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Postgraduate Dissertation

Exploring the supermarket turnover as a reflection of national economic health. An analysis assessing the link between supermarket turnover and volume indices, GDP growth, and household incomes from 2016 to today.

Aristeidis Pozrikidis

Supervisor: Dr. Apostolos Ballas

Patras, Greece, May 2026

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Aristeidis Pozrikidis

Supervising Committee

Supervisor:
Dr. Apostolos Ballas
Hellenic Open University

Co-Supervisor:
Dr. Timotheos Angelidis
Hellenic Open University

Patras, Greece, May 2026

Abstract

The dissertation attempts to tie the retail sector's performance to macroeconomic measures. Specifically, the main goal is to explore whether an interrelation between the national major supermarket businesses' turnover and volume indices and major national account indices exists while quantifying and analyzing in comprehensive figures the effects that the Gross Domestic Product, National and Household income have on the supermarkets' turnover and volume indices.

Supermarket products, represent a major component of household consumption and a permanent indicator of everyday economic activity. Supermarket turnover directly reflects domestic purchasing power and consumer confidence. In this dissertation, secondary data gathered by ELSTAT, the Hellenic principal government institution in charge of statistics and census data, are subject to descriptive statistical analysis, time series visualizations and regression analysis to realize how the Supermarkets' turnover and volume performance reflect on the general national economic health.

The study concludes that supermarket performance, during the span of the sampled period, does not interrelate with the measures of Gross Domestic Product or Gross Disposable Household Income.

The analysis elucidates on how the economic recession due to the capital controls of 2015, the COVID pandemic of 2020 and the excessive inflation and energy crisis post 2022 have affected the supermarkets' turnover and attempts to offer insight to both the state, as a policymaker, and businesses' strategists, while the findings of this research can enhance the established methods for monitoring economic performance through sectoral indicators.

Keywords

Supermarket sector, Household consumption, Gross Disposable Household Income, National economic health.

Περίληψη

Αυτή η διπλωματική εργασία επιχειρεί να συνδέσει την απόδοση του κλάδου της λιανικής πώλησης με συγκεκριμένους μακροοικονομικούς δείκτες. Συγκεκριμένα, ο κύριος στόχος είναι η διερεύνηση της αλληλεπίδρασης των δεικτών κύκλου και όγκου εργασιών των μεγαλύτερων, σε εθνικό επίπεδο, υπεραγορών και επιλεγμένων δεικτών των εθνικών λογαριασμών, ενώ παράλληλα επιχειρεί να ποσοτιτικοποιήσει και να αναλύσει μέσω διαγραμμάτων τις επιπτώσεις που δέχονται οι συγκεκριμένοι δείκτες από το Εθνικό ακαθάριστο προϊόν και το διαθέσιμο εισόδημα των νοικοκυριών.

Τα προϊόντα των υπεραγορών αποτελούν ένα μείζων ποσοστό της καταναλωτικής δαπάνης ενός νοικοκυριού και έναν σταθερό δείκτη της οικονομικής καθημερινής δραστηριότητας. Ο κύκλος εργασιών των υπεραγορών αντικατοπτρίζει άμεσα την εγχώρια αγοραστική δύναμη και την εμπιστοσύνη του καταναλωτή. Σε αυτήν την διπλωματική, δευτερογενή δεδομένα που συλλέγονται από την ΕΛΣΤΑΤ, την Ελληνική στατιστική αρχή, υπόκειται σε περιγραφική στατιστική ανάλυση και παρουσιάζονται χρονικά ώστε να κατανοήσει ο αναγνώστης πώς ο κύκλος εργασιών και όγκου των υπεραγορών αντικατοπτρίζει την γενική κατάσταση της εθνικής οικονομίας.

Η έρευνα καταλήγει στο γεγονός ότι η απόδοση των υπεραγορών δέχεται ελάχιστη αλληλεπίδραση από τους μακροοικονομικούς δείκτες του Εθνικού Ακαθάριστου Προϊόντος και του Διαθέσιμου Εισοδήματος των Νοικοκυριών.

Η ανάλυση διευκρινίζει πως η οικονομική ύφεση λόγο του μέτρων περιορισμού του κεφαλαίου του 2015, η πανδημία του COVID το 2020, ο υπερπληθωρισμός και η ενεργειακή κρίση από το 2022 και έπειτα έχουν επηρεάσει τον κύκλο εργασιών των υπεραγορών και τις συνήθειες του νοικοκυριού. Παράλληλα στόχος της ανάλυσης είναι να προσφέρει μια διορατική πληροφόρηση τόσο στο κράτος, ως κυρίως υπεύθυνο για την χάραξης κοινωνικής και οικονομικής πολιτικής, όσο και στους υπεύθυνους στρατηγικής των μεγάλων εταιριών του τομέα λιανικής πώλησης ενώ τα αποτελέσματα της έρευνας ευελπιστούν να βελτιώσουν τις καθιερωμένες μεθόδους παρακολούθησης της οικονομικής απόδοσης μέσω δεικτών του τομέα της εθνικής λιανικής πώλησης.

Λέξεις – Κλειδιά

Υπεραγορές, Κατανάλωση νοικοκυριών, Ακαθάριστο διαθέσιμο εισόδημα νοικοκυριών, Εθνική οικονομική υγεία

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List of Abbreviations & Acronyms

ARIMA	Autoregressive Integrated Moving Average
GDP	Gross Disposable Product
GDHI	Gross Disposable Household Income
ELSTAT	Hellenic Statistical Authority
IELKA	The Institute of Retail Consumer Goods
CPI	Consumer Price Index
OLS	Ordinary Least Squares
EC	European Commission
US	United States
PPI	Producer Price Index
HDI	Human Development Index
NACE	Nomenclature of Activities in the Communities
BEA	Bureau of Economic Analysis
OECD	Organization for Economic Co-operation and Development
LIS	Luxembourg Income Study Database
QNA	Quarterly National Accounts
QSA	Quarterly Non-Financial Sector Accounts
HBS	Household Budget Survey
COICOP	Classification of Individual Consumption by Purpose
ADF	Augmented Dickey-Fuller
AIC	Akaike Information Criterion
CV	Coefficient of Variation
RoC	Rate of Change
SER	Standard Error of the Regression

1. Introduction

Traditional retail channels, like farmer's markets and small producer's owned businesses, have given way in the past decades to major supermarket stores. Supermarkets are, nowadays, deeply integrated in the fabric of national economies and have evolved into the cornerstone of retail channels for food and other essential consumer goods (Reardon & Hopkins, 2006). In periods of increased economic expansion, the resulting increased employment and available disposable income, supports higher consumption and, subsequently, improved supermarket performance. In that logical postulation it is evident that the opposite holds true as well: in times of economic recession, households adjust their consumption and supermarket performance drops.

Considering that household consumption is interdependent with supermarkets' performance and, in turn, private consumption is interrelated with the available private income, this research explores whether the supermarket turnover and volume index has the potential to reflect the broad developments of national economic well-being.

In the course of the last decade, Greece, alongside the majority of all global economies, has experienced multiple, pivotal and, occasionally, overlapping economic shocks. The Greek debt crisis of 2015, the Covid pandemic of 2020, supply chain disruptions due to wars and foreign trade policies, as well as, extreme rise of energy prices and surge waves of inflation have resulted in divergences between nominal measures of economic activity recorded in the National Accounts, and the actual socioeconomic welfare of the nation (Menegakia & Tsagarakis, 2015).

Supermarket performance, however, despite its potent exploratory power as an economic activity indicator, is influenced by a number of other macroeconomic factors. Those factors include, among others, the volume of the products sold and the available disposable household income. This paper believes that an analysis of the relationship of the aforementioned measures, in addition with the measure of the gross domestic product can allow for a comprehensive understanding of the turnover index and explain whether the upward trend of the index is due to an increase in the ability of the nation to consume or it is driven primarily by inflation.

1.1 Scope and Research questions

The aim of this dissertation is to tie the retail sector's performance to macroeconomic measures. Specifically, the main scope of this paper is to determine whether there is an interrelation between the supermarket turnover and volume indices and the economic welfare of the nation over the period of 2016 to the present day. An exercise that may determine if it is meaningful for the indices to be monitored closely by both the state, as a policymaker, and businesses' strategists to gain valuable insight about the domestic economic activity.

To achieve its aim, this paper addresses the following questions:

i. How has the supermarket's sector turnover performance evolved over the past decade and how it compares to the supermarkets' volume sold performance.
ii. What is the relationship between supermarket's performance and the gross disposable product.
iii. What is the relationship between supermarkets' performance and the gross disposable household income.
iv. To what extend does the supermarket turnover index reflects real economic welfare, or it is solely driven by inflationary effects.

1.2 Methodological approach

This dissertation explores the interrelation between the national major supermarket businesses' turnover and volume indices and major national account indices by quantifying and analyzing the secondary quarterly data in comprehensive time series figures. To ensure comparability of the indices the analysis utilizes rates of change and constant 2020 prices measures. Descriptive statistics, graphical analysis, correlation and cointegration tests along with regression-based technics are employed to determine both short and long run relationships of the examined measures.

1.3 Dissertation Structure

The remainder of this paper is structured as followed. Chapter 2 reviews the relevant literature of all economic measures relative to this study. Chapter 3 outlines the overall design of this research, the data sources employed and the methods used to treat that data in order to transform it into a comparable set of variables, a review of the econometric methods used and the ethical considerations that envelop the entirety of this research. Chapter 4 presents and discusses the empirical results including descriptive outcomes and regression and correlation estimates. Chapter 5 concludes by summarizing the key main findings, discussing the limitations of this paper and proposing possible directions towards the continuation of the work presented.

2. Literature Review

2.1 Retail Turnover and Volume indices as macroeconomic indicators

Eurostat treats the retail turnover and volume performance indices as a pivotal source of information and the basis for relevant information on the short-term development of trade. Furthermore, Eurostat conceptualizes the aforementioned indices as a principal European indicator to estimate and monitor economic and monetary policies. Retail performance affects, in a major socioeconomic manner, the whole union. Retail trade generated approximately 5% of the total value added in in E.U. economies in the past years. According to Eurostat retail trade was forced into an unprecedented decline in March and April of 2020 due to COIND-19. The indices gained some momentum in the post COVID era but at Q1 of 2021 trade growth volume dropped again up until the day of writing revealing a connection between retail turnover and macroeconomic measures such as GDP, GDHI and unemployment (Eurostat, 2025).

The growth of retail trade is dynamically inclined to the real income growth of the population. In his work, Ergash (2026) after the application of descriptive, correlation and regression analysis concludes that a moderate relationship can be determined between the retail trade turnover and the economic growth. The research utilized investment and retail turnover as a means to evaluate economic activity in regions of Kashkadarya. The article measured the effects of industry factors to the region gross product by following the economic model:

$$GRP\_growth_t = a + \beta_1 Industry + \beta_2 Construction + \beta_3 Agricalture + \beta_4 Services + \beta_5 Investments \qquad (2.1)$$

The research identified that the ¨services¨ factor, which included all retail activity, had an estimated coefficient of 0,28 and had a significant part in the growth of Gross Regional Product with the model explaining 92% of the variations of the GDP growth. The article argues that the services sector presents an interrelation with the growth of the regional economy which is multiplied through the influence exhibited between the rise of transportation, consumer services, information technology services and the rise of retail sales.

The growth in the retail turnover indicates an accelerated incline in profits of retails witch, subsequently, translates into a growth into the population's wealth by providing elevated incomes and new jobs. In the article composed by Sukhanova, Shirnaeva, and Repina (2019), the authors devised a regression model with retail turnover as the dependent variable and consumer price index, unemployment rate and average monthly salary as independent variables. The time series included years from 1999 to 2019. The calculations presented that in case that the average monthly salary was to rise 1 ruble, retail turnover would exhibit a growth of 0,06 billion rubles. An increase in 1% of the price index would present a growth of the retail turnover by the amount of 7,09 billion rubles. On the other hand, a growth in unemployment by 1% would trigger a fall in the retail trade index. The results infer a significant interrelation between turnover and economic welfare of a community or a nation. A major conclusion was, that for all the related variables, an ARIMA model could be constructed to forecast values of explicable variability on the short-term future, indicating that there is a correlation- short term implications- between turnover and socio-economic indicators and macroeconomic measures, such as income and inflation rate.

Belesis and Gazilas (2023) provide a comprehensive analysis in the Hellenic retail sector and correlate it's results with macroeconomic indicators using the GDP and the GDP change along with household consumption to provide context to the outcomes of the research. The research spans for 7 years from 2015 to 2021 across seven sectors of retail activity, one of them being the retail sale of food, beverages and tobaccos in specialized stores, essentially, supermarkets. Net profit margin was calculated for the sector with an average ratio value for the entire period of 2,43%. The correlation coefficient of the sector's net profit margin ratio with the annual GDP change revealed that supermarkets' net profit margin appears to increase during periods of economic prosperity, linking the amount of the disposable income to the supermarkets' performance indices. However, the correlation coefficient of the sector's net profit margin ratio with the household's consumption as a percentage of GDP indicate that supermarkets and retail companies lost money as consumers spend more during the examined period. The article indicates that this can be due to the falling of consumer demand or the international retailer competition.

In an attempt to analytically demonstrate how GDP, consumption, purchasing power and retail turnover are economic indicators that form a relationship, Kozak (2015) states in his work, that unemployment and inflation have become part of the consumers' thinking and determine their decision patterns which, subsequently affects the retail sector and, evidently, the supermarket turnover rate. By comparing macroeconomic indices for the whole of the Hungarian territory from 1990 to 2011 the article comes to conclude that, when there are enough evidence of an upcoming recession in the economy, economic policy uses restrictive measures in connection with consumption, while in times of economic growth the quite lax rules of the free market dominate the state policy. A fact which leaves higher opportunities for profit. The author, in his work, continues on to estimate that to set the foundations of achieving national economic growth one must boost consumption suggesting that GDHI is related to the macroeconomic measures of turnover, volume and GDP.

Zisoudis, Zafeiriou, Garefalakis, Spinthiropoulos, and Garefalakis (2021) in their composed article, studied the economic performance of supermarket chains in Greece and the ways the supermarkets affected, what the article establishes as economic growth, the employment rate and the national income. The raw data of this research was sourced by ELSTAT and previous studies related to IELKA. The authors used a comparative analysis of 5 different major supermarket chains (AB Vassilopoulos, Sklavenitis, My Market, Masoutis, Galaxias) based on the GDP and established that, despite the fact that Greece has been facing economic austerity measures since 2010, had their share to the GDP doubled from the examined period of 2009 to 2017. The paper suggests that these kinds of specialized stores have created jobs and impacted positively the rate of unemployment and paid taxes and liabilities in a time when the extended European economic crisis and the consecutive economic shocks resulted in the limitation of the nation's disposable income. The outcome of this investigation validates the significant impact on the macroeconomic measures studied by this dissertation by the supermarket turnover.

By performing an analysis of the financial statements of supermarkets for 2012 to 2017 Zisoudis, Karelakis, Theodossiou, and Loizou (2020) postulate in their work, that an economic crisis usually occurs when GDP decreases, and the crisis becomes evident when unemployment rises and investments and demand decreases. As does, consequently, consumer consumption. The article examines the liquidity, working capital and efficiency ratios of Sklavenitis, Masoutis and AB Vassilopoulos. Three major supermarket chains in

Greece. The analysis discovers that all three examined ratios are consistently showing low results, mainly due to the impact of the economic shocks that have affected the disposable income that most supermarkets absorb. It is concluded that large chains managed to exhibit resilience due to well managed investment activity and the exploitation of economies of scale. The paper does, however, indicate that neither large, nor small retail companies' turnover can remain unaffected by the growth, or decline of the GDP and the GDHI.

Bauerova, Starzyczna, and Prazak (2022) state in their work that making decisions in retail management is strongly associated with the current trends in consumer demand. The paper analyzes a joint time series evolution of retail sales in Czech Republic and tests for cointegration. The research indicates that purchasing power can be affected by the available income, prices and domestic savings. The data of the time series examined by this research is at a frequency of quarterly intervals and covered sales from Q1 2001 to Q4 2019. In total six economic indicators were tested for cointegrating with the retail sales: Household final consumption expenditure, unemployment rate, CPI, gross wages, GDP and total employment. All measured in percentage change in the time series. The results revealed that the selected economic indicators, due to the established cointegration links on specific lag length between the retail sales and the examined economic indicators, could be used in short term business strategy planning. Furthermore, it is proved that gross wage- and by economic logic- GDHI, and total employment indicators can predict changes in retail sales activity. Establishing an interrelation between turnover, volume, GDP and GDHI indices. It must be mentioned that the data from the year 2020 are not included in this study as it, clearly, presents a structural breakdown in the measurements due to the COVID-19 pandemic.

Research conducted by the Federal Reserve Bank of New York (1996) describes the linkages between chain store data and official measures of consumer spending. In the report in question the statistical link between two chain store indices is tested. The first index is compiled by Mitsubishi's bank and the second from Johnson Redbase service, both indices cover multiple sectors of the retail sales. The paper examines the two indices and suggests that, them alone, are not capable of forecasting accurate future sales. However, the report argues that taking into account the macroeconomic measures and include the dependent variables of payroll, employment and gasoline prices can be useful for forecasting retail sales, proving in such a way, a correlation between the disposable income, the retail turnover and the general welfare of the economy. A fact that results in a more accurate view of the consumers' behavior. The best fitted regression model out of the sum of the models tested by the Federal Reserve resulted in a payroll coefficient of 1,063 and the overall model explained 37,9% of the retail sales variations. An outcome that was deemed satisfactory by the bank.

Zhang (2020) employed cointegration analysis and multiple dynamic regression in his research, to explain the relationship between total retail sales and the economic growth in China. An analysis that spans from 1992 to 2019. This research uses China's GDP to measure economic growth. The research finds a long run connection in the form that for each 1% of unit of increase in total retail sales of social consumer goods presents an effect of increasing economic growth by 2,02 percentage points, finding a significant positive impact between consumption and economic growth. The author concludes that the development of economic welfare of a nation is directly interconnected with the volume of retail sales and expanding consumption demand is pivotal to the GDP growth. The findings present a strong inference in an existing relationship between a nation's income and the volume of retail sales.

Olena (2024) models the dependencies between the development of retail trade and the economic development of European countries from the year 2005 to 2022. The author's study collected aggregated data from 30 European countries, sourced from the European commission databases. The model is described by the dependent variable of retail turnover and the independent variables of number of hours worked, gross wages, number of enterprises, production value, added-in value, total consumption, changes in stocks of goods and services, personnel cost, employment rates and investment rates. The study performed an OLS analysis and identified the impact of the specified economic development indicators on the retail trade index. The author identified a direct relation between GDP per capita and trade turnover, CPI and trade turnover and CPIA and no of employees. Moreover, the author identified an inverse relationship between unemployment and trade turnover, CPI and investment level and GDP per capita and investment level. The research overall indicates that trade turnover is greatly affected by the available income, price changes and the investments in the retail sector by the industry.

Mladenović, Mladenović, and Karanikić (2024) analyze the dynamic of consumer prices and the volume of turnover in the retail sale of food products in Serbia from 2006 to 2022 in their article. The research rises the hypothesis of whether the increase in rises of food products and non-alcoholic beverages does not have a statistically significant impact on the real volume of sales of this type of product. The analysis indicates that in the case of basic food stuff (and not chocolate or sugar-based stuff), the price level cannot be considered statistically significant to determine the real volume of this type of product sold in retail. A fact that reinforces the idea that food is considered a necessity and the volume sold must be considered price inelastic.

Big data can be utilized to identify trends in supermarket consumer behavior and the macroeconomic implications of those patterns. Stylianou and Pantelidou (2025) prove through their research that consumer purchasing patterns are not random but, rather, dependent and reflect shifts in consumer confidence, price sensitivity and household welfare. An outcome that implies that GDP and GDHI have a dependent relationship with the turnover and volume performance ofr the supermarket industry.

Karadi, Amann, Bachiller, Seiler, and Wursten (2023) provide evidence that, during the COVID-19 pandemic in European markets, the shock raised demand in food and beverage products sold by supermarket by restricted access to food away from home. However, this resulted in a minimized impact on costs because supermarkets were an essential sector, thus, unaffected from the lockdowns. The resulted inflation of the crisis, on the other hand, had an effect in the growth of prices in the supermarkets. A fact that links grocery prices with an outsized influence on inflation expectability due to their salience. This research does, indeed, describe a scenario were, essentially, the prices and the inflation rate are the driving source of supermarket turnover and volume, with GDP and GDHI following with a far less powerful impact.

2.2 GDP as a measure of economic growth and welfare

The Gross Domestic Product is defined by Yamarone (2017) as the sum of the market values of all final goods and services produced by the resources of a country residing in that country. It must be noted that, by definition, resales are not included in the accounts. GDP is the most comprehensive economic statistic and is considered a benchmark for the overall state of the affairs of a nation's economy. The formula to calculate the GDP using the expenditures approach is presented in Equation 2.2:

$$GDP_{\exp\_approach} = C + I + G + (X - M) \quad (2.2)$$

GDP, according to the expenditures approach, is the sum of the personal consumption expenditures (C), gross private domestic investment (I) government consumption expenditures and gross investment (G) and the net export value of goods and services (X-M). The expenditures approach stands as the most common approach in estimating GDP. A second approach is the income approach. A method that sums all incomes generated in the economy as depicted in Equation 2.3.

$$GDP_{inc\_approach} = Total\ National\ Income + Indirect\ Business\ taxes + Depreciation + Net\ Foreign\ Factor\ Income \quad (2.3)$$

The difference between real and nominal GDP is the level of inflation. To deflate the GDP to the prices of an elected base year in order to be comparable in a timeline series, the GDP in current prices must be deflated to constant prices of the base year's GDP with the employment of a GDP deflator.

Kalimeris, Bithas, Richardson, and Nijkamp (2020) in their work, analyze how GDP is an index of aggregate economic output in monetary terms representing the value of all finalized goods and services produced and traded within a certain period. Most commonly a year. Nowadays it is accepted by governmental institutions as the basis for measuring economic growth and socio-economic welfare. The paper suggests that GDP exhibits limitations in its capacity to measure welfare. In particular the index fails to account for inequality, ignores values like social cohesion and the environmental sustainability of the economy. The authors propose that research must be directed towards alternative indicators of economic welfare, but state, that for the time being, GDP remains the world's standard in measuring economic growth.

The fact that GDP is, at the whole economy level, the most widely used measure of output is discussed by Oulton (2004). In his article, the author, asserts that the growth of real output is what measures the economic growth of a nation. The paper studies the economic growth though two measures. GDP and Weitzmans Nominal Net Domestic Product deflated by the price of consumption. A final conclusion is reached that, in practice, GDP provided a fairer, truer and more thorough perspective of the US economic performance over the examined period spanning from 1990 to 1999.

Feldstein (2017) describes in his article, the procedure needed to be able to compare GDP in a timeline series. The paper indicates that nominal GDP must be converted to real GDP with the use of an inflation component and describes how in the US the bureau of labor statistics uses components base on the CPI and PPI indices to deflate the GDP. The author concludes that the governmental legislators in charge of reviewing and adopting policies that depend on economic output and its rate of change should view with a certain skepticism, when assessing the long-term economic growth, the measure of GDP. Overstating inflation, therefore underestimating real income, may lead to conclusions that do not take into account the value created by the introduction of new goods and services in the economy. A fact that implies that the officially measured pace of real output change, thus the economic growth and welfare of a nation, might end up being greater or lower than the actual output.

In a society where people's economic wants are satisfied, in order to provide a higher amount of satisfaction more inefficient ways to do so are required. Nørgard (2006) discusses how GDP growth is affected by the use of inefficient means and the consequences of it. The author illustrates that creating models for inefficient satisfaction by using the wrong means, can push an economy to pursue growth turning it into less efficient and highly more uneconomical for the consumers. Inferring that growth of GDP does not necessary means growth a nation's welfare, at least not, in a sustainable manner.

Oulton (2023) studies two models of trading economies and calculates whether the changes in output and welfare follow a change in the terms of trade. In his work, Case 1 models a small economy that produces and trades consumption goods. The model simulates an increase in the price of exports, relative to the price of imports, and tests if it raises economic welfare. Case 2 focuses in to two goods into the small economy. In this case the imported good is an intermediate input into the domestic one. The paper attempts to analyze the relationship between GDP and welfare. The first model concludes that real consumption rises while GDP remains constant. The second model, in the other hand, explains how, under imperfect competition, GDP increases when the terms of trad improve. The paper concludes that extracting estimates of welfare from the National Accounts can be accurate but challenging a task that requires diligence and proper estimations about the existing competition. It is stated that most macroeconomic models in modern times are, indeed, build on the assumption of imperfect competition.

In his work, Slesnick (2020) states that there are conceptual complications correlated with the utilization of GDP as a measure of social welfare. The author compares real GDP per capita with a number of consumption based social welfare measures in the US and illustrates that real GDP does not incorporate an accurate presentation of welfare, with divergencies incurring due to the price differences from area to area not reflected in the national CPI which is used to estimate the measure of the national GDP deflator. It is concluded that, with the same issue in mind, the inequality levels of income between countries, can produce inaccurate cross country welfare comparisons and failure to account for distributional effects in measuring the socioeconomic standard of living is considered ill advised practice.

Arrazak and Magriasti (2024) discuss the idea that social well being relates to social, health and happiness dimensions rather than defined as a sole economic matter in their article. The study indicates that GDP, despite serving as a measure of the total value of goods and services produced within a country, being utilized as a measure for economic growth for the long term by economists fails to account for income distribution or environmental factors that can impactfully effect quality of life. The paper concludes that to assess the well being of the population, apart from GDP, additional measurements such as the HDI or other happiness indicators are deemed necessary.

In accordance with aforementioned literature Chamberlin (2011) illustrates that GDP as a measure was, evidently, not designed to capture living standards, quality of life and well being of citizens. The author characterizes GDP as unable to accurately depict a nation's welfare due to its materialistic nature. The research, through comparative analytics, calculate that the real income has a higher welfare significance by relating to current and future consumption possibilities. It is thoroughly discussed how between a period spanning from 1987 to 2009 UK's real income has grown slightly faster than GDP. The same period that UK's output has been unsettled by a shift from production to services. It is deducted that since the fact that production in modern times is less capital intensive it resulted in a declining trend in capital consumption rates raising real income growth relative to GDP. The author, in essence, presents a case where the growth of the National Disposable Income has moved in a different pace than the growth of GDP depicting a different view of economic welfare.

Heys, Martin, and Mkandawire (2019) discuss two distinctive views of the GDP. The ¨orthodox view¨ where GDP is considered to provide clear insights to policy makers in relation to fiscal and monetary policy, as a measure of productivity of economy, and the ¨modernizer¨ view which strongly believes that GDP, and the National Accounts in general, should be transformed to capture a measure of welfare which reflects modern life, particularly the fact that the consumption of material goods is becoming less important as a measure of living standards. Heys et al., procced to conclude that a measure like GDP will continue to be of value to the government's legislators acting at the role of policymakers, as an informative measure, and whilst GDP is, theoretically, a weak and incomplete measure of welfare, economists should take action into considering ways to build alternative, more inclusive to factors that describe welfare, measures.

In an article published by Brynjolfsson, Collis, Diewert, Eggers, and Fox (2018) the authors develop a new framework to measure welfare change the real GDP growth in the presence of new and ¨free¨ goods and services, such as information and entertainment services. It is noted that the quantities of these goods, when consumed, have zero measured price and zero value in the National Accounts. Free goods are addressed with generating the microeconomic model of household cost minimization and the adjustment terms for real GDP growth to allow for those goods. The model's adjustments derive to a new metric. GDP-B and enables a more thorough exploration of the impacts of new and free goods with significant potential policy implications to the extent that the adjustments made, may explain the much documented and debated productivity growth slowdown by industrialized countries since 2004.

Syrquin (2011) argues that attempts to replace GDP are misguided in his paper. The author indicates that attempts that are mixing the income with estimates of non market activities no longer present a valid market representability. Syrquin discusses that the conceived new measures perform other functions not related to measuring growth and concludes that, in the spirit of understanding the limitations of current measures of the national accounts to gauge economic welfare, it is best to provide a range of indicators rather that a single number. The paper defends the notion that the, currently applicable measures of GDP and other National Accounts, should not be discarded and warns against stretching the concept of national income to include lots of non-market related information.

2.3 GDHI as a macroeconomic indicator

BEA defines household income as the remaining amount from the subtraction of personal contributions for government social insurance and personal current taxes from the personal income collected from major sources. Major sources of income are the private wages and salaries, supplements to wages and salaries, rental incomes, personal income receipts on assets and personal current transfer receipts. Real disposable household incomes are simply incomes adjusted for taxes and inflation, in essence, what is available for consumers to spend or save, and is generally considered a useful measure of potential spending power. Since a level of income is necessary for all economic activity, trends in income growth theoretically should permit inferences about future spending patterns. (Yamarone, Personal Income and Outlays, 2017).

Ven (2018) on an OECD conference discusses a report named "Report by the commission on the measurement of economic performance and social progress" and focuses on five, directly related to macro-economic statistics, recommendations:

i. When evaluating material wellbeing, one, must look at income and consumption rather than production.
ii. One must emphasize the household perspective.
iii. One must consider income and consumption jointly with wealth.
iv. One must give more prominence to the distribution of income, consumption and wealth.
v. One must broaden income measures to non-market activities.

The main thrust of the aforementioned recommendations is to suggest that a researcher must look at household disposable income when investigating economic growth. GDHI is an indicator that can be derived by the National Accounts and provides a much better indicator for monitoring the material well-being of resident households. The presentation of Ven (2018) describes that the main differences between the development of the real GDP and real GDHI are related to:

i. The shares of compensation of employees and income from self-employed and unincorporated corporations in the value added generated through the production process.
ii. The redistribution of income by government policy.
iii. Quite distinct movements between the price change in GDP and the price change of household final consumption.

The presentation in the conference concludes that policies with the sole purpose of driving the nation's GDP higher should not be the ultimate objective for a society. Instead, policies that guide towards the wellbeing of people (that affect positively the GDHI), without jeopardizing sustainability of the economy in the long run, should be more prominent.

Quarterly data on 20 European countries over the period of 1980-2023 were utilized by Cevik and Naik (2025) to analyze the dynamic relationship between house prices, disposable income and consumer spending. The paper estimates that household consumption responds strongly to house price movements and in disposable income growth in real terms. Increasing (decreasing) house price growth and gross disposable income can stimulate (dampen) private consumption growth by raising (lowering) household wealth and easing (tightening) borrowing constraints. A fact that infers that the retail sector's turnover, in general, and supermarkets' turnover, specifically, correlate and can be positively benefit from a rise in GDHI.

Ribarsky, Kang, and Bolton (2016) address in their work the fact that, in many OECD countries, nominal growth rates of GDP grow at a faster pace than real household income. The key findings from research done concerning a period from 1996 to 2013 at the differences in the two growth rates indicate that, prices faced by consumers grew at a faster pace than prices faced by producers -providing rising profit to corporations, and, rising value added to the GDP of corporations and government that is not, then, distributed as labor income widens the difference at the expense of household income. It is concluded that, although, GDP is a useful indicator of a country's economic activity, it does not sufficiently represents the actual material conditions of the society. It is stated that both GDP and GDHI measures evolve differently over time and a significant gap between the two developments can occur. With that fact in mind, one, should be careful in the interpretation of the national accounts measures when examining the economic welfare of a society within a particular country.

Sideris and Pavlou (2021) present an analysis performed for the period Q1 of 2003 and spans to Q1 of 2020 on the private consumption in Greece. The analysis decomposes the disposable income to labor and non-labor income, discussing the idea that consumption may differ across income types. Labor income is defined as compensation of employees minus direct taxes on income and wealth paid by households. Non-labor income is derived as the difference between disposable income and labor income. It is found that labor income is the most important determinant of private consumption in Greece. Furthermore, it is presented that social transfers and fiscal measures have a positive impact on private consumption in the short run. The conclusions of the paper agree with the works of Ven (2018) which, as formerly discussed, states that fiscal measures and policies regarding a nation's socioeconomic welfare should aim to rise GDHI.

There are differences in the effects of structural reforms on the GDP and the GDHI. Botev, Égert, and Turner (2022) compared data available to 34 OECD countries from the period of 1995 to 2019. The authors' work established that GDHI is closely correlated with GDP per capita. Moreover, the GDHI per capita, for all countries in the research, is less than the GDP per capita. The paper provides some interesting remarks concerning the two indicators. A 10% increase increase in real energy prices faced by consumers and industry, for a typical OECD country, translates to a fall of GDHI, relative to GDP, by 2 %. Furthermore, structural reform policies like in-kind family benefits or cuts in the income tax have a magnified effect on GDHI so that following a policy reform, long run percentage changes in GDHI are larger than for GDP. An expected phenomenon, as these policies work by boosting income for households already in employment. On the other hand, structural policies that typically their transmission mechanism depends mainly on productivity and capital intensity have weaker long run effects on GDHI than GDP.

Nolan, Roser, and Thewissen (2016) investigate the divergence between the evolution of GDP per capita from the path of income of a typical household a measured in household surveys across 27 OECD countries. The country and year coverage is defined by the availability of LIS microdata, starting from most countries the analysis at 1980s and ending to 2010. It is discovered that divergence between the two measures is the product of different factors at different times, sometimes related to factors such as changes in producers versus consumer prices, falling household size or increasing inequality or differences between national accounts and survey-based figures that are much less easy to interpret. The paper concludes by pointing out that in assessing how a country is performing the is no substitute for careful examination on a case by case bases of the various indicators available, how these have related to on another in the past and how the different drivers of potential divergence, such as household size and income inequality appear to be evolving. No single measurement, such as the GDHI, can reliably support judgment about the real income growth and the socioeconomic well -being of a country. In accordance to the authors' work this research was not solely based on the resulting correlation and cointegration tests between indicators Greece's national accounts but, instead, a critical view and comprehensive interpretation of the time series as a whole was performed to reliably judge the economic health of domestic household as derived from the supermarket performance.

3. Methodology

3.1 Introduction

This chapter defines the research methodology employed to assess the supermarket stores' sector performance and the effects on national economic health and household consumption trends. Furthermore, an extrapolation of whether an interrelation can be found between the supermarket turnover and volume indices and the national Gross Disposable Product and Household Income growth is attempted. The time period examined concerns secondary data gathered from 2016 to the most recent available index entries.

This study, operates under the concept that the best indicative index to measure household income and living standards is the GDHI as it reflects what households have available to spend after taxes and all mandatory social contributions.

Supermarket turnover was selected as a dependent variable, as it represents a major component of household consumption and a permanent indicator of everyday economic activity. Supermarket turnover, directly reflects domestic purchasing power and consumer confidence. The investigation of supermarket performance and its relation to macroeconomic measures can enhance the established methods for monitoring economic growth and household consumption through sectoral indicators.

The research examines publicly available secondary data obtained by ELSTAT. The use of this dataset ensures strong evidence since ELSTAT is Greece's principal authority in charge of statistics and census data.

This chapter outlines the research design, data collection and preparation method, the statistical models employed, the model diagnostics and robustness checks utilized, ethical considerations and limitations

3.2 Research Design

The research utilized a quantitive, observational, time series approach to examine publicly available secondary data obtained by ELSTAT. To ensure consistency and comparability of the data and validity of the results, turnover and volume indices were rebased to reflect the base year of 2020 = 100. All GDP and GDHI prices were converted to constant 2020 prices to prevent inflationary factors from distorting the econometric conclusions, and all series were aligned to reflect a quarterly frequency.

The study was structured in four essential stages. The first stage was the collection and preparation of the data.

At the second stage, descriptive statistics were applied to explore the evolution of the turnover and volume indices in relation to GDP and GDHI growth over time. Time series visualization, through comprehensive graphs, was leveraged to extrapolate the relationship between turnover, volume, GDP and GDHI and the effects of economic shocks throughout the decade (COVID-19 at 2020, cost of energy and ongoing inflation post 2022) on the national economic health, especially focused, on the non-financial national sector account of the GDHI.

The third stage involved, where permitted by the data, a cointegration and a correlation analysis to estimate whether a short term, linear, relationship or a, long term, stable equilibrium between the supermarkets' retail performance, GDP and GDHI exists and, if so, what is the direction and the strength of it. Instances where autocorrelation justified the use of Newey West Regression, the model was utilized instead of typical Spearman's correlation test, and the Enge-Granger approach for cointegration testing.

The fourth stage, consists of an application of a regression based econometric model to evaluate the extent to which variations in the turnover index are associated with the rest of the series of the study.

This research, utilized the appropriate tests to confirm that all the required assumptions of the statistical models used were satisfied and the statistical analysis was carried out using the MS Excel work suit with the Analysis ToolPak and XRealstats-Mac add-ins enabled.

3.3 Data Collection

Data collection methods are techniques for purposefully gathering information. This research utilized manual secondary data analysis, the review and analysis of pre-existing data sources, relying on human effort to record the initial information. The analysis employes a quantitive approach, a focus on numerical data.

3.3.1 Supermarket Turnover and Volume Indices

ELSTAT releases the Retail Trade Turnover and Volume Index with its current from since January 2005. The Retail Trade Turnover Index is a continuation of the Retail Sales Value Index, which had been complied during the period 1963 to 2004. Post 2005 the Retail Trade Volume index is also being compiled aiming at measuring changes in the volume of retail trade. The compilation of the aforementioned indices is governed by Council Regulation (EC) No. 1165/98 of 19 May 1998 concerning short-term statistics and by Regulation (EC) No. 1893/2006 of the European Parliament and of the Council of 20 December 2006 establishing the statistical classification of economic activities NACE Revision 2.

The reference period of the data is one month and the index covers the whole country of Greece with data coming from 61 regional units. The framework of the survey includes 41,801 retail trade enterprises listed in the business register of ELSTAT having an annual turnover equal or higher than 200.000 €. Out of these enterprises a random sample of 1,607 enterprises is selected. The turnover index is calculated by the chaining method and is reduced to a typical month of equal duration. Seasonal adjustment is applied to remove the impact of seasonality on the time series in order to improve the comparability over time.

ELSTAT, in its publications, provide specialized indies of the economic performance of supermarkets which are defined as non-specialised stores with food, beverages or tobacco predominating.

ELSTAT provides indices for the whole examined period:

- January 2016 → July 2018: Base year 2010 = 100,00
- August 2018 → December 2023: Base year 2015 = 100,00
- January 2024 → August 2025: Base year 2021 = 100,00

The official press releases publicizing the secondary data concerning the Retail turnover and volume performance and further information on the methodology concerning the compilation and calculation of the indices for the time series can be obtained from the Hellenic Statistical Authority (Hellenic Statistical Authority, 2025).

3.3.2 Gross Domestic Product Growth

ELSTAT announces the quarterly Gross Domestic Product index as part of its QNA public press releases. The QNA are compiled in accordance with the European System of Accounts

-ESA2010 of the Council Regulation (EU) No 549/2013 of the European Parliament and of the Council of 21 May 2013, as amended by Regulation (EU) 2023/734 of the European Parliament and of the Council The accounting period is the quarter and the accounts cover the whole Greek territory. The data are published in million euros and QNA aggregates are compiled at current prices, previous year prices and chained-linked volumes (base year:2020 = 100,00)

Seasonal adjustment is applied to remove the impact of seasonality on the time series in order to improve comparability over time.

To enable the alignment and the comparability of all series, this research, recorded the seasonally adjusted chain linked volume GDP at constant 2020 prices. The Chained linked volume at constant prices explains the real growth over time by adjusting for inflation removing price affected distortion and reveal the true volume change of the GDP (growth)

The official press releases announcing the secondary data concerning the Gross Domestic Product and further information on the methodology and detailed tables are available from the Hellenic Statistical Authority (Hellenic Statistical Authority, 2025).

3.3.3 Gross Disposable Household Income

The quarterly non-financial accounts by institutional sector Household and non-profit institutions serving households are released by ELSTAT at current prices in million euros. Last updated at 23nd of October of 2025 the document includes data from Q1 1991 to Q2 2025 with the current, and the last two years, being under provisional status. The QSA are compiled in accordance with with the European System of Accounts -ESA 2010 of the Council Regulation (EU) No 549/2013 of the European Parliament and of the Council of 21 May 2013, as amended by Regulation (EU) 2023/734 of the European Parliament and of the Council.

The accounting period of the publised data is the quarter and the geographical coverage expands across the whole of Greek territory.

The official QSA accounts, more information on the methodology and detailed tables are availabe for the reader on the Hellenic Statistical Authority website (Hellenic Statistical Authority, 2025).

3.3.4 Consumer Price Index

CPI is compiled by ELSTAT since 1959. From the year 2001 onwards it refers to the whole country covering urban, semi-urban and rural areas of the territory excluding collective households and non-resident households. Its published reference perod is monthly with a the reference year of 2020=100. The index follows the chain linking method introducing new weights annualy and having as a base the December of the previous year. The weights are estimated on the basis of the most recent available data of the HBS, extrapolated to the prices of December. The CPI, adjusted on an annual basis to the most recent consumption expenditure pattern of the private households of the country, ensures the representativeness of goods and services, which compose the basket of purchases of the average household. The prices collection outlets are retail stores, enterprises providing services, street markets etc. which are considered representative of the brnces of shops, where the households make their purchases in 27 cities covering the 13 regions of the country

The classification ot the CPI items is based on the international classification COICOP as this has been adapted to the needs of the HICPs of the EU member states with the COICOP5/HICP classification

The official published CPI records and further additional information concerning the methodology and the compilation of the time series are available on the Hellenic Statistical authority website (Hellenic Statistical Authority, 2025).

3.4 Data Preparation

The raw economical secondary data recorded by ELSTAT is not suitable for statistical analysis as they are published. The econometric methods applied by this research assume that the data must be on a consistent scale, comparable over time, free of seasonality and inflation distortions in order to produce meaningful results. Unprepared data will lead to spurious misleading conclusions. This section describes the methods utilized to prepare all the variables to provide credible econometric results.

3.4.1 Supermarket Turnover and Volume Indices Preparation

ELSTAT publishes continuous monthly supermarket turnover and volume records throughout the examined period of 2016 to 2025 but the data spans on 3 different base years.

An index value is relative to its own base year. The three separate base years on the provided indices compare growth relative to different starting points and cannot be compared without rebasing them.

To rebase the entire turnover index to a base year of 2020 = 100,00 the following steps were necessary:

- An overlapping entry found in both indices with the base year of 2010 = 100 and 2015 = 100 of August of 2018 was employed to compute the conversion factor in order to rebase all entries with a base year of 2010 = 100,00 to a base year of 2015 = 100,00. The conversion factor was calculated as the seasonally adjusted turnover index entry of August 2018 with a base year of 2015 = 100 over the seasonally adjusted turnover index entry of August 2018 with a base year of 2010 = 100:

$$Conversion\ factor_{2010\rightarrow 2015} = \frac{August\ 2018\ Index\ Value_{2015=100}}{August\ 2018\ Index\ Value_{2010=100}} \quad (3.1)$$

  The remaining entries of all 2010 = 100 base year values were multiplied by the conversion factor to produce rebased 2015 values.

- To compute the conversion factor to rebase entries with a base year from 2015 to a base year of 2020 = 100,00 January of 2020 was assigned a turnover index of 100. The conversion factor was calculated as 100, since the rebase intends to produce an index with a base year of 2020, divided by the seasonally adjusted turnover index value of January 2020 with a base year of 2015 = 100,00:

$$Conversion\ factor_{2015\rightarrow 2020} = \frac{January\ 2020\ Index\ Value_{2020=100}}{January\ 2020\ Index\ Calue_{2015=100}} \quad (3.2)$$

  The remaining entries of all 2015 = 100 base year values were multiplied by the conversion factor to produce rebased 2020 values.

- The index entries with a base year of 2021 = 100,00 were rebased to a base year of 2015 = 100,00 with a conversion factor calculated from the overlapping entry of January of 2024 which is found in both 2015 and 2021 base year indices. The conversion factor is calculated as the seasonally adjusted turnover index value of January 2024 with a base year of 2015, over the seasonally adjusted turnover index value of January 2024 with a base year of 2021:

$$Conversion\ factor_{2021\rightarrow 2015} = \frac{January\ 2024\ Index\ Value_{2015=100}}{January\ 2024\ Index\ Value_{2021=100}} \qquad (3.3)$$

The remaining entries of all 2021 = 100 base year values were multiplied by the conversion factor to produce rebased 2015 values. The resulting 2015 base values were multiplied by the conversion factor calculated at the Equation 3.2 to achieve the full transformation of an index compiled from entries from 3 different base years to a single index with a base year of 2020 = 100,00.

To achieve comparability with the rest of the macroeconomic indicators that are discussed at this research, the monthly entries were transformed to reflect a quarterly frequency. The Quarterly index was calculated as the average of each 3 months entry:

$$Index\ Value_q = {}^{1}\!/_{3}\,(TI_{m1} + TI_{m2} + TI_{m3}) \qquad (3.4)$$

The annual average Turnover Index was calculated as the average of each year's 4 quarters

$$Index\ Value_{an} = {}^{1}\!/_{4}\,(TI_{q1} + TI_{q2} + TI_{q3} + TI_{q4}) \; (3.5)$$

In essence, a similar methodology philosophy was elected to translate the entire volume index to a base year of 2020 = 100,00.

The published data provide the same overlapping months between turnover and volume indices. Initially, the entries with a base year of 2010 were rebased to 2015 with a calculated conversion factor described in Equation 3.1. January of 2020 was assigned a volume index of 100 and all index entries with a base year of 2015 were multiplied by the conversion factor calculated in Equation 3.2. Furthermore, the entries with a base year of 2021 were multiplied by the conversion factor described in Equation 3.3 and the subsequent results by the conversion factor calculated in Equation 3.2.

The end result achieved an, appropriately rebased, volume index aligned with all the other macroeconomic measures of interest. Lastly the monthly entries were calculated at a quarterly frequency and the annual average Volume index for the examined period was estimated.

The, rebased to year 2020 = 100,00, Turnover and Volume indices are presented at Appendix A, Table A.1.

3.4.2 Gross Domestic Product Index Preparation

ELSTAT publish quarterly GDP entries in chain linked volumes at constant 2020 prices. The raw data acquired by these publications did not need to receive any treatment in order to align with the rest macroeconomic measures. The quarter-to-quarter growth was specified as the difference between a quarter and each previous quarter value over the previous quarter value multiplied by 100:

$$Quarter\ growth_t = \frac{Q_t - Q_{t-1}}{Q_{t-1}} \times\ 100\ (3.6)$$

The annual total real 2020 GDP entries were calculated for each individual set of quarters by aggregating the quarter values and the annual growth estimated by employing the philosophy of Equation 3.6.

The resulting quarterly GDP index is presented at Appendix A, Table A.2.

3.4.3 Gross Disposable Household Income Preparation

The raw economic data concerning the GDHI are published by ELSTAT at current prices. To translate the index values to constant 2020 prices an appropriate deflator must be employed. CPI is a considered a tool for the measurement of the impact of inflation on household budgets and living standards.

This research, utilizes the collected CPI to measure price change from the prespective of an urban consumer and, thus, pertains to goods and services purchased out of pockets by urban consumers as indicated in the article by Church (2016) and can be considered an accepted approach as postulated by Litra (2009) to rebase GDHI to constant 2020 prices.

Gross Household Disposable Income, adjusted for inflation, and expressed at constant 2020 prices is calculated by multiplying the GHDI for each (t) year with the deflating factor of 100 divided by the GDP deflator calculated for the appropriate year t:

$$GDHI_{t\ real\ 2020} = GDHI_t \times \left(\frac{100}{CPI_t}\right) \quad 3.7$$

The quarter-to-quarter, annual growth and total real 2020 annual GDHI were calculated with an identical philosophy and course of action as described for the estimation of real 2020 GDP at Chapter 3.4.2. The resulting quarterly GDHI index can be reviewed at Appendix A, Table A.3.

3.5 Econometric Methods

This section defines the econometric methods implemented by this study and elaborates on their appropriateness and robustness. The methods used, ensure that the data and the interrelation of the variables in question is quantitatively assessed through formal and transparent tests. The methods utilized, reach conclusions that achieve outcomes free from bias and personal opinion but are, rather, the subject of critical evaluation of accurate empirical results. To this end, the methods chosen can clearly distinguish between systematic correlation and association and random variation while they can provide a reliable image of the national economic health in the past decade.

The robustness of the outcomes of this research is defended by tests designed to confirm the agreement with the methodological assumptions of all the econometric methods applied.

3.5.1 Descriptive statistics and time series visualization

The dataset collected consists of 3 series of monthly observations and 2 series of quarterly observations. All the series span from January 2016 to March 2025.

In order to achieve alignment in frequency between the series of quarterly and monthly observations the mean of each 3-month period of the later was estimated and recorded. This procedure resulted in a prepared compilation of 6 series of quarterly observation yielding 37 observation each.

For each series the whole year was selected as a reference time period and the measures of central tendency and variability were calculated for each of the four quarters that consist a full year.

- Measures of central tendency: The arithmetic mean was utilized to suggest a typical central value that served as the representative value of the quarter/year. The median was calculated as a contingency. If extreme values between the 4 quarters were to be detected, they would not affect the median, making it a proper alternative as the representative value of the quarter/year.

- Measures of variability: Range was employed to study the total set of the monthly/quarterly data to measure the total spread in the sets. Variance and Standard deviation were calculated for the monthly components compiling the prepared quarters and for the quarterly components compiling a full year to estimate the overall variability and the typical distance of observations from the mean to investigate the fluctuations of the data that would indicate macroeconomic volatility. The coefficient of variation was calculated for each series to capture the volatility across the whole of the series.

The numerical variables of each series were plotted against the time period associated with each numerical value of the variable. The research employes these time series plots to visualize trends and visually interpret the effects and the connection that the supermarket performance has on the rest of the macroeconomic measures of interest as well as attempted explanations on how the performance and the economic shocks have affected the household consumption over the past decade.

3.5.2 Correlation

Spearman's rank correlation test is a non-parametric test which measures how strongly two variables exhibit a positive or a negative correlation. This research, exploits the results of the correlation tests between the variables to detect any positive or negative correlation between them in an attempt to find an interconnection between the studied macroeconomic measures. Spearman's correlation test assumes that the observations are paired, stationary and independent (no autocorrelation).

To confirm the assumption of stationarity of the variables, ADF tests were performed for each series' differenced values. The model specifications for the stationarity included the max number of 4 past differences, optimal for quarterly data, and used AIC information criteria to define the appropriate lag length to minimize information loss. Since all the series have a non zero mean, drift was accounted for but trend was not. By design, differencing remove trends and leaves a series stationary around a mean.

To confirm the assumption of no autocorrelation between the variables a Ljung-box test at 4 lags was selected to reject or accept the null hypothesis that the residuals of the time series are random (no autocorrelation).

If both assumptions of the Spearman's correlation were satisfied a Spearman test was conducted and the resulting p-value and Spearman's coefficient rho were recorded and interpreted.

In cases where the results from the Ljung-box test discovered that the residuals were not white noise, a Breusch Godfrey diagnostic test was performed to confirm the presence of serial correlation and justify the use of Newey-West regression to estimate the covariance of the variables while accounting for autocorrelation and heteroskedasticity.

3.5.3 Cointegration

In this study, the Engel-Granger two step method is applied to test for long run equilibrium between pairs of the variable as means of detecting a long-term connecting relationship among the macroeconomic measures examined. The two-step method involves regressing the levels of non-stationary and integrated in same order variables and examine if the residuals are stationary. The model used to create the cointegration test is the add-in of excel Real Statistics. The model was constructed to account for trend present in the first-stage regression and use the correct Engel-Granger critical values for the stationarity test on the residuals.

The Engel-Granger test assumes that all variables in the model are non-stationary and are integrated in the same order, typically I(1), in levels and that enough lags to are included to validate that the residuals of the first regression are white noise.

To confirm the assumption of non-stationarity in levels and the appropriate order integration, an ADF test was conducted for each series. The ADF test on the residuals was modeled with a maximum lag length of 4, optimal for quarterly data and utilized AIC information criteria to ensure that the residuals do not exhibit serial correlation.

The p-value, t_{stat} and t_{crit} are recorded and appropriately examined to decide on the statistical significance the the relationship of the variables.

3.5.4 Cross correlation

Correlation tests detect for immediate effects. Cross correlation tests, on the other hand, examine delayed effects. From a businesswise point of view, this research, deemed necessary to perform cross correlation tests on the variables in order to elaborate on what the supermarket sector can expect by measuring the rest of the macroeconomic measures studied.

The cross-correlation tests performed, assume stationarity and normality of the variables. Stationarity has already been verified from previous ADF tests used in previous procedures. To examine for normality a Shapiro-Wilk test is used. Shapiro-Wilk test checks by comparing the data to a perfect normal distribution with a null hypothesis that the data is normal. The p-value of the test was employed to confirm or decline normality.

The Cross-correlation test's model has used a maximum of 4 lags between the differenced variables and a t test was utilized to check for statistical significance.

3.5.5 Regression

This paper, used a regression model to validate the relationships implied in the time series visualizations and quantify whether said relationships are statistically significant, strong or weak and meaningful. A regression analysis was used to confirm or reject the assumptions made mathematically in an attempt to prove what actually drives turnover, and which of the examined macroeconomic measures have the strongest effect on it. A multiple regression model that uses 3 independent variables, volume, GDHI and GPD, was employed to predict the value of the dependent variable chosen to be the supermarket's turnover volume index. The model developed originally is portrayed in Equation 3.8:

$$Turnover_t = a + \beta_1 Volume_t + \beta_2 GDHI_t + \beta_3 GDP_t + \varepsilon_t \quad (3.8)$$

The variables, being all part of a time series, were not stationary. The use of a linear multiple regression model on the prepared data would produce false results. To compensate for violations in normality, equal variance and linearity all the variables of the series were logarithmically transformed and their differences were calculated. The subsequent model of the differenced logarithmically transformed dependent variable Turnover and the differenced logarithmically transformed independent variables of volume, GDHI and GDP is portrayed in Equation 3.9:

$$\Delta ln(Turnover_t) = a + \beta_1 \Delta \ln(GDP_t) + \beta_2 \Delta \ln(GDHI_t) + \beta_3 \Delta \ln(Volume_t) + \varepsilon_t \quad (3.9)$$

By logarithmically transforming and then differencing the levels of the series allows this research to model for growth rates. $\Delta\ln(variable_t)$ is approximately the percental change from t-1 to t. This implies that β_t approximates the short run elasticity in growth rates.

The specific model removes long run level relationships, but as proved in previous procedures the independent variables are not cointegrated with the dependent variable deeming the particular trade off a non issue.

The variables inputted into the model are tested for stationarity. The residuals of the regression are tested to validate normality with a Shapiro-Wilk test. The assumption of no serial correlation in the residuals is validated by a performed Durbin-Watson test and, finally, the assumption of no Heteroskedascity is confirmed with a performed White test.

A stepwise method evolving backwards elimination was elected for this paper. The model started with the inclusion of all the variables. The p-values of the ANOVA and the predictors were recorded and evaluated. Then, the least significant variables were removed one by one until all remaining variables left are significant. Conclusions were inferred from the remaining regressors of the model.

The regression model was then altered to create two additional models to account for any lagged effects that may arise from GDHI and GDP. The resulting models are described in Equations 3.10 and 3.11:

$$\Delta ln(Turnover_t) = a + \beta_1 \Delta \ln(Volume_t) + \beta_2 \Delta \ln(GDHI_{t-1}) + \beta_3 \Delta \ln(GDHI_{t-2}) + \beta_4 \Delta \ln(GDHI_{t-3}) + \beta_5 \Delta \ln(GDHI_{t-4})\, \varepsilon_t \qquad (3.10)$$

$$\Delta ln(Turnover_t) = a + \beta_1 \Delta \ln(Volume_t) + \beta_2 \Delta \ln(GDP_{t-1}) + \beta_3 \Delta \ln(GDP_{t-2}) + \beta_4 \Delta \ln(GDP_{t-3}) + \beta_5 \Delta \ln(GDP_{t-4})\, \varepsilon_t \qquad (3.11)$$

The above models assume that turnover depends on current volume – under the assumption that they are economically linked- and past macroeconomic conditions. Conclusions of statistical importance are then inferred from the models as well.

3.6 Ethical Considerations

This research takes care to assure that data is clearly and transparently presented included clear documentation of the assumptions, tests and methodological choices. All datasets are described in sufficient detail and the raw data sources are provided allowing for replication of the hypotheses tested. All findings are described between the frame allowed by the methodology followed, reducing the probability of misleading the reader.

4. Presentation and Discussion of Empirical Results

4.1 Descriptive statistics

The measures of central tendency and variability that summarize the turnover and volume indices are coherently presented in Table 4.1

Year	Turnover					Volume				
	measures of central tendency		measures of variability			measures of central tendency		measures of variability		
	mean	median	range	variance	standard deviation	mean	median	range	variance	standard deviation
2016	90,91	91,04	6,76	3,695	1,922	92,50	92,47	7,30	4,399	2,097
2017	92,89	92,10	13,31	10,994	3,316	93,69	93,80	7,18	3,141	1,772
2018	94,87	95,07	5,10	2,743	1,656	96,80	97,74	5,36	2,976	1,725
2019	96,47	97,25	6,70	5,305	2,303	97,76	98,61	7,94	6,132	2,476
2020	103,46	101,65	25,78	46,689	6,625	103,00	101,11	26,41	50,539	6,866
2021	106,95	107,02	7,98	3,629	1,905	105,71	105,03	6,09	2,951	1,718
2022	114,63	117,20	13,39	20,092	4,482	98,92	103,09	8,86	6,903	2,627
2023	123,50	124,50	17,16	21,834	4,673	98,26	99,49	8,86	5,306	2,304
2024	130,23	132,51	24,04	39,702	6,301	98,26	98,50	21,06	28,017	5,293
2025	135,94	135,63	7,62	6,500	2,549	100,46	100,23	7,43	7,993	2,827
			Coefficient of variation for turnover over the decade:		14,3885122			Coeffiecient of variation for volume over the decade:		5,29048297

Table 4.1 Measures of central tendency and variability of the turnover and volume indices
**note* that for the year 2025, for both indices only the first 3 quarters were available at the time of writing.

For both indices, the annual mean, constructed by averaging the quarterly values of the respected index, is observed to present a negligible difference from the median for each year. A fact that indicates even spread of the values around the center and the absence of extreme outliers.

Years 2020, 2022-2024 for the turnover index and year 2020 and 2024 for volume index present significantly higher ranges, and standard deviation. This volatility within the years is likely attributed to changes in the behavior of the consumption of households during periods of economic instability that occurred during those years such as the Covid pandemic of 2020 and the energy crisis post 2022.

The comparison of the CV of the turnover index against the CV of the volume index reveals that the variation of the turnover throughout the decade is ≈3 times more volatile than the variation of the volume. A fact that suggests that real consumption is, relatively static and the main force that drive turnover is price and price inflation instead of volume sold. This assumption can be inferred by plotting the evolution of the quarterly turnover and volume indices against time as presented in Figure 4.1.

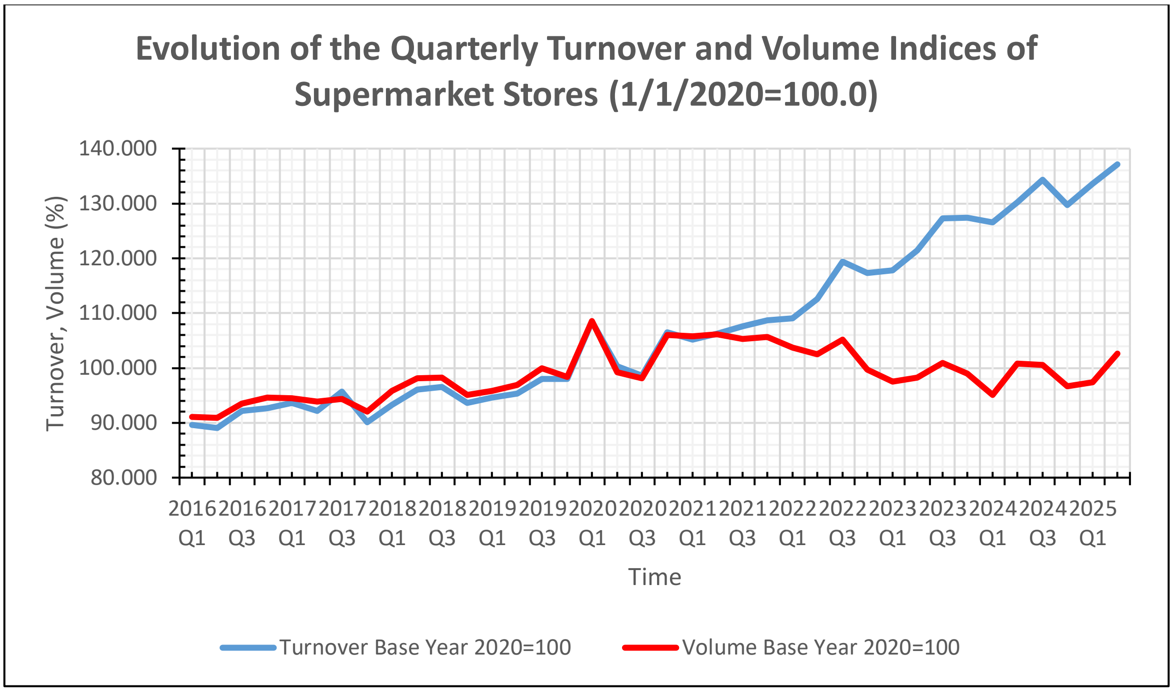

Figure 4.1 Turnover and volume indices. Time series visualization

As observed, post Q3 2021 turnover growth far exceeds volume growth. An indication of inflation in supermarket goods' prices. Consumers pay more to buy the same or less. A fact that reveals a possible demise of real purchasing power. Furthermore, a spike in Volume index is identified at Q1 2020. The first lockdown during the pandemic crisis was implemented during that specific quarter, more accurately on March. One of the reasons for the spike on volume index might be attributed to panic buying during the initial period of the lockdown.

Turnover indicates an upward trend as a sustained growth as it is observed. The volume index remains more conservative with a smaller growth factor

The in-year measures of variability concerning the Gross Domestic Product index and the annual total GDP at constant 2020 prices are presented at Table 4.2:

Year	Real 2020 GDP			
	Yearly aggregation of quarters	measures of variability (within year)		
		range	variance	standard deviation
2016	174,237	0,38	0,03	0,17
2017	176,715	0,63	0,07	0,26
2018	180,186	0,49	0,05	0,21
2019	184,183	0,42	0,03	0,18
2020	167,766	6,21	6,58	2,56
2021	181,541	2,54	1,35	1,16
2022	192,151	0,95	0,19	0,44
2023	196,615	0,90	0,14	0,38
2024	201,103	1,07	0,20	0,44
2025	101,909	0,29	0,04	0,21
		Coeffiecient of variation for GDP over the decade:		5,97023975

Table 4.2 Annual aggregated value and in-year measures of variability of the real 2020 GDP
**note* that for the year 2025 only 2 the first 2 quarters were available at the time of writing.

The annual Real GDP is calculated by summing the values of each year's respective quarters. GDP variates slightly around its annual level. With the exception of the year 2020. Year 2020 clearly constitutes a structural brake, more likely due to COVID 19 pandemic. The in-year standard deviation of 2,56 strongly indicates heavy volatility in the quarter-to quarter values. Consistent with lockdown related shutdowns and re openings of the industry through the year. Year 2021 still exhibits signs of exceptional volatility, as expected during the last phases of the pandemic and the last major lockdown of the commercial sector in the nation.

The CV of GDP describes a relatively stable index, especially if compared with the turnover index, and similar to the volume index. This research finds due to the low volatility of the CV of the GDP that this index captures long run effects on the economy and does not reflect possible high frequency movements of other macroeconomic measures.

Figure 4.2 presents the evolution of GDP at constant 2020 prices plotted against time while Figure 4.3 the quarterly rate of change of the index. The period from 2016 to 2019 the GDP is at stable expansion phase. Economy is in a steady upwards trend. At year 2020 drop of nearly 9,2% is observed which is carried into the first quarters of the year 2021 as the economy rebounds by the end of 2020. From 2023 to today growth settles in a normal sustainable rate indicating stabilization after the previous volatile period.

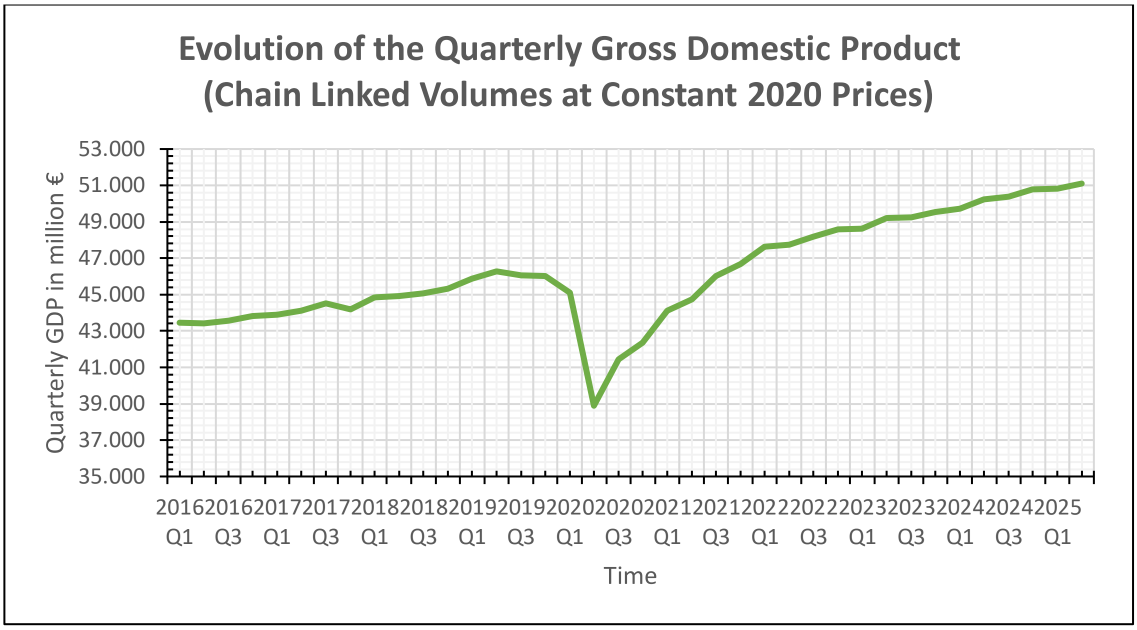

Figure 4.2 Quarterly real 2020 GDP. Time series visualization

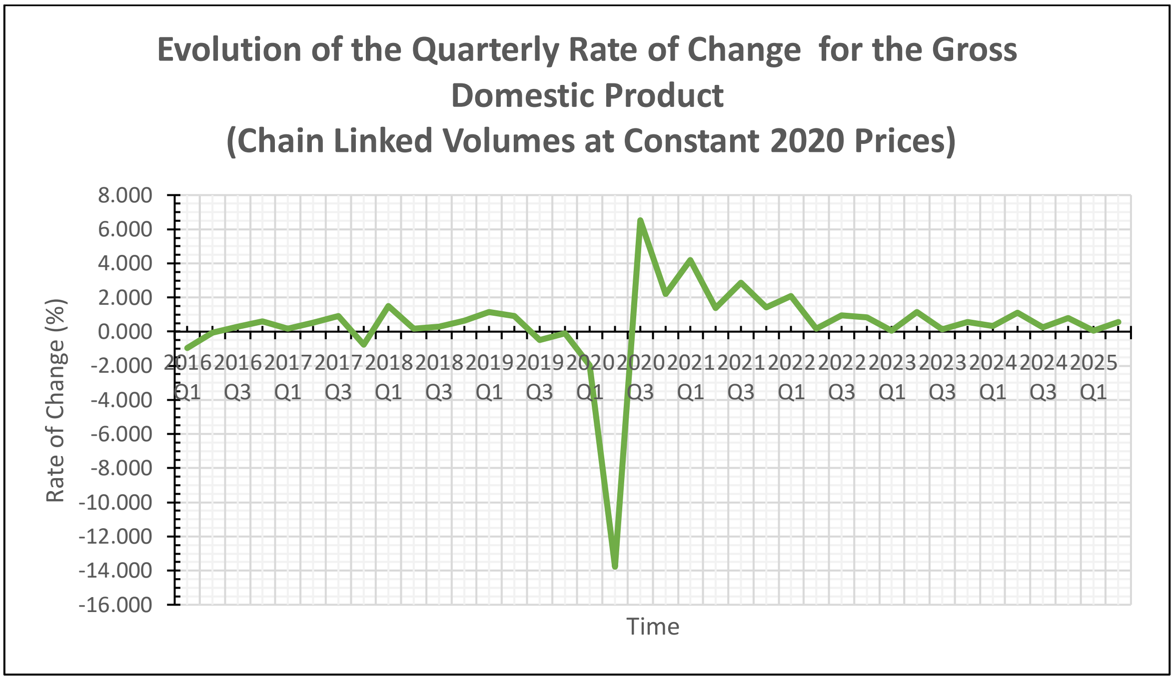

Figure 4.3 Quarterly GDP rate of change. Time series visualization

The RoC observed at Figure 4.3, displays signs of seasonality. Typical for tourist-driven economies, Q3 is the usually the highest quarter followed by Q4 which can be attributed to winter sales.

Table 4.3 displays the estimated annual Gross Disposable Household Income and tits quarterly dispersion. The mean annual value is calculated by summing the values of each year's respective quarters.

Year	Real 2020 GDHI				
	Yearly aggregation of quarters		measures of variability (within year)		
			range	variance	standard deviation
2016	116,493		2,91	1,52	1,23
2017	117,932		1,75	0,55	0,74
2018	115,650		2,51	1,23	1,11
2019	123,697		3,15	2,14	1,46
2020	119,850		4,15	3,32	1,82
2021	126,845		3,33	1,88	1,37
2022	126,312		6,01	7,89	2,81
2023	132,090		3,83	2,63	1,62
2024	134,687		4,93	4,46	2,11
2025	-		-	-	-
		Coeffiecient of variation for GDP over			7,12526192

Table 4.3 Annual aggregated value and in year measures of variability of real 2020 GDHI
** note that for the year 2025 only the first quarter's value was available at the time of writing.*

GDHI growths over the decade from 116,493 million € (2016) to 134,687 million € (2025). Despite minor setbacks, throughout the decade, index is trending up. Most years exhibit a moderate size of variability implying that an aspect of seasonality, typically present at tourist driven economies.

The CV of GDHI describes an index with moderate variability. Income growth and the total funds that households are available to spend after mandatory taxes and social contributions are reasonable stable during the past decade following a minor upwards trend. A fact that suggests that the funds available for spending in supermarket items, among other expenditures, remain fixed around a stable, but small, growth.

Figure 4.4 displays the evolution of the quarterly real 2020 GDHI plotted against time while Figure 4.5 presents the quarterly rate of change of the index. Observing the time series, this research, has found that during the period of 2016 to 2018 a stagnation is evident. Real income did not grow in any substantial way. 2016 was a period still on the wake of the disastrous capital controls that were introduced in the nation from June2015 to September

2015. 2019 as year displays a strong growth followed by the pandemic shock of 2020. Figure 4.4 exhibits a strong rebound from the pandemic at year 2021, consistent with the graphs of all the, already examined, indices. Post 2022, real income is devastated. Over inflation, and the exponential rise in the cost of power are some of the exogenous factors that may have played a major role in the exhibited shock.

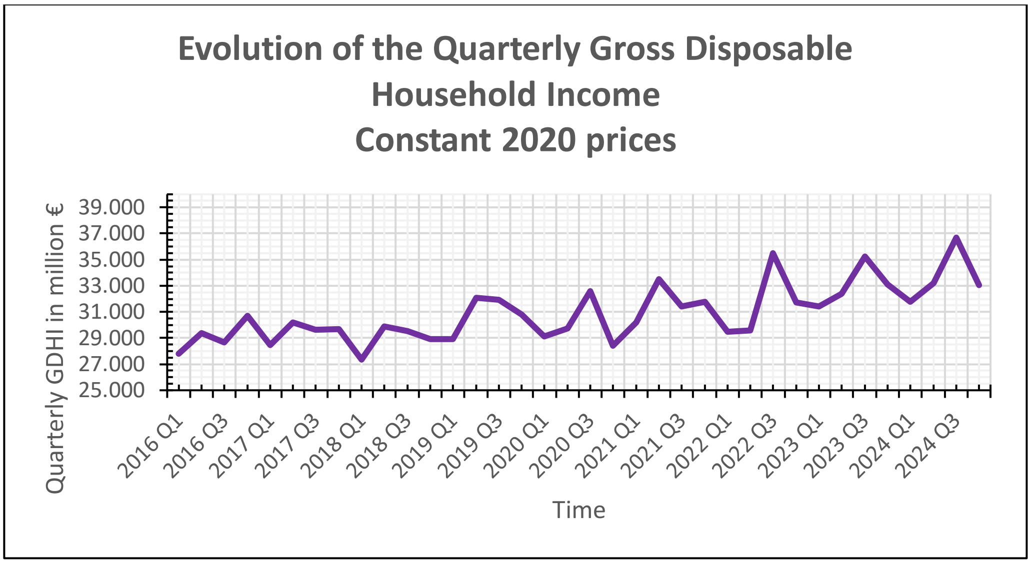

Figure 4.4 Quarterly GDHI. Time series visualization

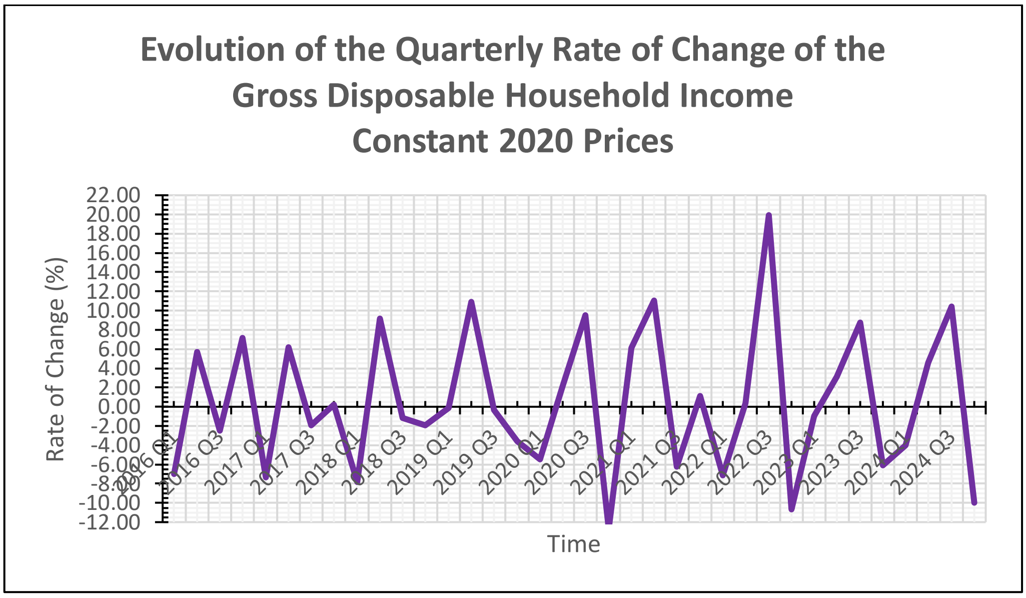

Figure 4.5 Quarterly GDHI rate of change. Time series vizualization

For a complete evaluation of the dataset spanning in the last decade, this research, compiled Table 4.4 to display the annual evolution of all the examined indices.

Year	Annual Turnover Average	Annual Turnover Growth (%)	Annual Volume Average	Annual Volume Growth (%)	GDP Annual Total at Constant 2020 Prices in million €	Real 2020 GDP Annual Growth (%)	Annual GDHI at Constant 2020 Prices in million €	Annual GDHI growth (%)
2016	90,91	-1,11	92,50	-0,021	174,237	-0,002	116,493	-0,75
2017	92,89	2,18	93,69	1,294	176,715	1,422	117,932	1,24
2018	94,87	2,13	96,80	3,318	180,186	1,964	*115,650*	*-1,93*
2019	96,47	1,68	97,76	0,992	184,183	2,218	123,697	6,96
2020	103,46	7,24	103,00	5,360	167,766	-8,913	119,850	-3,11
2021	106,95	3,38	105,71	2,630	181,541	8,211	126,845	5,84
2022	114,63	7,18	102,77	-2,781	192,151	5,844	126,312	-0,42
2023	123,50	7,74	98,92	-3,744	*196,615*	2,323	132,090	4,57
2024	130,23	5,45	98,26	-0,674	201,103	2,283	134,687	1,97
2025	135,94	4,38	100,46	2,241	-	-	-	-

Table 4.4 Annual evolution of the values and RoC of the examined indices
**note full data for GDP and GDHI were not available at the time of writing.*

The 2016 rate of change values presented on Table 4.4 for all the indices were calculated by gathering and treating the appropriate data from year 2015. An overview of 2015 index values of all the macroeconomic measures can be found in Appendix A, Table A.4.

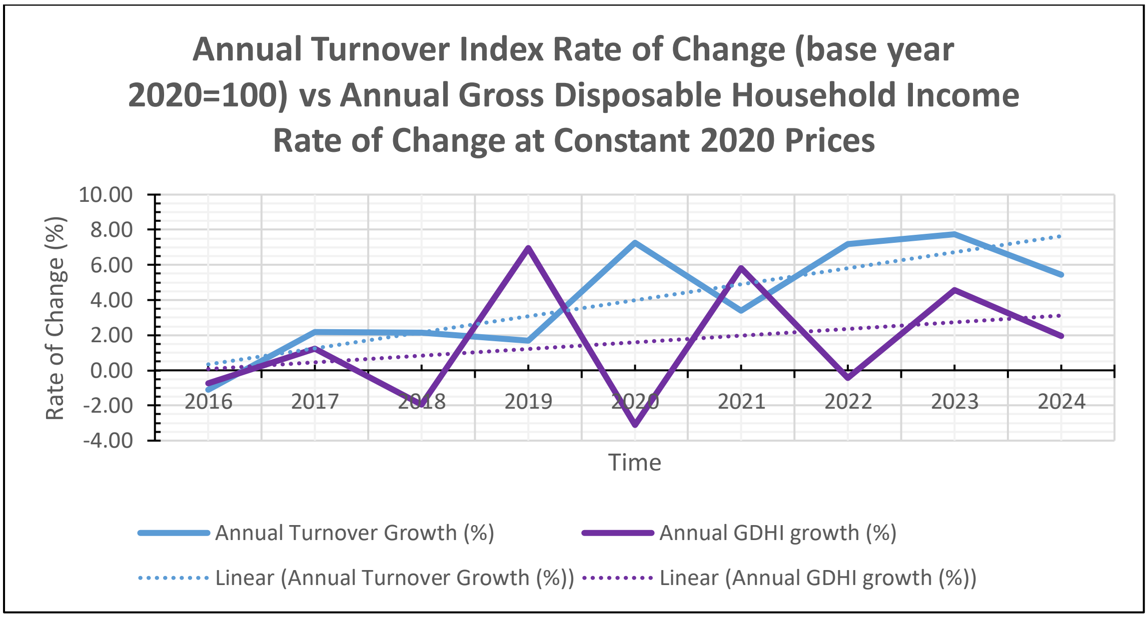

Figure 4.6 Turnover vs GDHI RoC Time series visualization

At Figure 4.6 a direct comparison between turnover and GDHI is portrayed. The linear trendlines display the, inferred before, fact that both indices are at a steady incline. However, the turnover trendline is on a steeper ascend indicating that the index exhibits signs of accelerated growth. GDHI's trendline in on a lighter ascend indicating that real household income grows at a much more decelerated pace than turnover. It is inferred that supermarket turnover increases faster than the real household purchasing power and that turnover is less driven by real income, especially post 2021.

Figure 4.7 presents the physical consumption in reference to the household income by plotting the RoC of indices of volume and GDHI against time.

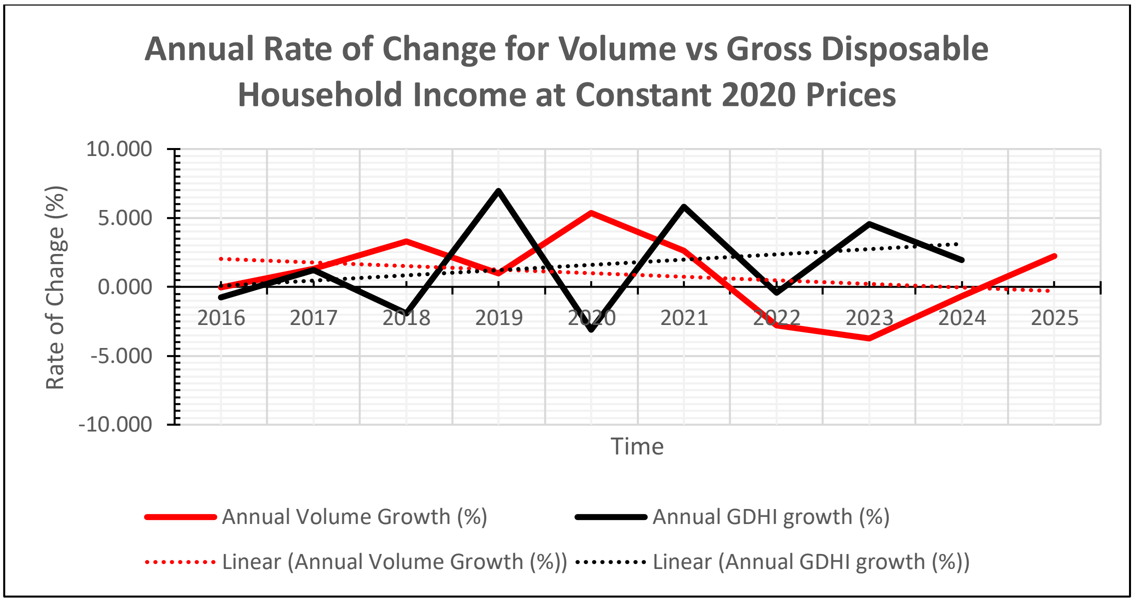

Figure 4.7 Volume vs GDHI RoC Time series visualization

The study extrapolates from Figure 4.7 that the rise of the turnover index of the supermarkets is mainly due to prices rising. The volume trendline is on slight descend while the household incomes' is in a slightly upwards trend. The graph may also suggest that the supermarket consumption is relatively inelastic: the volume trendline is highly stable suggesting changes in price don't cause large changes in the volume of items households buy from the supermarkets.

A final graph was designed, displaying the annual RoC for all indices plotted against time, to assess the interrelationships that the examined macroeconomic measures have shared over the past decade. The timeline series visualization is presented in Figure 4.8:

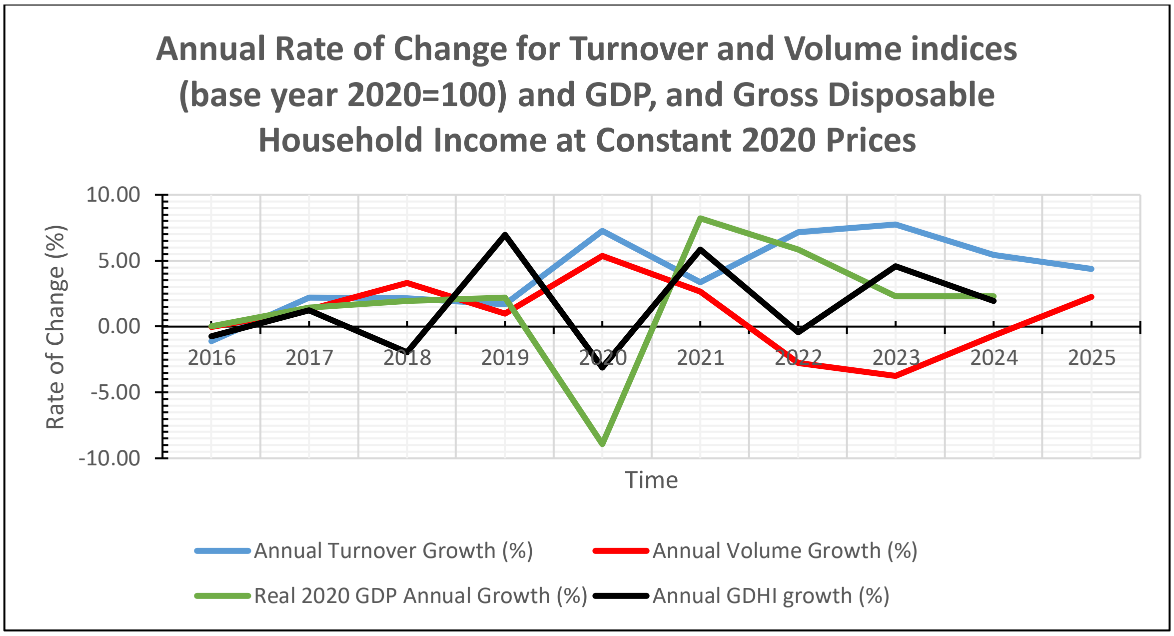

Figure 4.8 Turnover, volume, real 2020 GDP and real 2020GDHI RoC. Time series visualization

Figure 4.8 displays, as already suggested by examining the CV for each index, that turnover is more volatile than household income and GDP. An indication that supermarket turnover reacts more strongly than the economy as a whole.

Period 2016 to 2019 is characterized by a light economic stagnation. Small positive turnover and volume growth and moderate GDP and GDHI growth. Turnover reflects the moderate, stable growth of the economic health of the nation.

The year of 2020 income indices collapse while turnover rises sharply. Turnover increased while macroeconomic measures that reflect health declined. Turnover did not reflect the national economic health.

All indices recover by the end of year 2021 indicating that economy and turnover realign after the shock of COVID-19.

The period concerning 2022 to today exhibits an orderly, stable growth of GDP and GDHI. Turnover driven by prices due to inflation is rising in a much higher rate and then proceeds to decline gradually but stably above the other indices.

Turnover, especially post 2019, continues to grow faster than volume and the real spending power of households, a sign that suggests that inflation in prices is the main drive of the supermarkets' turnover. An outcome that suggests further statistical analysis is needed in order to find whether there is a true short or long term interrelationship between the examined indices. A reason why this research proceeds to test for correlation and cointegration between the indices.

4.2 Correlation and Cointegration Analysis

4.2.1 Relationship between Turnover and GDHI

This research took the differences of the levels of the two indices to remove trends in an attempt to leave the series stationary around a mean. The resulting series can be examined in Appendix A, Table A.5. To prove stationarity and ADF test was performed at each of the differenced series. The test model, constructed as described on Chapter 3.5.2, and the results, proving stationarity of the variables can be inspected at Table 4.5

ADF Test criteria and results							
Differenced Turnover index		Differenced GDHI index		Differenced GDP index		Differenced Volume index	
criteria	aic	criteria	aic	criteria	aic	criteria	aic
drift	yes	drift	yes	drift	yes	drift	yes
trend	no	trend	no	trend	no	trend	no
max lag	4	max lag	4	lag	4	lag	4
alpha	0,05	alpha	0,05	alpha	0,05	alpha	0,05
tau-stat	-7,18862625	tau-stat	-5,5896235	tau-stat	-6,1330461	tau-stat	-6,9865569
tau-crit	-2,94595128	tau-crit	-2,9459513	tau-crit	-2,9459513	tau-crit	-2,9459513
stationary	yes	stationary	yes	stationary	yes	stationary	yes
aic	5,26823574	aic	3,98146641	aic	3,39011303	aic	5,24916323
bic	5,40291461	bic	4,21048765	bic	3,47899006	bic	5,3838421
lags	*1*	*lags*	3	lags	0	lags	1
coeff	*-1,9592807*	*coeff*	-4,1152076	coeff	-1,0651572	coeff	-1,8767282
p-value	< .01	p-value	< .01	p-value	< .01	p-value	< .01

Table 4.5 ADF test criteria and results of the differenced series

To detect for serial correlation the Ljun box test was performed with criteria described in the methodology Chapter 3.5.2. The test indicated that ΔGDHI exhibits autocorrelation (Figure 4.9). A Spearman's autocorrelation test would produce a non trustworthy p-value. As per the elected methodology a Breusch Godfrey diagnostic test to confirm autocorrelation was conducted and a Newye-West regression was performed. Both the diagnostic test and the regression model are presented in Figure 4.10.

…

	White noise test:	acf		
	test	lag	stat	p-value
Turnover	ljung-box	4	9,35194635	0,05287994
GDHI	ljung-box	4	11,1076271	0,02538069

Figure 4.9 Ljung-box test result for Turnover and GDHI

Breusch-Godfrey Test

Lags	4
LM*	3,46166788
df1	4
df2	30
p-value	0,01933978
LM	11,3687119
p-value	0,02271826

Regression Analysis

OVERALL FIT			
Multiple R	0,08543919	AIC	95,7721169
R Square	0,00729986	AICc	96,5221169
Adjusted R S	-0,0218972	SBC	98,9391548
Standard Err	3,68102756		
Observations	36		

ANOVA Alpha 0,05

	df	SS	MS	F	p-value	sig
Regression	1	3,38776455	3,38776455	0,25002019	0,62028183	no
Residual	34	460,698773	13,5499639			
Total	35	464,086538				

ols	coeff	std err	t stat	p-value	lower	upper
Intercept	1,20717952	0,61402591	1,96600746	0,05750631	-0,0406713	2,4550303
Differenced (	0,1346787	0,26934652	0,50002019	0,62028183	-0,4126993	0,68205669

newey-west	coeff	std err	t stat	p-value
Intercept	1,20717952	0,34034486	3,54693036	0,00116064
Differenced (	0,1346787	0,43440994	0,31002674	0,758433

Figure 4.10 Breusch-Godfrey Test and Newey-West regression Y: Turnover X: GDHI

In Figure 4.10 ΔGDHI had a positive sign, as expected. The result, however, proves to be statistically insignificant and explains non of the variation in ΔTurnover. It is proven that short run changes in GDHI do not present a statistically detectable effect on short run changes in turnover in the examined past decade.

Spearman's test, while the p-value is not trustworthy due to the existence of autocorrelation, suggest a weak positive association as indicated in Figure 4.11.

Spearman's coefficient	
Alpha	0,05
Tails	2
rho	0,0972973
t-stat	0,5700405
p-value	0,57239808

Figure 4.11 Spearman's Correlation test Turnover, GDHI

The differenced, stationary, series were utilized to check for cross correlation between Turnover and GDHI. Shapiro-Wilk's test to validate normality was conducted (Figure 4.12) and proceeded with the cross correlation test which resulted in an indication that a change in GDHI is associated with a change in Turnover in the same direction two periods later, as depicted in Figure 4.13

Shapiro-Wilk Test	
W-stat	0,97155379
p-value	0,46949226
alpha	0,05
normal	yes

Figure 4.12 Shapiro-Wilk test for normality. Turnover - GDHI

Cross correlations		t-test	
Max # of lags	4	t	0,50002019
Optimum # of lags	2	p-value	0,62028183
Optimum correlation	0,24127876	lower	-0,2618134
Chart # of lags	2	upper	0,43269182
Chart correlation	-0,2412788		

Figure 4.13 Cross correlation and t test. Turnover - GDHI

The p value displayed in Figure 4.13 suggests that this research did not find enough evidence to confidently state that a correlation between the 2 series exists.

A cointegration test to check for a long term equilibrium between Turnover and GDHI could not be conducted as it was found out the GDHI index was stationary at levels disallowing further investigation of cointegration.

4.2.2 Relationship between Turnover and GDP

The ADF test to prove stationarity of the differenced Turnover and GDP values concluded that both series are stationary. The designed model and results are presented in Table 4.5. A Ljung-box test for serial correlation validated the assumption of no serial correlation in the series and a Spearman's correlation test indicated no monotonic association between the variables. However, the p-value of the correlation test signifies no statistical significance of the test. The Ljung box and Spearman's test models and results are presented at Figure 4.14.

White noise test: acf

	test	*lag*	*stat*	*p-value*
turnover	ljung-box	4,00	9,35	0,05
GDP	ljung-box	4,00	0,86	0,93

Spearman's coefficient

Alpha	0,05
Tails	2
rho	0,03989704
t-stat	0,2328231
p-value	0,8172947

Figure 4.14 Ljung box and Spearman's correlation test for Turnover and GDP

To detect cointegration the Engel-Granger two step method was utilized. First step involves ADF tests that prove non stationarity of the series in levels and that both variables are integrated of order one. An OLS regression is performed on the I(1) variables to detect stationarity of the residuals, an outcome that would indicate the cointegration of the original series. The modeling and the results of the Engel-Granger two step cointegration test are presented at Figure 4.15. It is concluded that no cointegration is detected among the original series during the 2016-2025 period.

ADF Tests					Engle-Granger Test	
	X var	Y var	X diff	Y diff	alpha	0,05
tau-stat	-2,0980303	-1,3021253	-6,0796117	-5,8639972	type	2
tau-crit	-3,5271495	-3,5271495	-3,5306303	-3,5306303	max lags	4
stationary	no	no	yes	yes	criteria	aic
aic	3,28730651	5,2011182	3,44004219	5,20141665		
bic	3,41926642	5,47321049	3,57335774	5,42816022	tau-stat	-2,5605608
lags	0	3	0	2	tau-crit	-4,0464328
coeff	-0,2364554	-0,208723	-1,0731656	-2,743751	cointegrated	no
p-value	> .1	> .1	< .01	< .01	lags	0
					p-value	> .1

Figure 4.15 ADF tests on levels and first differences and Cointeration test of Turnover and GDP

The differenced, stationary, series were utilized to check for cross correlation between Turnover and GDP. Shapiro-Wilk's test to validate normality was conducted and proceeded with the cross correlation test which resulted in an indication that optimum correlation occurs at Lag 0 and the magnitude of it is very moderate. There is no strong lead-lag relationship present in the series. The p value of the t test performed on the cross correlation results indicates that this research did not find enough evidence to confidently say that a cross correlation between the 2 series exists. The normality, the model and the results of the cross correlation test can be reviewed in Figure 4.16.

Shapiro-Wilk Test		Cross correlations		t-test	
W-stat	0,96398928	Max # of lags	4	t	1,79987118
p-value	0,28446929	Optimum # of lags	0	p-value	0,08076025
alpha	0,05	Optimum correlation	0,29494381	lower	-0,0380789
normal	yes	Chart # of lags	0	upper	0,62796651
		Chart correlation	0,29494381		

Figure 4.16 Shapiro-Wilk, Cross correlation and t-test for Turnover and GDP

4.2.3 Relationship between Volume and GDHI

The ADF test to prove stationarity of the differenced Volume and GDHI values concluded that both series are stationary. The designed model and results are presented in Table 4.5. A Ljung-box test for serial correlation detected that the series exhibit autocorrelation as depicted in Figure 4.17. A Breusch Godfrey diagnostic test to confirm autocorrelation was conducted and a Newey-West regression was performed. The model and outcomes of the regression are presented at Figure 4.18.

White noise test: acf

	test	lag	stat	p-value
Volume	ljung-box	4	8,13362383	0,08680421
GDHI	ljung-box	4	7,87405789	0,09630209

Figure 4.17 Ljung box test for Volume and GDHI

Breusch-Godfrey Test

Lags	4
LM*	2,69882596
df1	4
df2	30
p-value	0,04942687
LM	9,52636459
p-value	0,04920832

Regression Analysis

OVERALL FIT

Multiple R	0,08676759
R Square	0,00752861
Adjusted R S	-0,0216617
Standard Err	3,55872236
Observations	36

AIC	93,3392118
AICc	94,0892118
SBC	96,5062496

ANOVA — Alpha 0,05

	df	SS	MS	F	p-value	sig
Regression	1	3,26636109	3,26636109	0,25791463	0,61483548	no
Residual	34	430,593164	12,6645048			
Total	35	433,859525				

ols	coeff	std err	t stat	p-value	lower	upper
Intercept	0,16528559	0,59362439	0,27843463	0,78236516	-1,0411043	1,37167549
gdhi dif	0,13224352	0,26039726	0,50785296	0,61483548	-0,3969474	0,66143443

newey-west	coeff	std err	t stat	p-value
Intercept	0,16528559	0,37079242	0,44576312	0,65859409
gdhi dif	0,13224352	0,37960317	0,34837307	0,72970797

Figure 4.18 Breusch-Godfrey Test and Newey-West regression Y: Volume X: GDHI

The regression results in Figure 4.18 indicates that there is no significant statistical explanation on Volume variation due to GDHI. A Spearman's test as seen on Figure 4.19 was performed nonetheless, but must not be interpreted as genuine evidence of association between the variables, since the p value estimation cannot be trusted as it is plagued with autocorrelation. The two tests describe the co-movement of the variables and, definitely do not prove neither dependence nor causality.

Spearman's coefficient	
Alpha	0,05
Tails	2
rho	0,20592021
t-stat	1,22700707
p-value	0,2282488

Figure 4.19 Spearman's correlation test for Volume and GDHI

A cross correlation and cointegration test between the variables could not be performed. A Shapiro-Wilks test indicated a breach in the assumption of normality required for the cross correlation test and GDHI, as indicated in Chapter 4.2.1, is not stationary in levels prohibiting the construction of a cointegration test to test for long term equilibrium between the variables.

4.2.4 Relationship between Volume and GDP

The differenced series was tested for stationarity (Table 4.5) and were found stationary. A Ljung box test to reject the null hypothesis of autocorrelation was conducted which indicated that the series were not autocorrelated. The assumptions required to validate the conduction of a Spearman's correlation test were found to be true and the correlation test was performed. The autocorrelation and spearman's test can be inspected in Figure 4.20

	White noise test:	acf		
	test	*lag*	*stat*	*p-value*
Volume	ljung-box	4	8,13362383	0,08680421
GPD	ljung-box	4	7,87405789	0,09630209

Spearman's coefficient	
Alpha	0,05
Tails	2
rho	0,08262548
t-stat	0,48343825
p-value	0,63188349

Figure 4.20 Ljung box and Spearman's correlation test for Volume and GDP

Spearman's test, while the p-value indicates no statistical significance of the test, suggests a weak positive association between Volume and GPD.

To detect cointegration the Engel-Granger two step method was utilized. To confirm that the series contain a unit root and are integrated of order one an ADF test was performed. An OLS regression was performed on the I(1) variables. To detect stationarity of the residuals, the ADF test was modeled as described on Chapter 3.5.2 The modeling and the results of the Engel-Granger two step cointegration test are presented at Figure 4.21. It is concluded that no cointegration is detected among the original series during the 2016-2025 period

ADF Tests

	X var	Y var	X diff	Y diff
tau-stat	-2,0980303	-1,0834251	-6,0796117	-7,2858549
tau-crit	-3,5271495	-3,5271495	-3,5306303	-3,5306303
stationary	no	no	yes	yes
aic	3,28730651	5,25411847	3,44004219	5,23497344
bic	3,41926642	5,47858326	3,57335774	5,41454527
lags	0	2	0	1
coeff	-0,2364554	-0,1856211	-1,0731656	-1,9642799
p-value	> .1	> .1	< .01	< .01

Engle-Granger Test

alpha	0,05
type	2
max lags	4
criteria	aic
tau-stat	-0,9534102
tau-crit	-4,0464328
cointegrated	no
lags	2
p-value	> .1

Figure 4.21 ADF tests on levels and first differences and Cointegration test of Volume and GDP

This research did not test for cross correlation between the series of Volume and GDP. A Shapiro-Wilk test was performed and failed to confirm for normality in order to procced with the cross correlation test.

4.2.5 Relationship between Turnover and Volume

The ADF test to prove stationarity of the differenced Turnover and Volume values concluded that both series are stationary. The designed model and results are presented in Table 4.5. A Ljung-box test for serial correlation validated the assumption of no serial correlation in the series. The aforementioned steps validated all the needed assumptions to conduct a successful Spearman's correlation test. The autocorrelation and Spearman's test modeling and results are presented in Figure 4.22.

White noise test:	acf			
	test	*lag*	*stat*	*p-value*
Turnover	ljung-box	4	9,35194635	0,05287994
Volume	ljung-box	4	8,94638392	0,06245369

Spearman's coefficient	
Alpha	0,05
Tails	2
rho	0,8015444
t-stat	7,81650988
p-value	4,2544E-09

Figure 4.22 Ljung box and Spearman's correlation test for Turnover and Volume

Figure 4.22 displays that the p value of the Spearman's test indicates, with great statistical significance, that there is a very strong positive monotonic association between Turnover and Volume. A very natural and coherent with economic intuition result.

To detect cointegration a similarly modeled test as described in chapter 4.2.4 was employed. The modeling and results of the test are available to the reader in Figure 4.23.

ADF Tests	X var	Y var	X diff	Y diff
tau-stat	-1,0834251	-1,3021253	-7,2858549	-5,8639972
tau-crit	-3,5271495	-3,5271495	-3,5306303	-3,5306303
stationary	no	no	yes	yes
aic	5,25411847	5,2011182	5,23497344	5,20141665
bic	5,47858326	5,47321049	5,41454527	5,42816022
lags	2	3	1	2
coeff	-0,1856211	-0,208723	-1,9642799	-2,743751
p-value	> .1	> .1	< .01	< .01

Engle-Granger Test	
alpha	0,05
type	2
max lags	4
criteria	aic
tau-stat	-0,7622372
tau-crit	-4,0464328
cointegrated	no
lags	0
p-value	> .1

Figure 4.23 ADF tests on levels and first differences and Cointegration test of Turnover and Volume

With the cointegration results available this research can state that since the Engel-Granger test provides no evidence of a long term equilibrium between the variables (not cointegrated) but the estimated correlation computed in the differenced series indicate that there is a high correlation between the variables that the two series exhibit high correlated changes but still drift apart in levels. A fact that suggests combined movement in the short run despite the absence of a long run statistical relationship.

The two differenced, stationary, series were tested for cross correlation. Shapiro-Wilk's test to validate normality was conducted and then the paper proceeded with the cross-correlation test which resulted in an indication that optimum correlation occurs at Lag 0 and the magnitude of it is very strong. There is no time delay, as the relationship occurs at 0 Lag.

The p value of the t test performed on the cross-correlation results indicates that this research found strong evidence to confidently say that Turnover and Volume are strongly related at the same point in time. The normality, the model and the results of the cross-correlation test can be reviewed in Figure 4.24.

Shapiro-Wilk Test		Cross correlations		t-test	
W-stat	0,97673617	Max # of lags	4	t	9,76559243
p-value	0,63457394	Optimum # of lags	0	p-value	2,1339E-11
alpha	0,05	Optimum correlation	0,85859269	lower	0,67991737
normal	yes	Chart # of lags	0	upper	1,037268
		Chart correlation	0,85859269		

Figure 4.24 Shapiro-Wilk, Cross correlation and t-test for Turnover and GDP

4.3 Regression Analysis

The variables, as indicated in Table 4.5 are non-stationary in levels. To overcome violations of normality, equal variance and linearity the series have been logarithmically transformed and the resulting values were differenced. The final series that were inputted into the model can be inspected in Table A.6 located in Appendix A. Table 4.6 presents the ADF model and results proving that the logarithmically transformed differences are stationary. Turnover was selected as the dependent variable and all other indices as the independent. The resulting model is described by Equation 3.9 and attempts to describe the statistical significance and the magnitude that Volume, GDHI and GDP have on the variations of Turnover.

ADF Test for Δln(turnover)		ADF Test for Δln(volume)		ADF Test for Δln(GDHI)		ADF Test for Δln(GDP)	
criteria	aic	criteria	aic	criteria	aic	criteria	aic
drift	yes	drift	yes	drift	yes	drift	yes
trend	yes	trend	yes	trend	yes	trend	yes
lag	4	lag	4	lag	4	lag	4
alpha	0,05	alpha	0,05	alpha	0,05	alpha	0,05
tau-stat	-5,737767166	tau-stat	-7,0766006	tau-stat	-5,305647	tau-stat	-6,14590205
tau-crit	-3,534325755	tau-crit	-3,534325755	tau-crit	-3,5343258	tau-crit	-3,53432576
stationary	yes	stationary	yes	stationary	yes	stationary	yes
aic	-5,738112439	aic	-5,626365536	aic	-4,51137	aic	-5,6795091
bic	-5,509091204	bic	-5,44497068	bic	-4,2338241	bic	-5,54483023
lags	2	lags	1	lags	3	lags	0
coeff	-2,733411575	coeff	-1,957459063	coeff	-3,9831894	coeff	-1,09846364
p-value	< .01	p-value	< .01	p-value	< .01	p-value	< .01

Table 4.6 ADF test criteria and results of the differenced series

The model proved to be of a significant statistical importance (p value<0,05) while Shapiro-Wilk, a Dubrin-Watson and a White test that were employed validated the required assumptions to conduct the regression. The model of the regression, the tests to satisfy the necessary assumptions and the outcome are displayed in Figure 4.25.

Regression Analysis

OVERALL FIT

Multiple R	0,86583982		AIC	-335,19196
R Square	0,74967859		AICc	-333,12299
Adjusted R S	0,72545393		SBC	-328,97057
Standard Err	0,00789077			
Observations	35			

ANOVA — Alpha 0,05

	df	SS	MS	F	p-value	sig
Regression	3	0,00578066	0,00192689	30,946928	1,8897E-09	yes
Residual	31	0,00193019	6,2264E-05			
Total	34	0,00771085				

	coeff	std err	t stat	p-value	lower	upper	vif
Intercept	0,00396508	0,00135167	2,93347975	0,00625524	0,00120834	0,00672182	
volume	0,84565904	0,09393635	9,00246825	3,7046E-10	0,65407458	1,03724349	1,13338081
GDHI	-0,0220478	0,04275117	-0,5157239	0,6097061	-0,1092394	0,06514379	1,00498288
GDP	0,02202702	0,11011883	0,20002958	0,84276388	-0,2025618	0,24661587	1,12814435

Shapiro-Wilk Test

W-stat	0,97477187
p-value	0,58662945
alpha	0,05
normal	yes

Durbin-Watson Test

Alpha	0,05
D-stat	1,95066005
D-lower	1,2833
D-upper	1,65282
sig	no

White Test

LM stat	0,54426675
df	2
p-value	0,76175266
F stat	0,25273785
df1	2
df2	32
p-value	0,77820718

Figure 4.25 Linear regression Y: Δln(Turnover) X: Δln(volume), Δln(GDHI), Δln(GDP)

The overall model of the regression presents a low SER number and explains approximately 72.5% of the dependent variable's Y variations. It is noted, however that regressors GDHI and GDP, signified with red in Figure 25, are of no statistical importance to the analysis. As instructed by the elected course of action dictated by the methodology elected to be followed a subsequent model in the form of Equation 4.1 was created:

$$\Delta \ln(Turnover_t) = a + \beta_1 \Delta \ln(Volume_t) \quad (4.1)$$

The model proved to be of significance statistical importance. Furthermore, the assumptions of normality, equal variance and homoscedasticity were satisfied with the use of the appropriate tests. The model of the regression, the tests and the outcome are displayed in Figure 4.26.

Regression Analysis

OVERALL FIT

Multiple R	*0,864405*	*AIC*	*-338,84656*
R Square	0,74719605	AICc	-338,07237
Adjusted R S	0,73953533	SBC	-335,73587
Standard Erro	*0,0076857*		
Observations	35		

ANOVA — Alpha 0,05

	df	*SS*	*MS*	*F*	*p-value*	*sig*
Regression	1	0,00576152	0,00576152	97,5359376	2,2106E-11	yes
Residual	33	0,00194933	5,9071E-05			
Total	34	0,00771085				

	coeff	*std err*	*t stat*	*p-value*	*lower*	*upper*
Intercept	0,00395803	0,00130068	3,04305099	0,00457062	0,00131178	0,00660428
volume	0,84877954	0,08594341	9,87602843	2,2106E-11	0,67392636	1,02363271

Shapiro-Wilk Test

W-stat	0,97741768
p-value	0,67370099
alpha	0,05
normal	yes

Durbin-Watson Test

Alpha	0,05
D-stat	1,99093875
D-lower	1,40194
D-upper	1,51914
sig	no

White Test

LM stat	0,48311384
df	2
p-value	0,7854041
F stat	0,22394318
df1	2
df2	32
p-value	0,80060271

Figure 4.26 Linear regression Y: Δln(Turnover) X: Δln(volume)

The overall fit of the model is proved to be more optimal. Figure 4.26 displays a regression with a lower SER and the outcome explains 0,01% more of the turnover's variation than the regression depicted in Figure 4.25. This paper has found enough evidence to suggest that a 1% increase of the growth rate of the supermarkets' volume is associated with a 0,84% increase in the growth of the supermarkets' turnover. The estimated regression equation is described in Equation 4.2. Furthermore, this paper has not discovered significant evidence to support that, neither GDP, nor GDHI have significant relationship with the supermarket's turnover.

$$\Delta\ln(Turnover_t) = 0{,}0039 + 0{,}8487\Delta\ln(Volume_t) \qquad 4.2$$

To test for the assumption that the examined macroeconomic measures do not affect the performance of the supermarket instantly but, rather, in a delayed effect, the models described in Equations 3.10 and 3.11 were tested as well.

Those models allow this research to focus in lagged effects that GDHI and GDP might have on the turnover. With 35 observations total a number of 4 lags is deemed safe and the risk of forfeiting degrees of freedom is upscaled by the economic reasoning to test for the delayed effects of the independent variables.

Regression Analysis

OVERALL FIT

Multiple R	0,87513313	AIC	-291,00012
R Square	0,76585799	AICc	-286,13055
Adjusted R S	0,71902959	SBC	-282,39619
Standard Err	0,00839984		
Observations	31		

ANOVA — Alpha 0,05

	df	SS	MS	F	p-value	sig
Regression	5	0,00576967	0,00115393	16,3545616	3,4915E-07	yes
Residual	*25*	*0,0017639*	*7,056E-05*			
Total	*30*	*0,0075336*				

	coeff	std err	t stat	p-value	lower	upper	vif
Intercept	0,00403224	0,00160001	2,52013009	0,018487	0,00073695	0,00732753	
volume	*0,838645*	*0,0999045*	8,39446828	9,6627E-09	0,63288784	1,04440209	*1,1090156*
GDHI lag 1	*0,0624357*	*0,0695152*	0,89815864	0,37767006	-0,0807335	0,20560485	*2,0913393*
GDHI lag 2	*0,0080714*	*0,0839587*	0,09613486	0,92417996	-0,1648449	0,18098764	2,96059696
GDHI lag 3	0,04062514	0,08634357	0,47050567	0,64207292	-0,1372028	0,21845306	3,11366499
GDHI lag 4	0,02392735	0,07098672	0,33706798	0,73887912	-0,1222725	0,17012724	2,11275805

Shapiro-Wilk Test	
W-stat	0,97181584
p-value	0,57031509
alpha	0,05
normal	yes

Durbin-Watson Test	
Alpha	0,05
D-stat	1,92914571
D-lower	1,0904
D-upper	1,82522
sig	no

White Test	
LM stat	0,40043514
df	2
p-value	0,81855264
F stat	0,18320823
df1	2
df2	28
p-value	0,83358481

Figure 4.27 Linear regression Y: Δln(Turnover) X: Δln(volume), Δln($GDHI_{t-1}$), Δln($GDHI_{t-2}$), Δln($GDHI_{t-3}$), Δln($GDHI_{t-4}$)

Figure 4.27 displays the regression model of Equation 3.10 It is found that the assumptions of normality, equal variance and homoscedasticity of the residuals are validated from the appropriate Shapiro-Wilk, Dubrin-Watson and White tests respectively and the result is statistically relevant while it explains 71,9% of the turnover variance. VIF describes moderate collinearity at lags 2 and 3. The SER number is low but, however only the volume coefficient has explanatory power. It is strongly suggested that GDHI affects turnover through volume: An income change can affect demand which can show up as a growth in the supermarket turnover. This is a possibility that the paper reflects on later, on following chapters. The estimated regression equation is described in Equation 4.3

$$\Delta\ln(turnover_t) = 0{,}004 + 0{,}8386\Delta\ln(volume_t) \quad 4.3$$

Figure 4.28 displays the regression model of Equation 3.11. The assumptions of the regression are satisfied with the depicted test for normality, autocorrelation and homoscedasticity. It is proved that there is significance statistical importance of the outcomes at the level of confidence examined. However, there is the appearance of the repeated pattern that only the coefficient of volume provides any real explanatory power. The overall fit of the regression provides adequate explanation for 75.35% of the turnover's variations and the standard errors of the regression present a low number. The calculated regression equation is described in Equation 4.4

$$\Delta\ln(turnover_t) = 0{,}0034 + 0{,}8436\Delta\ln(volume_t) 4.4$$

This research has found sufficient evidence that only the independent variable of volume, out of the 3 examined macroeconomic measures, explains any of the variations in the dependent variant of turnover in the period of 2016 to 2025.

Regression Analysis

OVERALL FIT

Multiple R	0,89135798	AIC	-295,04793
R Square	0,79451905	AICc	-290,17836
Adjusted R S	0,75342286	SBC	-286,444
Standard Err	0,00786895		
Observations	31		

ANOVA Alpha 0,05

	df	SS	MS	F	p-value	sig
Regression	5	0,00598559	0,00119712	19,3331561	7,1755E-08	yes
Residual	25	0,00154801	6,192E-05			
Total	30	0,0075336				

	coeff	std err	t stat	p-value	lower	upper	vif
Intercept	0,00346698	0,00148205	2,33931675	0,02760918	0,00041464	0,00651931	
volume	0,8436083	0,09718716	8,68024419	5,1418E-09	0,64344759	1,04376901	1,19589584
GDP lag 1	0,12084385	0,10653901	1,13426857	0,26744138	-0,0985773	0,34026503	1,06042746
GDP lag 2	0,01965909	0,11140168	0,17647032	0,86134626	-0,209777	0,24909514	1,15933787
GDP lag 3	0,17703867	0,10472121	1,69057119	0,10335121	-0,0386387	0,39271604	1,02318667
GDP lag 4	0,12459868	0,10460145	1,19117539	0,24477157	-0,090832	0,3400294	1,02156759

Shapiro-Wilk Test

W-stat	0,94194339
p-value	0,09339858
alpha	0,05
normal	yes

Durbin-Watson Test

Alpha	0,05
D-stat	2,17873095
D-lower	1,0904
D-upper	1,82522
sig	unclear

White Test

LM stat	0,30318045
df	2
p-value	0,85934034
F stat	0,13827251
df1	2
df2	28
p-value	0,87145231

Figure 4.28 Linear regression Y: Δln(Turnover) X: Δln(volume), Δln(GDP_{t-1}), Δln(GDP_{t-2}), Δln(GDP_{t-3}), Δln(GDP_{t-4})

5. Conclusions

5.1 Summary of Key findings

5.1.1 Supermarket turnover surged in growth relative to volume

The empirical results of this research reveal that, during the period in question, the supermarket turnover has greatly increased in a, far more, exceedingly rate than volume. A, notably significant, divergence is observed from Q1 of 2021 (Figure 4.1) and onwards when turnover increases in magnitude, in spite of a stagnating or in the case of the years 2017, 2023 and 2024 declining growth rate of the volume index.

The results call attention to the significance of analyzing the turnover index in parallel with the volume index. Utilizing solely the turnover index can produce biased and misleading assumptions on the real consumption growth, which in turn, can lead to false statements about the economic health of the nation. Especially true, when inflation is high.

In essence the empirical results of this research, spanning over the last decade, describe that supermarket turnover has increased while consumption (supermarkets' volume of products sold) remained relatively stable, indicating, that the relationship between turnover and household consumption is, at best, very weak

5.1.2 Supermarket performance is weakly related to GDP.

This research proved that there is no strong lead-lag relationship present between turnover and GDP that could, likely, be employed by businesses' strategists to predict future economic trends and consumption behaviors (Figure 4.16). In the duration of the examined decade, turnover grew at an extraordinary rate related to GDP. Some co-movement is evident during periods of economic expansion, however, sharp corrections of the GDP index appear during times of economic shock. To illustrate, in 2020, during the COVID pandemic supermarket turnover grew by 7,24% when GDP presented an annual drop of 8,9% as observed in Table 4.4.

Overall, this research, for the span of the years of 2016 to 2025, despite literature stating otherwise, did not find enough evidence to proclaim a connection between the two indices. The results indicate that supermarket turnover cannot accurately describe macroeconomic performance. It is found, instead, that supermarkets supply highly essential goods and their turnover is less sensitive to short term GDP fluctuations in the short run.

5.1.3 GDHI does not hold significant explanatory power over turnover

The empirical results suggest that both turnover and GDHI indices present a steady incline over the decade, with the turnover index appearing to exhibit a far steeper incline as indicated in Figure 4.6. The results infare that turnover increase in an accelerated pace, relative to the household spending power. Furthermore, this research finds that changes in GDHI effect slightly and in a non-statistically significant way the runover growth over the sample period as proven in the calculations estimated in Figure 4.25.

In contrast to relevant literature, that states that there is a correlation present between income and consumption, the empirical results reveal that turnover increased despite of falling or stagnant GDHI, indicating, that households maintained a stable level of spending throughout the sampled time period. This paper finds that the disparity between the relevant literature, the economic theory, and the empirical results is due to the relationship been weakened by structural shocks, high inflation and the essentiality of supermarket goods- supermarkets being one the major sources for staple goods in modern economies.

5.1.4 Volume as an indicator of consumption and socioeconomic well-being

Sales volume provides a far more accurate picture of real consumption behavior than turnover. This dissertation has found strong evidence that volume explains almost 74% of the variations of the turnover. The regression illustrated on Figure 4.26 indicates that a 1% increase in supermarkets volume growth is associated with a 0,84% increase in turnover growth. One might infare that a rise in turnover, resulting for a rise in the volume sold could direct to the conclusion that the nation can consume with greater easiness, therefore, a rise in economic welfare is evident. However, by examining the regression model and the visualizations of the time series as a whole presented in Figure 4.4, the data suggests that the trend for the past decade is that households are purchasing the same, or in cases less, goods at higher prices. A fact that reinforces the conclusion that turnover alone must not be treated as an indicator of improvement in economic welfare and wellbeing after all.

5.1.5 Overall conclusions based on the empirical results

The aim of this research was to explore whether an interrelation between the supermarkets' sectorial performance, in terms of turnover and volume sold, and the economic health of the nation, in the form of Gross Domestic Product and Gross Disposable Household Income, exists. The statistical analysis performed, found evidence that supermarket performance is an incomplete and potentially misleading indicator of socioeconomic health when considered in isolation.

Turnover captures nominal spending but it does not reflect in a reliable way neither real consumption nor improvement on household life. Volume, on the other hand, is proven to be essential in explaining turnover movements but there is no strong evidence of a relationship either in the short run or in the long run between volume and GDP or GDHI.

To conclude, turnover can describe what transcribed in the past given that the index is studied alongside real disposable income and volume sold and it can be used to translate the dynamics of a market past periods of high inflation or economic instability.

5.2 Implications for businesses

This research has generated ample evidence that suggest that the volume sold index provides a better approximation for real consumption that turnover. The logistic centers of the supermarket chains should prioritize volume based-metrics when forecasting future needs in planning inventory or managing their supplier contracts.

The demand for essential goods that the supermarket stores supply is relatively income inelastic. As the empirical evidence suggests, the volume sold tends to stay stable even when disposable income declines. Supermarkets may benefit from promoting private labels rather than assuming that a higher income will translate into sales of a more expensive product of the same category.

Supermarkets should, apart from revenue-based indices, to monitor volume indices and unit sales to accurately gather and piece together a picture of consumer behavior to avoid overestimating the market strength. Furthermore, inflation driven turnover, creates growth that is vulnerable to a sudden correction in demand in response to high prices. Businesses should avoid creating strategies solely based on nominal turnover growth.

5.3 Implications for policymakers

The analysis presents that supermarket performance and, especially turnover, can rise even when GDP or GDHI declines. Policy makers must carefully evaluate all the statistics and refrain from under evaluating the economic strain of household by relying on retail performance alone. Instead, they should focus on other measures such as real consumption or available income.

Moreover, policymakers should refrain from interpreting stable supermarket spending as signs of economic welfare. They should complement their evaluation with other welfare indicators such as the Human Development Index or the Sustainable Economic Development Assessment.

Overall, it is concluded that measures and policies should be directed to target the welfare of the household, rather than to boost retail turnover. In turn, the augmented, by well targeted policies, households will then carry the strength to elevate the economy, retail indices included.

5.4 Research Limitations

This paper's dataset relies solely on unstructured data collected by ELSTAT aggregated at a national level. The outcome of the research provides aggregate economic relationships and may obscure underlying differences across regions or households. The secondary data was collected for preparation from numerous different publications by ELSTAT. In spite of the careful preparation the dataset is susceptive to procedural errors during the collection. Typos or incorrect record of a value of a variable can make the data inaccurate leading to flawed conclusions.

The analysis is based on quarterly data that spans from 2016 to the most recent available records. This results in a small sample size of 37 quarters. Such a small sample limits the statistical power of the examined hypotheses and may lead to failure to reject a false null hypothesis, commonly identified as a type II error in statistics.

The past decade is a period where major economic and cultural shocks have impacted on the nation. Structural brakes imposed to the data from events such as the Covid-19 pandemic, post 2022 overinflation and the, still ongoing, recovery of the Eurozone's debt crisis of 2010-2012 may negate the assumptions of the cointegration test. The absence of cointegration should be interpreted with caution.

The correlation and cross correlation analysis asceses association and not causation. A fact that should be dully noted. Although the time series figures visualize relationships that align with economic intuition the lack of statistical significance of the correlation tests indicate that there may be further dynamic interactions between multiple macroeconomic measures or that the t test values are influenced by the limited sample size.

In the regression model given the significance values of all the variables, minus the volume index, is low it must be assumed that the model may reflect true economic national behavior or the regression is influenced by the limited sample size. The resulting coefficients should be interpreted as associational rather than causal.

5.5 Future Research

Further research could apply structural break tests to distinguish whether the relationship between turnover and economic health differs fundamentally across normal economic periods and times of distress. This research would, most probably, need to include a far higher sample time period.

Moreover, given that Eurostat produces the appropriate raw secondary data, the analysis could be extended to include multiple countries to assess whether the results are specific to Greece or rather, represent the broader economic behavior of other nations' consumers as well.

Another direction proposed for the continuation of this research is to construct and utilize more disaggregated variables for the analysis. One direction could be to disaggregate the products sold by supermarket to two variables; essential and non-essential. Then compare the volumes of the two presented variables sold against the gross disposable income of households. A different proposition is to study the income group of the consumers. The results have the potential to provide a deeper insight in to how different households react to income or price changes.

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Appendix A: Treated Data

Rebased, using the process described in Chapter 3.4.1, at year 2020 = 100 annual and quarterly entries and growth of Turnover and Volume indices:

Quarter	Year	Turnover Base Year 2020=100	Quarterly Turnover Growth (%)	Annual Turnover Average	Annual Turnover Growth (%)	Volume Base Year 2020=100	Quarterly Volume Growth (%)	Annual Volume Average	Annual Volume Growth (%)
2016 Q1	2016	89,674	-1,54	90,91	-1,11	91,019	-0,92	92,50	-0,02
2016 Q2		89,046	-0,70			90,903	-0,13		
2016 Q3		92,225	3,57			93,451	2,80		
2016 Q4		92,705	0,52			94,609	1,24		
2017 Q1	2017	93,629	1,00	92,89	2,18	94,454	-0,16	93,69	1,29
2017 Q2		92,151	-1,58			93,914	-0,57		
2017 Q3		95,699	3,85			94,300	0,41		
2017 Q4		90,081	-5,87			92,100	-2,33		
2018 Q1	2018	93,297	3,57	94,87	2,13	95,844	4,07	96,80	3,32
2018 Q2		95,995	2,89			98,121	2,38		
2018 Q3		96,525	0,55			98,191	0,07		
2018 Q4		93,670	-2,96			95,045	-3,20		
2019 Q1	2019	94,618	1,01	96,47	1,68	95,845	0,84	97,76	0,99
2019 Q2		95,291	0,71			96,861	1,06		
2019 Q3		98,012	2,86			99,969	3,21		
2019 Q4		97,951	-0,06			98,369	-1,60		
2020 Q1	2020	108,410	10,68	103,46	7,24	108,556	10,36	103,00	5,36
2020 Q2		100,306	-7,48			99,261	-8,56		
2020 Q3		98,593	-1,71			98,122	-1,15		
2020 Q4		106,514	8,03			106,063	8,09		
2021 Q1	2021	105,168	-1,26	106,95	3,38	105,756	-0,29	105,71	2,63
2021 Q2		106,300	1,08			106,125	0,35		
2021 Q3		107,645	1,27			105,325	-0,75		
2021 Q4		108,685	0,97			105,633	0,29		
2022 Q1	2022	109,083	0,37	114,63	7,18	103,663	-1,86	102,77	-2,78
2022 Q2		112,630	3,25			102,493	-1,13		
2022 Q3		119,419	6,03			105,202	2,64		
2022 Q4		117,370	-1,72			99,723	-5,21		
2023 Q1	2023	117,798	0,36	123,50	7,74	97,538	-2,19	98,92	-3,74
2023 Q2		121,437	3,09			98,246	0,73		
2023 Q3		127,309	4,84			100,923	2,73		
2023 Q4		127,462	0,12			98,984	-1,92		
2024 Q1	2024	126,578	-0,69	130,23	5,45	95,076	-3,95	98,26	-0,67
2024 Q2		130,226	2,88			100,842	6,06		
2024 Q3		134,375	3,19			100,503	-0,34		
2024 Q4		129,761	-3,43			96,602	-3,88		
2025 Q1	2025	133,588	2,95	135,94	4,38	97,416	0,84	100,46	2,24
2025 Q2		137,129	2,65			102,572	5,29		
		137,093	-0,03			101,385	-1,16		

Table A.1 Prepared Turnover and Volume Indices. Base year 2020=100

The compiled, per the procedure described in chapter 3.4.2, real 2020 GDP index:

Quarter	Year	GDP (Chain Linked Volumes at Constant Prices 2020) in million €	Quarterly GDP Growth (%)	GDP Annual Total at Constant 2020 Prices in million €	Real 2020 GDP Annual Growth (%)	GDP at current prices in million €	Annual Total at Current Prices in million €
2016 Q1	2016	43,450	-0,978	174,237	-0,002	43,453	174,626
2016 Q2		43,431	-0,044			43,689	
2016 Q3		43,550	0,274			43,616	
2016 Q4		43,806	0,588			43,868	
2017 Q1	2017	43,888	0,187	176,715	1,422	44,030	177,251
2017 Q2		44,122	0,533			44,162	
2017 Q3		44,519	0,900			44,661	
2017 Q4		44,186	-0,748			44,398	
2018 Q1	2018	44,854	1,512	180,186	1,964	44,921	180,531
2018 Q2		44,935	0,181			45,003	
2018 Q3		45,057	0,272			45,137	
2018 Q4		45,340	0,628			45,470	
2019 Q1	2019	45,856	1,138	184,183	2,218	45,996	184,571
2019 Q2		46,279	0,922			46,586	
2019 Q3		46,045	-0,506			46,060	
2019 Q4		46,003	-0,091			45,929	
2020 Q1	2020	45,103	-1,956	167,766	-8,913	45,420	167,949
2020 Q2		38,890	-13,775			38,984	
2020 Q3		41,427	6,524			41,230	
2020 Q4		42,346	2,218			42,315	
2021 Q1	2021	44,129	4,211	181,541	8,211	43,820	183,854
2021 Q2		44,731	1,364			45,026	
2021 Q3		46,016	2,873			46,417	
2021 Q4		46,665	1,410			48,591	
2022 Q1	2022	47,646	2,102	192,151	5,844	50,527	207,076
2022 Q2		47,725	0,166			51,523	
2022 Q3		48,185	0,964			51,904	
2022 Q4		48,595	0,851			53,122	
2023 Q1	2023	48,630	0,072	196,615	2,323	54,796	224,392
2023 Q2		49,195	1,162			56,094	
2023 Q3		49,256	0,124			56,183	
2023 Q4		49,534	0,564			57,319	
2024 Q1	2024	49,704	0,343	201,103	2,283	57,826	236,854
2024 Q2		50,249	1,096			58,958	
2024 Q3		50,374	0,249			59,444	
2024 Q4		50,776	0,798			60,626	
2025 Q1	2025	50,807	0,061	101,909		61,141	123,161
2025 Q2		51,102	0,581			62,020	

Table A.2 Quarterly and annual real 2020 and at current prices value and growth of GDP

The compiled GDHI index at constant 2020 prices, as described in chapter 3.4.3:

Quarter	Year	GDHI in Market prices in million €	GDHI in constant 2020 prices in million €	CPI	Quarterly GDHI at Constant 2020 Prices Growth (%)	Annual GDHI at Constant 2020 Prices in million €	Annual GDHI growth (%)
2016 Q1	2016	27,340	27,786	98,39	-7,02	116,493	-0,75
2016 Q2		29,317	29,365	99,83	5,68		
2016 Q3		28,334	28,643	98,92	-2,46		
2016 Q4		30,673	30,698	99,92	7,17		
2017 Q1	2017	28,379	28,443	99,77	-7,34	117,932	1,24
2017 Q2		30,534	30,197	101,12	6,17		
2017 Q3		29,575	29,612	99,88	-1,94		
2017 Q4		29,904	29,680	100,75	0,23		
2018 Q1	2018	27,254	27,348	99,66	-7,86	115,650	-1,93
2018 Q2		30,357	29,861	101,66	9,19		
2018 Q3		29,754	29,505	100,85	-1,19		
2018 Q4		29,478	28,937	101,87	-1,92		
2019 Q1	2019	28,998	28,904	100,32	-0,11	123,697	6,96
2019 Q2		32,691	32,054	101,99	10,90		
2019 Q3		32,190	31,941	100,78	-0,35		
2019 Q4		31,403	30,798	101,96	-3,58		
2020 Q1	2020	29,304	29,104	100,69	-5,50	119,850	-3,11
2020 Q2		29,914	29,742	100,58	2,19		
2020 Q3		32,204	32,574	98,86	9,52		
2020 Q4		28,393	28,429	99,87	-12,73		
2021 Q1	2021	29,882	30,168	99,05	6,12	126,845	5,84
2021 Q2		33,785	33,494	100,87	11,02		
2021 Q3		35,316	31,417	112,41	-6,20		
2021 Q4		33,137	31,766	104,32	1,11		
2022 Q1	2022	31,390	29,495	106,42	-7,15	126,312	-0,42
2022 Q2		33,206	29,604	112,17	0,37		
2022 Q3		39,911	35,505	112,41	19,93		
2022 Q4		35,813	31,708	112,95	-10,69		
2023 Q1	2023	35,383	31,401	112,68	-0,97	132,090	4,57
2023 Q2		37,239	32,383	115,00	3,13		
2023 Q3		40,500	35,227	114,97	8,78		
2023 Q4		38,598	33,079	116,68	-6,10		
2024 Q1	2024	36,891	31,756	116,17	-4,00	134,687	1,97
2024 Q2		39,174	33,211	117,95	4,58		
2024 Q3		43,388	36,685	118,27	10,46		
2024 Q4		39,486	33,035	119,53	-9,95		
2025 Q1	2025	37,137	31,167	119,15			
2025 Q2							

Table A.3 Quarterly and annual real 2020 and at current prices values and growth GDHI

The annual indices values of year 2015, adjusted for inflation and suitable for comparison

Year	Annual Turnover Average	Annual Volume Average	Annual GDP at Constant 2020 Prices in million €	Annual GDHI at Constant 2020 Prices in million €
2015	91,93	92,51	174,586	117,370

Table A.4 Index values employed to extract the annual RoC for 2016 indices

The differenced Turnover, volume, GDHI and GDP series that are employed for correlation tests:

Differenced turnover series	Differenced GDHI series	Differenced Volume series	Differenced GDP series
-0,6284	1,5792	-0,1158	-0,0190
3,1789	-0,7220	2,5476	0,1190
0,4805	2,0541	1,1580	0,2560
0,9241	-2,2545	-0,1544	0,0820
-1,4786	1,7539	-0,5404	0,2340
3,5485	-0,5849	0,3860	0,3970
-5,6185	0,0680	-2,2002	-0,3330
3,2158	-2,3324	3,7442	0,6680
2,6984	2,5138	2,2774	0,0810
0,5303	-0,3567	0,0699	0,1220
-2,8555	-0,5677	-3,1467	0,2830
0,9480	-0,0326	0,8002	0,5160
0,6728	3,1497	1,0157	0,4230
2,7217	-0,1127	3,1086	-0,2340
-0,0612	-1,1434	-1,6005	-0,0420
10,4587	-1,6935	10,1878	-0,9000
-8,1040	0,6380	-9,2952	-6,2130
-1,7125	2,8318	-1,1388	2,5370
7,9205	-4,1452	7,9409	0,9190
-1,3456	1,7393	-0,3078	1,7830
1,1315	3,3254	0,3693	0,6020
1,3456	-2,0768	-0,8002	1,2850
1,0398	0,3491	0,3078	0,6490
0,3976	-2,2709	-1,9698	0,9810
3,5474	0,1090	-1,1696	0,0790
6,7890	5,9005	2,7085	0,4600
-2,0489	-3,7964	-5,4786	0,4100
0,4281	-0,3076	-2,1853	0,0350
3,6391	0,9823	0,7079	0,5650
5,8716	2,8441	2,6777	0,0610
0,1529	-2,1478	-1,9391	0,2780
-0,8841	-1,3229	-3,9083	0,1700
3,6482	1,4550	5,7663	0,5450
4,1489	3,4736	-0,3392	0,1250
-4,6139	-3,6504	-3,9007	0,4020
3,8270	-1,8673	0,8141	0,0310

Table A.5 Differenced series of all indices

The logarithmically transformed and differenced Turnover, volume, GDHI and GDP series that were inputted into the regression model:

Δln(turnover)	Δln(volume)	Δln(GDHI)	Δln(GDP)
-0,003054	-0,0005529	0,02400671	-0,00019
0,01523375	0,01200388	-0,0108119	0,00118833
0,00225698	0,00534852	0,03007853	0,00254544
0,00430766	-0,0007093	-0,0331275	0,00081219
-0,00691291	-0,0024919	0,02598665	0,0023094
0,01640977	0,00178136	-0,0084949	0,00389021
-0,02627652	-0,010253	0,00099612	-0,0032607
0,01523382	0,01730628	-0,0355451	0,00651649
0,0123826	0,01019883	0,03819047	0,00078357
0,00239236	0,00030921	-0,0052192	0,00117753
-0,01304144	-0,0141457	-0,0084382	0,00271924
0,00437331	0,00364132	-0,0004899	0,00491465
0,00307714	0,00457813	0,04492036	0,0039878
0,01223058	0,01371928	-0,0015299	-0,0022015
-0,0002711	-0,0070092	-0,0158318	-0,0003963
0,0440593	0,04279869	-0,0245625	-0,0085807
-0,0337424	-0,0388757	0,00941772	-0,0643675
-0,00747881	-0,0050114	0,03949731	0,02744554
0,03355844	0,03379696	-0,0591121	0,00952891
-0,0055213	-0,0012621	0,02578967	0,01791169
0,00464759	0,0015141	0,0454124	0,00588452
0,0054629	-0,0032873	-0,0278003	0,01230026
0,00417476	0,00126727	0,00479892	0,00608241
0,00158569	-0,0081752	-0,0322131	0,00903518
0,01389861	-0,0049278	0,00160201	0,00071949
0,02541932	0,01132782	0,07893323	0,00416593
-0,00751607	-0,023227	-0,0491129	0,00367972
0,00158131	-0,0096228	-0,0042333	0,00031268
0,01321361	0,00314064	0,01337808	0,0050167
0,02050652	0,01167853	0,03656031	0,00053818
0,0005213	-0,0084254	-0,0273211	0,00244426
-0,0030227	-0,0174953	-0,0177245	0,00148794
0,01234012	0,02557181	0,01945657	0,00473608
0,01362052	-0,0014633	0,04320179	0,00107901
-0,01517392	-0,0171917	-0,0455191	0,00345205

Table A.6 Logarithmically transformed and diffrenced series

Author's Statement:

I hereby declare that, in accordance with article 8 of Law 1599/1986 and article 2.4.6 par. 3 of Law 1256/1982, this thesis/dissertation is solely a product of personal work and does not infringe any intellectual property rights of third parties and is not the product of a partial or total plagiarism, and the sources used are strictly limited to the bibliographic references.