainian Agribusiness Reference Guide, 2020/2021).

By the year 2020, therefore, Ukraine had become a true agricultural superpower. Most impressive was the number one ranking globally in sunflower oil export with 5.3 billion dollars in revenue. Similarly, they ranked well in the export markets for corn, wheat and barley. In 2020 the total exports of plant products were 11.9 billion dollars where corn accounted for 4.9 billion dollars, while wheat was valued at 3.6 billion dollars (Ukrainian Agribusiness Reference Guide, 2020/2021).

In addition, the geographical reach of agricultural products was large. Every continent received agricultural products, where Asia purchased 11.9 billion dollars of products, Europe acquired 5.7 billion dollars, and Africa bought 3.4 billion dollars. (Ukrainian Agribusiness Reference Guide, 2020/2021). Hence, countries like China, India, Egypt and Spain were significant customers of Ukrainian grain and oil.

On July 1, 2021, Ukraine's agricultural land market was opened. It was a major step forward in Ukraine's agricultural history. The land market had been closed since 2001 due to a 20-year moratorium. In the first phase, buying was possible up to 100 ha of agricultural land. There were 155,000 land transactions covering 93,949 hectares in the first four months after the opening of the market (Ukrainian Agribusiness Reference Guide, 2020/2021). This market opening promised to improve land use efficiency and provide farmers with better access to capital by allowing land to serve as collateral.

Unfortunately, the success of this development was spoiled by the invasion of russia in February of 2022. The total losses in Ukrainian agriculture sector, at the latest calculation show that the damage suffered had amounted to 10.3 billion dollars by February 2024. The losses included damages to machinery and buildings, the amount of machinery damaged or lost being 5.8 billion dollars and storage buildings 1.8 billion dollars (Neyter et al., 2024). The total economic impact, including both destroyed assets and lost income, reached $69.8 billion.

The territorial effects were just as harmful. The amount of agricultural land available declined from 43 million hectares to 33 million hectares, a 26% decline. Arable land dropped 31.93%. In spring 2022, transportation infrastructure sustained 36.8 billion dollars in damage, including the destruction of 25,400 km of roads and more than 8% of grain storage capacity (Bogonos et al., 2024; Yanovska et al., 2025).

In July 2023, russia withdrew from the Grain Deal, forcing Ukraine to find new ways to export its grain. Ukraine responded by creating its own maritime corridor through military operations against russian naval forces. Despite these challenges, Ukraine managed to maintain most of its sea-based exports, though they dropped slightly from 76% to 70% of total export volume (Yanovska et al., 2025).

At the same time, Ukraine developed EU-Ukraine Solidarity Lanes as backup routes. These alternative paths helped export 88.1 million tons of agricultural products by December 2023. However, these land routes created new problems - trucks and trains now wait 40-60 days at border crossings, and the different railway systems between Ukraine and EU countries cause major delays (Yanovska et al., 2025).

Nonetheless, despite these major obstacles, Ukraine's agrarian economy is showing an extraordinary resilience. For the 2024-2033 period, projections show overall growth, with considerable structural changes driven by economic realities (Bogonos et al., 2024). Total cereal production is expected to increase, but the crop structure will shift toward oilseeds. This shift is driven by oilseeds' greater profitability and the rapid increase in demand for feed from expanding poultry production. The livestock sector will show a similar structural transformation. Poultry meat production will increase appreciably because economies of scale favor large enterprises that produce both feed and meat. In contrast, beef and pork production will continue its long-term decline because small household-farm enterprises are decreasing more rapidly than large-scale farms can be established to compensate (Bogonos et al., 352).

However, a blind spot remains in the story of Ukraine's agricultural development, and it exists still today. While the country exports raw commodities, it is still largely raw commodities, and not processed or more complex value-added product options.

To be fair, Ukraine's focus on raw materials has its advantages. The country became immensely efficient in agriculture and developed high competitiveness, producing big volumes of high-quality grain and oilseeds with world-class efficiency. And this requires an easier, less complicated and costly infrastructure and marketplace development than if it has created processing industries instead.

Export figures reveal how much money Ukraine left on the table. In 2020, Ukraine exported 78.5% of its corn production as raw grain, 66.2% of wheat as unprocessed kernels, 52% of barley straight from fields, and 87% of rapeseed without processing

(Ukrainian Agribusiness Reference Guide, 2020/2021). Countries, who import Ukrainian raw materials built entire industrial ecosystems around Ukrainian agriculture, capturing the higher-value manufacturing jobs and profits.

2.3 Related Studies Overview

For the past two decades, researchers have been working to understand how value has been created in agriculture from farm to fork. Although we have learned a lot, there are significant gaps in our understanding of how this operates in many different countries and under varying contexts.

This review seeks to summarize what we already know about the creation of value in agrarian systems and, in particular, the agriculture of Europe and Ukraine.

Most discussions relating to agricultural value focus on Michael Porter's value chain theory (Porter, 1985; 2003). However, transferring this business idea to agriculture is not completely straightforward, as agriculture has several unique features and challenges, such as biological constraints, seasonal cycles, and perishable products that don't fit neatly into traditional business models.

Coltrain, Barton & Boland, (2000) provide one of the earliest more definitive and clear definitions of value-added agriculture, which they defined as: "the process to increase 'economic value' to a product by modifying its current place, time and form attributes to attributes that are favored in the marketplace." Although it seems a little formalized it is essentially about using value-added processes to create more value from the change in the place, time, or form of an agrarian product in the marketplace.

Perhaps what is most interesting about their work is their premise that no matter the desire to add value, production efficiency is still required. This is particularly relevant in Ukraine, where many farmers are still trying to develop their basic production efficiency while creating more value from their product.

They also argued for a shift away from the traditional "I will grow it first and then figure out how to sell it" to an actual understanding of consumers' needs and wants, which is precisely what Ukrainian agriculture needs as it attempts to become integrated into European markets.

More recent work has moved beyond this product-centric approach. Lu and Dudensing (2015) argue that value creation is really about aligning farm practices with consumer preferences, it recognizes agriculture as part of a broader food system rather than isolated production. This evolution makes sense, but it also reveals a key problem such as most research focuses on how to create value rather than where value is actually created along the chain.

Miranda et al. (2023) identify three main types of business models in the agri-food sector: sustainable business models (SBMs), technology-based business models (TBMs), and cooperative business models (CBMs). This taxonomy may help clarify development options for Ukraine. However, the authors identify a significant research gap: despite crises like COVID-19 and the war in Ukraine demonstrating market vulnerabilities, there is insufficient research on agri-food business model innovation driven by shortages of raw materials or labor, energy crises, or external dependencies on local markets. For a country rebuilding after war, addressing these crisis-driven innovations could be particularly valuable.

Most studies performed on the agricultural value chain rely upon qualitative studies, commonly case studies, they very seldom take the qualitative assessment of the performance into a quantitative area. Cucagna and Goldsmith (2018) are a notable exception, they used new approach Economic Value Added (EVA) to measure value creation across agricultural chains in the Americas.

This creates challenges for evidence-based policymaking. Without quantifiable measures of value creation, it's difficult to advise investors or policymakers on where to allocate resources. Ryzhakova et al. (2022) attempted to address this gap for Ukraine using analytical methods, though their work illustrates the difficulties of conducting empirical research in conflict zones.

The relationship between value creation and government input is complex and at times contradictory. On one hand, Franc, Bilas and Trifunić (2021) illustrate how CAP

(Common Agricultural Policy) serves a well-rounded support mechanism. CAP has allocated €387 billion for 2021-2027, not only providing monetary assistance but also institutional stability, which helps farmers to make long-term decisions. However, EU environmental policies are pushing farmers to grow more expensive products. New rules aim to cut pesticide use in half and make 25% of farms organic by 2030. This pushes farmers to grow specialized, high-value crops instead of basic ones.

On the other hand, this might create a problem. Kołodziejczak (2020) argues that while subsidies help farm incomes in the short term, they can make farmers too dependent on government support. This leaves us with a dilemma: farmers need support, but too much support can prevent the difficult changes needed to make farming competitive in the long run.

Ukraine has taken a distinctly different tactical approach to stimulate value creation in agriculture, primarily through export quotas and tariffs on raw materials. The most significant illustration can be seen in the sunflower sector, where Ukraine introduced a 23% export tariff on sunflower seeds in 1999.

Nivievskyi (2016) suggests that this policy made exporting raw sunflower seeds economically impossible and effectively forced almost 100% of those seeds into domestic processing. The results seem impressive, processing capacity increased by more than five times from 0.3 million tons to 1.56 million tons in 16 years. And Ukraine became the top global exporter of sunflower oil, which is a source of national pride for agricultural officials.

However, this also raises some important issues as to whether it is actually creating new economic value or simply redistributing, or changing, production patterns. Based on Nivievskyi's analyses, when processing costs were put into consideration (around $ 38 per ton in Ukraine vs. $27 per ton in the EU), additional value creation was less certain. Processing costs above $25 per ton on the contrary, could destroy value rather than create it.

The key problem with Ukraine's approach arises because it represents an income redistribution, rather than a true value creation. The export taxes and VAT non-refunds redistribute income, which allows the government to take from producers and give it to processors, but does not create any more economic efficiency or competitiveness in the agricultural sector. Producers lose income through artificially low-priced raw materials, while processors benefit from cheap inputs, regardless of whether they are operating efficiently.

The Recovery Plan has targets, as an 85% increase in processor volume, and 50% of that to eventually be exported volume by 2030. However, the Recovery Plan does not address the overarching question raised through this early analysis as to whether this processing creates a net gain of value at all, or if it is merely redistributing value while increasing costs.

This review revealed an important knowledge gap. We have somewhat of an understanding of how agricultural value creation works in established market economies. However, we understand much less about how it works in developing countries and countries going through major changes.

Ukraine's situation is especially important for several reasons: it has huge agricultural potential, it is working to join the EU, and it is dealing with war-related disruptions. These factors make it hard to understand how much value the agricultural sector can actually create. Ukraine's policy of forcing domestic processing by restricting raw material exports provides a real-world test case for value chain policies, but whether this approach actually works remains unclear.

CHAPTER 3. METHODOLOGY

3.1 Research Design and EVA Framework

The objective of this research study is to understand where value is created in agricultural value chains especially compared with European and Ukrainian companies. The problem was to discover a methodology to go beyond descriptive case studies to get cases of actual quantitative evidence about value creation patterns.

An interesting approach was found during the literature review. This was developed by Cucagna and Goldsmith (2018) who used Economic Value Added (EVA) measures to analyse value creation across the agricultural value chains in the Americas. Their methodology was very attractive for several reasons.

First, as EVA gives a much better measure of value creation than traditional profitability measures, the EVA processes give a much more sophisticated measures of value creation since it takes account of all the costs associated with capital used, both loans and equity. This is important because a company can show a profit accounting-wise, when in fact they are destroying value, as their profits do not exceed those costs of capital.

Second, their model separates the agricultural value chain into the four separate stages inputs and equipment, production, processing and manufacture, and retailing and distribution. This enables a systematic comparison of the patterns of value creation across the different positions in the chain. The stage approach is helpful in trying to find the answers to the research questions about where value is created in the value chain.

Third, the processes used have previously been tested in agricultural contexts. Hence, there is some confidence they will be applicable to European and Ukrainian agricultural companies.

The methodology gives a two-phase approach. First, the companies are classified according to the four stages of the value chain depending on what their main business activities are. Secondly, Economic Value Added (EVA) is calculated for each company, in order to find their measure of value added and then conduct comparison across the stages.

EVA represents the value that a company achieves over and above the returns the average investors in the company expect. Investors provide the capital to a company and expect a return on that in accordance with the capital that they risk. If a company achieves business profits that are greater than this required return, they are creating value. If not, they are destroying value, even though they may be showing positive accounting profits.

Formally, EVA is expressed as:

$$\left(\frac{Adjusted\ NOPAT}{NOA} - Cost\ of\ Capital\right) * NOA \tag{1}$$

where AdjNOPAT is the adjusted Net Operating Profit After Tax, NOA represents Net Operating Assets, and Cost of Capital is the weighted average cost of capital (WACC).

Net Operating Profit After Tax (NOPAT) is the profit the company earns from its core operations after tax but before the funding of these operations is considered. The calculation is conducted in accordance with common practice as follows:

$$NOPAT = Operating\ Income * (1 - Tax\ Rate) \tag{2}$$

The Adjusted NOPAT removes non-recurring items such as one-time charges for restructuring and one-time gains and losses so as to better encompass sustainable operating performance. It is important to make this distinction because the objective is to measure the value provided by continuing business activity and not a temporary effect.

Net Operating Assets (NOA) represents the capital invested in a company's core business operations:

$$NOA = Total\ assets - Non - operating\ assets - Current\ Liabilities \tag{3}$$

According to Cucagna and Goldsmith, non-operating assets (i.e., excess cash or investments which are not associated with core business operations) are subtracted to reflect the capital employed in core business activity. This ensures that the efficiency with which companies utilize their operating capital is measured rather than the size of the investment portfolio.

The cost of capital represents what investors require as compensation for providing capital to the company. It is the weighted average of the cost of debt and the cost of equity:

$$WACC = r_d * (1 - t) * \left(\frac{D}{D+E}\right) + r_e * \left(\frac{E}{D+E}\right) \tag{4}$$

where r_d is the cost of debt, r_e is the cost of equity, D is total debt, E is total equity, and t is the corporate tax rate. The $(1 - t)$ term reflects the tax deductibility of interest payments, which makes debt financing cheaper than it appears at first glance. Equation (1) can be understood in two parts. The term in parentheses

$$\left(\frac{Adjusted\ NOPAT}{NOA} - Cost\ of\ Capital\right)$$

measures the percentage return on capital above (or below) what investors require. Multiplying this spread by the amount of capital employed (NOA) gives the absolute value created in euro terms. A positive EVA means the company is creating value; a negative EVA means it is destroying value.

However, EVA as calculated in Equation (1) has an important limitation: it is highly correlated with firm size. Larger companies, simply by virtue of employing more capital, will tend to have larger absolute EVA values even if they are not more efficient. This creates a potential bias when comparing companies of different sizes across value chain stages.

To address this size bias, Modified EVA (MEVA) is also calculated, which expresses value creation as a percentage return above the cost of capital:

$$MEVA = \left(\frac{Adjusted\ NOPAT}{NOA} - Cost\ of\ Capital\right) * 100 \qquad (5)$$

MEVA therefore allows for a meaningful comparison between firm and firm by the virtue of the fact that it shows capital efficiency and not absolute value creation and thus a firm having a MEVA of 5 per cent creates value at the rate of 5 percentage points above the cost of capital irrespective of its physical size.

In order to confirm the results and explore different aspects of value creation, two extra measures are added. The first, Creation or Destruction of EVA (CEVA), is a binary variable:

$$CEVA = \begin{cases} 1\ if\ MEVA > 0 \\ 0\ \ otherwise \end{cases} \qquad (6)$$

This measure captures whether a company creates or destroys value in a given year, regardless of the magnitude. It focuses on the consistency of value creation rather than how much value is created. This is useful because it is less sensitive to extreme values that might occur in particular years due to unusual circumstances.

Finally, Persistence of EVA (PEVA) helps to capture long-term value creation consistency:

$$PEVA = \begin{cases} 1\ if\ MEVA > 0\ at\ lease\ 5\ years \\ 0\ \ otherwise \end{cases} \qquad (7)$$

This identifies companies that create value consistently over time instead of in discrete years. A company may create a large amount of value one or two years but destroy value over all. PEVA indicates the difference in genuinely strong performers and those companies with a volatile performance.

By using these four complementary measures, the idea of value creating can be approached from different perspectives, ensuring that the conclusions regarding value creating are robust to various ways of measuring.

3.2 Variable Measurement and Definition

This research contains a panel of 28 companies over the time period of 2015-2024 providing about 280 company year observations. There are a number of reasons for the period used. 2015 is a reasonable starting point after the Ukraine revolution in 2014 and initial economic stabilization of the economy so that a useful comparison can be made with the case of European countries. The end of this time period in 2024 also gives the latest complete data available and a sufficiently long 10-year period for the evaluation of persistence of value creation. In addition, this period includes both normal economic conditions as well as the disruption of the russian full scale invasion in 2022, which is interesting in that it provides the opportunity to evaluate the various stages of the value chain when there are major shocks to the system.

The financial data comes from Tikr.com[1], a professional financial data platform. Tikr.com has been chosen as the main source of information since it is strong in all reporting of companies in the sample regardless of country of stature or listing exchange. This sample is limited to publicly listed companies, because an extended set of financial information from each company is needed for the EVA computation. This limitation also eliminates private companies, agricultural cooperatives and family-owned companies which again may be accredited in agriculture but do not give public reports of the financials needed for our purposes. Finding companies which were applicable to this study proved to be one of the most difficult tasks. The goal was to produce balanced representation across all four value chain stages, while still keeping an eye on Ukrainian and European companies. However, the size of the sample was strongly dependent on availability of data, which limited the selection in some stages.

In stage 1 (inputs and machinery) European companies offered many good possibilities. Germany is strongly represented in agricultural chemicals, seeds and

[1] Tikr.com (https://tikr.com) is a financial data and analysis platform that collects and standardizes financial statements, market information, and company fundamentals from many sources including SEC filings, company reports, and major data providers. The platform standardizes the data using various accounting standards (IFR, US GAAP, local GAAP) to allow for cross-country comparisons.

machinery, with companies like Bayer, BASF and KWS Saat. These are large and established companies with good data availability and definite classification as suppliers of inputs. Also included were Yara International from Norway (fertilizers), CNH Industrial and AGCO Corporation for agricultural machinery. These companies were included because even though AGCO is US-headquartered, it has strong European operations and services to European markets.

Stage 2 (primary production) presented the most difficulty. Most production of European belong to family farms, cooperatives or private companies, which do not trade in shares. This is a fundamental limitation of a study based on public data of agricultural value chains, as the production stage is systematically underrepresented, as most producers do not exploit public capital markets.

Better opportunities were presented by Ukrainian companies, which have several large agricultural producers that are quoted on the Warsaw Stock Exchange. Companies like KSG Agro and IMC are examples of large scale agricultural production. But several of these Ukrainian agricultural companies have been affected by war since 2022 and have suspended reporting or had severe operational disruptions. This creates both data availability problems and potential bias in results for recent years.

Given these restrictions, it became necessary to broaden the sample beyond the original Europe - Ukraine focus so that some global agricultural producers were included. Companies such as Adecoagro, Argentina; BrasilAgro, Brazil; and Select Harvests, Australia were included. Although this departs from the original geographical scope, it strengthens the research in two important ways. First, it gives adequate statistical representation of the production stage. This makes possible a valid comparison with results concerning the other stages. Second, it gives examples of a few relatively pure agricultural production companies that are not very integrated into processing. This helps to clarify the characteristics of the production stage itself.

For Stage 3 (processing and manufacturing), it was much easier finding suitable companies because there are many publicly owned food processing companies in both Ukraine and Europe. Ukrainian companies such as MHP (poultry processor), Kernel (grain and oilseed processor), Astarta (sugar processor), and Ovostar (egg processor), furnish good examples of agricultural processors in the context of a transition economy. Some of the European companies such as Nestlé, Danone, Heineken, Unilever, Südzucker, and Associated British Foods, represent large scale food and beverage processing companies. They have very good data quality and simple models of business in that they are oriented to changing agricultural inputs to consumer products.

Stage 4 (retail and distribution) provides good European representation, as the retail markets in Western Europe have been subject to more development. Sample companies such as Tesco (UK), Carrefour (France), Ahold Delhaize (Netherlands), Metro (Germany) and Jerónimo Martins (Portugal) provide good examples of large-scale food retailers that have a long history of operation and consistent financial reporting. Unfortunately, the vast majority of retailing companies operating in Ukraine are private, thus limiting public financial data available for this stage in Ukraine.

Another methodological concern is about the classification of vertically integrated enterprises, which are companies working in more than one part of the value chain. The agriculture companies, especially those in the Ukraine, are involved in both farming and processing. For instance, Kernel Holding does grain farming and processing of grain into sunflower oil. Astarta operates sugar beet farms and processing facilities. The MHP company does its own feed grain farming and poultry processing, also.

According to the logic of Cucagna and Goldsmith, such companies were classified as belonging to that stage where they made the greatest value, by virtue of revenues and capital used. This was a judgment call but was the same kind of logic. For Instance, Kernel was put in Stage 3 (Processing) because its (of the companies mentioned) oilseed crushing operations, grain elevators, and export loading terminal facilities represented their major marketing and profit-producing industries. Also here, these operations produced the major amount of their revenues and capital used, although they operate sizable areas of farmland. Also the competitive advantage and management focus of Kernel was with their processing and transportation facilities and not from farming efficiency.

Similarly, Astarta was classified as Stage 3 due to their sugar processing facilities being their core business, despite significant farming operations to supply these facilitiesThe MHP company was classified in Stage 3 also due to the nature of its competitive advantage in vertically integrated poultry and producing branded chicken products. The growing of corn or soybeans is not the competitive advantage of the MHP company. Their agricultural businesses exist mainly to provide input to their processing businesses and reduce input price variability.

This classification is controversial and leads to possible measurement error. A company classified in Stage 3 might also engage in Stage 2 activities that could lead to erroneous conclusions as to the overall performance of the company, which could bias estimates of the stage-specific effects. However, since it is impossible to classify all companies perfectly which are engaged in vertical integration, the method followed, which centers attention on the principal source of revenues and the deployment of capital, is a convenient and reasonable method which can be uniformly applied to all companies in the sample. Since vertical integration occurs much more frequently in Stages 2 and 3, this classification problem has a more serious effect on the comparison of these two stages, while the comparison of the other stages 1 and 4 is cleaner.

The final distribution of the sample is as follows: 6 companies in Stage 1 (inputs), 7 companies in Stage 2 (production), 10 companies in Stage 3 (processing), and 5 companies in Stage 4 (retail), as shown in Appendix A. The breakdown of the sample is 6 Ukrainian companies (21%), 17 European companies (61%), and 5 companies in other regions (19%). This distribution gives reasonable and sufficiently symmetrical distribution across the various stages, but it still presents a principal biasing by concentrating upon the European and Ukrainian companies.

The cost of capital in computing for this international sample was quite difficult to handle as well. Companies in all these countries differ not only as to country, which gives them a different risk profile, but also in the different segments of the agricultural value cycle in which they are engaged with different business risks, and the different capital structures which they employ. A methodology is needed that can consistently estimate the cost of capital across all these companies while accounting for their specialties. The Capital Asset Pricing Model (CAPM) was chosen in this case.

The CAPM is the generally accepted procedure in corporate financing for estimating the cost of equity, and while it has well-defined limitations, nevertheless it has the virtue of affording a consistent and reproducible framework which has been tested widely in the empirical fields.

$$Cost\ of\ Equity\ = Risk - free\ Rate + (\beta * Market\ Risk\ Premium) + Country\ Risk\ Premiums \quad (8)$$

The risk-free rate is defined as the expected rate of return available to an investor with no risk, in this case the U.S. Treasury 10-Year Constant Maturity yield, which is presented in The Federal Reserve Economic Data (FRED), is used. The U.S. Treasury yield has become the international standard for risk-free rates, as the U.S. Government bonds are deemed free of default risk and highly liquid. The 10-year rate is employed because it follows closely the long-term investment horizon associated with equity investors.

Beta (β) represents the various systematic risks associated with a particular company with respect to the entire stock market. A beta of 1.0 represents the stock moving in relation to the entire stock market, a beta greater than 1.0 signifies that the stock is more volatile than the market, while a beta lower than 1.0 implies that the stock is less volatile than the market. Company-specific betas were determined from Yahoo Finance's "Beta (5Y monthly)" series for each company ticker (Yahoo Finance, n.d). These betas represent a time series of five years of monthly returns, which provides an adequate balance of both weaknesses in the data generated with the generation of continuous stable estimates and yet be of current nature so as the reflect the existing business conditions. These betas may be subject to fluctuation depending upon the changes that they undergo in their business structure and operations, or in their capital structure, though it is the best estimate out of the data constraint problem available.

The market risk premium is the extra return investors require for holding risky stocks instead of bonds with virtually no risk. This research will use market risk premiums which are year specific as given in Damodaran's database (Damodaran, n.d) which vary from 4 percent to 6 percent over the period of the research. By using different premiums for different years this truly reflects market conditions than using one fixed number.

The country risk premium reflects the extra risks involved in investing in various countries. For example, companies operating in Ukraine, have political and overall economic risks, which companies operating in Germany do not face, and there is an extra expectation of return required, in order to compensate for the extra risks involved.

The country risk premiums given in Damodaran's database (Damodaran, A.) are used which are computed from sovereign credit default swap spreads and sovereign ratings. For Ukrainian companies, this country risk premium has been increased significantly since 2022, due to the war situation, to reflect the very real additional risks which these companies face.

The cost of debt is estimated simply as:

$$Cost\ of\ Debt = \frac{Interest\ Expense}{Total\ Liabilities} \tag{9}$$

This gives the average interest rate which the company is paying on its debt. Total liabilities are used instead of just interest bearing debt, as a detailed breakdown of interest and non-interest bearing items is not consistently available for all companies and years in the sample. This may lead to slight underestimation of the cost of debt, but the bias should be consistent across companies.

The total parameters for WACC calculations for the companies and years are given in Appendix B. It is recognized that this method involves a number of assumptions and possible sourcing errors. For example, historical betas are taken to indicate future risk, U.S. treasury rates are used for companies operating anywhere in the world except the United States, the tax rates are assumed to be constant for the countries involved during the various periods involved, all of which led to some imprecision in the estimates. However, these are the accepted methodologies for applied research in corporate finance and by using them consistently on all companies in the sample, it is ensured that any biases present are such that they will apply to all companies similarly and not favor certain stages or certain countries.

The independent variables are many, as they are required to test the hypotheses which have been developed in Chapter 2. The stage dummy variables (Stage1, Stage3, Stage4) are used to contrast these various stages with Stage 2 (production) as the what is called the reference category. These dummies take on the value of 1, if the company is in this respective stage, and 0 otherwise. The coefficient estimates on these dummy variables are therefore a direct test of the hypotheses about which of these stages creates more value.

Firm size is measured as the natural logarithm of adjusted total assets:

$$Size = ln(Total\ Assets - Goodwill - Intangible\ Assets) \tag{10}$$

Goodwill and intangible assets are subtracted from total assets, so that double counting of these items does not occur, as these are referred to separately in the innovation measures. The logarithm is utilized for two main reasons. Firstly, it deals with the extreme right skewness of the firm size distributions, in that very few firms such as Nestle are many times larger than the median firm. The logarithm compresses this distribution and makes the estimates from the regression less sensitive to extreme values than it would be in the case of employing straight-line values. Secondly, the use of logarithms leads to the coefficient being interpreted as an "elasticity" (approximately) which is much more intuitive than the effect of a one dollar increases in assets.

Innovation is included in two variables as indicated in the literature review in Chapter 2. Innovation is represented by Innovation2 which represents intangible assets and goodwill measured as:

$$Innovation2 = ln(Intangible\ Assets + Goodwill + 1) \tag{11}$$

This reflects the cumulative investments the firm has made in brand, patents, customer relationships, and other intangible assets. One is added before taking the logarithm because of some firms´ having no intangible assets and the logarithm of zero is not defined. This is a customary way in which to handle logarithms with data allowing zeros. Innovation is also represented by Innovation3, which measures research and development expenditures.

Innovation3 captures research and development expenditure:

$$Innovation3 = ln(R\&D\ Expenditure + 1) \tag{12}$$

This measures the company's current investment in developing new products, processes, or technologies. One is again added to handle companies with zero R&D spending, which is common in Stage 2 (production) and Stage 4 (retail).

Product differentiation is measured by the cost of goods sold (COGS) as a percentage of sales:

$$COGS\_ratio = \frac{Sales}{Cost\ of\ Goods\ Sold} \times 100 \tag{13}$$

The rationale for using COGS as a measure of product differentiation is seen from the design of the value chain. If the company purchases inputs which cost €80 and sells the product for €100, the COGS are 80%. This indicates relatively less extra value has been added by way of processing, branding, or service; effectively, the firm is effectively handing on the input purchase, making a mark up to be sure, but the actual added value is not great. On the other hand, if the firm purchases inputs costing €30 and sells at €100, then COGS is 30%, indicating that the actual value added to the product is relatively great. Ratios of cost of goods sold are less, thus there are high gross margins and by implication product differentiation. Firms with less COGS ratios are expected to yield greater added value.

3.3 Econometric Specification

The analysis employs ordinary least squares (OLS) regression models with country and year fixed effects to test the hypotheses. Following Cucagna and Goldsmith (2018), the main specification takes the form:

$$ValueCreationMeasure\_it = \alpha + \beta_1 Stage1\_i + \beta_2 Stage3\_i + \beta_3 Stage4\_i + \gamma_1 ln(Size)\_it + \gamma_2 ln(Innovation2 + 1)\_it + \gamma_3 ln(Innovation3 + 1)\_it + \gamma_4 COGS\_ratio\_it + \gamma_5 Leverage\_it + \delta\_c + \theta\_t + u\_it \quad (14)$$

where:

- i indexes firms and t indexes years (2015-2024)
- $ValueCreationMeasure$ represents EVA, MEVA, CEVA, or PEVA
- $Stage1$, $Stage3$, $Stage4$ are dummy variables for value chain stages (Stage 2 is the reference category)
- δ_c epresents country fixed effects
- θ_t represents year fixed effects
- u_it is the error term

The role of the fixed effects is crucial for the validity of the estimates. Country fixed effects (δ_c) control for time-invariant differences across countries. These differences may be due to institutional quality, legal systems, physical infrastructure, government quality variables, or cultural variables which affect the performance of businesses. For example, firms in Germany may have systematic differences from firms in Ukraine due to a better system of law, a more mature capital market, or other areas of physical infrastructure. Because these fixed effects are introduced there is a comparison of firms simply on the basis of the nature of the country they are in and there is not a comparison made on the basis of differences which are confounding.

Year fixed effects θ_t account for common shocks affecting all companies in a given year. These might include global commodity price changes, macroeconomic conditions, changes in global interest rates, or major events like the COVID-19 pandemic or the start of the war in Ukraine in 2022. For example, 2022 was a very difficult year for all agricultural companies due to supply chain disruptions and price volatility from the war. Year fixed effects absorb these common shocks, so companies are compared based on how they performed in 2022 relative to the average for that year, rather than to the average across all years.

The combination of country and year fixed effects addresses many potential confounding factors and increases confidence that the estimates of the stage effects (the β coefficients) reflect true differences in value creation across stages rather than differences in the environments in which companies operate.

Equation (14) is estimated separately for each of the four value creation measures: EVA, MEVA, CEVA, and PEVA. For EVA and MEVA, which are continuous variables, standard OLS regression is used. For CEVA and PEVA, which are binary variables (0 or 1), the appropriate econometric model would technically be a probit or logit model.

3.4 Limitations

There are several limitations to this methodology that must be acknowledged. First, the EVA methodology relies on accounting information, which may not necessarily capture economic reality. Different accounting principles may introduce errors when comparing countries, despite relying on an overall consistent data source that standardizes financial statements. The companies also have discretion in interpreting certain items and applying aggressive accounting concepts may distort the apparent economic value generated, but all companies are subject to uniform governing accounting principles for their particular jurisdiction and, as fixed effects for countries are included, any distortion here will be significant only if different stages systematically apply different accounting principles, which is probably not the case.

Second, the necessity of sample selection involves compromises. By including companies not European in stage 2, as it was necessary to obtain sufficient statistical balance, there might be some distortion for European-Ukraine comparisons. In addition, classifying vertically integrated companies involved some subjective judgment about where each company primarily creates value. Different analysts might classify certain companies differently. However, the same consistent method to all companies was applied, basing classifications on measurable factors like revenue composition and capital allocation rather than arbitrary choices.

Third, the cost of capital calculations has assumptions such as risk premiums, and beta estimates, which may not represent risk characteristics perfectly of companies in their markets. As well, the betas established statistically through historical stock return information may not be accurate predictors for the future, especially of companies that are undergoing change or are in rapidly developing industries. The use of risk premiums of country services based on sovereign credit ratings may not reflect certain firm specific risks as well. However, again, these are the standard limitations of the CAPM approach and the use of a consistent methodology for all companies ensures that any measurement discrepancies should equalize all companies rather than systematically bias specific stages.

Fourth, the emphasis on publicly held companies should bias the sample necessarily to the larger, more successful companies. Many agricultural concerns, especially in Europe, remain private or cooperative and this may and probably does limit the generality of the results. This is particularly true with respect to stage 2 which is underreported by most producers being private, so this stage 2 sample may be a grouping of unusually large producers which may not be representative of the typical farm. This is a limitation on the validity of the study since publicly accessible financial data is utilized, but means that the results will apply significantly to larger commercial transition stages rather than to agriculture in general.

Fifth, the sample period (2015-2024) includes the extraordinary disruption of russia's full-scale invasion of Ukraine in 2022. This creates both opportunities and challenges. It allows observation of how different value chain stages respond to major shocks, which is scientifically interesting. However, it also means that results for recent years may reflect crisis conditions rather than normal operations, particularly for Ukrainian companies. The year fixed effects help control for this, but the severe impact on Ukrainian agricultural companies in 2022-2024 may affect estimates of stage effects if these companies are concentrated in particular stages (which they are—most Ukrainian companies in the sample are in Stages 2 and 3).

CHAPTER 4. DATA

This chapter provides an overview of the characteristics and patterns that emerge from the assembled dataset using the methodological framework. It presents several interesting insights that do not support some commonly held views regarding where and how agricultural firms create economic value.

The first element presented, in panel A of Table 1, is a summary of statistics according to the various stages of value chain. It indicates that there is considerable heterogeneity of firm characteristics and performance measures across the various stages. This composition of sample members should be kept in mind when evaluating the results. The results are out of larger publicly traded firms rather than all types of agricultural firms as samples.

Table 1: Descriptive statistics, panel A[2]

Stage	Firms	Observations	NOA (mean)	NOA (sd)	AdjNOPAT (mean)	EVA (mean)	EVA (sd)	Size (mean)
1	6	60	20,050.5	23,678.8	2,025.1	1,071.3	1,296.6	33,524.0
2	7	70	292.1	403.7	20.6	(8.0)	31.6	487.1
3	10	99	16,332.8	17,431.8	2,755.6	1,920.5	3,427.2	21,222.1
4	5	48	8,671.4	7,253.6	1,395.5	1,077.4	823.7	29,802.7

The operators in Stages 1 and 3 are working with capital bases of significantly larger amounts than in the other stages. This distribution of size seems to be a reasonable one. Input suppliers and processors of agricultural products must have large amounts of fixed capital in such things as manufacturing plants, distribution facilities and inventory control. But producers of the agricultural product, especially in Europe, tend to be a small type of

[2] Notes: NOA = Net Operating Assets; NOPAT = Net Operating Profit After Tax; EVA = Economic Value Added; MEVA = Market Value Added. CEVA and PEVA indicate the share of firms with positive and persistent EVA, respectively. All figures are averaged by stage; standard deviations (sd) are reported where applicable.

operation where much of the value of land does not show up in our NOA computations. Also, many farms in Europe are privately held and consequently do not show up in the financial data available to the public.

The coefficient of variation gives us some idea of the amount of within stage heterogeneity as manifested by a comparison of the standard deviation of size. It is seen that Stage 1 manifests a fairly homogeneous size distribution which would appear to indicate more standard capital requirements for the manufacture of inputs on a larger scale (no size variation). Stage 2 shows significantly more variation in size, which might reflect variations in production types from specialized niche operations to large-scale commodity producers.

Looking at adjusted Net Operating Profits After Tax, Stages 1 and 3 show much higher absolute earnings than Stages 2 and 4. However, this observation should be interpreted cautiously, as absolute profit levels naturally correlate with firm size. More interesting is the comparison between Stages 2 and 4 which show about the same profitability despite their widely different positions in the value chain.

Traditional profit measures make companies look similar, but value creation measures tell a different story. This reveals that earnings alone don't accurately show how much economic value a company creates. Two companies with identical earnings can create vastly different amounts of value, depending on how much capital they use and what that capital costs.

The EVA measures show a pattern which is more complex than that indicated by looking at basic profitability measures. In absolute terms Stages 1 and 3 are the greatest gainers in terms of economic value, while Stage 2 is the least valuable. However, as indicated in Chapter 3, absolute EVA is necessarily and inherently related directly with the size of the firm. The larger firm utilizing more capital will necessarily be able to make larger absolute increments of value creation, though its capital efficiency may be fairly low.

The MEVA measure directs attention toward this size anomaly in that it measures capital creation in terms of the percentage returns over cost of capital on the investment made. Results here arise widely and materially from the absolute EVA about the extent to which size relates to these measures of value creation. As discussed previously, the capital efficiency with which the various stages of the agricultural chains create value is shown in Table 1, Panel B.

In Stage 1, there is a recognized ability to create returns that far exceed the cost of capital. In Stages 2 and 3 there is positive MEVA which shows that there is also economic value creation but at a lower level of efficiency. Stage 4 has negative MEVA which is interpreted to mean that returns are less than the cost of capital, even though in an accounting sense there are profits.

Table 1: Descriptive statistics, panel B

Stage	MEVA (mean)	CEVA (mean)	PEVA (mean)	WACC (mean)	COGS (mean)	Innovation1 (mean)	Leverage (mean)
1	19.1	90.0%	100.0%	0.1	61.4	14,896.5	2.3
2	4.1	48.6%	57.1%	0.1	73.4	21.6	1.2
3	3.0	76.8%	89.9%	0.1	65.9	13,244.1	1.3
4	(3.9)	93.8%	100.0%	0.04	81.4	5,878.2	3.4

The finding suggest that creating value and using capital efficiently are two different things. Companies can create large amounts of value while using their capital inefficiently. Conversely, companies can be very efficient with their capital but still create little total value simply because they're too small.

The finding that Stage 1 achieves the highest capital efficiency is noteworthy, as it challenges the widespread belief that downstream companies (Stages 3, 4) earn excessive profits compared to farmers and producers at the beginning of the supply chain. Similarly, the finding that Stage 4 has negative MEVA means that the retailing operations relatively speaking do not obtain returns sufficient to repay investors for the capital which they use, which shows the distinction between accounting profits and economic value creation.

Table 1, Panel B indicates gross differences in investment in innovation among the various stages when expressed in terms of the total sum of intangible assets, goodwill and R&D expenditures. Stages 1 and 3 have substantially higher absolute values of innovation assets than has Stage 4, while Stage 2 has very little investment in innovation assets. These forms of investment appear to be consistent with the operational characteristics of the various stages. Supply of inputs and processors develop various types of proprietary goods and services and proprietary ideas, brands and processes. For these there is very large investment in research, development and organization of the ideas as intellectual property. Agricultural producers buy inputs having little or no proprietary characteristics and sell the legal parts as commodities with few opportunities for proprietary innovation or development. Retailers invest moderately, likely in logistics systems, supply chain management, and customer relationship technologies rather than product R&D.

The formal tests in Chapter 5 will more rigorously examine how innovation contributes to value creation, while controlling other factors that might distort the simple relationships seen in the descriptive statistics.

The COGS ratios in Table 1, Panel B show the differences in cost structures. The COGS ratio is highest at Stage 4, which indicates that purchased goods are the largest part in the value of sales. Also COGS is high at Stage 2. However at Stage 3 the COGS ratio is lowest. In a similar way Stage 1 maintains a relatively low COGS.

These results align with expected business model differences. The COGS at retail are high since the major portion of revenues of the retailer comes from the resale of the goods it purchases with a limited value created. The high COGS in agriculture indicates that they have great reliance upon their purchased inputs with limited power of price.

In a contrast, processing secures the lowest COGS indicating that in this industry there is developed a great amount of product individuality by transformation, branding and marketing. The suppliers of inputs mantain a comparatively low COGS probably due to the proprietary products they produce in the form of seeds, chemicals or equipment.

However, cost structure alone does not fully explain value creation. Stage 3 combines strong margins with only moderate capital efficiency, while Stage 1 pairs good margins with high efficiency. This shows that improving gross margins does not automatically create value, the capital required to achieve those margins also matters.

Competitive dynamics vary widely across stages of industry. Production (stage 2) is largely characterized by competitive or fragmented industries, where producers operate largely as price takers. Input supply and retailing are more concentrated industries characterized by fewer producers of larger capital size, allowing some degree of market price influence. Processing occupies an intermediate position with differentiation opportunities through brands but competitive pressures from both suppliers and buyers. These structural differences in competition affect directly the return possibilities in excess of capital cost.

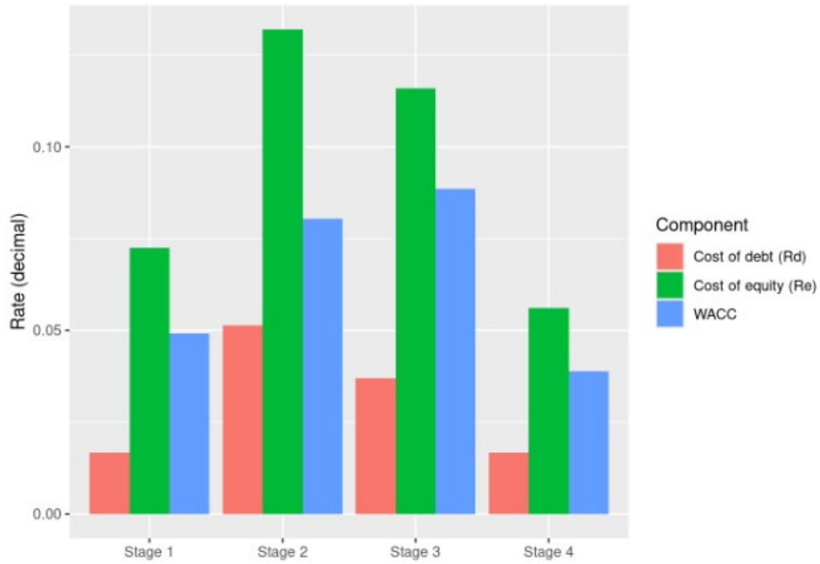
In addition, customer relationships differ fundamentally across stages as well. Stage 1 sells primarily to Stage 2, Stage 2 to Stage 3, Stage 3 to Stage 4, and Stage 4 to consumers. Being nearest the final product consumers appears to also affect the ability to add value. Retailing is thus in a position to respond to consumer wants of end consumers and thus capture consumer surplus via convenience and service. Producers are isolated from end consumers and thus kept from the final determination of value.

Cost of capital also vary widely in the various stages of operations as shown in Table 1, Panel B. Cost of capital of Stage 4 is much less than for the other three stages and other three stages are very similar in capital costs.

Such differences represent the perception of risk on the part of investors respecting the various locations in the agricultural value chain process. Cost of capital of Stage 4 is in line with the discussions about consistency earlier, and which be discussed deeper in Chapter 5. Retailing operations can afford to provide modest but predictable earnings which are viewed by investors as low risk investments. The lower cost of capital therefore means relatively low return needed to add economic value.

Stages 1, 2, and 3 have similar and high costs of capital. This means they must generate larger earnings just to break even economically and meet investors' required returns. The similar cost of capital suggests investors see these stages as equally risky. Despite their different operations, input supply, production, and processing all face substantial risks from market fluctuations, operational uncertainties, and commodity price swings.

Figure 1: Average Re, Rd and WACC by stage



As shown in Figure 1, the cost of equity is far higher than the cost of debt at all stages. This gap implies that while lenders view agricultural enterprises as acceptable credit risks (perhaps because of tangible collateral), equity investors view them as having high operating risks and therefore requiring a higher return. The difference between equity and debt appears to be especially severe at some stages, implying that equity investors consider certain parts of the agricultural value chain to be riskier compared to others.

Leverage varies by stage. Stage 4 utilizes the highest leverage and Stage 2 the least. This pattern is consistent with differences in business models. Retail operations with stable cash flow and low perceived risk can support higher levels of leverage. Producers on the agricultural side of the business facing large weather and price risk maintain lower leverage, which may reflect either the unwillingness of lenders to extend debt to risky operations or the preference of producers for operational flexibility.

CHAPTER 5. RESULTS

Before presenting the main results, it is appropriate to note some limitations. The dataset is subject to several limitations: first, the rather small sample size; second, the inclusion of companies from different regions to achieve adequate stage representation, and, third, the difficulty that arises from classifying the vertically integrated businesses.

Given these limitations, the interpretation will focus primarily on the directional patterns and the economic logic behind the relationships rather than treating specific numerical coefficients as precise measurements. The analysis aims to understand whether innovation matters for value creation, or whether production is more or less efficient than processing, rather than claiming to measure these relationships with perfect precision. This approach seems appropriate given the exploratory nature of this research and the inherent complexities of agricultural systems.

To begin with, it is crucial to explain the process used to select the appropriate econometric specification. The first step in the analysis was to consider the question of fixed or random effects for company level variation in the panel regression. The result of the Hausman test gave a p-value of 0.35, and hence there was no statistical ground for rejecting the null hypothesis. This implies that the random effects model is consistent, and that fixed effects for individual companies are not necessary. Also, it shows that the observable characteristics included in the model, such as stage membership, size of company, innovative investments, and cost structure adequately accounted for the significant differences which existed between the companies. Fixed effects for individual companies would not materially improve the power of the model to explain the value creation pattern.

In order to ascertain whether the findings were robust, four different specifications of the model were tested for MEVA outcome. MEVA was chosen for this comparison because it represents the scale-neutral form of EVA, allowing clearer assessment of capital efficiency across firms of different sizes.

Table 2: MEVA Model Comparison

Variable	Pooled OLS (no FE)	OLS: FE (country, year)	Mixed: firm RE + FE (country, year)	RE: two-ways (firm + time)
Stage 1	-3.2 (9.2)	-11.0 (14.0)	-11.0 (23.7)	-2.6 (8.9)
Stage 3	-16.0 (8.8)	-30.4 (21.6)	-30.4 (24.1)	-15.4 (8.5)
Stage 4	-38.7 (19.7)	-33.6 (23.9)	-33.6 (27.9)	-37.6 (19.4)
LN(Size)	3.6 (2.0)	4.0 (2.4)	4.0 (4.3)	3.5 (1.9)
Leverage	7.7* (3.1)	5.3 (3.1)	5.3 (3.0)	7.5* (3.1)
Innovation 2	0.0 (0.0)	-0.0 (0.0)	-0.0 (0.0)	0.0 (0.0)
Innovation 3	-0.0** (0.0)	-0.0 (0.0)	-0.0 (0.0)	-0.0** (0.0)
COGS	-0.3 (0.3)	-0.2 (0.3)	-0.2 (0.3)	-0.3 (0.3)
R-squared	0.1	0.2	—	NA
Observations	270	270	270	270

Coefficient significance is denoted by * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$; standard errors are in parentheses

Four specifications were tested:

1. **Pooled OLS (no effects)** - The base case, modelling all observations as independent
2. **OLS with fixed effects for country and year** - Following Cucagna and Goldsmith (2018) this specification controls for macro-economic differences between countries, and temporal factors such as economic cycles or crises

3. **Mixed model (firm random effects + country + year fixed effects)** - Random effects at firm level are allowed for, whilst country and year are controlled for as fixed factors
4. **Two-way random effects (firm + time)** - Random differences in firms and over years are accommodated both

The comparison demonstrated that across all models, the sign of the coefficients bore no sign of change, indicating that the fundamental relationships are robust to different modelling approaches. This stability indicates that there is good reason to regard the results as reflecting economic facts rather than the conclusion of a particular statistical specification.

The mixed model (specification 3) with random effects, and fixed (country/year) effects produced results very similar to the simpler OLS with fixed country/year effects (specification 2). In addition, the summary statistics for the mixed model demonstrated that the random effects for companies were relatively zero, with standard deviation of 0.000. This indicates that there are no substantial differences between firms which require them to be modelled separately, beyond those already modelled through the inclusion of other variables in the model.

This finding was in line with the results of the Hausman test, and with the procedure followed in the original study by Cucagna and Goldsmith. Therefore, following their methodology and based on these diagnostic tests, the final specification uses OLS regression with fixed effects for country and year. Country fixed effects accommodate for time invariant differences cross-nationally. Year fixed effects allow for common shocks which effect all firms in a given year.

Table 3: Regression results

Variable	EVA (1)	MEVA (2)	CEVA (3)	PEVA (4)
Stage 1	132.8	-11.0	2.0	6.2****
	(587.3)	(14.0)	(1.6)	(1.4)
Stage 3	-42.9	-30.4	0.7	-2.2
	(622.0)	(21.6)	(1.2)	(2.0)
Stage 4	-3.5	-33.6	6.5***	-1.6

Variable	EVA (1)	MEVA (2)	CEVA (3)	PEVA (4)
	(708.4)	(23.9)	(1.0)	(1.9)
LN(Size)	-9.7	4.0	-0.1	-0.7*
	(132.2)	(2.4)	(0.2)	(0.3)
Leverage	65.2	5.3	0.1	-0.6***
	(99.7)	(3.1)	(0.2)	(0.2)
Innovation 2	0.1	-0.0	-0.0	0.0***
	(0.1)	(0.0)	(0.0)	(0.0)
Innovation 3	-0.3	-0.0	0.0	-0.0***
	(0.3)	(0.0)	(0.0)	(0.0)
COGS	1.2	-0.2	-0.1**	0.1***
	(6.8)	(0.3)	(0.0)	(0.0)
Country fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
P-value Stage 1 = Stage 3	0.6	0.3	0.2	0.0
P-value Stage 1 = Stage 4	0.7	0.3	1.0	0.0
P-value Stage 3 = Stage 4	0.9	0.8	1.0	0.5
R-squared	0.8	0.2	0.6	0.8
Observations	270	270	270	270

Coefficient significance is denoted by * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$; standard errors are in parentheses

The regression analysis provides evidence, which help to test the three primary hypotheses developed in Chapter 1. The hypotheses involved whether value added levels were different between stages, whether stages lower in the value chain added more value than stages higher in the chain, and whether innovation and differentiation produced value added levels in relationship to the various stages.

The results confirm the first of the hypotheses: the levels of value added differ significantly between the four stages of the agricultural value chain. Each of the stages adds value in a different manner with systematic differences existing in relationship both to the amount of value generated and to the relative constancy of the value generation process.

When control for size of firm, cost structure, outlay on innovations and leverage are included, Stage 2 (production) appears to be the most capital efficent stage of the value chain. When one considers the MEVA, which measures returns on capital above the cost of capital, the Stage 2 section appears to be positive in its capital efficiency. The base category, (Stage 2) indicates that producers are capable of producing returns in excess of their cost of capital even in exceedingly competitive commodity markets. This is contrary to the generally held assumption that all agriculture producers destroy value uniformly, due to commodity conditions.

This efficiency, however, does not translate into consistent value creation. The CEVA (Creation or Destruction of Economic Value Added) indicates that the creation of positive values exists only in 48.6% of the observations of Stage 2 in any given year. Among the four stages, the consistency is at the lowest level in this stage. In addition, PEVA results show that among the firms in Stage 2, only 57.1% can create value on a five-year basis persistently, which, again, is the lowest percentage of all stages along the chain. This pattern illustrates an important truth in agricultural production: there is a very high capital efficiency together with a very high volatility. Producers can achieve very high returns on capital, if weather conditions or biological factors, or fluctuations in prices of commodities are favorable. However, they are very vulnerable to the unfavorable changes in those same features, which will very shortly change their positive returns to losses. Because of this, the production stage shows up the pattern of "feast or famine."

The contrast with Stage 4 (retail and distribution) sheds a further light to the situation. The negative coefficient in the dummy variable indicating the Stage 4 firms in the MEVA definition gives us the fact that retailers themselves show lower capital efficiency as measured by rate of return on capital than producers, controlling for other factors. Nevertheless, CEVA results show that retail operations achieve positive value creation in the vast majority of observations, representing the highest consistency rate across all stages. Similarly, the PEVA results indicate that all retail firms in the sample demonstrate persistent value creation over five-year periods.

This apparent paradox, lower average efficiency and higher consistency: gives us a valuable viewpoint of the contrasts in the various patterns of value creations in the agricultural chains. Retail operations earn modest returns above their cost of capital in most periods, but the consistency of these returns provides a risk-return profile different from agricultural production. Retailers may not achieve the capital efficiency maxes of successful producers in good years, but they don’t have disastrous value loss that producers face in lean years. This stability likely explains why retail operations can attract capital despite generating lower average returns, as investors value predictability alongside magnitude.

Stage 3 (processing and manufacturing) is placed in an intermediate position. The negative coefficient obtained relative to Stage 2 suggests less capital efficiency than agricultural production, but the magnitude suggests that processing is better than retail in this respect. Again, examining consistency measures, it is seen that, in general, processing has a greater frequency of positive value creation than production and less than in the case of retail. This intermediate appearance is probably due to processors having some of the commodity price volatility of production (affecting their input costs) but being able to offset this to some degree by product differentiation, brand development, and customer relationships giving them some measure of price-making ability.

Stage 1 (inputs and equipment) appears to show capital efficiency comparable to agricultural production. However, the PEVA results suggest that input suppliers may demonstrate more persistent value creation, with the highest statistical significance observed. The finding that all Stage 1 firms in the sample show long-term value creation suggests that input suppliers might operate relatively robust business models.

These findings raise questions as to the truth of the second hypothesis and policy assumption underlying Ukraine's reconstruction priorities. The MEVA findings show that production has, controlling for firm characteristics, higher capital efficiency than either processing or retailing. The notion that "moving up the scale in value" automatically will produce more desirable returns contradicts the finding. Processing, of course, adds to the value product of gross output, transforming wheat into flour, thus raising the monetary value of the product. This addition of value may not be productive of proportionately greater economic value, however, when the capital requirements are correctly accounted for.

The third hypothesis tested whether the investments of firms into innovations (R&D) and how different their products are (differentiation) will produce firm level value creation across stages. The regression results provided supportive but not totally direct evidence of the hypotheses. It also showed complexity in its predictions relative to simple theoretical constructs.

The innovation variable produced some interesting trends. Innovation2 (Accumulated intangible assets and goodwill) has a positive relationship with long term value creation (PEVA) that is statistically significant. Therefore, it appears that firms investing large amounts of money into brand names, patents, and customer relations, can create consistent value over time. As well, investing in such ways creates sustainable competitive advantages and generates income over the long term.

However, there were more complexities in the relationship between innovation and short-term value creation (CEVA). In several specifications, especially those related to year-over-year value creation (CEVA), the innovation measures had negative coefficients. This does not contradict prior research. Instead, it identifies another important characteristic of R&D investments. These investments typically decrease profitability in the near term, and ultimately create assets that have value to a company over extended periods.

As previously mentioned, the COGS ratio measures the degree to which a firm uses cost to differentiate itself from others. The COGS ratio did measure the role of differentiation in producing value. Firms with lower COGS ratios have a significantly greater chance of creating value in the CEVA model. However, the PEVA model shows a positive coefficient on COGS, which seems counterintuitive at first glance. This may be indicative that companies with very low COGS ratios (highly differentiated) may find it difficult to maintain that differentiation over the long run because competitors begin to mimic the successful strategies.

CHAPTER 6. CONCLUSIONS AND RECOMMENDATIONS

6.1 Implications for Business Strategy

The results imply a number of considerations for agricultural businesses, although these should be interpreted with caution in light of the limitations of the study. For producers, their high capital efficiency in Stage 2 indicates a possibility for strong returns but the volatility suggests looking at risk management strategies in place, including diversifying crops and markets, using derivatives for hedging or arrangements with other participants in the value chain for stability while still operating independently.

The fact that Stage 2 companies invest very few resources in innovation assets may be taken as both a limitation and an opportunity. While the producers may not possess the resources required to engage in substantial R&D, the analysis suggests that they are benefitting from innovation occurring outside the scope of their activities by other chain participants. This also highlights the idea of collaborative innovation networks as potentially valuable, offering producers the opportunity to access upstream and downstream research activities without incurring significant investment.

For processing companies, the mixed performance in Stage 3 indicates that the act of transforming inputs may not be sufficient to create value. The COGS as a proportion of sales (65.89%) exposes the processing sector to considerable raw material cost. Success in this case is probably ensured by developing strong brands or customer relations which allow for premium pricing or possessing operational efficiencies which allow for profitable operation despite the volatilities of commodity prices.

For retail operations, the trade-off between capital efficiency and consistency suggests their business model succeeds through reliability rather than exceptional returns. However, the negative MEVA suggests that there are opportunities to improve the way in which capital investment is deployed, particularly through technological advancements, improved inventory management and through partnerships which offer opportunities for development without ownership of assets and without making capital intensive investments.

For input suppliers, the strong performance in the sample suggests that proprietary products, technical expertise, and customer service create sustainable competitive advantages. However, the small sample size limits confidence in these conclusions.

6.2 Recommendations for Ukrainian Agricultural Reconstruction

The findings may help to shape several policy priorities:

1. Focus on the entire value chain system rather than favoring specific stages.

The fact that agricultural production shows high capital efficiency when properly managed suggests that reconstruction should be directed towards improvement of all stages in the value chain. Reconstruction policies should strengthen all stages rather than assume that downstream activity automatically produces more value. Also, reconstruction policies which target increased volume of processing or refinement may not have the benefits desired. If the processors cannot earn a sufficient return on their capital to cover their cost of capital, then policies to direct more volume towards processing may not produce more value. However, if reconstruction funds were used to enhance the competitive market position of the different stages, including farm efficiency, innovation, retailing infrastructure, etc. it might be possible to construct an environment where more value could be produced. This means that value creation depends more on the ability of the firms to operate within their stage than on which stage they occupied.

2. Prioritize risk management and stability mechanisms.

The findings suggest that agricultural production shows high efficiencies but extreme volatility. This may suggest that if producers could meet their risks, their abilities to create value consistently could be enhanced. Reconstruction policies may be directed to follow this approach by developing crop insurance markets, futures trading structures, and contract farming methods which might allow risk sharing between producers and processors. This might serve the dual purpose of allowing efficiency in production and minimizing volatility, which destroys value.

3. Support innovation networks rather than expecting every firm to innovate independently.

The analysis indicates that the amount of investment in innovation is vastly different among the segments of the industry, with the producers indicating minimal fixed investment while the input suppliers and processors indicating that expenses are incurred in research and development. Rather than requiring that each farmer show his innovation capability, policies might be to facilitate innovation transfer by means of extension services, research in cooperative programs, etc. which will allow the producers to take advantage of upstream and downstream innovation.

4. Develop institutional infrastructure that enables value creation.

The findings suggest that even without direct support of any particular segment, value creation depends on the general atmosphere of business in the economic sphere. Reconstruction policies should ensure businesses can access capital markets and borrow money at reasonable interest rates. Governments and regulators should protect investments, enforce contracts, and build essential infrastructure (transportation, storage, energy systems). This reduces operating costs and risks, allowing companies at all stages to compete effectively.

5. Recognize that market forces may allocate resources more efficiently than directed interventions.

The history of Ukraine sunflower seed export tariffs is an example of an effective compulsory domestic processing step. This brings the question of whether compulsory intervention will be a more effective method of producing results. While the original objective was accomplished in that processing capacity increased, it is uncertain if this increased capacity was of net economic value when cost of processing are taken into account. The current analysis suggests that forcing development of particular stages may not generate expected returns. Reconstruction policies might focus more on removing obstacles and creating enabling conditions rather than directing resources toward predetermined outcomes.

6.3 Suggestions for Future Research

This study opens several avenues for future investigation that could address its limitations and extend understanding of agricultural value creation.

Future research could benefit from larger, more representative samples that include private companies and cooperatives. While data availability presents challenges, surveys or case study approaches might capture value creation patterns in smaller, non-public agricultural enterprises. The impact of vertical integration on value creation deserves dedicated study. As many agricultural companies operate across multiple stages, understanding how integration affects value creation compared to specialized operations could inform both business strategy and policy.

Another key direction for future research is the impact of technology change and digitalization on value creation patterns. As digital platforms, precision agriculture products, and supply chain transparency are all potential avenues through which value is created in the agri-food system.

Finally, testing this approach across different countries and agricultural systems would enable assessment of the generalizability of these results and the impact of institutional, cultural, and policy differences on value creation patterns in agricultural value chains.

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APPENDIX A

Table 4: List of Companies in the Sample

Stage	Company Name	Business Description	Country	Stock Exchange	Ticker
Stage 1	Bayer AG	Crop protection chemicals, seeds, digital farming	Germany	XETRA	BAYN
Stage 1	BASF SE	Agricultural chemicals, seeds, crop protection	Germany	XETRA	BAS
Stage 1	KWS Saat SE & Co. KGaA	Seeds, plant breeding, biotechnology	Germany	XETRA	KWS
Stage 1	Yara International ASA	Fertilizers, crop nutrition solutions	Norway	OSE	YAR
Stage 1	CNH Industrial N.V.	Agricultural machinery (Case IH, New Holland)	Italy/Netherlands	NYSE/BIT	CNHI
Stage 1	AGCO Corporation	Agricultural equipment (Fendt, Massey Ferguson)	USA (EU operations)	NYSE	AGCO
Stage 2	KSG Agro S.A.	Diversified agricultural production	Ukraine	WSE	KSG
Stage 2	IMC S.A.	Dairy farming and milk production	Ukraine	WSE	IMC
Stage 2	Adecoagro S.A.	Agricultural production and land development	Argentina	NYSE	AGRO
Stage 2	BrasilAgro	Agricultural land development and farming	Brazil	NYSE	LND
Stage 2	Select Harvests Limited	Almond production and farming	Australia	ASX	SHV
Stage 2	S&W Seed Company	Seed production and crop farming	USA	NASDAQ	SANW
Stage 2	Calavo Growers Inc.	Avocado and citrus production	USA	NASDAQ	CVGW
Stage 3	Kernel Holding S.A.	Oilseed processing and grain trading	Ukraine	WSE	KER
Stage 3	Astarta Holding N.V.	Sugar processing and farming	Ukraine	WSE	AST
Stage 3	Ovostar Union N.V.	Egg processing and production	Ukraine	WSE	OVO
Stage 3	MHP SE	Poultry processing and meat products	Ukraine	LSE	MHPC
Stage 3	Heineken N.V.	Beer and beverage processing	Netherlands	Euronext	HEIA

Stage 3	Nestlé S.A.	Food and beverage processing	Switzerland	SIX	NESN
Stage 3	Danone S.A.	Dairy products and nutrition	France	Euronext	BN
Stage 3	Unilever PLC	Food processing and consumer goods	UK/Netherlands	LSE	ULVR
Stage 3	Südzucker AG	Sugar processing and bioethanol	Germany	XETRA	SZU
Stage 3	Associated British Foods plc	Food processing and ingredients	United Kingdom	LSE	ABF
Stage 4	Tesco PLC	Grocery retail and distribution	United Kingdom	LSE	TSCO
Stage 4	Carrefour S.A.	Hypermarkets and retail	France	Euronext	CA
Stage 4	Ahold Delhaize N.V.	Retail and food distribution	Netherlands	Euronext	AD
Stage 4	Metro AG	Wholesale and retail food distribution	Germany	XETRA	B4B
Stage 4	Jerónimo Martins SGPS S.A.	Food retail and distribution	Portugal	Euronext Lisbon	JMT

APPENDIX B

Table 5: List of Parameters for WACC Calculations

Year	Country	Risk-free	Equity Risk Premium	Country Risk Premium	Corporate Income Tax Rate
2015	Germany	2.1358	5.16	0	29.9
2015	Netherlands	2.1358	5.16	0	25
2015	United Kingdom	2.1358	5.16	0.8	20
2015	France	2.1358	5.16	0.8	33.33
2015	Switzerland	2.1358	5.16	0	21.1
2015	Ukraine	2.1358	5.16	16.02	18
2015	Norway	2.1358	5.16	0	27
2015	Australia	2.1358	5.16	0	30
2015	Portugal	2.1358	5.16	1.6	31.5
2015	United States	2.1358	5.16	0	38.9
2015	Argentina	2.1358	5.16	16.02	35
2015	Brazil	2.1358	5.16	3.34	34
2016	Germany	1.8417	4.5	0	29.9
2016	Netherlands	1.8417	4.5	0	25
2016	United Kingdom	1.8417	4.5	0.8	20
2016	France	1.8417	4.5	0.8	33.3
2016	Switzerland	1.8417	4.5	0	21.1
2016	Ukraine	1.8417	4.5	16.02	18
2016	Norway	1.8417	4.5	0	25
2016	Australia	1.8417	4.5	0	30
2016	Portugal	1.8417	4.5	1.6	31.5
2016	United States	1.8417	4.5	0	38.9
2016	Argentina	1.8417	4.5	16.02	35
2016	Brazil	1.8417	4.5	3.34	34
2017	Germany	2.33	4.75	0	29.9
2017	Netherlands	2.33	4.75	0	25
2017	United Kingdom	2.33	4.75	0.8	19
2017	France	2.33	4.75	0.8	33.33
2017	Switzerland	2.33	4.75	0	21.1
2017	Ukraine	2.33	4.75	16.02	18

2017	Norway	2.33	4.75	0	24
2017	Australia	2.33	4.75	0	30
2017	Portugal	2.33	4.75	1.6	31.5
2017	United States	2.33	4.75	0	38.9
2017	Argentina	2.33	4.75	16.02	35
2017	Brazil	2.33	4.75	3.34	34
2018	Germany	2.91	5.55	0	29.9
2018	Netherlands	2.91	5.55	0	25
2018	United Kingdom	2.91	5.55	0.8	19
2018	France	2.91	5.55	0.8	33
2018	Switzerland	2.91	5.55	0	21.1
2018	Ukraine	2.91	5.55	16.02	18
2018	Norway	2.91	5.55	0	23
2018	Australia	2.91	5.55	0	30
2018	Portugal	2.91	5.55	1.6	31.5
2018	United States	2.91	5.55	0	25.8
2018	Argentina	2.91	5.55	16.02	30
2018	Brazil	2.91	5.55	3.34	34
2019	Germany	2.1442	5.06	0	29.9
2019	Netherlands	2.1442	5.06	0	25
2019	United Kingdom	2.1442	5.06	0.8	19
2019	France	2.1442	5.06	0.8	31
2019	Switzerland	2.1442	5.06	0	21
2019	Ukraine	2.1442	5.06	16.02	18
2019	Norway	2.1442	5.06	0	22
2019	Australia	2.1442	5.06	0	30
2019	Portugal	2.1442	5.06	1.6	31.5
2019	United States	2.1442	5.06	0	25.8
2019	Argentina	2.1442	5.06	16.02	30
2019	Brazil	2.1442	5.06	3.34	34
2020	Germany	0.8942	4.94	0	29.9
2020	Netherlands	0.8942	4.94	0	25
2020	United Kingdom	0.8942	4.94	0.8	19
2020	France	0.8942	4.94	0.8	28
2020	Switzerland	0.8942	4.94	0	19.7
2020	Ukraine	0.8942	4.94	16.02	18
2020	Norway	0.8942	4.94	0	22
2020	Australia	0.8942	4.94	0	30
2020	Portugal	0.8942	4.94	1.6	31.5

2020	United States	0.8942	4.94	0	25.8
2020	Argentina	0.8942	4.94	16.02	30
2020	Brazil	0.8942	4.94	3.34	34
2021	Germany	1.4425	4.9	0	29.9
2021	Netherlands	1.4425	4.9	0	25
2021	United Kingdom	1.4425	4.9	0.8	19
2021	France	1.4425	4.9	0.8	26.5
2021	Switzerland	1.4425	4.9	0	19.7
2021	Ukraine	1.4425	4.9	16.02	18
2021	Norway	1.4425	4.9	0	22
2021	Australia	1.4425	4.9	0	30
2021	Portugal	1.4425	4.9	1.6	31.5
2021	United States	1.4425	4.9	0	25.8
2021	Argentina	1.4425	4.9	16.02	35
2021	Brazil	1.4425	4.9	3.34	34
2022	Germany	2.9517	5.11	0	29.9
2022	Netherlands	2.9517	5.11	0	25.8
2022	United Kingdom	2.9517	5.11	0.8	19
2022	France	2.9517	5.11	0.8	25
2022	Switzerland	2.9517	5.11	0	19.7
2022	Ukraine	2.9517	5.11	16.02	18
2022	Norway	2.9517	5.11	0	22
2022	Australia	2.9517	5.11	0	30
2022	Portugal	2.9517	5.11	1.6	31.5
2022	United States	2.9517	5.11	0	25.8
2022	Argentina	2.9517	5.11	16.02	35
2022	Brazil	2.9517	5.11	3.34	34
2023	Germany	3.9575	4.57	0	29.9
2023	Netherlands	3.9575	4.57	0	25.8
2023	United Kingdom	3.9575	4.57	0.8	25
2023	France	3.9575	4.57	0.8	25
2023	Switzerland	3.9575	4.57	0	19.7
2023	Ukraine	3.9575	4.57	16.02	18
2023	Norway	3.9575	4.57	0	22
2023	Australia	3.9575	4.57	0	30
2023	Portugal	3.9575	4.57	1.6	31.5
2023	United States	3.9575	4.57	0	25.8
2023	Argentina	3.9575	4.57	16.02	35
2023	Brazil	3.9575	4.57	3.34	34

2024	Germany	4.2083	4	0	29.9
2024	Netherlands	4.2083	4	0	25.8
2024	United Kingdom	4.2083	4	0.8	25
2024	France	4.2083	4	0.8	25
2024	Switzerland	4.2083	4	0	19.7
2024	Ukraine	4.2083	4	16.02	18
2024	Norway	4.2083	4	0	22
2024	Australia	4.2083	4	0	30
2024	Portugal	4.2083	4	1.6	31.5
2024	United States	4.2083	4	0	25.8
2024	Argentina	4.2083	4	16.02	35
2024	Brazil	4.2083	4	3.34	34
2025	Germany	4.2083	4	0	29.9
2025	United Kingdom	4.2083	4	0.8	25

APPENDIX C

Table 6: List of Companies` Betas

Company Name	Stage	Beta
Bayer AG	Stage 1	0.99
BASF SE	Stage 1	1.14
KWS Saat SE & Co. KGaA	Stage 1	0.5
Yara International ASA	Stage 1	0.44
CNH Industrial N.V.	Stage 1	1.61
AGCO Corporation	Stage 1	1.21
KSG Agro S.A.	Stage 2	1.39
IMC S.A.	Stage 2	0.62
Adecoagro S.A.	Stage 2	0.7
BrasilAgro	Stage 2	0.29
Select Harvests Limited	Stage 2	-0.37
S&W Seed Company	Stage 2	1.83
Calavo Growers Inc.	Stage 2	0.41
Kernel Holding S.A.	Stage 3	1.15
Astarta Holding N.V.	Stage 3	0.84
Ovostar Union N.V.	Stage 3	0.13
MHP SE	Stage 3	0.29
Heineken N.V.	Stage 3	0.56
Nestlé S.A.	Stage 3	0.4
Danone S.A.	Stage 3	0.39
Unilever PLC	Stage 3	0.2
Südzucker AG	Stage 3	0.29
Associated British Foods plc	Stage 3	1.19
Tesco PLC	Stage 4	0.62
Carrefour S.A.	Stage 4	0.58
Ahold Delhaize N.V.	Stage 4	0.28
Metro AG	Stage 4	0.49
Jerónimo Martins SGPS S.A.	Stage 4	0.46