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Is There Gold in Green?

A Modified Perspective of Income Developments in Active Agriculture

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NORWEGIAN SCHOOL OF ECONOMICS

Abstract

This thesis seeks to answer how active agricultural incomes in Norway have evolved from 1970 to 2021, by modifying the aggregated account. The calculation of the farmer's income has been a contentious debate for a longer period, and our aim is for this thesis to calculate a more realistic development model for agricultural incomes.

By utilizing agricultural statistics from various sources, we present the modified aggregated account, as outlined by the Grytten Committee in 2022, spanning from 1970 to 2021. Our findings indicate that active farmers generally have a lower pre-tax income when applying this framework compared to the original aggregated account. Our objective is not to provide a specific figure for the earnings of Norwegian farmers but rather to examine how income has evolved over time.

We apply the Hodrick-Prescott filter to several time series to compare developments in the cyclical components over time. For agricultural income and economic cycles, we find no clear correlations. This is partly due to agricultural incomes being subject to extensive support schemes and market regulations. Furthermore, we identify a positive relationship between agricultural incomes and agricultural production. This aligns with our assumptions, as a portion of the income is directly tied to production. We also demonstrate that fluctuations between incomes and subsidies often exhibit close covariance, although not universally. The inconsistency stems from excessive subsidies leading to overproduction and subsequently reduced income, and due to subsidies serving multiple purposes.

Our findings reveal a growing divergence between NIBIO's and our modified account over time, but also demonstrates the independence of income from broader economic fluctuations. Thanks to strong support systems and favorable market regulations for agriculture, incomes remain relatively insulated from economic cycles and, to some extent, also production fluctuations. Nevertheless, production will still have a certain correlation with incomes, as a portion of the earnings is directly linked to the sale of goods.

Acknowledgements

This master's thesis has been completed as part of the Master of Science in Economics and Business Administration at the Norwegian School of Economics, where both of us are majoring in Financial Economics. Our work builds upon the work presented by the Grytten Committee in NOU 2022: 14.

We both found it intriguing when our supervisor, Ola Honningdal Grytten, suggested that we explore the historical development of agricultural incomes. Throughout the process, we have acquired new insights, both regarding the income development of Norwegian farmers and the processing of time-series data.

Our sincere appreciation goes to Ola Grytten for providing us with excellent guidance throughout the semester, and for always being available on short notice. We are genuinely grateful for the valuable insights and perspectives he has shared with us.

We would also like to express our gratitude towards the Norwegian Institute of Bioeconomy Research. We extend our special thanks to Heidi Knutsen at the Bergen office and Senior Advisor Oddmund Hjukse, both of whom played a pivotal role in providing us with essential data required for calculating historical results.

We hope that this thesis can be useful for further research on agricultural income development, or in the process of restructuring the aggregated account for agriculture.

Norwegian School of Economics

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1 Introduction

Every year since 1950, the Norwegian state and representatives from the agricultural sector have engaged in the Agricultural Settlement to establish the framework for Norwegian agriculture, including setting prices for agricultural products and subsidies. One of the negotiation materials is the aggregated account for agriculture, which includes the performance metric “return on labor and equity”. The aggregated account serves as a sectoral statement designed to measure income development in agriculture, enabling comparisons with income trends in other societal sectors. The current calculation of average income in agriculture involves dividing the total surplus in the sector by the number of full-time equivalents (FTEs).

There is broad political consensus on the importance of preserving Norwegian agriculture, ensuring food security, and facilitating opportunities for farmers to increase their income. To achieve these goals, agriculture should to some extent be subsidized by the government. However, disagreements arise regarding the determination of support mechanisms and the qualifying criteria for receiving economic support.

In recent years, a growing debate has unfolded regarding the principles used to calculate the aggregated account. Since 1970, the number of agricultural enterprises and FTEs has decreased by more than 75 percent. Simultaneously, production has been sustained through a combination of technological advancements, increased capital investments, and scaling of production among the remaining enterprises. Farmers’ discontent largely revolves around the fact that the equity, increasingly tied up in investments, lacks compensation for alternative applications within the aggregated account. They advocate for the inclusion of a return on invested capital in the calculation of return on labor and equity.

Critics of return on equity in agriculture point out that the industry consists of businesses with varying economic motivations. In more than one-third of farms, less than one FTE is carried out, and most of these have other employment as their main source of income, implying variation in economic motivation for engaging in agriculture. The aggregated account, functioning as a sectoral account, does not capture this diverse motivation. This can potentially result in the industry receiving collective returns, also for investments not primarily intended to generate income.

In 2021, because of the questions raised regarding the suitability of the aggregated account as a measure of income development, the government proposed to establish an expert committee for income measurement in agriculture. The committee, hereafter referred to as the Grytten Committee, was established, among other objectives, to discuss principles for measuring agricultural income. On October 3, 2022, the committee presented an alternative to the aggregated account that, through various modifications, seeks to offer a more precise and identifiable depiction of economic returns in *active* agriculture. The modification made by the Grytten Committee extends back to 2005.

On November 1, 2023, during the writing of this master's thesis, the parties in the Agricultural Agreement agreed to adjust the numerical basis for negotiations based on the Grytten Committee's proposal. The change will be implemented starting with the agricultural negotiations in 2024 (Ministry of Agriculture and Food, 2023).

1.1 Research Question

Our master's thesis extends the Grytten Committee's research by computing a time series depicting the income development within active agriculture from 1970. Given the substantial changes in the agricultural industry over the past decades, we aim to examine the evolving discrepancy between active agriculture and the existing aggregated account over time. To gain a comprehensive understanding of the factors influencing income development, we conduct an analysis of the co-variation between income, production, and economic cycles. Thus, the research questions this thesis aims to answer can be expressed as follows:

"How has income in active Norwegian agriculture evolved from 1970 to 2021, and to what extent is this development influenced by fluctuations in business cycles and production trends?"

1.2 Limitation

The data within the aggregated account is accessible dating back to 1959, while most of the time series data from Statistics Norway does not extend beyond 1970. Considering the substantial scope of this dataset and the inherent limitations of historical data in terms of accuracy and completeness, in addition to the practical use, we have decided not to extend the modification beyond 1970. In addition, the analysis is solely conducted at a sector level and, therefore, does not extensively discuss the developments within specific divisions in agriculture.

1.3 Structure

The thesis follows a systematic progression, with Chapter 2 introducing key theories, concepts and historical events that form the basis of the analysis. Moving on to Chapter 3, the aggregated account is initially presented in its original form, followed by the introduction of the modified version proposed by the Grytten Committee in 2022, and a review of existing literature concerning criticisms of the data foundation. Chapter 4 presents relevant data, while Chapter 5 provides an in-depth understanding of the empirical methods applied in the analysis. Furthermore, Chapter 6 presents the modification step by step in addition to a restructuring of the period accounted for in NOU 2022: 14. In Chapter 7, our results are presented and discussed in the context of theoretical concepts and economic events. Lastly, Chapter 8 presents our conclusions.

2 Theoretical Framework

The theoretical framework provides the conceptual basis to interpret our empirical results and draw meaningful conclusions. First, we review economic theory in the form of gross domestic product (GDP) and business cycle theory, followed by an exploration of agricultural production and subsidies. We then examine historical economic and agricultural events in Norway, before finally highlighting the country's distinctive features.

2.1 Gross Domestic Product

GDP is a vital economic indicator that quantifies the total monetary value of all goods and services produced within a country's borders during a specific time, typically a year or a quarter (Statistics Norway, 2021a). It reflects the collective economic activity and output of a nation.

When examining the relationship between agricultural income and business cycles, we employ fixed Mainland GDP. Using fixed prices offers a robust way to account for changes in production that are not merely due to price changes (Grytten & Hunnes, 2016). Additionally, Mainland GDP isolates economic activity within the country, excluding income generated from the oil and gas sector (Statistics Norway, 2021a). The oil industry constitutes approximately 14 percent of the total value added. The output in this sector can vary significantly without substantial implications for employment and unemployment rates. Hence, Mainland GDP is a more relevant metric for our task in assessing the income development in agriculture.

There are, however, certain concerns associated with the utilization of real GDP as an indicator for predicting immediate or very recent economic developments. These concerns stem from the propensity of GDP data to undergo subsequent revisions long after their initial publication (Koenig & Emery, 1991).

2.2 Business Cycles

A business cycle is defined by Burns and Mitchell as

> a type of fluctuation found in the aggregate economic activity of nations that organize their work mainly in business enterprises: a cycle consists of expansions occurring at about the same time in many economic activities, followed by similarly general recessions, contractions, and revivals which merge into the expansion phase of the next cycle; this sequence of changes is recurrent but not periodic; in duration, business cycles vary from more than one year to ten or twelve years; they are not divisible into shorter cycles of similar character with amplitudes approximating their own (1946, p. 3).

Economic indicators are typically presented as a time series, which can be presented as follows (Koilo & Grytten, 2019):

$$x_t = g_t + c_t + s_t + i_t \qquad 2.1$$

The s_t and i_t represent the seasonal and the irregular components, respectively. In this thesis, it is reasonable to consider these components as part of c_t. The result is a combination of the trend and cyclical components, which is equivalent to real GDP:

$$x_t = g_t + c_t \qquad 2.2$$

The trend component, denoted as g_t, represents the long-term economic trajectory of the economy. It serves as an indicator of potential output or potential GDP, offering insights into what would have been achieved if all input factors were fully utilized (Grytten & Hunnes, 2016). The cyclical component, denoted as c_t, portrays the short-term fluctuations around the trend. This is often referred to as the output gap and is typically measured as a percentage deviation from the underlying trend.

An economy is in an expansion phase when real GDP grows faster than the trend, and in a contraction phase when it lags the trend. Furthermore, an economy is in an economic boom when real GDP surpasses the trend, whereas it is termed a bust when it falls below the trend. We employ the Hodrick-Prescott filter (HP filter) to effectively distinguish between the trend and cyclical components, which will be addressed further in Section 5.1. Economic indicators exhibit either a procyclical tendency, characterized by a simultaneous increase with GDP, or a countercyclical behavior, indicated by a decline during periods of growth. Moreover, leading indicators anticipate economic shifts ahead of GDP, providing an early indication of the direction of the economy, while lagging indicators exhibit delayed responses.

In the context of identifying turning points in business cycles, one usually looks at the peak and the trough of real GDP. Okun's method posits that a recession commences with the initial of two successive quarters experiencing production contraction and concludes with the first of two consecutive quarters witnessing growth (Del Negro, 2001). Nevertheless, this approach will exclude recessions where there is a substantial contraction in real GDP for one quarter followed by a period of weak growth. Therefore, exploring a more comprehensive framework may provide a more nuanced understanding.

The National Bureau of Economic Research (NBER) uses Mitchell's three Ds to define a recession. According to this method, a fluctuation must meet three criteria to be classified as a turning point: duration, depth, and diffusion (National Bureau of Economic Research, 2022). However, there are situations where an extreme value in one of these criteria can significantly influence the categorization of an economic phase. Duration refers to the time elapsed between turning points, while depth examines the disparity between peaks and troughs. The concept of diffusion underscores the significance of considering indicators beyond GDP alone when assessing economic cycles. This can include factors such as employment, private consumption, and gross national income (GNI).

2.3 Agricultural Production

This thesis introduces two different production definitions, i.e., production value and gross production. We use Statistics Norway's definitions of the two concepts, where production value is defined as the turnover of produced volume, adjusted for changes in inventory (Statistics Norway, 2005). Gross production is defined as production value minus production inputs and can be considered as agriculture's value added to the GDP (Statistics Norway, n.d.a). Production output is valued at the price the producer receives upon selling a product, after accounting for any product taxes and subsidies. Product inputs are valued at the purchase price.

In real terms, gross production and production value have increased by 46 and 55 percent, respectively, since 1970. During the same period, the population has grown by 40 percent, and the number of agricultural enterprises has decreased by 75 percent from approximately 155,000 to 38,000 in 2021, closely following the reduction in the number of FTEs by 77 percent (Statistics Norway, 2023a) (Statistics Norway, 2023b).

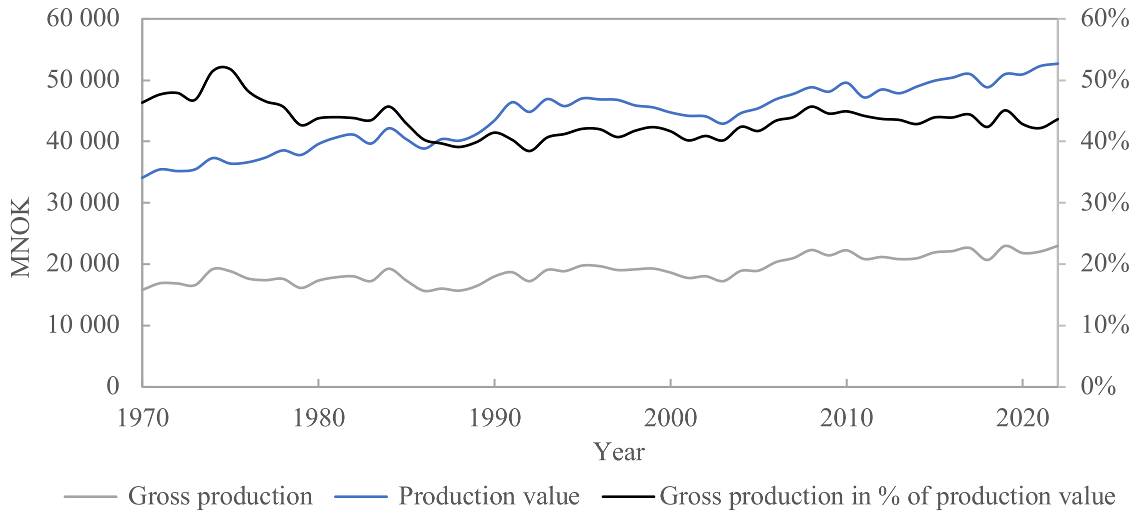

Figure 2.1*: Production, real 2022-values*
Source: Statistics Norway

This means that Norwegian agriculture yields a higher output per FTE and per farm compared to the levels in 1970 caused by industrial transformation driven in part by industrialization and urbanization (NOU 2022: 14). This development has not only led to increased labor productivity but also increased value creation in agriculture. This is attributed, among other factors, to the gain in labor productivity, which, in turn, outweigh the loss in capital productivity associated with increased investments.

2.4 Agricultural Subsidies

The government and the agricultural sector, the latter represented by the Norwegian Agrarian Association, and the Norwegian Farmers and Smallholders' Union, have annually negotiated an agreement on prices of agricultural products and other provisions for the industry since 1950 (Ministry of Agriculture and Food, 2020). This agreement also regulates rates and conditions for subsidies in agriculture. The Norwegian Institute of Bioeconomy Research's (NIBIO) overview of agricultural subsidies includes statistics for 113 categories of subsidies granted from 1960 to now, where most of the subsidies are related to production (Landbruksdirektoratet, n.d.).

Production grants are given under the condition of engaging in "ordinary agricultural production" (Forskrift om produksjonstilskudd og avløsertilskudd i jordbruket, 2014). The assessment of whether the production is considered "ordinary" is based on professional judgment, and the production must have a clear industrial character (Landbruksdirektoratet, 2023). We will not delve into the specifications of the main conditions for receiving subsidies, but it should be emphasized that the calculation of production grants is based on objective metrics, such as the number of animals, land area, or geographical factors such as location. Subjective factors such as the farm's income, expenses, or the farmer's overall financial situation have no significance in determining most of the granted subsidy.

In figure 2.2, a graphical representation of production income and total operating subsidies, including subsidies as a percentage of the farmer's total income, is presented based on NIBIO's aggregated account (Norwegian Institute of Bioeconomy Research, 2023a). From 1970 to 2022, the sum of operational subsidies as a percentage of total income has increased from approximately five percent to nearly 26 percent, constituting a significant portion of the farmer's overall income, surpassed only by livestock.

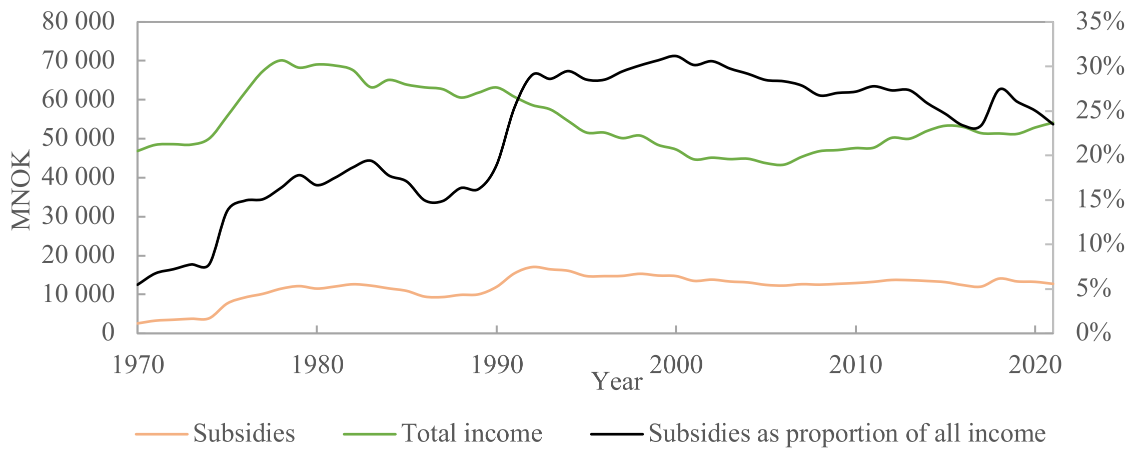

Figure 2.2: *Development income and subsidies*
Source: Norwegian Institute of Bioeconomy Research

A note from Ruralis on the effects of increased budget support for Norwegian agriculture indicates that one Norwegian Krone (NOK) in increased subsidies leads to a corresponding 0.55 NOK rise in income for active farmers (Mittenzwei, 2022). This is partly due to the increase in subsidies leading to increased capitalizing on land and quota prices as opposed to deriving returns from labor and depreciable capital. We discuss the interplay between subsidies and income in Chapter 7.

2.5 Economic Developments in Norway (1970 to 2021)

In this section, we provide a brief overview of the key developments that characterized the Norwegian economy, as well as the agricultural sector, between 1970 and 2021. While Mainland GDP excludes income from oil and gas, it is crucial to consider oil industry developments for a comprehensive understanding of the Norwegian economy. Due to the sector's substantial scale, petroleum dynamics have a significant impact on government revenues and overall economic stability.

1970s: Oil Wealth

In the 1970s, Norway experienced a significant economic upswing, primarily driven by the newfound oil wealth. While large parts of the Western world experienced stagflation, Norway benefited from the increased oil prices (Grytten & Hunnes, 2016). The growth in the oil sector led to a strengthening of the currency, making other Norwegian exports more expensive in the global market (Hansen, 2001). Towards the end of the decade, the Norwegian economy was also, however, impacted by unfavorable trends in the global economic landscape (Grytten & Hunnes, 2014).

The 1970s also marked a significant increase in both grain production and agricultural income (Norwegian Institute of Bioeconomy Research, 2023a). The surge in income stemmed from the Norwegian Parliament's goal of achieving a net income per labor equivalent comparable to the average annual salary of adult men in industry (Dalberg et al., 1984). In 1975, the Norwegian Parliament adopted a plan to realize this goal, with the ambition of achieving it as promptly as possible.

1980- and 1990s: "Jappetid", Bank Crisis, and Boosting Agricultural Incomes

The 1980s were characterized by the "jappetid", primarily driven by a surge in oil investments and the liberalization of credit and currency markets (Eika T. , 2008; Grytten & Hunnes, 2016). The period of high economic growth continued until 1985. However, the abrupt fall in oil prices in the mid-1980s due to Saudi Arabia's decision to increase oil production, brought about a financial crisis (Kengor, 2007). This crisis was further compounded by the necessity for Norway to align with international interest rates, despite its petroleum-dependent economy often diverging from global economic trends. This, in combination with the perception that Norway's oil wealth had been significantly reduced, led to a strict fiscal policy (Steigum, 2004). Consequently, the Norwegian economy went through a severe recession, and unemployment rates more than doubled (Eika T. , 2008).

As for agriculture, the income boost in 1975 resulted in a temporary strong income growth in agriculture, lasting up until 1982 (St. prp. nr. 2 (1982-83)). However, substantial investments, capacity buildup, as well as reduced demand following the discontinuation of consumer subsidies for meat and milk, led to overproduction (NOU 2022: 14). This marked the end of the income escalation. In 1984, a quota system for milk production was introduced to prevent overproduction (Regjeringen, 2023).

Norway entered the 1990s with a set of economic challenges that had their roots in the previous decade (Benedictow, 2006). The increase in unemployment towards the end of the 1980s was accompanied by falling housing prices and rising household debt, stemming from the excesses of the "jappe" era. These factors collectively weakened household demand. The situation was further exacerbated by the global economic recession, which extended the economic challenges for Norway until 1992. However, from 1993 onward, Norway entered a prolonged period of economic expansion. This was a result of a combination of factors, including the stabilization of household finances through debt repayment, increased investments in the petroleum sector, and the adoption of more expansionary fiscal policies. Concurrently, there was a notable reduction in international interest rates, contributing to the nation's economic growth.

In the agricultural sector, milk consumption experienced a significant decline throughout the 1990s, accompanied by weak profitability and productivity development in grain production (Statistics Norway, 2000). Moreover, in 1995, Norway transitioned from a quantitative import protection system, characterized by import bans, to a tariff-based import protection system following the enactment of the WTO agreement (Mittenzwei & Svennerud, 2010).

2000s (up to 2021): Financial Crisis, Oil Downturn, and Pandemic

The early 2000s began with the aftermath of the dot-com bubble burst (Grytten & Hunnes, 2016). Norway was also affected by this global economic turmoil, entering a recession hitting its trough in 2003. Significant wage increases in Norway, driven by the prior economic upturn, led to higher interest rates to curb inflation (Benedictow, 2006). Other countries, on the other hand, reduced their interest rates. This divergence in monetary policy caused the NOK to appreciate, making Norwegian exports more costly in the global market. Consequently, GDP declined, and unemployment increased. However, Norway's economic resilience, driven in part by a significant reduction in Norwegian interest rates, contributed to a relatively swift recovery.

In 2008, the global financial crisis unfolded. This had an impact on Norway due to reduced oil demand and a subsequent downturn in the Norwegian stock market. Nevertheless, the Norwegian economy did not undergo as severe a downturn as many countries, primarily attributed to its oil wealth and the prompt implementation of stabilizing measures by the government and the central bank (The central bank of Norway, 2010). Norwegian banks had proactively adopted a more cautious approach in the period leading up to the financial crisis (Grytten & Hunnes, 2014). In the mid-2010s, another significant event, known as the "oil downturn" occurred because of a sharp decline in oil prices (Grytten & Hunnes, 2016). This downturn posed challenges for the petroleum sector but was partially mitigated by a weakened NOK and low interest rates.

In 2020, the outbreak of the COVID-19 pandemic led to a substantial supply-side crisis in Norway, while a sharp decline in oil prices and global demand shocks further exacerbated the situation (The central bank of Norway, 2020). The central bank responded by reducing the policy rate to zero in 2021, marking the first time in the country's history that interest rates reached such a low level (Tveita, 2023). As of December 2021, the interest rate had increased to 0.5 percent.

In the early 2000s, the Norwegian agrarian sector underwent a substantial policy transformation. This involved integrating the pre-tax income value of the agricultural deduction into the aggregated account for income assessment (The Budget Committee for Agriculture, 2022). As of 2022, the deduction averages around NOK 31,000 per FTE, with variations ranging from zero to approximately NOK 71,000 (NOU 2022: 14).

Over the following decade, from around 2005, real agricultural income experienced an increase, partly attributed to robust productivity growth (The Budget Committee for Agriculture, 2022). However, the resurgence of overproduction challenges led to increased inventory levels, higher turnover taxes, and declining prices (NOU 2022: 14). The sector faced additional adversity with an extreme drought in 2018. Conversely, measures implemented in response to the pandemic resulted in a surge in domestic demand.

2.6 Distinctive Features of Norway

Norway's economy is characterized by its small and open structure, making it highly sensitive to global political and economic developments (Grytten & Hunnes, 2016). The Norwegian economy heavily relies on its oil industry, which contributed to a substantial 14 percent of the country's GDP in 2019 (Ulfeng, 2022). Consequently, the nation's economic stability is significantly influenced by fluctuations in global oil and gas prices.

As opposed to the oil industry, Norway's agricultural sector is relatively small, representing merely 0.56 percent of total GDP in 2019. An important characteristic of this sector is its inelastic demand. This implies that a modest price adjustment has a limited impact on consumption, whereas a moderate shift in production significantly influences prices (Grytten, n.d.). An implicit consequence of this, is that higher subsidies stimulate greater investments, resulting in increased production and subsequently lower prices. The increase in supply does not proportionally increase demand, further driving prices down.

3 The Aggregated Account for Agriculture: A Measure of Agricultural Income Development

The following chapter introduces the original aggregated account prepared by NIBIO before presenting the modified aggregated account proposed by the Grytten Committee in NOU 2022: 14. The latter forms the basis for our extended calculations, which is described in Chapter 6. Lastly, we conduct a literature review of critiques towards the aggregated account and the Grytten committee's proposal, along with suggestions for alternative modification approaches.

3.1 NIBIO's Aggregated Account

The aggregated account for agriculture is an annual sectoral report prepared by the Budget Committee for Agriculture (BFJ) and published by NIBIO, extending back to 1959 (The Budget Committee for Agriculture, 2022). The account provides insight into the total income, including subsidies, expenditures, labor contributions, and the utilization of agricultural area and products within the agricultural sector. One of the main purposes behind the compilation of this account is to illustrate the income development in agriculture over time to, among other objectives, monitor agricultural developments in comparison to other sectors.

The performance metric used to measure income development, making up parts of the material used in agricultural negotiations, is "return on labor and equity". This metric is derived by subtracting non-permanent production assets, capital costs, and real interest on borrowed capital from the sum of production income and subsidies.

The aggregated account is a sectoral statement designed to illustrate the development and total value of Norwegian agriculture and is not suitable for level comparisons. This is because it includes all agricultural operations, regardless of the economic significance for each entity. If a level comparison would apply, questions arise regarding which part of active agriculture the level should apply to. This, in turn, requires evaluations concerning the operational scope for all entities and the importance of agricultural income for each user. This thesis will not discuss the income level in agriculture, solely income development.

3.2 The Modified Aggregated Account for Agriculture: The "Active" Farmer

As a result of the debate surrounding the suitability of the original aggregated account outlined in the introduction, the government's Agricultural Settlement proposition in 2021 proposed to establish an expert committee for income measurement in agriculture with a mandate to

> Discuss and clarify principles and methods, as well as possibilities and constraints, for measuring incomes for the agricultural sector and for individual farmers as private entrepreneurs, along with the foundation and prerequisites for comparing business incomes with employee wages (Prop. 120 S (2021–2022)).

Pursuant to directives from the committee, Statistics Norway compiled an extensive report spanning the years 2004 to 2020, focusing on farmers' income (Eika & Vestad, 2022). The outcomes reveal a significant correlation between sustained low agricultural income and low operational scale. Moreover, a considerable proportion of farmers primarily rely on alternative sources of income. Approximately one-third of Norwegian farmers report a standard turnover of less than 150,000 NOK, and a corresponding proportion reports negative business income. The Grytten Committee's report indicates that a considerable number of farming enterprises have objectives for their operations that extend beyond the maximization of economic profits.

Considering these findings, the proposal suggested a thorough reassessment of the negotiation framework for agricultural discussions to represent the income and expenses of active farming businesses more realistically. One of the modifications proposed is to compute the aggregated account utilizing established accounting principles, through measures such as to

1. Calculate capital depreciation based on historical cost and use the nominal interest rate on debt.
2. Recognize income and expenses related to the leasing of land and milk quotas[1] and reduce the capital of active farming operations accordingly.

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[1] There is no register for continuous price monitoring for quota rentals. Additionally, there is no comprehensive overview of agreements or settlement methods involving such leases. As a result, the data foundation is rather limited, and neither the Committee's modified aggregated account nor this thesis accounts for adjustments related to milk quota rentals. The Committee suggests the development of a relevant quota rental statistics system that can be integrated into the aggregated account in the future. The proposal was adopted by the parties in the Agricultural Settlement on November 1, 2023, and the statistics will be compiled within the agricultural negotiations in 2024.

3. Record hired labor as an expense and reduce the labor input accordingly.

In consideration of the diverse economic motivations driving farmers' operations, the Committee recommends utilizing tax data to capture the variability in income opportunities within the agricultural sector, employing a "best results" approach. Furthermore, they introduce a hybrid model that integrates the modified total budget with tax data, enabling level comparisons. This approach demands an extensive dataset. Due to time constraints, we have opted not to explore this further within the confines of this master's thesis.

3.2.1 Defining the Active Agricultural Enterprises

To characterize the income situation of actively engaged farmers more accurately, it is imperative to first quantify and establish a clear definition. It has been established that a significant proportion of farmers operate with limited scale and possess objectives beyond pure economic profit.

Statistics Norway and the BFJ employ the term "Agricultural Enterprises" (Statistics Norway, n.d.b). These entities are primarily those eligible for production subsidies as outlined in the Agricultural Agreement. They engage in standard agricultural production and are recipients of production subsidies. Those who own agricultural land and solely lease it out are not classified as active agricultural enterprises. As this demarcation provides distinct and well-documented statistics for subsidy distribution, this thesis adopts the definition of an active farmer as someone who receives production subsidies.

3.2.2 Step 1: Established Accounting Principles - Historical Cost and Nominal Interest Rate

In NIBIO's aggregated account, operating assets undergo annual price adjustments using the consumer price index (CPI), and capital depreciation is computed based on the adjusted amount (Norwegian Institute of Bioeconomy Research, n.d.a). Consequently, real interest on debt is employed instead of nominal interest, primarily because capital depreciation is also subject to inflation adjustments. This approach departs from conventional accounting principles and could be a contributing factor to why individuals may not identify with the average figures in the income data serving as the basis for agricultural settlements.

To enhance the recognizability of the aggregated account, one of the modification steps involves aligning with the established accounting principles. This includes a shift to historical cost accounting for operating assets, resulting in reduced depreciation. Furthermore, a transition to nominal interest rates for debt and leasing costs allows us to term the outcome as the annual pre-tax earnings. On average, the modified series tends to increase the return on labor and equity compared to the inflation-adjusted series, although there are variations due to the fluctuating real interest rates.

3.2.3 Step 2: Lease of Non-Depreciable Assets - Land Quotas

In NIBIO's aggregated account, the leasing expenses of the active farmer are not explicitly delineated. As a result of the account being structured as a sectoral account, where land is defined to belong to the sector, there is no distinction made regarding whether these transactions occur between actively operating farmers or landowners without business income from the agricultural sector. Instead of recording annual income and expenses from land leases, this capital is included within the agricultural sector's capital and appears as higher debt and interest costs. The proportion of rented land has risen steadily from approximately 15 percent in 1969 to 47 percent in the latest public census of 2020. Figure 6.7 exhibits a stabilization at this level in recent years. (Statistics Norway, 2022). This suggests a progressively increasing leasing cost that is not reflected in the aggregated account.

According to the Norwegian Agricultural Directorate, agricultural land is predominantly leased from non-active agricultural enterprises, although some land is also leased from other active farms (NOU 2022: 14). To offer a more accurate representation of active agriculture, leasing costs are recorded on a gross basis, with all leased acreage being expensed. Meanwhile, the portion leased from other active farms is recorded as income. This approach also leads to a reduction in the sector's debt, interest costs, and agricultural capital, as it excludes non-operative agriculture from the account.

3.2.4 Step 3: Expensing Hired Labor

In the current formulation of the aggregated account, the cost of hired labor from non-agricultural businesses is not itemized. Instead, these external labor hours are included in the total labor consumption, with no distinction made between the farmers' work and hired labor. As a result, the final metric, including compensation for labor and equity per FTE, is presented as a composite of all labor input, regardless of who performs the work.

In their modification of the aggregated account, The Grytten Committee suggested including the expense of hired labor costs and the removal of corresponding FTEs from the calculations (NOU 2022: 14). This shift seeks to redefine the metric from being a measure of earning capacity to becoming a performance indicator for farmers and their families.

3.2.5 Refining Principles in Account Calculations

Following the submission of the Grytten Committee's report featuring the modified aggregated account in October 2022, fundamental principles within the account calculation have undergone revisions pertaining to leasing and investments.

Previously, both import statistics and data provided by the leasing companies and the Association for Financing Companies, formed the basis for calculating investments in machinery and leasing (The Budget Committee for Agriculture, 2023). However, BFJ has now transitioned to using survey results from Statistics Norway, a change prompted by the increasing discrepancies between the data sources, particularly noticeable in leasing figures. This restructuring has altered the gross investment in machinery, where machine components previously categorized as investments are now treated as maintenance expenses. The modification impacts gross investments, depreciation, maintenance, and leasing for the entire period in our dataset. The effects are more notable in recent years, given that leasing used to represent a considerably smaller proportion of the aggregated account considering the increasing trend in the past decades.

The overall restructuring has resulted in a reduction in return on labor and equity, ranging from a one to five percent decrease over the period 1970 to 2021, with increasing differences in recent years. For instance, nominal figures in 2021 have transitioned from NOK 424,068, used by the Grytten Committee, to NOK 401,374 (Norwegian Institute of Bioeconomy Research, 2023a; NOU 2022: 14).

3.3 Other Perspectives on the Aggregated Account

On November 1, 2023, the parties involved in the Agricultural Settlement reached an agreement to modify the numerical basis of the aggregated account, drawing from the Grytten Committee's modification proposal. Leaders of the Agrarian Association and the Smallholders' Association, Bjørn Gimming and Tor Jacob Solberg, emphasized that despite the agreement, disagreements persist, particularly regarding capital return and the number of hours in an FTE within the numerical basis (Eide, 2023). The demand for a return on equity has remained a central point of contention, causing substantial debate among the parties involved in the agricultural negotiations.

Menon Economics, commissioned by the Smallholders' Association, has conducted an evaluation of various methods for computing capital costs within the aggregated account (Grünfeld & Winther-Larsen, 2023). While they, in alignment with the Grytten Committee, recommend a shift to nominal accounting principles, they emphasize the necessity of a return on equity to investment-related price increases over time. They claim that the required rate of return should be 8.5 percent and consists of the risk-free rate along with a risk premium and a liquidity premium. If integrated into the aggregated account, it would signify an income development roughly 25 percent weaker than the current version. Moreover, the argument posits that the aggregated account serves as a tool to measure income development relative to other groups, emphasizing the need to focus on purchasing power. This rationale is grounded in that purchasing power, adjusted for capital costs, accommodates that a portion of income must be allocated to investments sustaining production capacity and ensuring further operations.

Several responses to the Menon report in the regional business newspaper, Nationen, highlight the implications of introducing a return requirement for equity. Grytten et al. (2023), for instance, argue that only considering current returns will not account for changes in value, stating that there is no practical way to quantify this in comparison to other income groups. They argue it is fundamentally incorrect to stipulate the same return requirement for all capital in agriculture when investment motives vary widely. Pettersen and Mittenzwei (2023) also argue that farmers cannot claim compensation for risk twice, given that the state already mitigates the farmers' risk through measures such as subsidies, market regulations, and import protection.

In an article on capital and labor returns in agriculture, Special Advisor at Statistics Norway, Ann Lisbet Brathaug, and Professor at NTNU, Jon Olaf Olaussen, assert that the profitability in agriculture is not sufficiently high to cover an average Norwegian wage while simultaneously yielding a positive return on capital (Brathaug & Olaussen, 2022). The Grytten Committee's report also explicitly states that, on average, agricultural production does not provide a market-based return to both labor and capital (NOU 2022: 14). Accordingly, Brathaug and Olaussen argue against the separation of returns on labor and capital, given their interdependence. They find it intuitively unsound for only return on labor to cover debt repayment and investments, asserting that return on equity should also contribute to maintaining tied-up capital in the enterprise. Consequently, they argue that isolating return on equity from the performance metric serves no purpose, neither in principle nor through technical calculations.

It is currently not possible to determine the proportion of the unit's income derived solely from capital investment isolated from labor, as there are no accounting entries indicating this ratio. Excluding equity from the income would contradict all performance metrics used elsewhere, also implicitly assuming that labor and capital are distinctly separable, and their interaction is irrelevant to income generation. Based on the strong counterarguments and the inherent complexities associated with incorporating equity returns into the overall calculation, we will not delve further into a required rate of return in this thesis. The fact that the parties in the Agricultural Settlement have reached a consensus on the numerical basis for the 2024 negotiations might be seen as a reinforcement of the foundation for not deviating from the modified aggregated account proposed by the Grytten Committee.

4 Data

In this section, we describe the figures forming the basis for calculating the modified aggregated account back to 1970. We also introduce data used for annual salary, agricultural production, and GDP, which we employ in our analysis. Finally, we present weaknesses in our dataset.

4.1 Agricultural Income

The modification of the aggregated account is primarily based on NIBIO's annual farm accountancy data network (FADN) and agricultural censuses. The FADN serves the purpose of portraying the financial status and trends within the agricultural sector, particularly the enterprises where a significant portion of income is derived from farming and forestry activities (Norwegian Institute of Bioeconomy Research, n.d.b). Accordingly, individuals participating in the survey are required to have an annual standard turnover of more than 150,000 NOK, excluding subsidies. The survey aims to represent farms of varying sizes, production types, and geographical locations.

Agricultural censuses assess agricultural land and its utilization, but these are conducted only once every decade (Statistics Norway, 2023b). Since 1999, Statistics Norway has compiled an annual comprehensive population overview of agricultural enterprises. This draws information from various administrative registers, providing a robust foundation for compiling statistics on land use, even in years without extensive censuses (Statistics Norway, 2023c). Between 1969 and 1999, agricultural censuses were supplemented by sample surveys in intervening years.

While most of the data needed for the modification is available in public registers, data on nominal interest costs is unavailable after the change of principle in the aggregated account in 2022. However, Oddmund Hjukse, Senior Advisor for Agricultural Economic Analysis at NIBIO, has provided us with this data.

The time series analyzed in these statistics are originally presented in nominal values, not distinguishing between factors influenced by general price fluctuations and those stemming from changes in actual physical output. Real returns on labor and equity are computed by deflating with the CPI, which describes the price developments of goods and services demanded by private households in Norway, making it a suitable deflator.

4.2 Annual Salary

In Chapter 7, we use data on the average annual income in Norway in the context of visualizing the cyclical components of agricultural income and GDP. Data on annual wages are sourced from the National Accounts and calculated by dividing total wages by total employed FTEs, resulting in the average annual wage in Norway (Statistics Norway, 2023d). For optimal comparability, we have adjusted for inflation using the CPI, the same approach used for agricultural incomes.

4.3 Agricultural Production

Figures for production value and gross production is sourced from Statistics Norway, which, in turn, relies on the BFJ as the main source for calculations (Sagelvmo & Sjølie, 2001). In deflating production figures within the National Accounts, price data is sourced from BFJ's Volume and Price Index for Agriculture (Zahirovic, 2012). This index operates at a detailed product level, utilizing up to three different price indices per product.

4.4 Gross Domestic Product

The GDP figures employed are prepared by Statistics Norway from 1970 to 2021 for annual data, and from Q1 1978 to Q4 2021 for quarterly data. We use the implicit GDP deflator from Statistics Norway. While the CPI deflator covers goods consumed in Norway, the GDP deflator applies exclusively to goods produced in Norway.

By using fixed prices, we ensure that changes in GDP are due to actual shifts in production volume. The selection of seasonally adjusted figures allows us to explore underlying economic cycles without the interference of seasonal variations.

4.5 Weaknesses

The calculations in this thesis are based on a range of estimates and historical data. Consequently, interpretation should be done cautiously as the data basis for our calculations relies on specific assumptions and generalizations that could introduce inaccuracies.

GDP figures are tentative as of 2021 and 2020 for the annual and quarterly data, respectively. Tentative or recent GDP data can introduce volatility due to frequent revisions, which may extend over several years. These revisions can potentially impact the accuracy of our analysis.

Another limitation is that our dataset primarily consists of annual data. While quarterly data is commonly recognized for offering a more nuanced perspective in business cycle analysis, our choice of annual figures is driven by the nature of the aggregated account and the modified aggregated account, which are compounded annually. Unfortunately, quarterly data for these metrics is not available.

The data pertaining to agricultural land and land use is incomplete for several years due to the agricultural census being conducted only once a decade before 1999. Particularly, the estimate for the constant lease of land from other active farmers is a highly simplified estimate. Furthermore, inconsistencies in the focus area within the Agricultural Statistics across different years contribute to data gaps in hired labor, paid labor, and associated costs for certain periods. To address these gaps, we make estimates for the missing years.

5 Empirical Methods

This section provides a detailed description of the HP filter, followed by a presentation of the method used for dating business cycles and conducting correlation analysis. These empirical methods form the basis for the analysis in Chapter 7.

5.1 The Hodrick-Prescott Filter

The HP filter was initially introduced in a working paper in 1981 by Hodrick and Prescott (Hodrick & Prescott, 1981). Our choice of this filtering technique is underpinned by the focus of our analysis, examining how agricultural income development has evolved in relation to production fluctuations and economic cycles. To achieve this, we use structural time series analysis.

In Section 2.2, we saw that the seasonal and error components in a time series could be seen as part of c_t. We were therefore left with the trend and the cyclical component, which we expressed as:

$$x_t = g_t + c_t.$$

The HP filter is designed to identify these components. To perform this decomposition, the filter aims to minimize two aspects. It seeks to reduce both the deviations of the original time series from its underlying trend and the curvature or variations of the estimated trend. This can be expressed in the following equation (Koilo & Grytten, 2019):

$$min_{g_t} \sum_{t=1}^{T} (x_t - g_t)^2 + \lambda \sum_{t=2}^{T-1} [(g_{t+1} - g_t) - (g_t - g_{t-1})]^2. \quad 5.1$$

The first term quantifies how far the actual figures deviate from the underlying trend, while the second term represents the rate of change in the trend from one period to the next (Sørensen & Whitta-Jacobsen, 2010). Lambda (λ) is a smoothing parameter determining the balance between the two above mentioned optimization objectives. The minimized solution is presented as follows:

$$g = (I_n - \lambda F)^{-1} x. \quad 5.2$$

According to Koilo and Grytten, "I_n is an *n x n* identity matrix when F is the penta-diagonal *n x n* matrix" (2019, p. 71). This can be shown theoretically as:

$$F = \begin{pmatrix} f & 0 & 0 & & 0 & 0 & 0 \\ 0 & f & 0 & \cdots & 0 & 0 & 0 \\ 0 & 0 & f & & 0 & 0 & 0 \\ & \vdots & & \ddots & & \vdots & \\ 0 & 0 & 0 & & f & 0 & 0 \\ 0 & 0 & 0 & \cdots & 0 & f & 0 \\ 0 & 0 & 0 & & 0 & 0 & f \end{pmatrix}. \quad 5.3$$

The cycle component can be calculated by subtracting the estimated trend from the actual time series.

$$c_t = x_t - g_t. \quad 5.4$$

Given the emphasis on relative gaps rather than absolute values in our analysis, in addition to significant variation in the numerical magnitudes, we utilize the logarithm of the components, expressed as:

$$\log(c_t) = \log(x_t) - \log(g_t). \quad 5.5$$

We can apply the HP filter minimization problem expressed in equation (5.1) on equation (5.2) to obtain the following relationships:

$$min_{g_t}\sum_{t=1}^{T}(x_t - g_t)^2 = x_t - \lambda\sum_{t=2}^{T-1}[(g_{t+1} - g_t) - (g_t - g_{t-1})]^2, \quad 5.6$$

where the left-hand side of the equation displays the estimated cycle component, or the residual. Using equation (5.6) on equation (5.5) allows us to derive the relative cycles, which aligns with our objective:

$$\log(c_t) = \log(x_t) - \log(\lambda\sum_{t=2}^{T-1}[(g_{t+1} - g_t) - (g_t - g_{t-1})]^2). \quad 5.7$$

Lambda ranges between zero and infinity and plays a pivotal role in deciding the smoothness of the estimated trend. A higher lambda prioritizes the second term of equation (5.1), resulting in a more gradual and smoother trend estimate. Conversely, a lower lambda allows the estimated trend to follow the data more closely, potentially capturing shorter-term fluctuations. High smoothing parameters, therefore, result in larger fluctuations in the cycles than lower ones.

Conventional practice involves setting λ=1,600 for quarterly figures and λ=100 for annual figures (Backus & Kehoe, 1992; Kydland & Prescott, 1990). Nonetheless, it is important to consider specific characteristics of the data and the context of the analysis when setting a lambda value. In the case of the Norwegian economy, which is relatively small and vulnerable to random fluctuations in individual sectors and investment projects, a higher lambda value may be necessary to accurately capture real business cycles rather than short-term variations (Eika & Lindquist, 1997). Grytten (2011) argued for multiplying the general lambda values by 25 for Norwegian figures. This results in a lambda value of 2,500 for annual figures and 40,000 for quarterly figures, which are the values we have adopted in this thesis.

While the HP filter is a broadly accepted method for detrending and analyzing economic and financial data, it is important to acknowledge its limitations. First, it is noteworthy that the filter has the potential to generate business cycles even when the original data does not inherently exhibit such patterns (Cogley & Nason, 1995). Second, selecting an appropriate value for the smoothing parameter presents a challenge. This parameter significantly impacts the resulting trend and cycle, and the choice of lambda can lead to substantial variations in the estimated components. To address this issue, we have consulted relevant literature to identify the most suitable lambda value for our specific dataset.

Third, the filter has been criticized for its end-point problems in the estimation of the trend and cycle (Baxter & King, 1999). These issues arise because the filter employs a combination of both forward- and backward-looking observations in its calculations. At the two end points, however, only a single data point is available, which can lead to distortion near the boundaries. Bernhardsen et al. (2004) argue that higher values of lambda amplify the impact of fluctuations at the endpoints, emphasizing the issue. To address potential end-point concerns, one approach is to extend the time series beyond the observed period (Frøyland & Nymoen, 2000). However, data for agricultural income development and production is not available before 1970. We therefore acknowledge that the application of the HP filter to the first and last years may be susceptible to end-point problems.

5.2 Dating of Business Cycles

To assess the state of the business cycle, it is customary to compare production development against an underlying trend level. In the context of the Norwegian economy, a common indicator for production development is Mainland GDP (Statistics Norway, 2018). Therefore, we employ the above-mentioned HP filter on GDP figures to date economic cycles. We use the NBER definition for dating the business cycles along with discretionary adjustments based on Norwegian economic history. For visual representation, we use a dummy variable to distinguish between years with and without recessions.

5.3 Correlation Analysis

We use correlation analysis to examine the relationships between agricultural income to GDP and agricultural production value. To assess whether the variables coincide, lead, or lag concerning agricultural income, we generate variables with first order differences in STATA. Finally, we conduct significance tests at a five percent level. The significance test serves only as a control to assess whether there is a significant relationship between the variables, while the primary analysis involves visually assessing the interplay of the cyclical fluctuations.

6 Modifying the Aggregated Account

In the following chapter, the steps taken in the calculation of the modified aggregated account are presented in detail. These calculations form the basis for the results presented in the next chapter.

While the Grytten Committee has modified the aggregated account back to 2005, we aim to examine the performance of active farming over time to examine how the discrepancy between active agriculture and NIBIO's aggregated account has evolved over time. Recent changes in BFJ's calculation principles, along with varying access to historical data, require us to base our computations on multiple estimates at each stage of the modification process.

6.1 Step 1: Established Accounting Principles - Historical Cost and Nominal Interest Rate

As outlined in Chapter 4, NIBIO has provided us with data on nominal interest costs. Although there is existing data on real interest in the aggregated account, discrepancies in the proportions arise due to differing base years between NIBIO's and the Grytten Committee's account, as illustrated in figures 6.1 and 6.2.

To adjust for the disparate base years, we initially compute the ratio between real and nominal interest rates in 2005. Subsequently, this ratio is multiplied by the provided updated nominal interest rate to derive the real interest rate in the base year. The real interest rate from the updated aggregated account in respective years is then multiplied by the ratio of updated and previous real interest rate in 2005, presented in figure 6.3. While acknowledging the inherent imprecision in this approach, we consider the estimate as the most accurate approximation, yielding a consistent ratio within the interest rates. Calculations behind the development are presented in the Appendix, table 10.1.

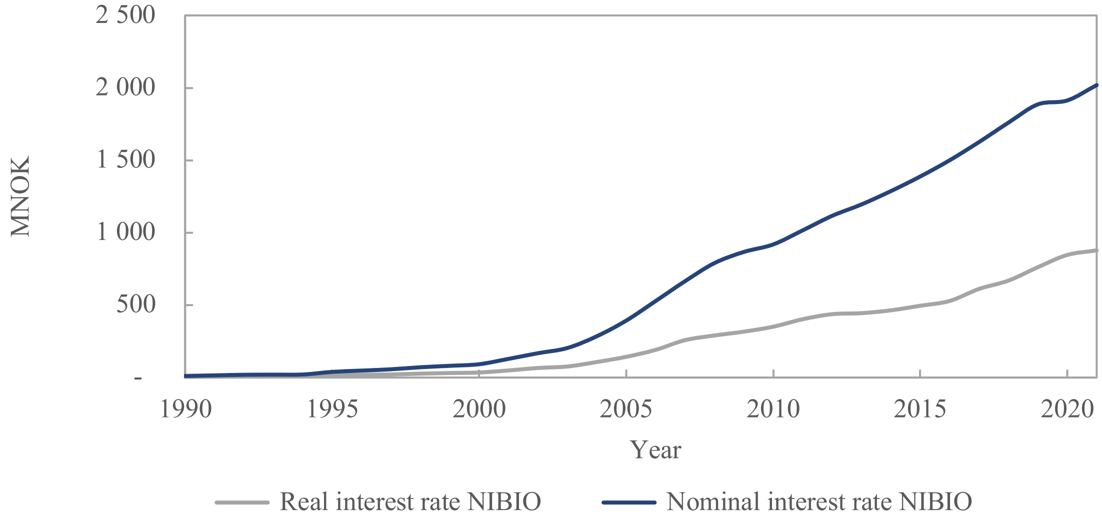

Figure 6.1*: Real and nominal interest rate, unadjusted*
Source: Norwegian Institute of Bioeconomy Research

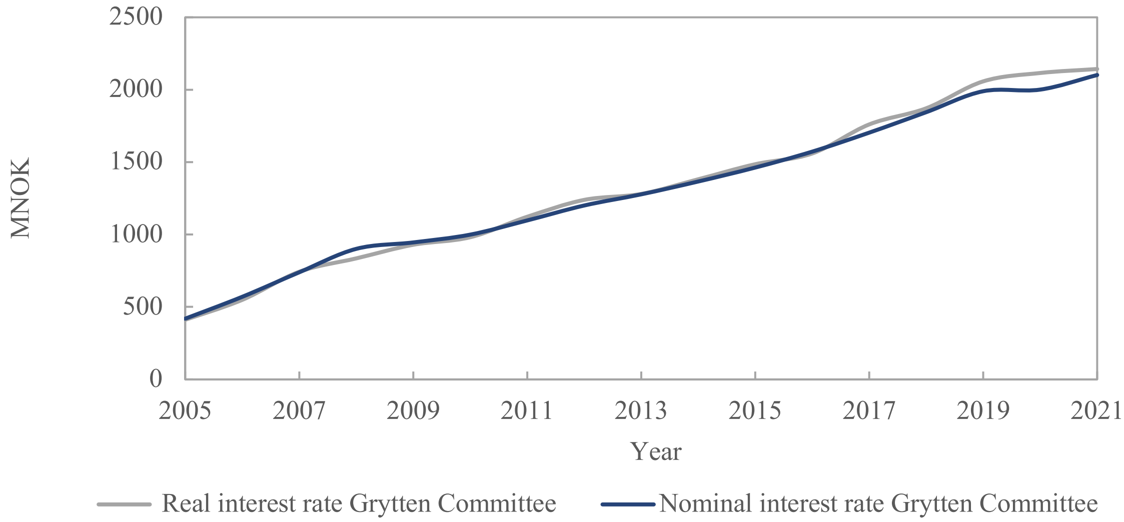

Figure 6.2*: Real and nominal interest rate, Grytten Committee*
Source: Norwegian Institute of Bioeconomy Research

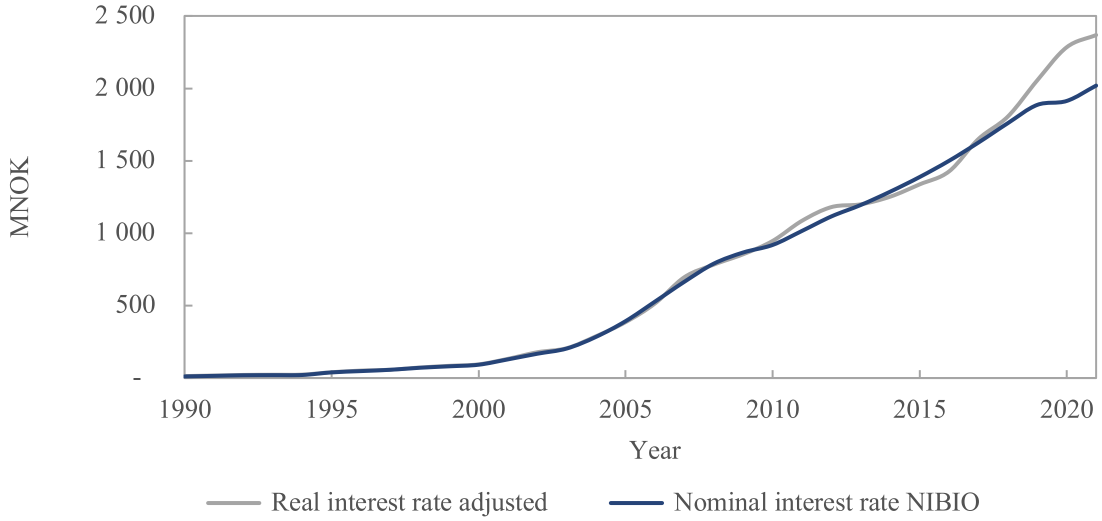

***Figure 6.3**: Real and nominal interest rate, adjusted*

6.2 Step 2: Lease of Non-Depreciable Assets - Land Quotas

The historical data on agricultural land and land leasing, while recorded annually throughout the timeframe 1970 to 2021 in censuses and samples as discussed in Chapter 4, is somewhat incomplete (Statistics Norway, 2023e). In the sample surveys, the average number of units and agricultural land in active operation from 1970 to 1980 is six percent lower than in the comprehensive censuses (Statistics Norway, 1980). The reason is that agricultural properties not operating as independent businesses in 1969 were excluded from that year's agricultural census and were not part of the sample. Some of these properties have since become independent, as owners took over the operation of previously leased land or initiated cultivation on formerly unused land. This increase is not reflected in the annual sample surveys.

When comparing figure 6.5, which incorporates sample surveys, to figure 6.4, which exclusively depicts agricultural censuses, we observe notable inconsistencies in the underlying calculations. Due to limitations in the data foundation of the sample surveys, we employ a level-log regression to estimate the total area, as illustrated in figure 6.6. Despite the simplicity of this approach, we consider a logarithmic annual growth between agricultural censuses to be more realistic than relying on data from the sample surveys, given their inherent weaknesses. Numbers from censuses and sample surveys are presented in Appendix table 10.3.

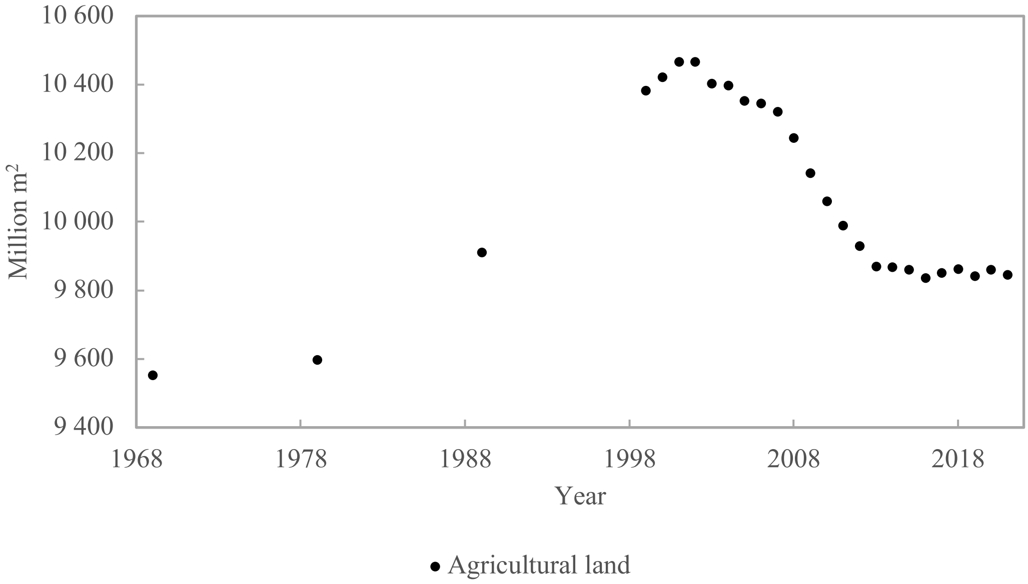

Figure 6.4*: Agricultural land, censuses*
Source: Statistics Norway

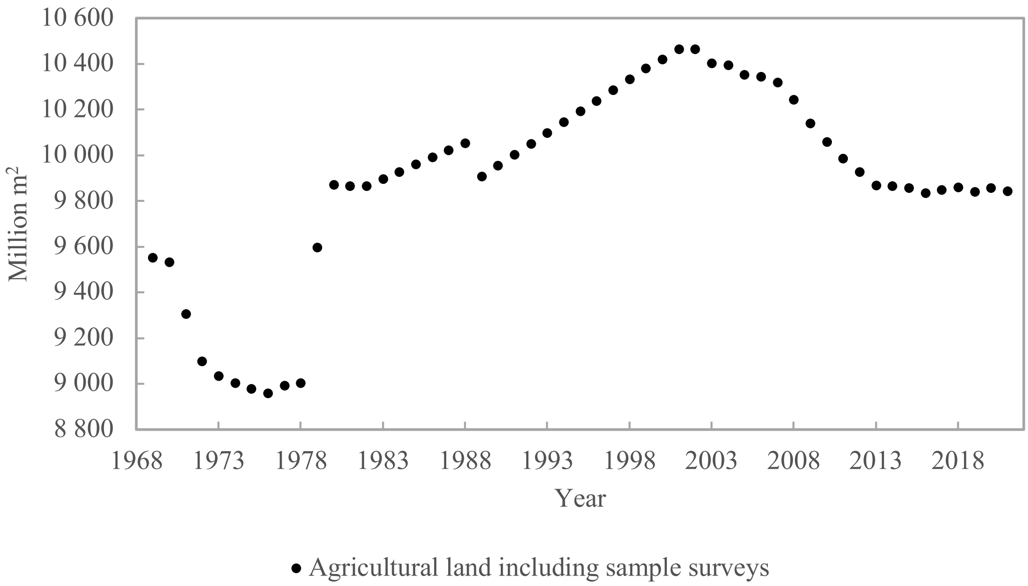

Figure 6.5*: Agricultural land, censuses and sample surveys*
Source: Statistics Norway

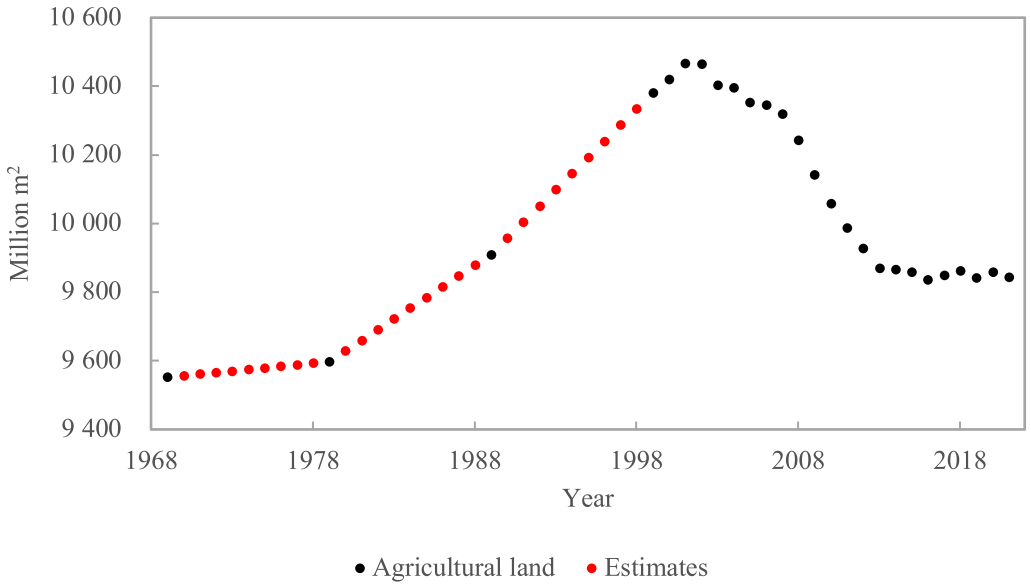

Figure 6.6*: Agricultural land, censuses and estimate*
Source: Statistics Norway

For the proportion of leased land, there is no data available from sample surveys, and data from 2021 has not been published yet (Statistics Norway, 2021b). We generate estimates for the interim years, illustrated in figure 6.8, as the trend indicates diminishing growth, illustrated in figure 6.7. Consequently, we estimate the trend using a logarithmic trendline by interpolating between the agricultural censuses. We acknowledge the limitations of such an estimate but lacking a solid basis to project the interim developments, we believe that a declining growth model is more accurate than linear interpolation. The calculations are presented in table 10.4 in the Appendix.

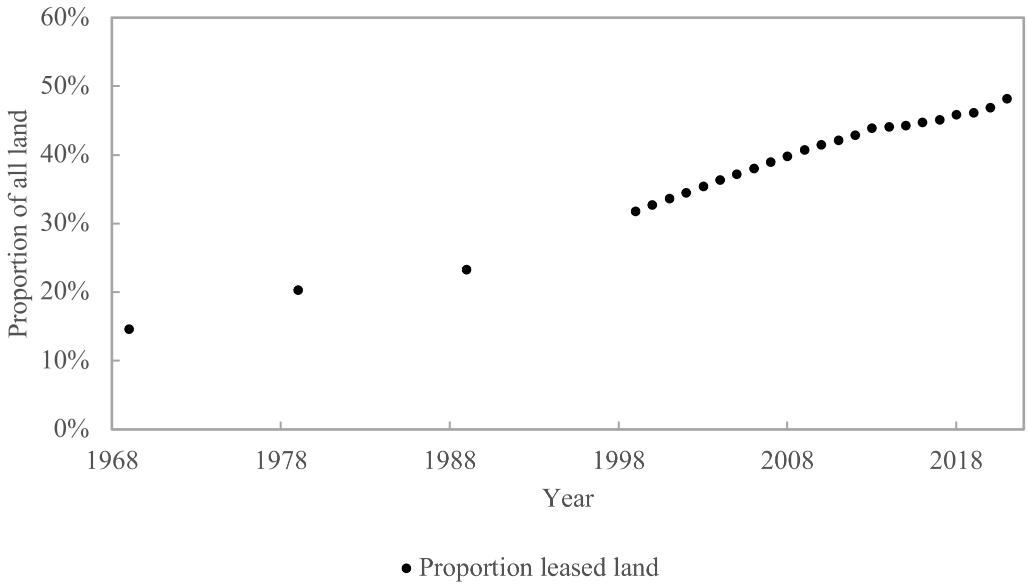

Figure 6.7*: Agricultural land, leased proportion*
Source: Statistics Norway

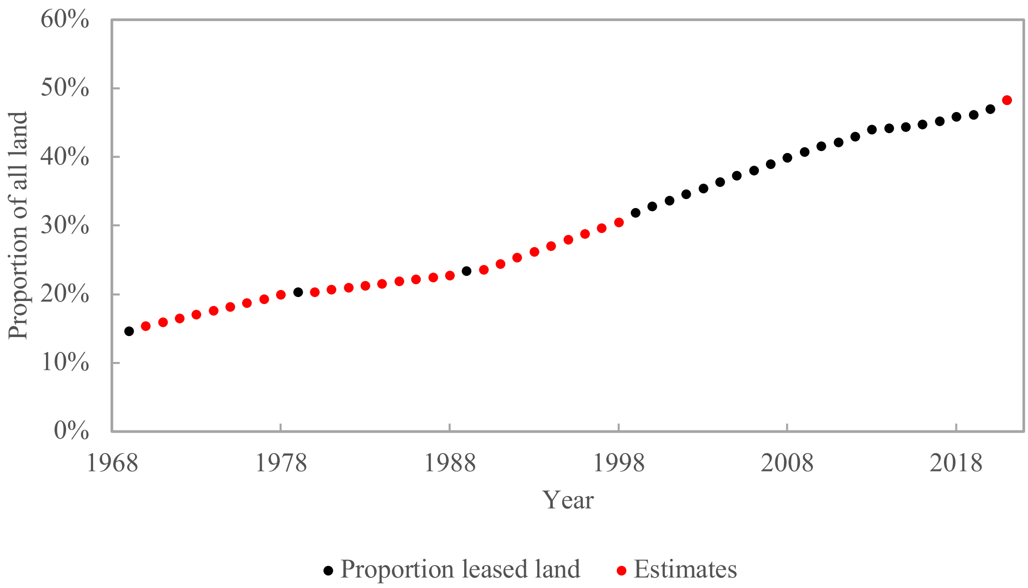

Figure 6.8*: Agricultural land, leased proportion, estimate*
Source: Statistics Norway

There is no sector-specific data available for the cost of leased land. However, NIBIO's FADN compiles statistics at an individual unit level on leased areas and the cost of leased land. This enables the calculation of the cost per acre by dividing these two variables (Norwegian Institute of Bioeconomy Research, 2022). Digital records of the FADN data are accessible from 1997 onwards, while we have accessed data from NIBIO's physical offices in Bergen from 1970 to 1996. Before 1974, the proportion of the leased land was negligible, and therefore, this specific statistic was not compiled. To estimate the cost of the leased land, we assume exponential growth to estimate the values for the period between 1970 and 1974. These estimates are based on the subsequent three years, 1974, 1975, and 1976. This approach is justified by the discernible exponential growth trends observed in both the cost and the leased areas, as depicted in figures 6.9 and 6.10. Data foundation from FADN and estimations are presented in table 10.5.

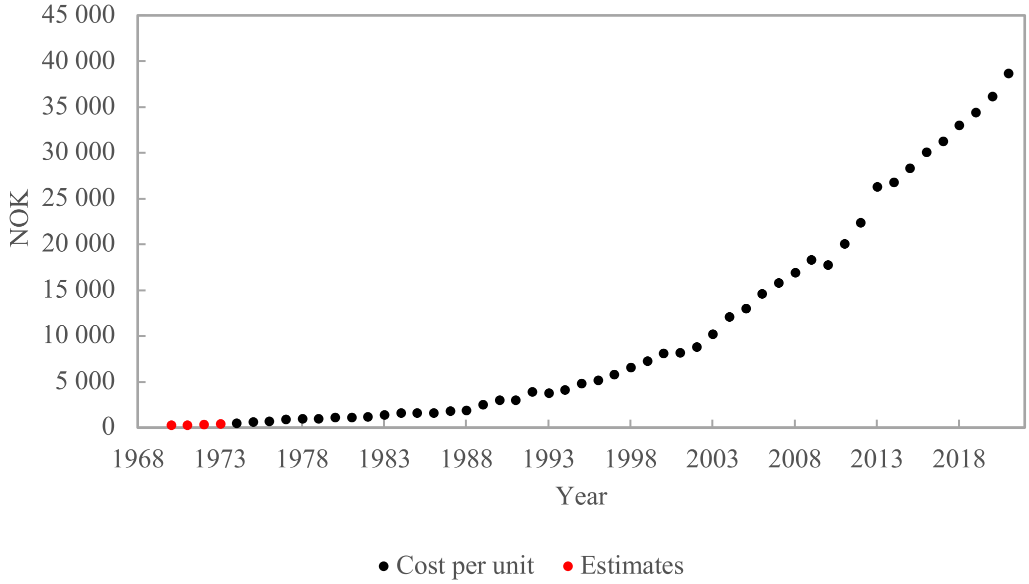

Figure 6.9*: Leased land, cost per unit, estimate*
Source: Farm Accountancy Data Network, Norwegian Institute of Bioeconomy Research

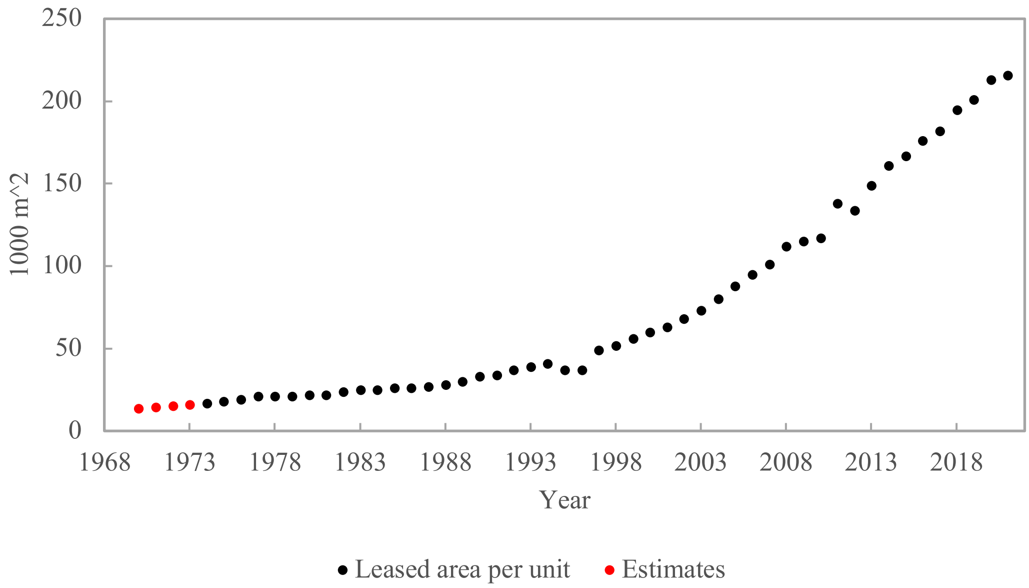

Figure 6.10*: Leased land, 1000 m*^{2} *per unit, estimate*
Source: Farm Accountancy Data Network, Norwegian Institute of Bioeconomy Research

A portion of the land is leased from other active entities and must be accounted for to reflect the active farming. This involves the gross recording of land leased as an expense for all leased areas, with an income offset for the portion leased from other active entities. However, no historical statistics on the percentage of the land leased from other active farms are recorded, except for one survey conducted by the Agricultural Directorate in 2020, which states that 3.5 percent of the land is leased from other active entities (NOU 2022: 14). In an email, Oddmund Hjukse, senior advisor at NIBIO, states that there is insufficient data to estimate for historical periods. Furthermore, it can be questioned whether the price per acre is representative of the land leased from active entities, given substantial variations in prices across different productions and regions. The uncertainty regarding both percentage and price estimates extending back to 1970 is therefore considerable. However, in the absence of more sufficient data, a consistent percentage is employed throughout the entire period. This approach is justified by the modest overall magnitude of the leased land, which also diminishes even further in earlier periods.

As we adjust for the lease income from non-active farmers, we must also consider the related interest expense, which reduces the net lease cost. The interest is calculated based on the land lease cost for active entities, corresponding to the lease income for the non-active ones. This is determined using a two-step index approach based on the volume in 2005, as calculated by NIBIO for the expert committee (NOU 2022: 14). This is done by first calculating an annual interest cost at a fixed interest rate (2005), and then fluctuating this with the nominal interest rate from the central bank of Norway (The central bank of Norway, 2007). We estimate that interest follows the same volume trend as the lease but needs to be adjusted for the current year's interest rate, as detailed in the calculations in table 10.6. The step-by-step calculations of step two is presented in table 10.7.

6.3 Step 3: Expensing Hired Labor

The measure of the owner's pre-tax earnings is determined by expensing hired labor while excluding the associated FTEs. Historical data on hours of hired labor is available in Statistic Norway's labor surveys, along with data on the cost of hired labor in NIBIO's FADNs. However, due to varying quality and coverage of historical data, several estimations and assumptions are made.

Precise data on the count of FTEs for hired labor is unavailable. However, Statistic Norway's labor surveys have provided frequent gender-segmented overviews of the hours dedicated to hired labor in agriculture since 1937 (Statistics Norway, n.d.c). Nevertheless, there are sporadic gaps in the data materials, for instance no statistics between 1957 and 1968, as seen in figure 6.11. For the years 1969 and 1971, the hours for self-employed and hired labor are combined (Statistics Norway, 1983, p. 85). We calculate an estimate for the proportion of hired labor based on the graphical representation in figure 6.12, using interpolation with available data as far back as 1956. Numerical values are presented in Appendix table 10.8 and 10.9. Examining the plot, we recognize an exponential trend over the years, though it is a bit less definite for women than for men.

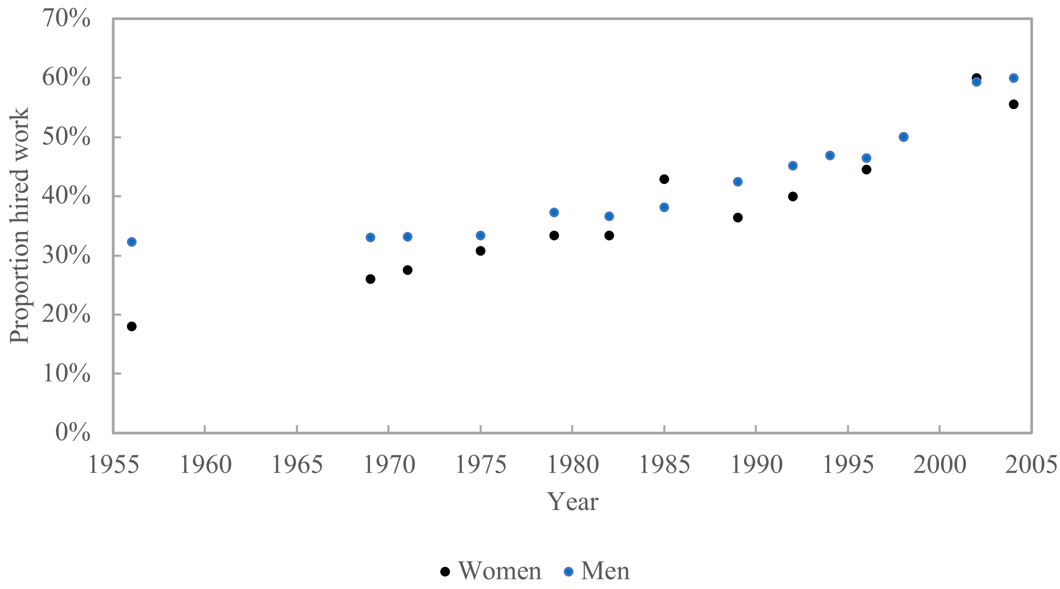

***Figure 6.11**: Proportion hired labor*
Source: Statistics Norway

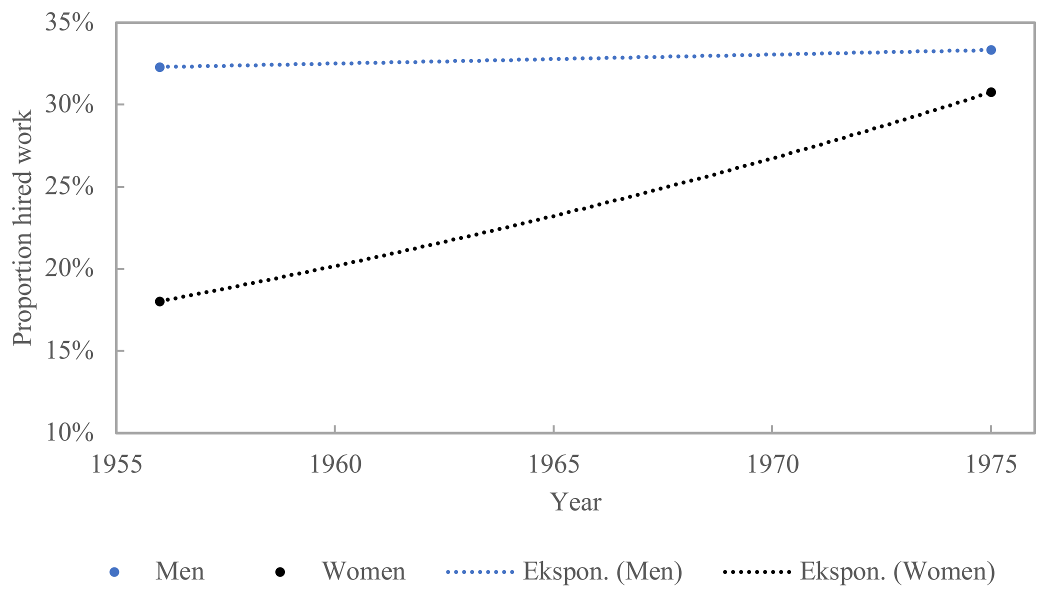

Figure 6.12: *Proportion hired labor, estimate*

The total number of hours for hired labor is missing for several years. This is due to the annual agricultural survey focusing on workforce every second or third year, and not recording hired labor in the intervening years (Statistics Norway, 2006). Based on the plot in figure 6.13, the volume of hired labor exhibits an annual decrease in the number of hours from 1950 to around 1975, before stabilizing at approximately 20 million annual hours. We estimate the hourly count by interpolating between preceding and subsequent year measurements, except for 1970 and 2003. For these years, we also use data from 1956, and 2005 and 2006, respectively, to calculate a better estimate considering the trend. There is no data in the intervening years, but we consider a decreasing trend more likely than a linear relationship, as illustrated in figure 6.13. These estimates allow us to approximate the number of FTEs for hired labor. Numerical values and estimations are presented in table 10.10.

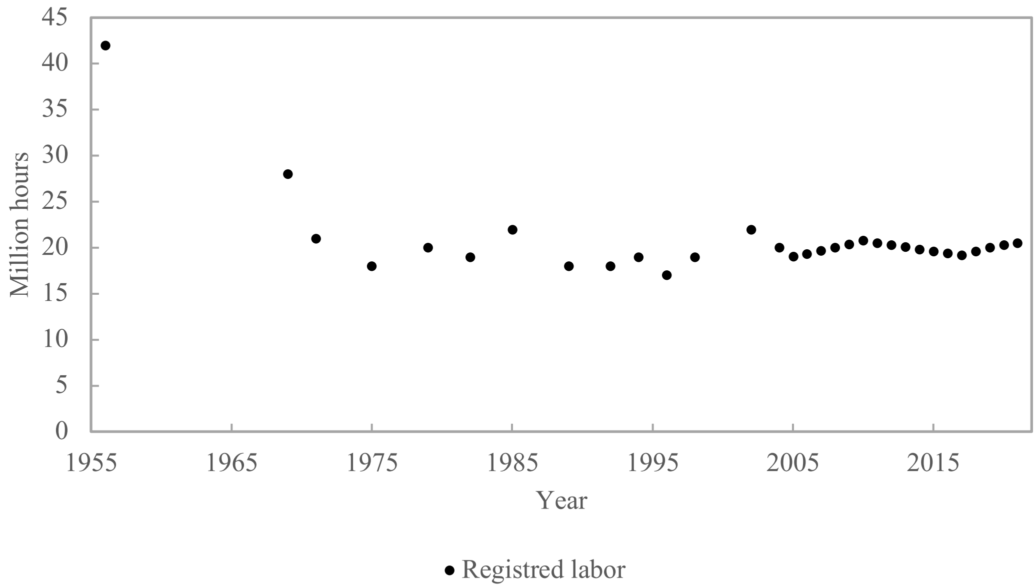

Figure 6.13: *Hired labor, registered hours*
Source: Statistics Norway

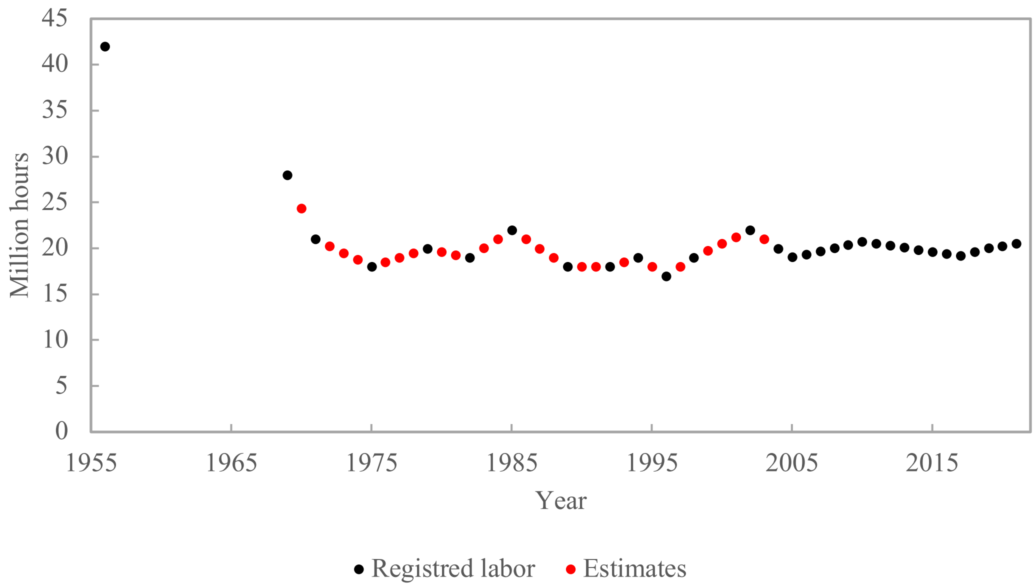

Figure 6.14: *Hired labor, registered hours and estimates*
Source: Statistics Norway

Furthermore, not all hired labor is compensated. FADN's table 7 provides an overview of the number of hours of paid and unpaid labor per farm, dating back to 2002 (Norwegian Institute of Bioeconomy Research, 2023b, p. 150). The associated costs of hired labor in the main table 13b are only linked to the paid portion, making it necessary to estimate the ratio of paid to unpaid labor back in time.

The visual representation of the proportion of paid labor in figure 6.15 shows variations between 74 and 81 percent in the years 2002 to 2021. There is no clear trend throughout the entire period, but we can discern a development indicating a lower proportion of paid labor in earlier years. This observation aligns with the broader societal trend characterized by stricter regulations related to unpaid and unreported labor in more recent years. Consequently, we use the years 2002 to 2006 as a starting point to estimate the trend back in time. We employ a logarithmic function, where the proportion of paid labor is lower, but with an expectation that the decline will diminish the further back we go. In the absence of relevant historical statistics, this approach reflects our understanding of the proportion of paid labor in a historical context.

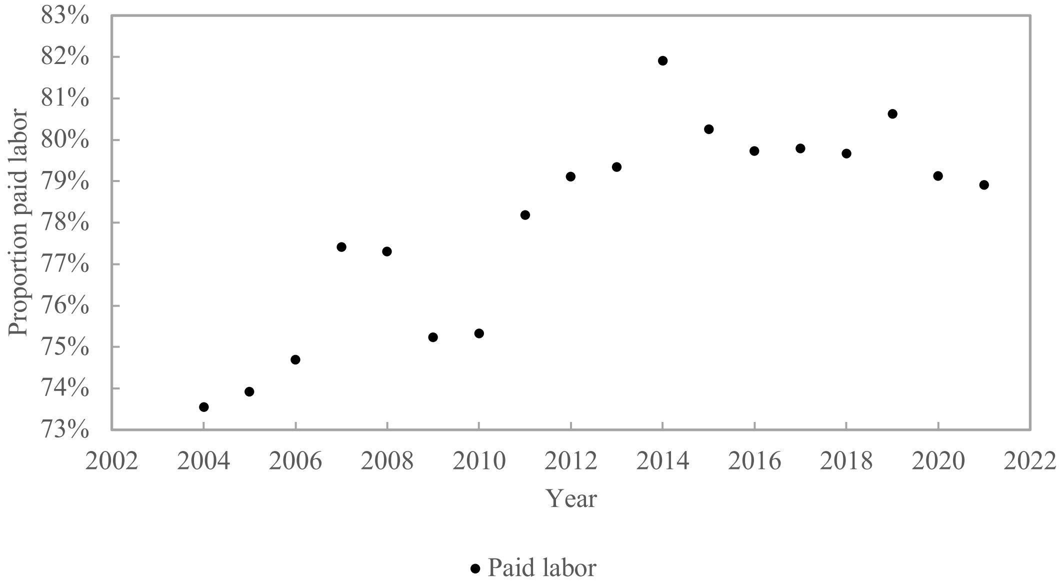

Figure 6.15*: Proportion paid labor*
Source: Norwegian Institute of Bioeconomy Research

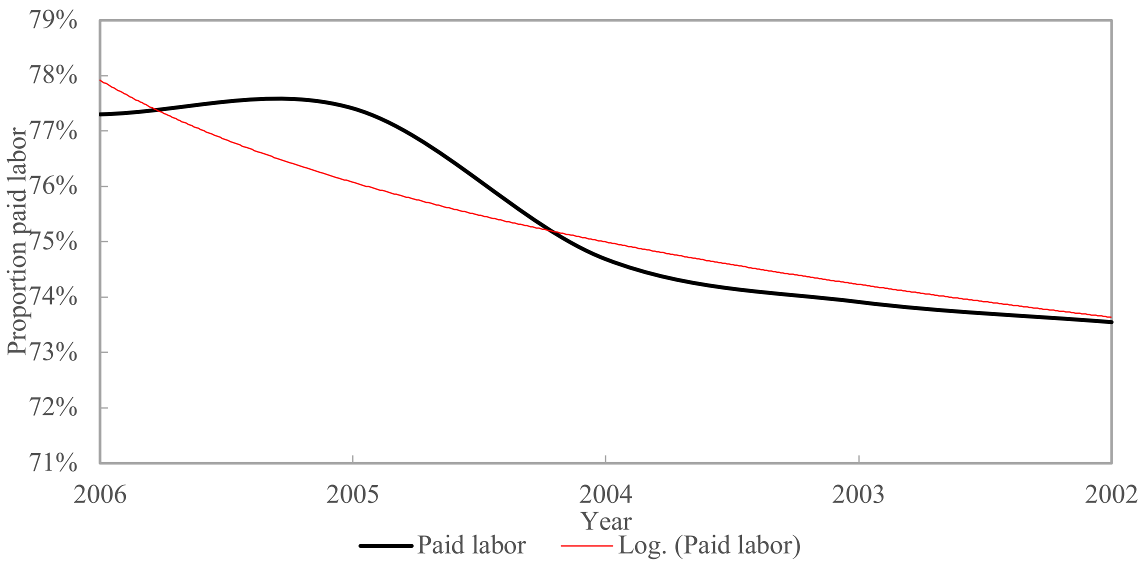

Figure 6.16*: Proportion paid labor, estimate*

For the years 1972 and 1973, NIBIO lacks statistical data on hours of hired labor, regardless of whether it was paid or unpaid. Even though we have estimated the proportion of paid labor, we lack the specific number to derive this ratio. Examining the trend for hours of hired labor in the other years of the period, does not reveal a clear pattern. Consequently, we opt to use the average of the two preceding years and the three subsequent years to estimate the number of hours in 1972 and 1973. This results in an average of 652 hours per entity, as indicated in table 6.17. Numerical values and calculations of both the paid ratio and total hours are presented in table 10.11.

Figure 6.17*: Hired labor per entity, total hours paid and unpaid, estimate*
Source: Norwegian Institute of Bioeconomy Research

We locate the unit costs for hired labor in FADN's table 13b (Norwegian Institute of Bioeconomy Research, 2023b, p. 168). Before 2002, the statistics are somewhat different compiled. As mentioned earlier, there is no distinction between paid and unpaid labor in the years prior to 2002 in table 7. The unpaid work is instead categorized as "voluntary work" in table 13b for those preceding years. This data is available in terms of hours in table 7 for the years 1995 to 2001. Prior to 1995, both social expenses, relief workers, and voluntary work were combined under the category "hired labor" (Norwegian Institute of Bioeconomy Research, 1996). To isolate the actual cost of paid work, we estimate the proportion of voluntary work in the years 1970 to 1994, before excluding this from the calculations. In this plot, there is no apparent visual trend. However, to mirror the decreasing trend in paid work during time, as shown in figure 6.18, we estimate a declining increase in the proportion of voluntary work, as depicted in figure 6.19.

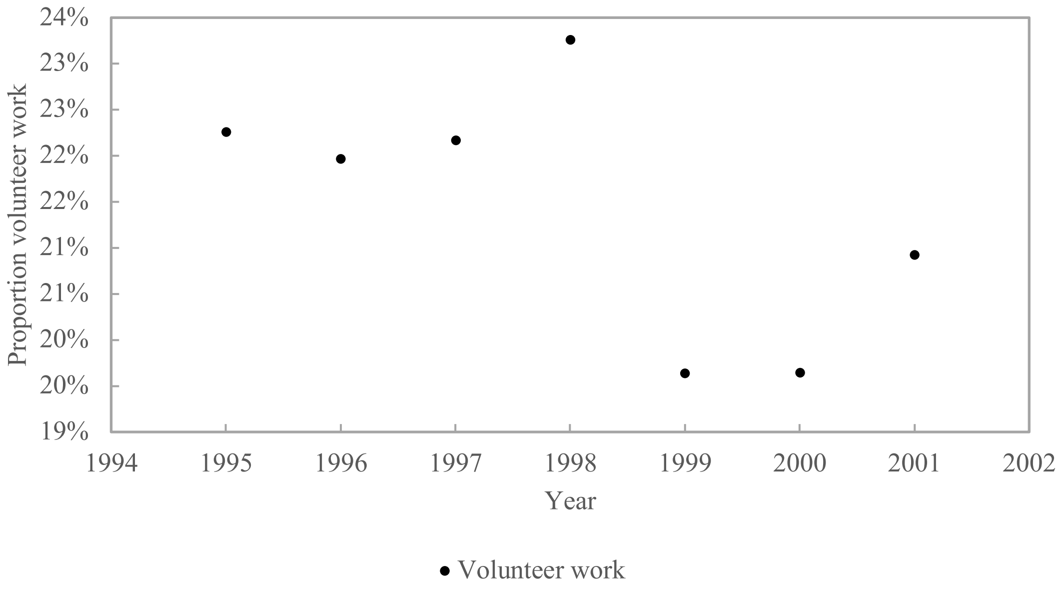

Figure 6.18*: Proportion volunteer work*
Source: Norwegian Institute of Bioeconomy Research

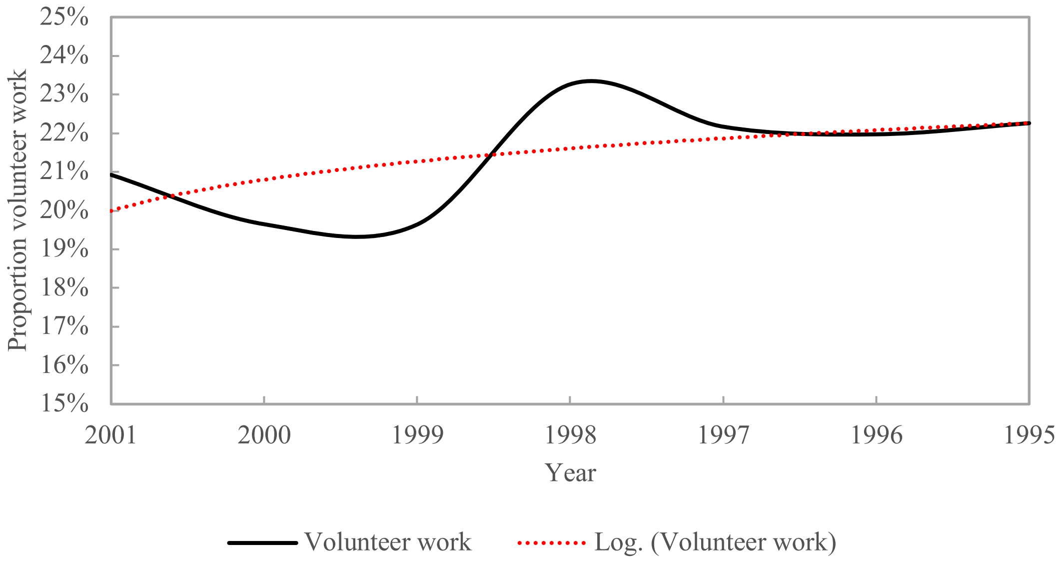

Figure 6.19*: Proportion volunteer work, estimate*

Finally, we also lack the total hours for hired labor for 1972 and 1973. The figures are presented in nominal values, and it is therefore most reasonable to assume a declining trend in costs back in time. The estimate is based on the two preceding and the two subsequent years in a logarithmic function. See figure 6.20 and 6.21 for a visual representation. Numbers and calculations for volunteer work and the total cost of hired labor are presented in Appendix table 10.12.

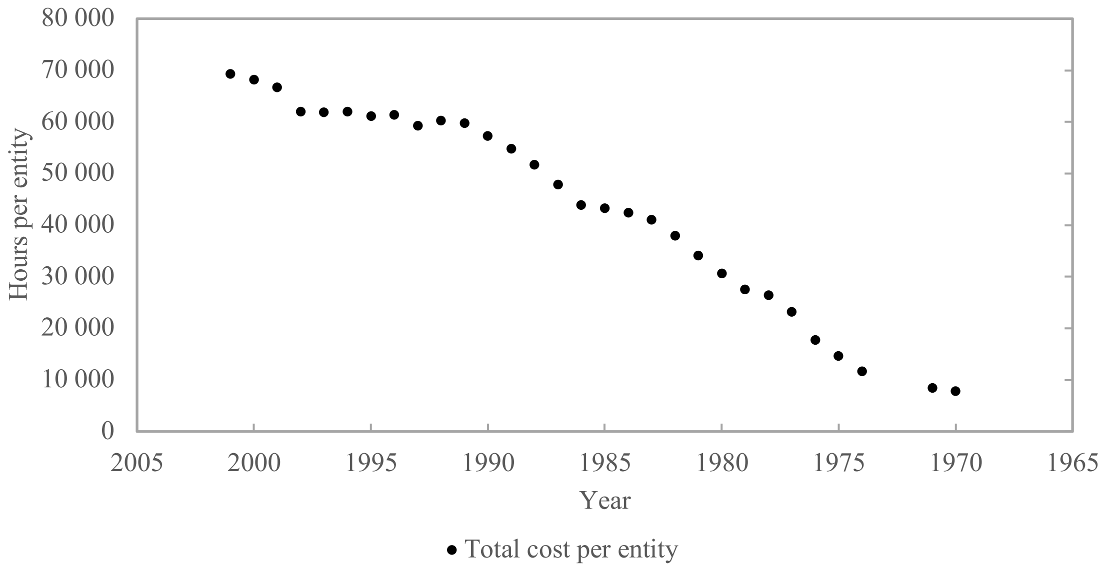

Figure 6.20*: Hired labor per entity, total cost*
Source: Norwegian Institute of Bioeconomy Research

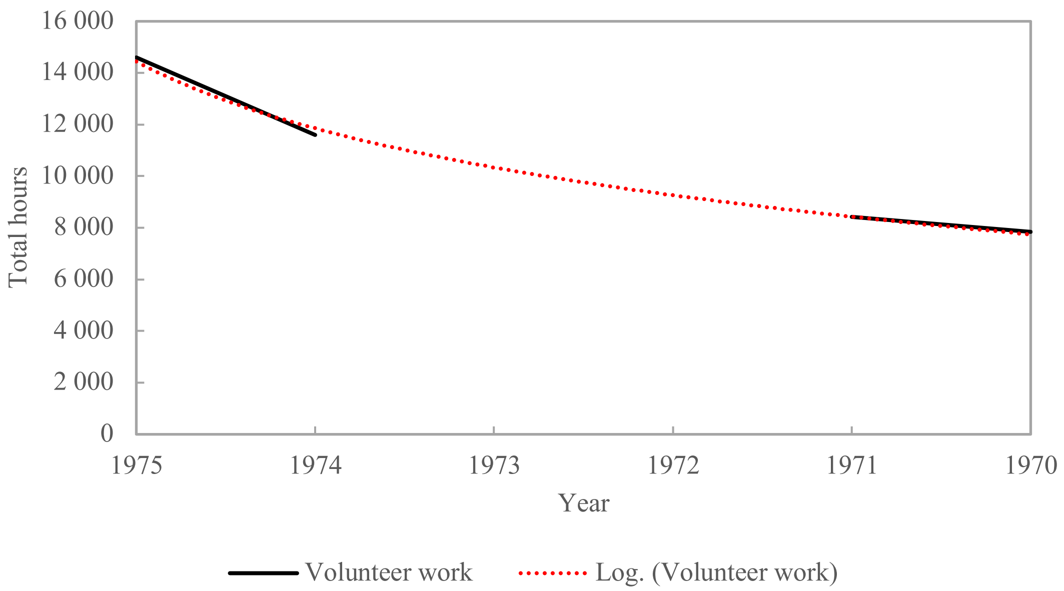

Figure 6.21*: Hired labor per entity, total cost, estimate*
Source: Norwegian Institute of Bioeconomy Research

7 Results and Discussion

In the subsequent part, the empirical results are presented and discussed. First, we describe the findings from the modified aggregated account, followed by the presentation and discussion of cycle deviations obtained through the HP filter. Additionally, we conduct correlation analyses to assess the strength and direction of the relationships.

7.1 The Modified Aggregated Account

The modified aggregated account, on average, yields a lower pre-tax result than return on labor and own capital according to NIBIO's calculations in December 2023. The isolated effects of each step are presented in table 10.2, 10.7 and 10.13. Over the entire period from 1970 to 2021, the modified version's pre-tax annual result, on average constitutes 94 percent of the aggregated account's return on labor and own capital per FTE. However, there are significant variations between years, and the modified version ranges between 82 and 107 percent of NIBIO's published aggregated account.

The green line in figure 7.1 represents the aggregated account after step 1 – historical cost and nominal interest. Both land lease and hired labor contribute to reducing the overall income. Historical cost and nominal interest, in most cases, increase the result because non-adjusted capital depreciation and leasing are lower than inflation-adjusted values. Simultaneously, this series varies to a much greater extent than steps 2 and 3 due to significant fluctuations in the real interest rate, as illustrated in the relative change statistics in figure 10.14. In 2022 values, historical cost and nominal interest impact income anywhere from an increase of NOK 31,000 to a decrease of 21,000.

In the blue line, the cost of the leased land is subtracted from the green line. The cost of the leased land reduces the result per FTE by a range of 1,300 to 20,000 NOK, illustrating a clear increasing trend in costs over time. This increase aligns with the overall development, as the leased land area has grown by nearly 1,600 percent from 1970 to 2021.

The black line illustrates the impact of the cost of hired labor on the aggregated account, accumulated with the previous steps. Hired labor reduces the pre-tax result by amounts ranging from 6,000 to 35,000 NOK in 2022-values. However, there is no clear trend regarding increased costs, despite the significant increase in the proportion of hired labor from 6.5 to

26.4 percent throughout the period. At the same time, there are substantially fewer FTEs in the agricultural sector now than in 1970, which reduces the overall number of hours for hired labor.

Except for the period 1989 to 1998, when the figures for capital depreciation and real interest rates were particularly high, the modified aggregated account, on average, yields a lower pre-tax result than the original return on labor and own capital.

Table 10.14 in the Appendix illustrates the development of the relative difference between the modified and original account over the period. A ten-year moving average demonstrates a clear increase in percentage discrepancies between the two versions, suggesting significant changes in agricultural operations since 1970. This is particularly emphasized in step 2 through a growing share of leased land, emphasizing the need for a revision of the data foundation in the total calculation in line with the development of the agricultural sector.

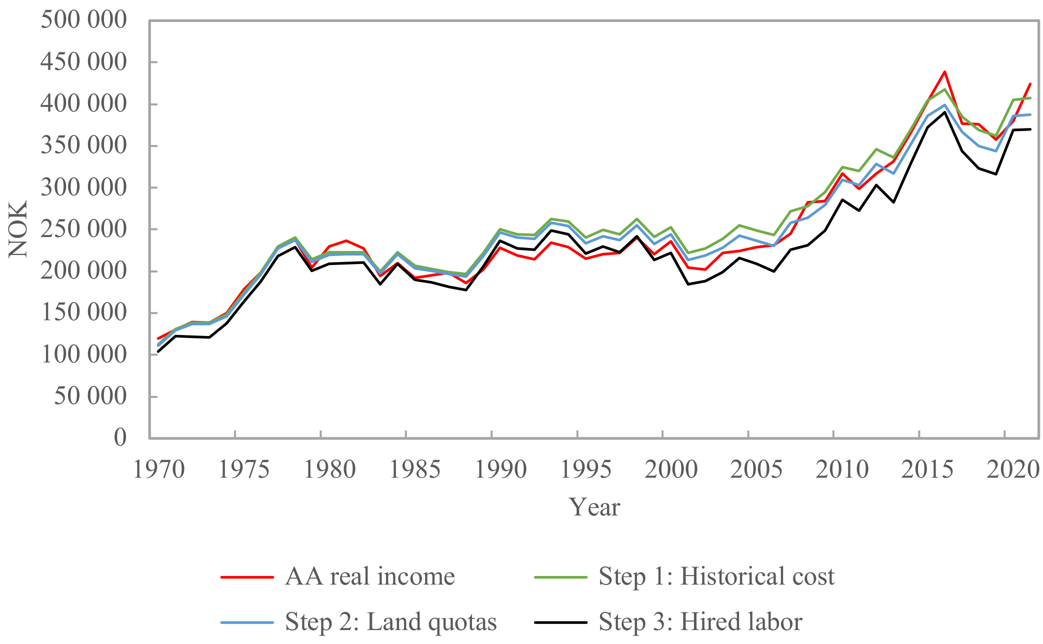

Figure 7.1*: Return on labor and equity 1970 to 2022. All modification steps employed, real 2022-values*

Table 7.1: Modification, all steps

Year	BFJ April 2022	Step 1: Historical Cost	Step 2: Land Quotas	Step 3: Hired Labor
1970	12 461	11 715	11 575	10 836
1971	14 544	14 571	14 397	13 687
1972	16 532	16 460	16 244	14 422
1973	17 747	17 731	17 473	15 420
1974	20 997	20 749	20 443	19 242
1975	27 893	27 248	26 882	25 630
1976	33 871	33 969	33 559	32 050
1977	42 604	42 836	42 341	40 735
1978	47 905	48 380	47 805	46 025
1979	43 163	45 199	44 600	42 285
1980	53 766	52 075	51 404	48 772
1981	62 805	59 152	58 467	55 610
1982	67 282	65 894	65 186	62 165
1983	62 415	64 114	63 294	59 226
1984	71 691	76 121	75 148	71 366
1985	69 163	74 354	73 385	68 417
1986	75 304	78 382	77 395	71 982
1987	83 236	83 690	82 576	76 132
1988	83 183	87 963	86 758	79 571
1989	94 552	103 915	102 333	96 479
1990	111 165	122 033	120 226	115 241
1991	110 437	122 927	121 035	114 772
1992	110 593	125 563	123 158	116 778
1993	123 518	138 662	136 205	131 231
1994	122 465	138 885	136 161	130 676
1995	118 005	131 630	127 915	121 202
1996	122 482	138 754	134 431	127 623
1997	126 488	138 922	134 987	126 873
1998	140 108	152 857	148 500	141 071
1999	131 445	143 718	138 927	127 412
2000	145 211	155 315	149 963	136 616
2001	129 512	140 457	134 989	116 945
2002	129 610	145 963	140 140	120 928
2003	145 929	157 005	150 104	130 768
2004	148 098	168 134	159 946	142 183
2005	153 623	166 892	158 487	140 244
2006	158 498	167 115	157 828	136 990
2007	169 364	187 897	178 073	155 753

2008	202 730	198 968	189 159	165 544
2009	207 856	216 057	204 673	182 415
2010	237 615	243 730	232 184	213 994
2011	226 713	243 320	230 541	207 369
2012	242 660	264 656	251 068	231 599
2013	258 760	262 753	247 648	220 607
2014	291 915	294 999	280 588	262 593
2015	328 136	329 588	314 460	302 901
2016	370 246	352 391	336 614	329 318
2017	323 767	331 261	314 955	295 646
2018	332 006	325 586	309 107	285 267
2019	322 884	326 844	309 955	285 535
2020	347 319	369 811	352 737	336 953
2021	401 374	385 272	366 384	349 775

As we substitute “return on labor and equity” with the performance metric “pre-tax result”, henceforth, we formally denote this metric as “agricultural income” or “income".

7.2 Results from HP-filtering

In the following section, we present the estimates obtained through the HP filter, which hinge on our decision to employ a logarithmic transformation of the data. As a result, the cyclical movements in the variables are captured in a logarithmic format.

7.2.1 The Aggregated Account

The cyclical components of the modified and the original aggregated account are presented in figure 7.2. We do this to assess whether the two exhibit significant deviating trends, especially to identify specific periods or years when the two diverge notably. We do not expect to see such differences, given that the modification steps are applied to more modest entries in the aggregated account. We observe a close alignment in the fluctuations, although the modified version tends to exhibit slightly more volatility. The co-variation between the two suggests that they respond similarly to the same economic indicators, not exhibiting any fundamental differences. This can be attributed to the fact that the major components of the aggregated account remain unchanged.

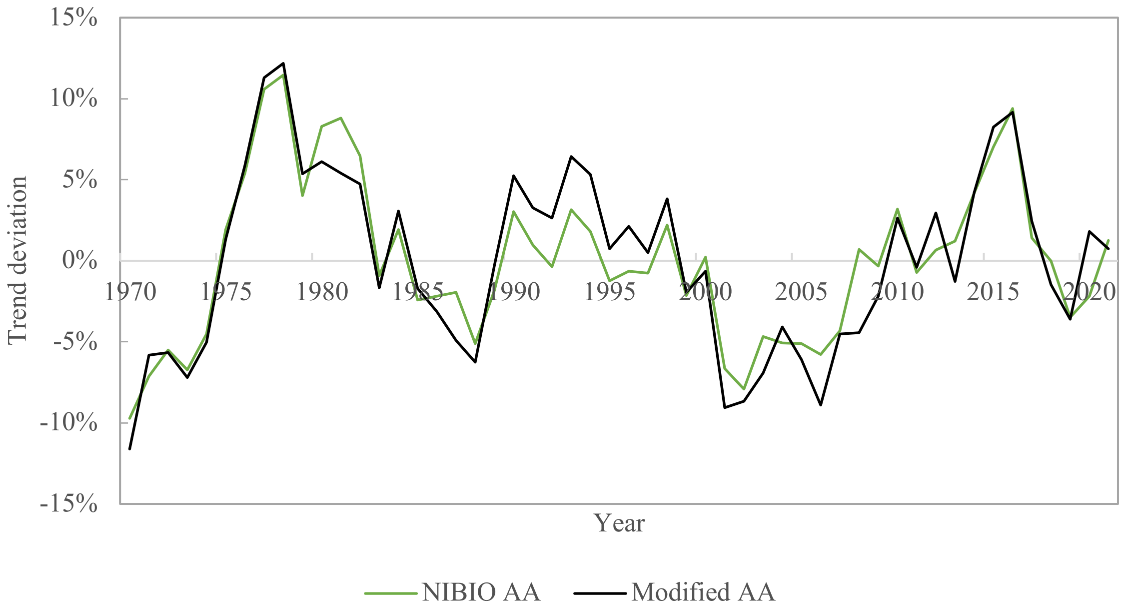

Figure 7.2: *NIBIO's and the modified aggregated account*
Source: Norwegian Institute of Bioeconomy Research, Statistics Norway

7.2.2 Dating Business Cycles

In figure 7.3, we present the results of the HP filter on annual GDP figures. The purple and grey lines correspond to the real Mainland GDP and its underlying trend, respectively. Figure 7.4 illustrates the deviations from this underlying trend, referred to as the percentage output gap, while figure 7.5 presents the output gap when applying the HP filter on quarterly GDP figures.

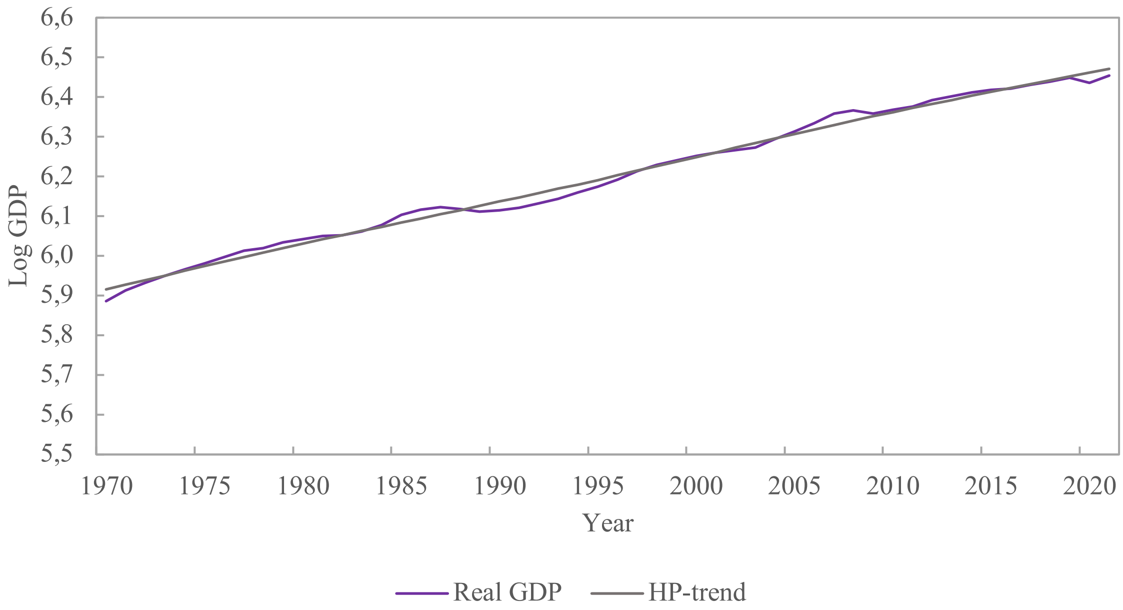

Figure 7.3*: Real GDP and trend*
Source: Statistics Norway

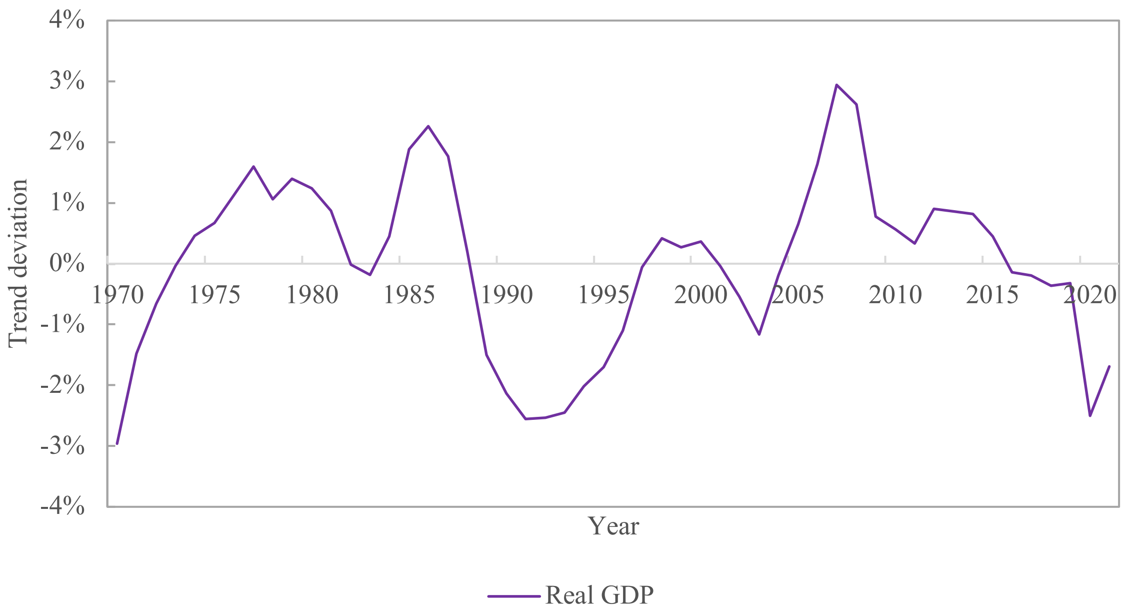

Figure 7.4*: Annual cyclical component GDP 1970 to 2021*
Source: Statistics Norway

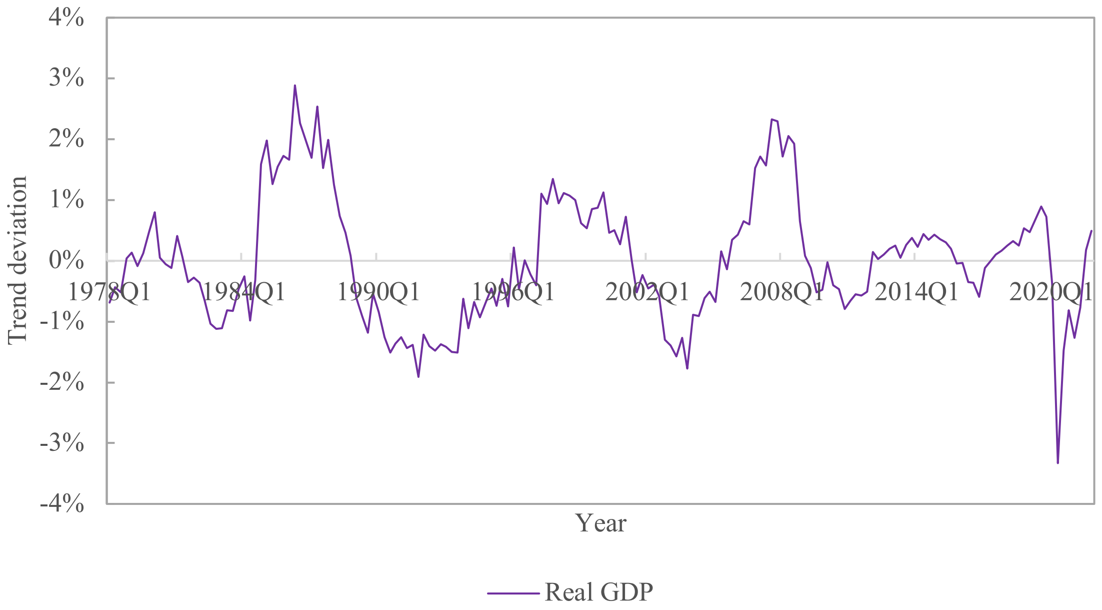

Figure 7.5: *Quarterly cyclical component GDP 1978 to 2021*
Source: Statistics Norway

We employ the output gap to date business cycles by utilizing quarterly figures between 1978 and 2021, since quarterly data is not available for the preceding years. Nevertheless, the annual data does not show any signs of recession before 1978.

When applying the NBER method and exercising discretion considering historical events during the relevant period, we choose not to designate the period between 1981 and 1982 as a recession. We contend that neither the duration nor the significance of the GDP decline justifies this definition. Recognizing the value of examining variables beyond GDP, we also plot the cyclical components of Norwegian employment, private consumption, and GNI in figure 7.6. We observe a negative deviation from the trend for employment and private consumption between 1981 and 1982, while the deviation for GNI is positive. The latter aligns with the overall economic prosperity in Norway following the oil discoveries in the 1970s.

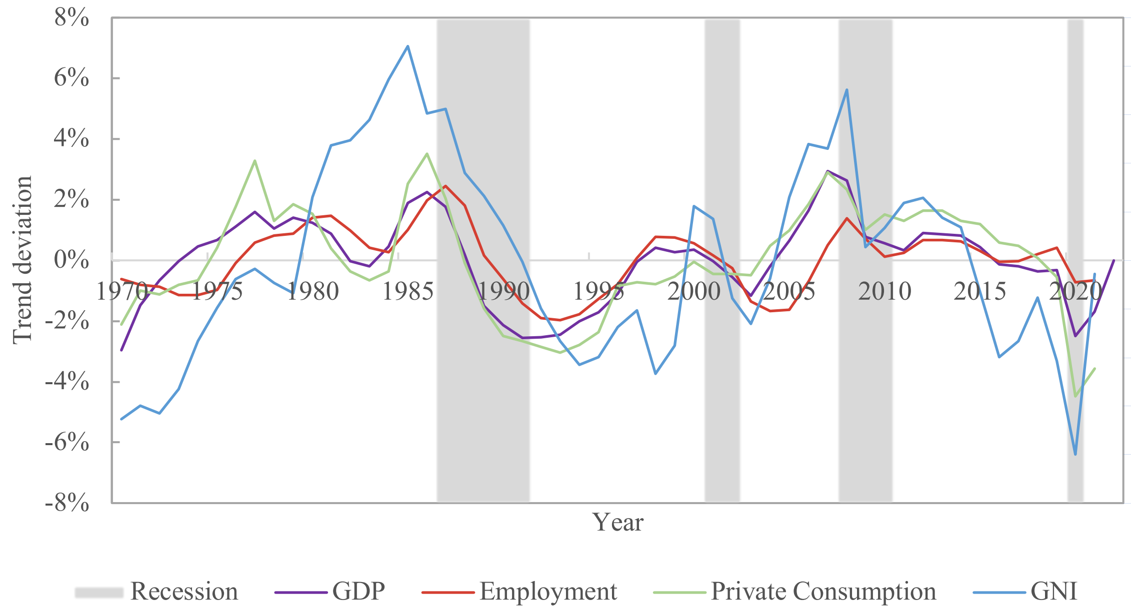

***Figure 7.6**: Economic indicators: GDP, employment, private consumption, and GNI*
Source: Statistics Norway

By using the same method, we identify the subsequent recession starting in the latter half of 1986 and ending in late 1991. This five-year span satisfies the duration requirement, and the magnitude of the decline fulfills the depth criterion. The three other economic indicators in figure 7.6 also show a decline during this period, further supporting the recession characterization. We have also presented that Norway experienced an economic downturn during this period due to the international drop in oil prices, stricter fiscal policies, and a substantial decrease in employment.

Subsequently, we observe a negative deviation from the trend in GDP, employment, and GNI, accompanied by a modest growth in private consumption from early 2001 to late 2003. During this period, Norway's economy faced increased interest rates, driven by rising wages due to the prosperity in the preceding decade. However, the recession appears relatively brief, attributed to Norway's stable financial sector.

Post-2003, Norway entered a phase of expansion until the financial crisis hit at the end of 2008, lasting until late 2010. This downturn originated from the global financial crisis, impacting Norway due to reduced demand for oil and a subsequent contraction in the Norwegian stock market, given its substantial reliance on oil. This recession period also exhibits a noticeable negative deviation from the trend in the variables in figure 7.6, aligning with the diffusion criterion.

Following the financial crisis in 2010, the economy experienced growth until the beginning of 2016. A relatively brief and moderate negative deviation from the trend emerged until the end of the year, as well as for employment and private consumption. However, GNI experienced a more substantial negative deviation. Considering the events in a historical context, the reduction in GDP can be linked to the declining oil prices. Comparing the period with other recessions in the dataset, the downturn's depth is not particularly drastic, nor can the duration be deemed significant. Following NBER's methodology and exercising discretion, we do not classify this downturn as a recession.

The most recent recession in our dataset begins in the last quarter of 2019 and extends until mid-2020. Figure 7.6 reveals a contraction in GDP, mirroring the trend observed in all other indicators. Despite the relatively short duration, we characterize the period as a recession due to its substantial depth. The recession can be contextualized within the global impact of the COVID-19 pandemic. Subsequently, we observe a quick convergence of the deviation from the trend, aligning with the significant reduction in interest rates to stimulate market demand.

Now that we have defined recession periods, they can be visualized in a figure. We opt to date the economic cycles based on quarterly GDP, seen in figure 7.7, as it provides more detailed information. Subsequently, we use these results to plot recessions as accurately as possible in figure 7.8 with annual data. While the latter representation is not as precise, it is more practical for our comparative analysis of cyclical patterns in other variables with annual data. The shaded areas in the figures denote recession periods.

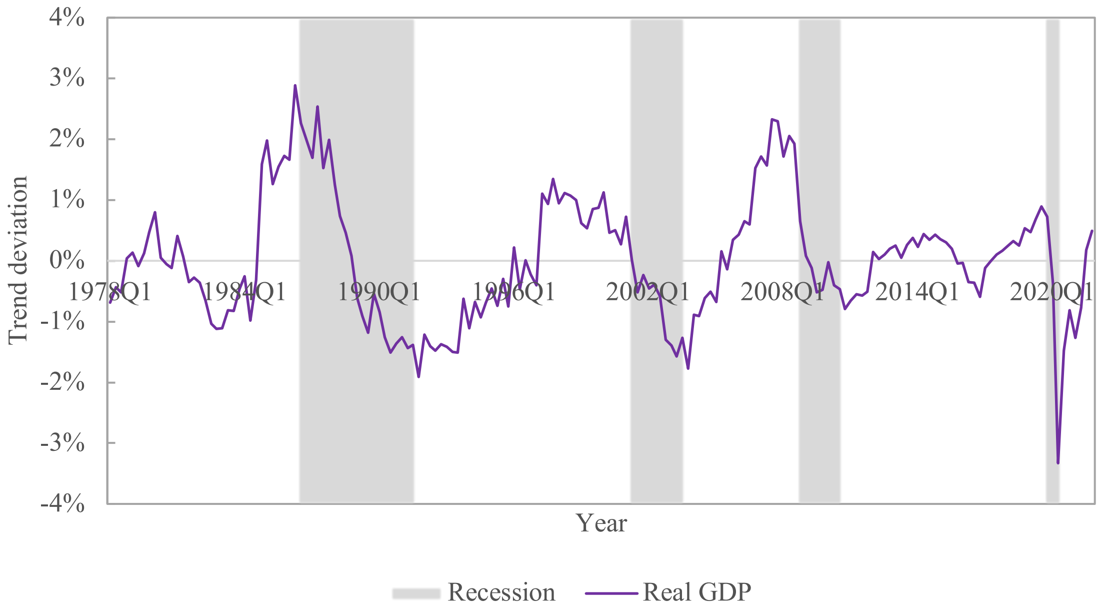

Figure 7.7: *Recessions with quarterly GDP*
Source: Statistics Norway

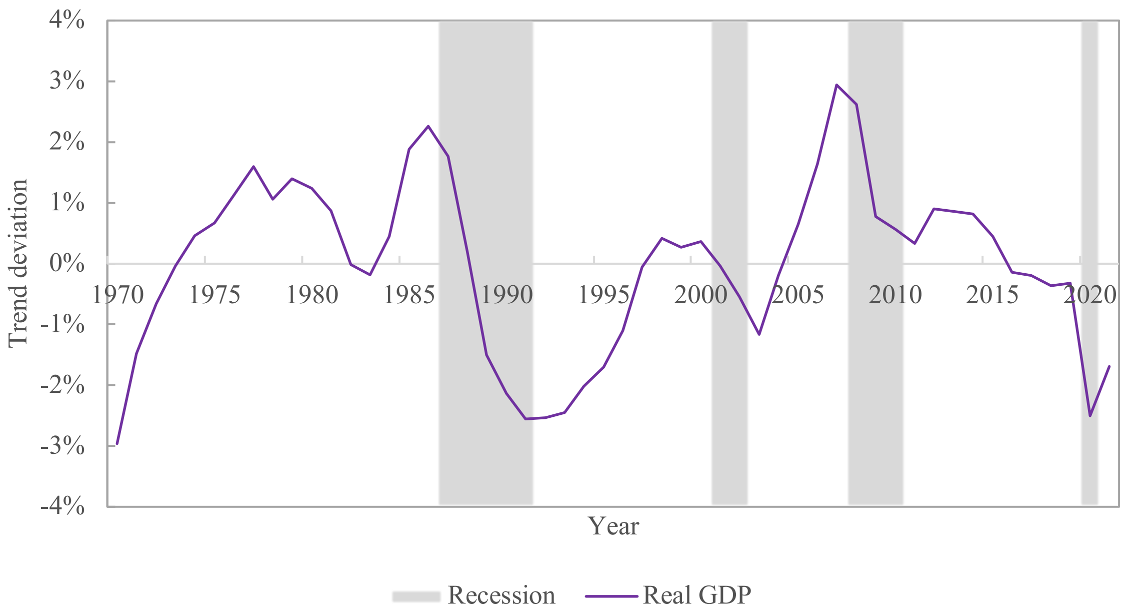

Figure 7.8: *Recessions with annual GDP*
Source: Statistics Norway

7.3 Correlations with Cyclical Components

We now aim to investigate whether the cycle component in agricultural income correlates with the output gap, as well as cycles in agricultural production, with different leading indicators.

7.3.1 Agricultural Income and Gross Domestic Product

Comparing Norwegian agricultural income to business cycles, income demonstrates more volatile cycles, presented in figure 7.9. This heightened volatility can be attributed to the specificity of agricultural income to a single sector, whereas Mainland GDP is composed of multiple sectors, making it more robust and less sensitive to various economic and non-economic factors.

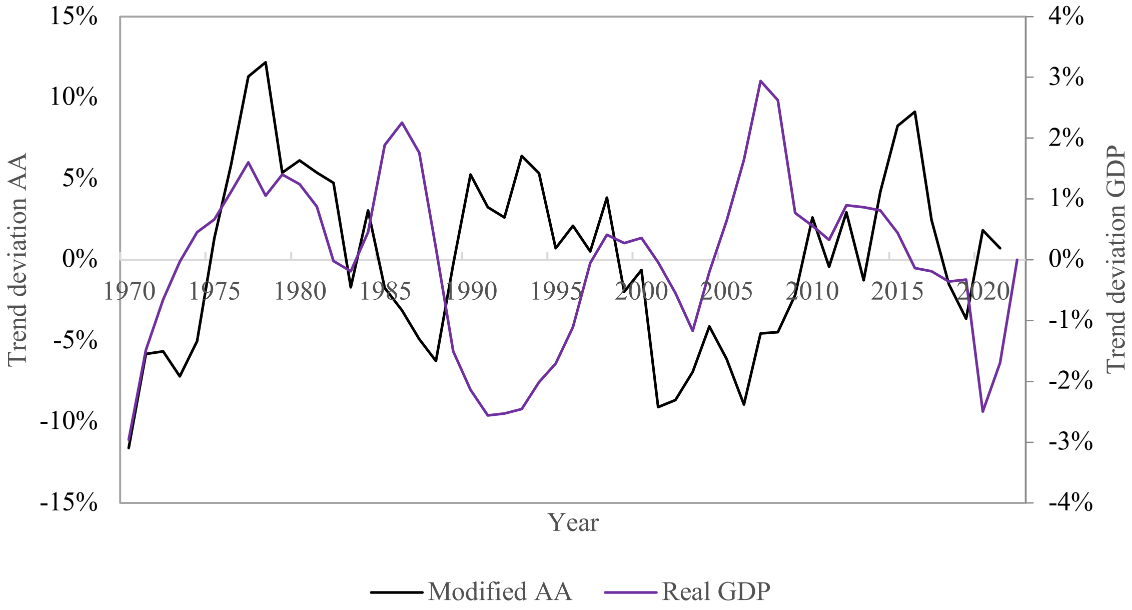

Figure 7.9: *The modified aggregated account (left axis) and GDP (right axis)*
Source: Statistics Norway

The correlation coefficients are presented in table 10.15. It shows that the variables have the highest correlation when income and GDP coincide, with a value of 0.0081. This coefficient indicates a very low procyclical relationship. However, this result is not statistically significant, implying that we should rather interpret the fluctuations visually. Correlations for real GDP leading and lagging for one period are also insignificant.

Figure 7.9 indicates that income and business cycles show deviations with similar trend directions from 1970 to 1984. This could suggest that agricultural income is dependent on economic cycles to some extent, with prosperous times for Norway also benefiting the agricultural sector, and vice versa. However, it is essential to note that the concurrent expansion can be attributed to separate events. While the growth in income was a result of the convergence goal, the GDP expansion was driven by Norway's newfound oil resources. Finally, it must be noted that endpoint issues from the HP filter may introduce implications for the initial years of the dataset, requiring to exercise caution when drawing conclusions early in the period.

After 1984, there is little evidence of co-variation between income and economic cycles. It is conceivable that the discovery of oil led to a diversification of the Norwegian economy. While several sectors experienced significant growth, traditional sectors like agriculture may not have undergone the same level of expansion.

Moving into the 1990s, the decline in milk consumption and alterations in agricultural protection policies likely played a role in shaping the income trends. Notably, during the 2008 global financial crisis, while the economy experienced a recession, agricultural income was in an expansion phase. This suggests that factors such as stable demand for agricultural products or effective government support programs for farmers could have played a role in buffering the agricultural sector against the broader economic downturn.

Similar patterns emerge in 2020, with the economy reaching a trough due to the COVID-19 pandemic, while agricultural income grew. This divergence could be explained by changes in consumer behavior. It is natural to assume that the demand for agricultural goods increased due to restrictions that led people to stay at home. Additionally, there was a heightened interest in locally produced food during this period.

The correlation coefficients in table 10.15 underscore the independence of agricultural incomes from economic cycles. This is also supported by referring to the sector's relatively modest contribution to the overall economy. It is likely that various factors, including weather conditions, commodity prices, and international trade dynamics contribute to the influence of agricultural income beyond GDP. Another contributing factor could be the inelastic demand for agricultural products, particularly considering the predominant focus of production on staples like milk and meat.

Norway also possesses one of the world's most extensive support systems for the agricultural sector, driven by challenging natural conditions and high costs. In Section 2.4 we visualized that the proportion of subsidies to the total income of farmers had increased significantly throughout the relevant period. It is plausible that incomes were more influenced by broader economic trends when subsidies made up a smaller portion. This may explain why incomes fluctuated more in line with GDP at the beginning of the period but appear to become more independent over time.

In contrast to agricultural income, the cyclical component of average wages in Norway closely tracks the developments in business cycles, as illustrated in figure 7.10. The difference in volatility between a standard annual income and agricultural income is substantial. The overall wage level reflects the trends in Norwegian production, as expected, given that GDP is often referred to as a measure of a country's level of prosperity.

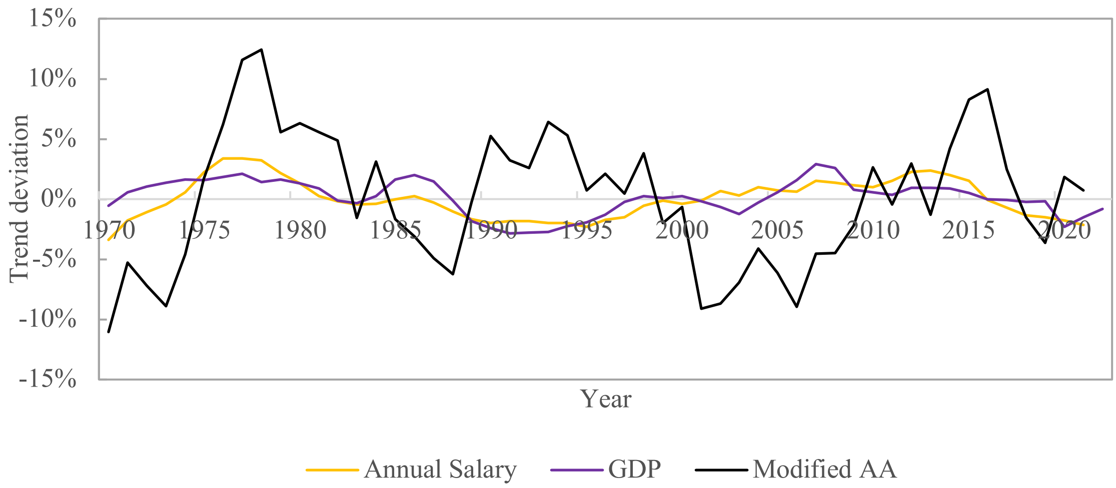

Figure 7.10: *The modified aggregated account, GDP, and average annual salary*
Source: Statistics Norway

It is important to note, however, that wage and GDP figures comprise a significantly larger number of observations than agricultural incomes. These data are also diversified across a wide range of sectors, collectively contributing to mitigating the volatility in fluctuations. Nevertheless, we can ascertain that the volatility in agricultural income is influenced by other factors independent of GDP fluctuations.

7.3.2 Agricultural Income and Subsidies

Figure 7.11 shows that incomes and subsidies generally exhibit covarying cyclical fluctuations, with occasional exceptions, as observed between 2014 and 2017, in years of agricultural prosperity and reduced reliance on support. We have observed that excessive subsidies have a negative long-term impact on incomes, as the subsidies provide incentives for overproduction, leading to a relatively larger downside through price declines than the upside gained from increased demand.

Subsidies, functioning as a political tool in agriculture, serve multiple purposes. Apart from being a means to increase incomes in agriculture, the grant system is used during challenging times to mitigate losses from poor harvests, as observed in 2018. Thus, it should not be presumed that the cyclical components co-vary every year.

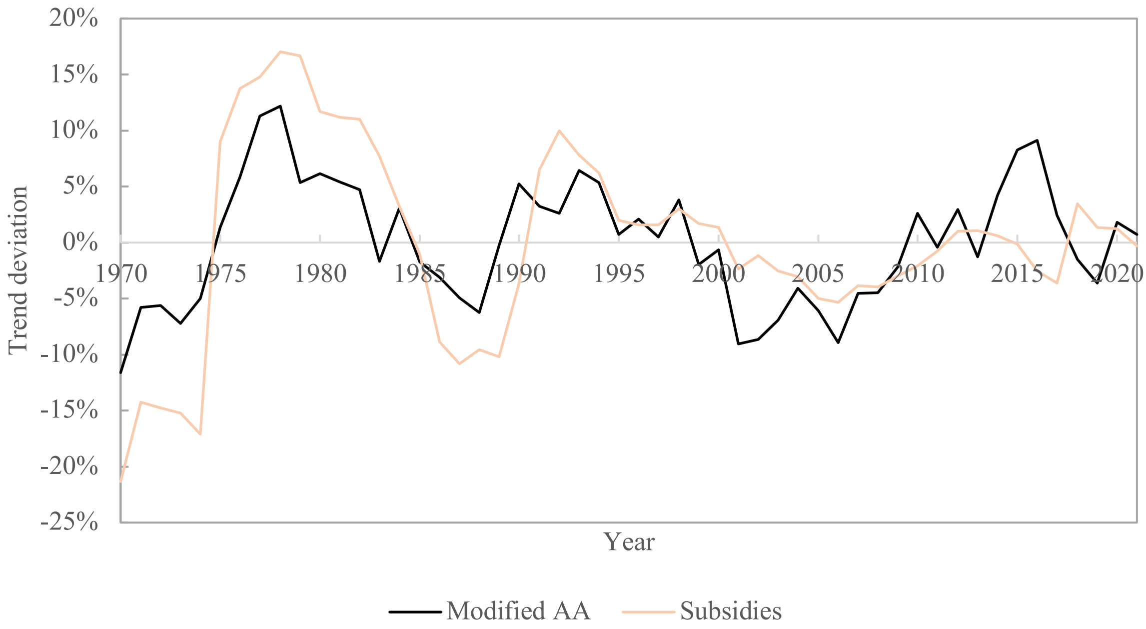

***Figure 7.11**: The modified aggregated account and subsidies*
Source: Norwegian Institute of Bioeconomy Research

7.3.3 Agricultural Income and Production

The fluctuations in the cyclical components of gross production and production value closely track each other, but with consistently larger cyclical swings for gross production, as illustrated in figure 7.12. While both variables are affected by the quantity sold and selling prices, gross production is also impacted by the fluctuations in input variables, such as changes in costs for production inputs and market price fluctuations, making it more volatile.

We aim to further explore the correlation between cyclical patterns in production value and income to assess the alignment of farmers' financial outcomes with actual production. Separating input factors by considering production value allows for a more direct reflection of total sales revenue and better captures market conditions and demand compared to gross production, as it does not include production inputs.

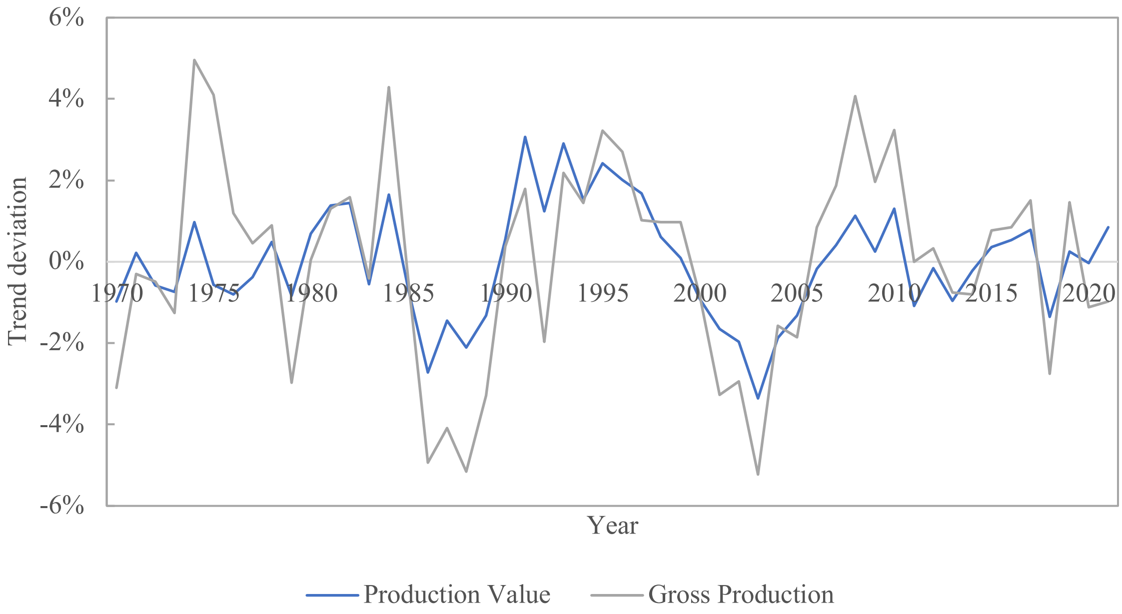

Figure 7.12: *Gross production and production value*
Source: Statistics Norway

Figure 7.13 exhibits multiple co-varying cyclical fluctuations between the variables, yet the income component is more sensitive, with higher percentage deviations from the trend. To better understand the co-movements between these variables, we have plotted the income's cyclical component on the left side and the production's cyclical component on the right side.

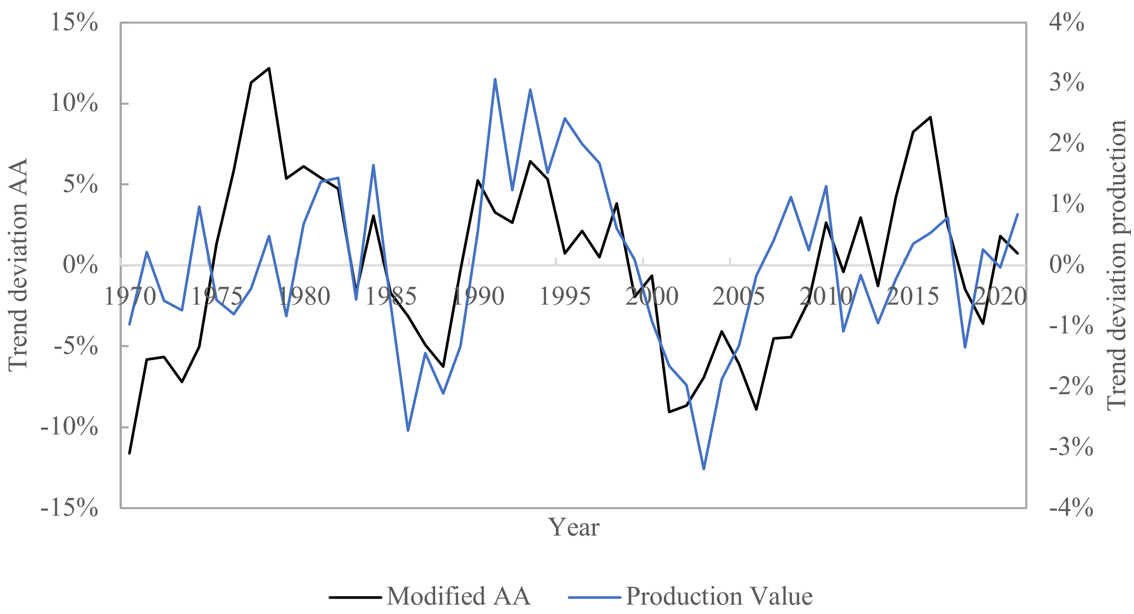

Figure 7.13*: The modified aggregated account (left axis) and production value (right axis)*
Source: Statistics Norway

Figure 7.14 further illustrates the trends in production, the modified aggregated account, and subsidies, depicting a notably higher growth in the two latter. As previously noted, the real production value in Norway has remained stable, partly due to the inelastic demand for agricultural goods. This emphasizes that income in agriculture is increasingly influenced by factors outside the value chain. It is, however, reasonable to assume a positive correlation between production and the active farmer's income in agriculture, as the production value is included in the income, adding to the result.

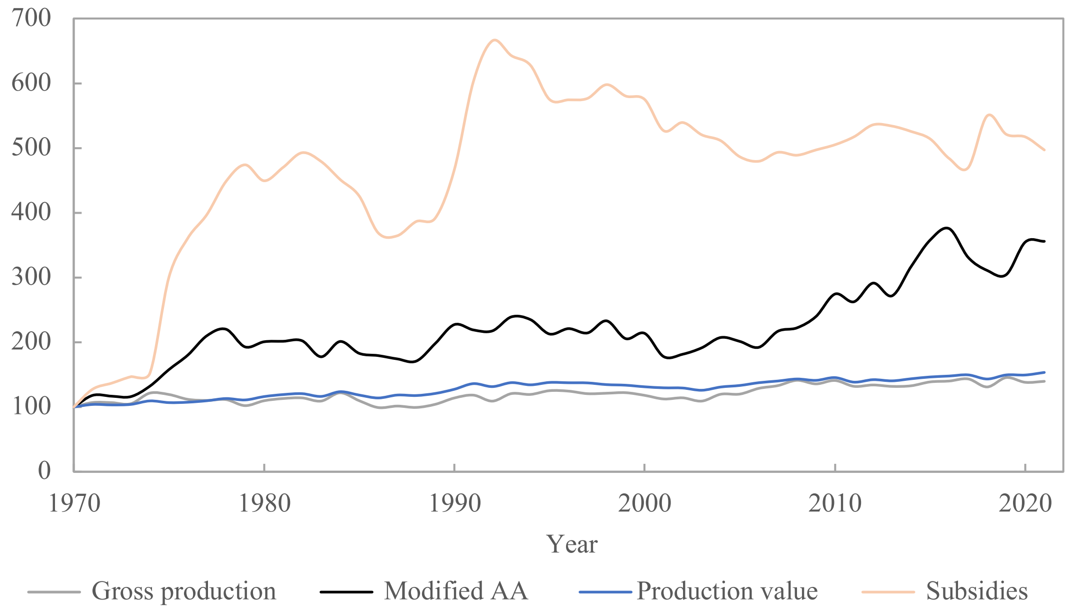

Figure 7.14*: Development income, subsidies, and production. 1970=100*
Source: Statistics Norway

The cyclical fluctuations of income in figure 7.13 vary roughly between negative ten and positive ten percent, while the production value's fluctuations range between negative and positive two percent.

The first countercyclical movement in our dataset occurs in 1975, coinciding with the time around the convergence resolution when farmers' income experienced a boost as a direct result of political decisions, independent of demand and production. However, the escalation served as an incentive for increased investments, eventually leading to overproduction by the late 1970s. Simultaneously, consumer subsidies for meat and milk were removed, resulting in a decline in demand.

From the mid-1980s, both production and income experienced a downturn following the completion of the income escalation in 1982. In addition, the quota system for milk production was introduced to limit production levels, stabilize prices, and prevent overproduction. From the mid-1990s, we observe repeated countercyclical movements between production and income. During this time, subsidies became a significant portion of farmers' total income, while overproduction led to price decreases for end consumers, resulting in lower income for the farmers.

The growth in both variables from the mid-2000s can be attributed, among other factors, to the previously mentioned increase in productivity, as well as agricultural negotiations favoring the farmer. After a period of stability in both production and income in the early 2010s, the agricultural sector experienced an economic upturn from 2013 to 2016. This occurred during a period of very low interest rates, a growing emphasis on climate and sustainability, and an increasing commitment to locally produced food.

In 2018, the drought season resulted in a sudden drop in both production and income due to challenging growing conditions. However, the fall in agricultural income was short-lived, due to increased subsidies following the poor harvests. A new upturn was recorded in 2020 due to increased demand in the domestic market following the eruption of COVID-19. After 2021, energy prices, interest rates, and inflation have risen rapidly after the pandemic, while agricultural negotiations have been favorable for farmers. This has been supported by the current government prioritizing domestic agriculture.

The correlation analysis of the cyclical components of income and production value in table 10.15 presents a significant, procyclical correlation in three out of three cases, contemporaneously and with the production as both lead and lag. This complicates our ability to make definitive statements about causation between the two because they appear to mutually influence each other. The visualization of the cyclical components in figure 7.13 and the discussion above supports this assertion. Income seems to have acted as a lead on increased investments during the escalation period, followed by overcapacity and increased production. Income as a lead variable yields a correlation coefficient with production value of 0.35. However, it is worth noting that when income appears to act as a leading indicator for production, income is influenced by factors determined outside of the agricultural value chain, such as political measures like the income escalation in 1975, and the increased subsidies during the 2018 drought.

The correlation coefficient in contemporaneous years is 0.50 and 0.39 with production value as the lead variable, shown in table 10.15. The high correlation in concurrent years is likely attributed to the fact that the income side of the farmer's pre-tax result is directly dependent on parts of the production value. However, the production value also includes produced but unsold goods, and income includes the sales of goods produced in earlier periods. Therefore, it is reasonable to assume that a higher production value than the sales in one year indicates an expectation of increased income in the subsequent year. The production value, thus, leads the income with a positive correlation coefficient.

While there is a distinct correlation between production value and income, it is important to note that both are also influenced by several of the same external factors. Political regulations such as quota systems and market regulations, climate-related conditions, international trade, food trends, sustainability, and environmental trends, as well as technological development, are all examples of factors that impact both production and income in agriculture.

8 Conclusions

This master's thesis presents a revised and expanded version of the modified aggregated account for agriculture with information available as of November 2023. The new figures are based on the calculations provided by the Grytten Committee in 2022. The timeline extends as far back as 1970, incorporating changes in the initial modification due to recent restructuring. The modified aggregated account aims at representing the income development of active Norwegian farmers from 1970 to 2021.

To derive the modified aggregated account back in time, we follow a three-stage methodology, ensuring that the calculations align with standard accounting principles and are applicable to active agriculture. In the first step, we transition from inflation-adjusted depreciation on operating assets to using historical cost, resulting in reduced depreciations. On average, the inflation adjustment increases the pre-tax income, but with variations occurring throughout the period due to fluctuations in real interest rates. This adjustment may not favor farmers in agricultural negotiations but will, in turn, bring the aggregated account closer to official and recognizable accounting standards.

The second step introduces land lease as an expense, as we assume that leased land is predominantly rented from non-active to active farmers, consequently reducing the modified income. Step number three separates hired labor expenses and FTEs from total labor cost and hours, transforming the aggregated account from a measure of earning capacity to a performance indicator for active farmers and their families. Overall, there is a growing percentage difference between the modified and the original account over time, emphasizing the necessity for a revision of the data foundation.

After the Grytten Committee's modification, NIBIO has made revisions in the initial aggregated account related to leasing and investments, reducing return on labor and equity by one to five percent throughout the period, necessitating an adjustment for the already modified years.

Finally, we examine the relationships between agricultural incomes found through the stepwise modifications, and business cycles and agricultural production. We accomplish this by using the HP filter to extract cyclical fluctuations in the figures. We also generate time series with first-order differences, before finally testing for correlations between the variables.

We find little evidence of co-variations between incomes and GDP, indicating low dependency between incomes and business cycles. This could likely be attributed to the fact that Norwegian support mechanisms aim at bolstering the agricultural industry, effectively sustaining the sector during economic challenges.

The results suggest a procyclical relationship between income and production, with the strongest correlation observed for contemporaneous time series, coinciding with our anticipated findings. The alignment is associated with the fact that a substantial portion of farmers' return to labor and equity is directly linked to the produced quantity. Despite this strong correlation, our discussion emphasizes the probability of additional variables, not considered in the correlation analysis, simultaneously influencing both agricultural income and production.

In conclusion, our findings reveal an increasing divergence between NIBIO's and our modified aggregated account over time, aligning with the modernization in agricultural operations. Our analysis also underscores the independence of agricultural incomes from business cycles while supporting the co-variation between fluctuations in agricultural income and production. At the same time, there is no absolute dependence on production, as highlighted by the recognition that agricultural incomes are subject to one of the world's most extensive subsidy programs and are increasingly reliant on political negotiations.

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10 Appendix

In this chapter, estimates pertaining to the modification of the aggregated account are provided. Estimates are presented in blue, and data from sample surveys are presented in grey.

10.1 Modification Step 1

***Table 10.1**: Real interest rate*
Source: Norwegian Institute of Bioeconomy Research, NOU 2022:14

Year	Real Interest Rate Adjusted	Real Interest Rate NIBIO	Real Interest Rate - Grytten	Nominal Interest Rate NIBIO	Nominal Interest Rate Grytten
1990	14	5		11	
1991	17	6		15	
1992	21	8		19	
1993	23	8		20	
1994	24	9		21	
1995	40	15		39	
1996	51	19		48	
1997	58	21		57	
1998	73	27		71	
1999	84	31		81	
2000	94	35		92	
2001	133	49		129	
2002	178	66		168	
2003	206	76		204	
2004	289	107		285	
2005	386	143	412	393	419
2006	515	191	549	528	570
2007	697	258	743	665	740
2008	783	290	836	790	901
2009	855	317	930	867	946
2010	947	351	982	919	1 000
2011	1 086	403	1 123	1 016	1 098
2012	1 180	437	1 239	1 116	1 201
2013	1 200	445	1 281	1 195	1 278
2014	1 252	464	1 382	1 287	1 366
2015	1 337	496	1 486	1 388	1 463
2016	1 427	529	1 560	1 500	1 573
2017	1 651	612	1 760	1 626	1 704
2018	1 806	669	1 872	1 760	1 845
2019	2 056	762	2 058	1 886	1 990
2020	2 284	846	2 116	1 913	2 001
2021	2 368	878	2 143	2 019	2 102

***Table 10.2**: Modification step 1*

	Inflation Adjusted and Real Interest			Historical Cost and Nominal Interest Rate			**Total**
Year	Depreciation, mill. NOK	Real Interest, mill. NOK	Leasing	Depreciation, mill. NOK	Nominal interest, mill. NOK	Leasing	**Difference Depreciation, Interest and Leasing**
1970	684	-160	-	524	134	-	**-133**
1971	742	-31	-	558	149	-	**5**
1972	804	-65	-	587	163	-	**-11**
1973	882	-81	-	625	178	-	**-2**
1974	996	-136	-	684	212	-	**-36**
1975	1 166	-238	-	773	246	-	**-91**
1976	1 353	-135	-	892	311	-	**14**
1977	1 599	-137	-	1 061	368	-	**33**
1978	1 830	-19	-	1 214	532	-	**65**
1979	2 009	259	-	1 359	638	-	**271**
1980	2 317	-201	-	1 520	807	-	**-211**
1981	2 711	-424	-	1 688	1 045	-	**-447**
1982	3 065	-126	-	1 844	1 260	-	**-166**
1983	3 294	320	-	1 937	1 478	-	**200**
1984	3 470	631	-	2 035	1 555	-	**511**
1985	3 696	776	-	2 194	1 686	-	**591**
1986	3 996	716	-	2 372	1 997	-	**343**
1987	4 319	687	-	2 504	2 452	-	**49**
1988	4 548	1 241	-	2 617	2 683	-	**488**
1989	4 661	1 568	-	2 695	2 595	-	**939**
1990	4 773	1 596	14	2 793	2 515	11	**1 064**
1991	4 786	1 675	17	2 821	2 456	15	**1 187**
1992	4 755	1 839	21	2 840	2 358	19	**1 398**
1993	4 709	1 536	23	2 850	2 025	20	**1 372**
1994	4 676	1 134	24	2 910	1 435	21	**1 468**
1995	4 713	796	40	2 984	1 317	39	**1 209**
1996	4 737	1 007	51	3 089	1 257	48	**1 401**
1997	4 783	577	58	3 154	1 170	57	**1 037**
1998	4 806	825	73	3 205	1 385	71	**1 043**
1999	4 847	1 028	84	3 266	1 632	81	**981**
2000	4 884	788	94	3 287	1 616	92	**772**
2001	4 890	1 041	133	3 285	1 841	129	**809**
2002	4 815	1 498	178	3 285	1 876	168	**1 163**

2003	4 820	818	206	3 310	1 579	204	**751**
2004	4 780	1 050	289	3 371	1 167	285	**1 296**
2005	4 829	618	386	3 461	1 160	393	**819**
2006	4 954	497	515	3 589	1 339	528	**510**
2007	5 017	1 582	697	3 719	1 858	665	**1 053**
2008	5 247	908	783	3 869	2 484	790	**-204**
2009	5 406	923	855	4 024	1 867	867	**426**
2010	5 591	677	947	4 187	1 805	919	**304**
2011	5 714	1 343	1 086	4 344	1 975	1 016	**807**
2012	5 769	1 805	1 180	4 462	2 133	1 116	**1 043**
2013	5 887	1 063	1 200	4 561	2 209	1 195	**185**
2014	5 995	1 112	1 252	4 652	2 280	1 287	**140**
2015	6 125	842	1 337	4 759	2 092	1 388	**65**
2016	6 374	-280	1 427	4 903	1 903	1 500	**-786**
2017	6 557	811	1 651	5 081	1 987	1 626	**325**
2018	6 765	213	1 806	5 232	2 066	1 760	**-275**
2019	6 921	801	2 056	5 369	2 355	1 886	**168**
2020	7 032	1 255	2 284	5 524	2 174	1 913	**960**
2021	7 294	-665	2 368	5 695	1 962	2 019	**-678**

10.2 Modificaiton Step 2

***Table 10.3**: Cultivated land*
Source: Statistics Norway

Year	Cultivated Land	Estimates
1969	9 553	
1970	9 536	9 558
1971	9 308	9 562
1972	9 101	9 567
1973	9 037	9 571
1974	9 007	9 576
1975	8 981	9 581
1976	8 962	9 585
1977	8 995	9 590
1978	9 005	9 594
1979	9 599	
1980	9 873	9 630
1981	9 868	9 661
1982	9 868	9 692
1983	9 899	9 724
1984	9 930	9 755
1985	9 962	9 786
1986	9 993	9 817
1987	10 024	9 848
1988	10 055	9 880
1989	9 911	
1990	9 958	9 958
1991	10 005	10 005
1992	10 052	10 053
1993	10 099	10 100
1994	10 147	10 147
1995	10 194	10 194
1996	10 241	10 241
1997	10 288	10 288
1998	10 335	10 335
1999	10 382	
2000	10 422	
2001	10 467	
2002	10 466	
2003	10 404	

2004	10 397
2005	10 354
2006	10 346
2007	10 321
2008	10 245
2009	10 143
2010	10 060
2011	9 989
2012	9 929
2013	9 871
2014	9 868
2015	9 860
2016	9 837
2017	9 851
2018	9 863
2019	9 843
2020	9 860
2021	9 845

Table 10.4: *Proportion leased land*
Source: Statistics Norway

Year	Proportion Leased Land, Censuses and Estimates
1969	14.7 %
1970	15,4 %
1971	16,0 %
1972	16,5 %
1973	17,1 %
1974	17,7 %
1975	18,2 %
1976	18,8 %
1977	19,4 %
1978	19,9 %
1979	20.3 %
1980	20,4 %
1981	20,7 %
1982	21,0 %
1983	21,3 %
1984	21,6 %
1985	21,9 %
1986	22,2 %
1987	22,5 %
1988	22,8 %
1989	23.4 %
1990	23,6 %
1991	24,5 %
1992	25,4 %
1993	26,2 %
1994	27,1 %
1995	28,0 %
1996	28,8 %
1997	29,7 %
1998	30,6 %
1999	31,9 %
2000	32,8 %
2001	33,7 %
2002	34,6 %
2003	35,5 %

2004	36,4 %
2005	37,3 %
2006	38,1 %
2007	39,0 %
2008	39,9 %
2009	40,8 %
2010	41,6 %
2011	42,2 %
2012	43,0 %
2013	44,0 %
2014	44,2 %
2015	44,4 %
2016	44,8 %
2017	45,2 %
2018	45,9 %
2019	46,2 %
2020	47,0 %
2021	48,3 %

***Table 10.5**: Cost of leased land and leased 1000m^2 per unit*
Source: Farm Accountancy Data Network, Norwegian Institute of Bioeconomy Research

Year	Costs Land Lease per Unit	Leased 1000m^2 per Unit
1970	256	14
1971	303	14
1972	359	15
1973	425	16
1974	500	17
1975	600	18
1976	700	19
1977	900	21
1978	1 000	21
1979	1 000	21
1980	1 100	22
1981	1 100	22
1982	1 200	24
1983	1 400	25
1984	1 600	25
1985	1 600	26
1986	1 600	26
1987	1 800	27
1988	1 900	28
1989	2 500	30
1990	3 000	33
1991	3 000	34
1992	3 900	37
1993	3 800	39
1994	4 100	41
1995	4 800	37
1996	5 200	37
1997	5 800	49
1998	6 600	52
1999	7 300	56
2000	8 100	60
2001	8 200	63
2002	8 800	68
2003	10 200	73
2004	12 100	80
2005	13 000	88
2006	14 600	95

2007	15 800	101
2008	16 900	112
2009	18 300	115
2010	17 800	117
2011	20 100	138
2012	22 400	134
2013	26 300	149
2014	26 800	161
2015	28 300	167
2016	30 100	176
2017	31 300	182
2018	33 000	195
2019	34 400	201
2020	36 200	213
2021	38 700	216

***Table 10.6**: Nominal interest rate*
Source: The Central Bank of Norway

Year	Total Land Lease Cost mill NOK	Average Loan Rate, Central Bank of Norway	Fixed Interest Rate 5,98%	Nominal Interest
1970	28	6,9 %	1,6	1,8
1971	32	7,0 %	1,9	2,2
1972	37	7,2 %	2,2	2,6
1973	43	7,3 %	2,5	3,0
1974	50	7,8 %	2,9	3,8
1975	58	8,4 %	3,4	4,7
1976	66	8,7 %	3,8	5,6
1977	80	8,9 %	4,6	6,8
1978	91	10,6 %	5,3	9,3
1979	93	11,0 %	5,4	9,8
1980	98	11,8 %	5,7	11,1
1981	100	13,1 %	5,8	12,6
1982	102	13,6 %	5,9	13,3
1983	116	13,9 %	6,7	15,5
1984	135	13,7 %	7,8	17,8
1985	132	13,3 %	7,6	16,9
1986	134	15,0 %	7,7	19,4
1987	148	16,5 %	8,5	23,5
1988	153	16,6 %	8,8	24,5
1989	193	14,9 %	11,2	27,7
1990	214	14,3 %	12,3	29,4
1991	216	13,9 %	12,5	28,9
1992	269	13,4 %	15,5	34,7
1993	258	10,6 %	14,9	26,4
1994	275	8,2 %	15,9	21,7
1995	370	7,7 %	21,3	27,3
1996	415	7,0 %	23,9	28,1
1997	362	5,9 %	20,9	20,6
1998	401	7,9 %	23,1	30,4
1999	432	8,1 %	24,9	33,8
2000	461	8,2 %	26,6	36,5
2001	459	8,8 %	26,5	39,0
2002	469	8,5 %	27,1	38,2
2003	516	6,0 %	29,8	30,1
2004	572	4,1 %	33,0	22,6
2005	572	6,0 %	33,0	33,0
2006	607	6,1 %	35,0	36,0

2007	628	7,9 %	36,2	48,0
2008	617	10,6 %	35,6	63,0
2009	658	6,8 %	38,0	43,0
2010	636	6,5 %	36,7	40,0
2011	687	6,3 %	39,6	42,0
2012	713	6,4 %	41,1	44,0
2013	769	5,9 %	44,3	44,0
2014	724	6,2 %	41,8	43,0
2015	740	5,2 %	42,7	37,0
2016	754	4,5 %	43,5	33,0
2017	766	4,5 %	44,2	33,0
2018	765	4,5 %	44,1	33,0
2019	778	4,8 %	44,9	36,0
2020	788	4,1 %	45,4	31,0
2021	852	3,3 %	49,2	27,0

***Table 10.7**: Modification step 2*

Year	FTEs	Costs Land Lease per Unit	Leased $1000m^2$ per Unit	NOK per $1000m^2$	Prop. Leased Land	Cult. Land $1000m^2$	Total Land Rental Cost mill NOK	Rental Income for Active Entities	Net Rental Cost for Active Entities	Red. Interest Non-Active Entities	**Net Cost**
1970	178 200	256	14	19	15,4 %	9 558	28	1	27	2	**25**
1971	165 800	303	14	21	16,0 %	9 562	32	1	31	2	**29**
1972	154 500	359	15	24	16,5 %	9 567	37	1	36	3	**33**
1973	149 900	425	16	26	17,1 %	9 571	43	2	42	3	**39**
1974	144 800	500	17	29	17,7 %	9 576	50	2	48	4	**44**
1975	140 600	600	18	33	18,2 %	9 581	58	2	56	5	**51**
1976	142 700	700	19	37	18,8 %	9 585	66	2	64	6	**58**
1977	141 200	900	21	43	19,4 %	9 590	80	3	77	7	**70**
1978	136 700	1 000	21	48	19,9 %	9 594	91	3	88	9	**79**
1979	133 300	1 000	21	48	20,3 %	9 599	93	3	90	10	**80**
1980	124 500	1 100	22	50	20,4 %	9 630	98	3	95	11	**84**
1981	122 300	1 100	22	50	20,7 %	9 661	100	3	96	13	**84**
1982	119 800	1 200	24	50	21,0 %	9 692	102	4	98	13	**85**
1983	117 400	1 400	25	56	21,3 %	9 724	116	4	112	16	**96**
1984	115 400	1 600	25	64	21,6 %	9 755	135	5	130	18	**112**
1985	113 900	1 600	26	62	21,9 %	9 786	132	5	127	17	**110**
1986	111 500	1 600	26	62	22,2 %	9 817	134	5	129	19	**110**
1987	107 000	1 800	27	67	22,5 %	9 848	148	5	143	23	**119**
1988	102 100	1 900	28	68	22,8 %	9 880	153	5	148	24	**123**
1989	100 300	2 500	30	83	23,4 %	9 911	193	7	186	28	**159**
1990	97 900	3 000	33	91	23,6 %	9 958	214	7	206	29	**177**
1991	95 000	3 000	34	88	24,5 %	10 005	216	8	209	29	**180**
1992	93 400	3 900	37	105	25,4 %	10 053	269	9	259	35	**225**
1993	90 600	3 800	39	97	26,2 %	10 100	258	9	249	26	**223**
1994	89 400	4 100	41	100	27,1 %	10 147	275	10	265	22	**244**
1995	88 700	4 800	37	130	28,0 %	10 194	370	13	357	27	**329**
1996	86 100	5 200	37	141	28,8 %	10 241	415	15	400	28	**372**
1997	83 400	5 800	49	118	29,7 %	10 288	362	13	349	21	**328**
1998	81 800	6 600	52	127	30,6 %	10 335	401	14	387	30	**356**
1999	79 900	7 300	56	130	31,9 %	10 382	432	15	417	34	**383**
2000	76 400	8 100	60	135	32,8 %	10 422	461	16	445	36	**409**
2001	73 900	8 200	63	130	33,7 %	10 467	459	16	443	39	**404**
2002	71 100	8 800	68	129	34,6 %	10 466	469	16	452	38	**414**
2003	67 800	10 200	73	140	35,5 %	10 404	516	18	498	30	**468**
2004	64 700	12 100	80	151	36,4 %	10 397	572	20	552	23	**530**

2005	61 700	13 000	88	148	37,3 %	10 354	572	20	552	33	**519**
2006	59 200	14 600	95	154	38,1 %	10 346	607	21	586	36	**550**
2007	56 800	15 800	101	156	39,0 %	10 321	628	22	606	48	**558**
2008	54 300	16 900	112	151	39,9 %	10 245	617	22	596	63	**533**
2009	52 000	18 300	115	159	40,8 %	10 143	658	23	635	43	**592**
2010	49 700	17 800	117	152	41,6 %	10 060	636	22	614	40	**574**
2011	48 600	20 100	138	163	42,2 %	9 989	687	24	663	42	**621**
2012	47 400	22 400	134	167	43,0 %	9 929	713	25	688	44	**644**
2013	46 200	26 300	149	177	44,0 %	9 871	769	27	742	44	**698**
2014	45 500	26 800	161	166	44,2 %	9 868	724	25	699	43	**656**
2015	44 750	28 300	167	169	44,4 %	9 860	740	26	714	37	**677**
2016	44 000	30 100	176	171	44,8 %	9 837	754	26	727	33	**694**
2017	43 300	31 300	182	172	45,2 %	9 851	766	27	739	33	**706**
2018	42 800	33 000	195	169	45,9 %	9 863	765	27	738	33	**705**
2019	42 300	34 400	201	171	46,2 %	9 843	778	27	750	36	**714**
2020	42 700	36 200	213	170	47,0 %	9 860	788	28	760	31	**729**
2021	42 100	38 700	216	179	48,3 %	9 845	852	30	822	27	**795**

10.3 Modification Step 3

***Table 10.8**: Proportion hired labor, men*
Source: Farm Accountancy Data Network, Norwegian Institute of Bioeconomy Research

Men				
Year	Family	Hired	%Hired	Total
1956	65	31	32 %	96
1975	28	14	33 %	42
1979	27	16	37 %	43
1982	26	15	37 %	41
1985	26	16	38 %	42
1989	19	14	42 %	33
1992	17	14	45 %	31
1994	17	15	47 %	32
1996	15	13	46 %	28
1998	14	14	50 %	28
2002	11	16	59 %	27
2004	10	15	60 %	25
1971	35	17	33 %	52
1969	46	22	33 %	68

***Table 10.9**: Proportion hired labor, women*
Source: Farm Accountancy Data Network, Norwegian Institute of Bioeconomy Research

Women				
Year	Family	Hired	%Hired	Total
1956	50	11	18 %	61
1975	9	4	31 %	13
1979	8	4	33 %	12
1982	8	4	33 %	12
1985	8	6	43 %	14
1989	7	4	36 %	11
1992	6	4	40 %	10
2994	6	4	40 %	10
1996	5	4	44 %	9
1998	5	5	50 %	10
2002	4	6	60 %	10
2004	4	5	56 %	9
1971	11	4	27 %	15
1969	16	6	26 %	22

***Table 10.10**: Hours hired labor*
Source: Statistics Norway

Year	Registered million hours hired labor
1956	42
1969	28
1970	24
1971	21
1972	20
1973	19
1974	19
1975	18
1976	18
1977	19
1978	19
1979	20
1980	20
1981	19
1982	19
1983	20
1984	21
1985	22
1986	21
1987	20
1988	19
1989	18
1990	18
1991	18
1992	18
1993	19
1994	19
1995	18
1996	17
1997	18
1998	19
1999	20
2000	21
2001	21
2002	22
2003	21
2004	20

2005	19
2006	19
2007	20
2008	20
2009	20
2010	21
2011	21
2012	20
2013	20
2014	20
2015	20
2016	19
2017	19
2018	20
2019	20
2020	20
2021	21

***Table 10.11**: Paid labor*
Source: Statistics Norway

	Unpaid Hired Labor	Paid Hired Labor	Total	Paid Labor %
2021	211	664	875	76 %
2020	202	666	868	77 %
2019	181	677	858	79 %
2018	170	644	814	79 %
2017	163	678	841	81 %
2016	170	666	836	80 %
2015	164	647	811	80 %
2014	160	629	789	80 %
2013	156	634	790	80 %
2012	150	679	829	82 %
2011	162	622	784	79 %
2010	160	606	766	79 %
2009	161	577	738	78 %
2008	172	525	697	75 %
2007	158	480	638	75 %
2006	143	487	630	77 %
2005	143	490	633	77 %
2004	161	475	636	75 %
2003	162	459	621	74 %
2002	164	456	620	74 %
2001	161	438	599	73 %
2000	168	447	615	73 %
1999	179	468	647	72 %
1998	172	443	615	72 %
1997	180	457	637	72 %
1996	188	471	659	72 %
1995	195	486	681	71 %
1994	203	498	701	71 %
1993	200	486	686	71 %
1992	202	488	690	71 %
1991	204	489	693	71 %
1990	209	498	707	70 %
1989	213	502	715	70 %
1988	215	504	719	70 %
1987	216	503	719	70 %
1986	224	517	741	70 %
1985	238	549	787	70 %

1984	250	571	821	70 %
1983	256	583	839	69 %
1982	254	574	828	69 %
1981	249	562	811	69 %
1980	252	565	817	69 %
1979	256	570	826	69 %
1978	254	563	817	69 %
1977	245	541	786	69 %
1976	220	484	704	69 %
1975	230	506	736	69 %
1974	219	479	698	69 %
1973	205	447	652	69 %
1972	206	446	652	68 %
1971	167	362	529	68 %
1970	179	385	564	68 %

Table 10.12: Volunteer work
Source: Farm Accountancy Data Network

Year	Paid Labor Hours	Volunteer Work Hours	Total	Volunteer Work %
2001	54 800	14 500	69 300	20,9 %
2000	54 800	13 400	68 200	19,6 %
1999	53 600	13 100	66 700	19,6 %
1998	47 500	14 400	61 900	23,3 %
1997	48 100	13 700	61 800	22,2 %
1996	48 300	13 600	61 900	22,0 %
1995	47 500	13 600	61 100	22,3 %
1994	47 560	13 740	61 300	22,4 %
1993	45 850	13 350	59 200	22,6 %
1992	46 551	13 649	60 200	22,7 %
1991	46 098	13 602	59 700	22,8 %
1990	44 109	13 091	57 200	22,9 %
1989	42 207	12 593	54 800	23,0 %
1988	39 775	11 925	51 700	23,1 %
1987	36 736	11 064	47 800	23,1 %
1986	33 706	10 194	43 900	23,2 %
1985	33 138	10 062	43 200	23,3 %
1984	32 496	9 904	42 400	23,4 %
1983	31 397	9 603	41 000	23,4 %
1982	29 001	8 899	37 900	23,5 %
1981	25 997	8 003	34 000	23,5 %
1980	23 381	7 219	30 600	23,6 %
1979	20 998	6 502	27 500	23,6 %
1978	20 145	6 255	26 400	23,7 %
1977	17 616	5 484	23 100	23,7 %
1976	13 490	4 210	17 700	23,8 %
1975	11 121	3 479	14 600	23,8 %
1974	8 831	2 769	11 600	23,9 %
1973	7 867	2 473	10 339	23,9 %
1972	7 045	2 219	9 264	24,0 %
1971	6 411	2 023	8 434	24,0 %
1970	5 958	1 885	7 843	24,0 %

***Table 10.13**: Modification step 3*

Year	FTEs	Family FTEs	Hours one FTE	Hours Hired Labor	FTEs Hired Labor	Cost per Entity	Hours per Entity	Hourly Cost	**Total Cost mill NOK**
1970	178 200	166 608	2 100	24 344 006	11 592	5 581	361	11	**257**
1971	165 800	155 800	2 100	21 000 000	10 000	6 411	362	12	**255**
1972	154 500	144 858	2 100	20 247 469	9 642	9 264	446	21	**421**
1973	149 900	140 616	2 100	19 497 279	9 284	10 339	447	23	**451**
1974	144 800	135 873	2 100	18 747 469	8 927	8 831	479	18	**346**
1975	140 600	132 029	2 100	18 000 000	8 571	11 121	506	22	**396**
1976	142 700	133 334	1 975	18 498 335	9 366	13 490	484	28	**516**
1977	141 200	131 581	1 975	18 998 461	9 619	17 616	541	33	**619**
1978	136 700	126 827	1 975	19 498 335	9 873	20 145	563	36	**698**
1979	133 300	123 173	1 975	20 000 000	10 127	20 998	570	37	**737**
1980	124 500	114 557	1 975	19 637 154	9 943	23 381	565	41	**813**
1981	122 300	112 526	1 975	19 303 818	9 774	25 997	562	46	**893**
1982	119 800	110 180	1 975	19 000 000	9 620	29 001	574	51	**960**
1983	117 400	107 269	1 975	20 008 216	10 131	31 397	583	54	**1 078**
1984	115 400	104 763	1 975	21 008 216	10 637	32 496	571	57	**1 196**
1985	113 900	102 761	1 975	22 000 000	11 139	33 138	549	60	**1 328**
1986	111 500	100 870	1 975	20 994 723	10 630	33 706	517	65	**1 369**
1987	107 000	96 876	1 975	19 994 471	10 124	36 736	503	73	**1 460**
1988	102 100	92 482	1 975	18 994 723	9 618	39 775	504	79	**1 499**
1989	100 300	90 700	1 875	18 000 000	9 600	42 207	502	84	**1 513**
1990	97 900	88 300	1 875	18 000 000	9 600	44 109	498	89	**1 594**
1991	95 000	85 400	1 875	18 000 000	9 600	46 098	489	94	**1 697**
1992	93 400	83 800	1 875	18 000 000	9 600	46 551	488	95	**1 717**
1993	90 600	80 730	1 875	18 505 433	9 870	45 850	486	94	**1 746**
1994	89 400	79 267	1 875	19 000 000	10 133	47 560	498	96	**1 815**
1995	88 700	79 104	1 875	17 993 338	9 596	47 500	486	98	**1 759**
1996	86 100	77 033	1 875	17 000 000	9 067	48 300	471	103	**1 743**
1997	83 400	73 798	1 875	18 004 463	9 602	48 100	457	105	**1 895**
1998	81 800	71 667	1 875	19 000 000	10 133	47 500	443	107	**2 037**
1999	79 900	69 365	1 875	19 753 502	10 535	53 600	468	115	**2 262**
2000	76 400	65 465	1 875	20 503 689	10 935	54 800	447	123	**2 514**
2001	73 900	62 565	1 875	21 253 502	11 335	54 800	438	125	**2 659**
2002	71 100	59 176	1 845	22 000 000	11 924	58 200	456	128	**2 808**
2003	67 800	56 423	1 845	20 990 365	11 377	61 200	459	133	**2 799**
2004	64 700	53 860	1 845	20 000 000	10 840	63 900	475	135	**2 691**
2005	61 700	51 400	1 845	19 038 220	10 319	-	490	135	**2 570**

2006	59 200	48 700	1 845	19 362 269	10 494	-	487	138	**2 672**
2007	56 800	46 100	1 845	19 693 698	10 674	-	480	149	**2 934**
2008	54 300	43 400	1 845	20 043 577	10 864	-	525	154	**3 087**
2009	52 000	40 900	1 845	20 398 991	11 056	-	577	156	**3 182**
2010	49 700	38 400	1 845	20 763 630	11 254	-	606	160	**3 322**
2011	48 600	37 500	1 845	20 526 609	11 126	-	622	167	**3 428**
2012	47 400	36 400	1 845	20 295 123	11 000	-	679	171	**3 470**
2013	46 200	35 300	1 845	20 076 552	10 882	-	634	182	**3 654**
2014	45 500	34 800	1 845	19 827 938	10 747	-	629	183	**3 629**
2015	44 750	34 100	1 845	19 597 775	10 622	-	647	191	**3 743**
2016	44 000	33 500	1 845	19 378 681	10 503	-	666	195	**3 779**
2017	43 300	32 900	1 845	19 170 657	10 391	-	678	204	**3 911**
2018	42 800	32 200	1 845	19 631 995	10 641	-	644	206	**4 044**
2019	42 300	31 400	1 845	20 025 645	10 854	-	677	207	**4 145**
2020	42 700	31 700	1 845	20 279 933	10 992	-	666	216	**4 380**
2021	42 100	31 000	1 845	20 534 220	11 130	-	664	223	**4 582**

10.4 Additional Calculations

***Table 10.14**: Numerical and relative change from modification steps, real 2022-values.*

Year	Historical Cost Impact %	Land Quotas Impact %	Hired Labor Impact %	Total Impact %	Historical Cost Impact	Land Quotas Impact	Hired Labor Impact	Total Impact
1970	-6 %	-1 %	-6 %	-13 %	-7 155	- 1 341	- 7 090	- 15 586
1971	0 %	-1 %	-5 %	-6 %	248	- 1 561	- 6 360	- 7 673
1972	0 %	-1 %	-11 %	-13 %	-601	- 1 819	- 15 327	- 17 747
1973	0 %	-1 %	-12 %	-13 %	-121	- 2 017	- 16 062	- 18 200
1974	-1 %	-1 %	-6 %	-8 %	-1 769	- 2 182	- 8 571	- 12 523
1975	-2 %	-1 %	-4 %	-8 %	-4 123	- 2 342	- 8 002	- 14 467
1976	0 %	-1 %	-4 %	-5 %	576	- 2 396	- 8 826	- 10 646
1977	1 %	-1 %	-4 %	-4 %	1 249	- 2 658	- 8 612	- 10 021
1978	1 %	-1 %	-4 %	-4 %	2 364	- 2 858	- 8 848	- 9 342
1979	5 %	-1 %	-5 %	-2 %	9 656	- 2 841	- 10 975	- 4 161
1980	-3 %	-1 %	-5 %	-9 %	-7 235	- 2 870	- 11 262	- 21 367
1981	-6 %	-1 %	-5 %	-11 %	-13 757	- 2 581	- 10 762	- 27 101
1982	-2 %	-1 %	-4 %	-8 %	-4 695	- 2 395	- 10 220	- 17 309
1983	3 %	-1 %	-7 %	-5 %	5 298	- 2 557	- 12 677	- 9 936
1984	6 %	-1 %	-5 %	0 %	12 984	- 2 851	- 11 085	- 952
1985	8 %	-1 %	-7 %	-1 %	14 422	- 2 691	- 13 802	- 2 071
1986	4 %	-1 %	-7 %	-4 %	7 976	- 2 557	- 14 024	- 8 605
1987	1 %	-1 %	-8 %	-9 %	1 081	- 2 650	- 15 336	- 16 905
1988	6 %	-1 %	-9 %	-4 %	10 674	- 2 692	- 16 046	- 8 063
1989	10 %	-2 %	-6 %	2 %	19 998	- 3 379	- 12 503	4 116
1990	10 %	-2 %	-4 %	4 %	22 281	- 3 705	- 10 219	8 357
1991	11 %	-2 %	-6 %	4 %	24 779	- 3 753	- 12 426	8 601
1992	14 %	-2 %	-6 %	6 %	28 996	- 4 657	- 12 359	11 980
1993	12 %	-2 %	-4 %	6 %	28 699	- 4 656	- 9 426	14 617
1994	13 %	-2 %	-4 %	7 %	30 692	- 5 092	- 10 252	15 348
1995	12 %	-3 %	-6 %	3 %	24 861	- 6 778	- 12 250	5 834
1996	13 %	-4 %	-6 %	4 %	29 301	- 7 785	- 12 259	9 257
1997	10 %	-3 %	-6 %	0 %	21 846	- 6 914	- 14 255	677
1998	9 %	-3 %	-5 %	1 %	21 896	- 7 482	- 12 760	1 655
1999	9 %	-4 %	-9 %	-3 %	20 590	- 8 037	- 19 318	- 6 765
2000	7 %	-4 %	-9 %	-6 %	16 435	- 8 704	- 21 709	- 13 978
2001	8 %	-4 %	-14 %	-10 %	17 298	- 8 641	- 28 519	- 19 861
2002	13 %	-4 %	-15 %	-7 %	25 517	- 9 086	- 29 977	- 13 546
2003	8 %	-5 %	-13 %	-10 %	16 855	- 10 502	- 29 423	- 23 070

2004	14 %	-6 %	-12 %	-4 %	30 376	- 12 413	- 26 929	- 8 966
2005	9 %	-5 %	-12 %	-9 %	19 800	- 12 541	- 27 222	- 19 963
2006	5 %	-6 %	-13 %	-14 %	12 568	- 13 545	- 30 390	- 31 367
2007	11 %	-6 %	-13 %	-8 %	26 838	- 14 225	- 32 322	- 19 710
2008	-2 %	-5 %	-12 %	-18 %	-5 249	- 13 688	- 32 953	- 51 890
2009	4 %	-5 %	-11 %	-12 %	11 203	- 15 550	- 30 404	- 34 751
2010	3 %	-5 %	-8 %	-10 %	8 155	- 15 395	- 24 253	- 31 494
2011	7 %	-6 %	-10 %	-9 %	21 858	- 16 819	- 30 498	- 25 459
2012	9 %	-6 %	-8 %	-5 %	28 766	- 17 769	- 25 462	- 14 465
2013	2 %	-6 %	-10 %	-15 %	5 114	- 19 342	- 34 626	- 48 854
2014	1 %	-5 %	-6 %	-10 %	3 869	- 18 076	- 22 572	- 36 779
2015	0 %	-5 %	-4 %	-8 %	1 784	- 18 577	- 14 195	- 30 988
2016	-5 %	-4 %	-2 %	-11 %	-21 163	- 18 702	- 8 647	- 48 512
2017	2 %	-5 %	-6 %	-9 %	8 723	- 18 980	- 22 476	- 32 732
2018	-2 %	-5 %	-7 %	-14 %	-7 272	- 18 668	- 27 007	- 52 947
2019	1 %	-5 %	-8 %	-12 %	4 390	- 18 718	- 27 065	- 41 393
2020	6 %	-5 %	-5 %	-3 %	24 617	- 18 686	- 17 275	- 11 344
2021	-4 %	-5 %	-4 %	-13 %	-17 031	- 19 978	- 17 568	- 54 576

***Table 10.15**: Correlations between the cyclical components of agricultural income to GDP and production value, with first-order differences. * Indicates significance at 5% level.*

	Income
GDP	0.0081
Lag GDP	-0.0041
Lead GDP	-0.0319
Production value	0.4983*
Lag Production value	0.3500*
Lead Production value	0.3873*