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Estimation of the Product Profitability Index Based on the Product Complexity Index

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Abstract

Profit, as presented in financial statements, is one of the most important performance metrics and a key determinant of an economic entity's value. The primary objective of this research is to assess product profitability based on a Product Complexity Index (PCI), considering the product's diversity and market reach across different markets. The study analyzes a sample of 500 profitable companies listed in the Fortune, spanning the financial years from 2014 to 2018. The analysis employs both panel and pooled data methods.

The study aims to estimate the profitability of each product to help investors identify the most profitable products for investment, based on their profitability as determined by the PCI. The findings suggest that adopting a new approach focused on producing high-complexity products, rather than merely selecting product types or business activities, along with measuring the profitability index of each product, can enhance decision-making. By examining the relationship between product complexity and profitability, and introducing an index to forecast product profitability, investors who are key users of financial information can make more decisions that are informed. These decisions, based on the optimal combination and selection of products, can foster economic growth and contribute to the development of society. The results show a positive and significant relationship between operating profit and the Product Complexity Index, as well as the estimation of profitability based on product diversity and market reach.

Highlights

- The study uses a Product Complexity Index (PCI) to assess profitability.
- Results show a strong link between PCI and operating profit.
- High-complexity products improve decisions and foster growth.

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1. Introduction

Performance evaluation in the decision-making process, especially considering the growing importance of capital markets, is a critical topic in finance and economics. As such, the role of financial and economic indicators in evaluating the performance of enterprises has become a necessity. One of the primary objectives of economic entities is to achieve short-term profits and to enhance the long-term economic wealth of their owners (Aflatoni, 2021).

In today's global economic environment, the accurate transmission and reporting of financial information to decision-making bodies is crucial. When evaluating a company's performance and its potential for profitability, the reported profit figure plays a pivotal role in investment decisions. Moreover, economic policymakers and investors can make optimal choices by understanding how accounting calculations interact with macroeconomic indicators, particularly in relation to selecting business activities and determining the types of products to produce. According to Kothari et al. (2013), who introduced the concept of macro accounting in contemporary accounting studies, the goal is to establish a proper link between accounting practices and economics. At the macro level, the accounting profits of companies contribute to a nation's economic growth. When companies achieve higher profits, they tend to reinvest in their businesses, create jobs, and develop infrastructure—all of which contribute to economic expansion. The significance of profit in the economy lies in its ability to incentivize companies to produce new products that have the potential to be profitable.

Chen & Josephiu (2012) demonstrated a significant positive relationship between product diversification, diversification strategy, and corporate profitability. According to their findings, companies should focus on producing profitable products in order to enhance their profitability. Furthermore, Hausmann & Hidalgo (2008) offered a new perspective on economic development, emphasizing that it depends on the production of diverse and complex products. In this view, a nation's long-term income is not solely determined by the volume of production measured in monetary terms, but by the production of high-complexity products. The economic wealth of a country is linked to its capacity to produce such products. This is particularly relevant for investors who seek to maximize profits by selecting the most profitable products based on future profitability forecasts. However, there is a noticeable gap in current research and reporting practices regarding a metric that allows shareholders to predict profit from product selection based on economic conditions, as reflected in company profits. Therefore, measuring the profitability of products, based on their complexity, rather than merely selecting product types and business activities, is crucial.

Hausmann & Hidalgo (2008) argue that certain capabilities are required to produce complex products. These capabilities, when considered at the macro level, encompass a range of economic, political, cultural, and other infrastructural factors. At the micro level, these capabilities relate to the production of complex, high-profit products and their impact on investors' decisions and future economic

projections. According to their theory, if a product requires a multitude of capabilities to be produced, it is considered complex. On the other hand, products that require fewer capabilities are categorized as mainstream or widespread. Therefore, countries with a broad range of diverse capabilities can produce complex products and, in turn, be considered high-complexity economies. Generally, the more complex a product, the more diverse the capabilities needed for its production. As a result, the type of product has a significant impact on its profitability. Products with unique characteristics, such as luxury or specialized items, tend to have higher profit margins, while more general and inexpensive products may yield lower profit margins due to intense competition. Factors such as innovation, quality, and differentiation also play a role in determining profitability.

This study aims to first investigate the relationship between operating profit and the product complexity index by utilizing the economic complexity index and analyzing the types of products selected for investment in companies. In the second phase, the research will develop a new metric, the Product Profitability Index, by examining the complexity levels of products produced by the most profitable companies globally. The main objective of the study is to create this new profitability index, which will assist investors in making informed decisions. Finally, the research will test the significance of the hypothesis by analyzing the relationship between the product complexity index and profitability in the most profitable companies worldwide.

By exploring the relationship between product complexity and profitability and introducing a profitability index based on product complexity, this research aims to significantly reduce managerial errors in financial reporting and accounting practices. It will also contribute to identifying profitable products and improving the overall quality of accounting information.

In the following sections, relevant theories on product complexity and company profitability are reviewed, and the research methodology, including the research model and estimation method, is discussed. The results of the data analysis are then presented, followed by the conclusion and summary of the study.

2. Theoretical Framework

In today's economic environment, the appropriate selection of economic activities and product production to achieve higher profits and greater success, ultimately contributing to economic growth and progress, is one of the most debated and compelling topics in economic and accounting research. Accurate profit assessment plays a critical role in fostering economic growth, as it enhances the credibility of financial information, and the credibility of such information is directly linked to economic development (Ahmadpour et al., 2012). The intensification of competition across industries, coupled with the impact of economic conditions, has caused fluctuations in company performance. As a result, even companies that were once successful now face significant uncertainties. Due to the low transparency of financial disclosures, investor

judgment is increasingly sensitive and subject to greater scrutiny (Mousavi et al., 2023). In making investment decisions, investors consider all aspects of a company's performance and aim to make the most rational and informed choice (Saadat Zadeh Hesar et al., 2021). Moreover, since poor company performance imposes substantial economic and social costs on society, performance evaluation has become one of the primary responsibilities of organizations and management (Chen et al., 2018). From a macroeconomic perspective, predicting the performance of profit-oriented units is crucial, as resources wasted in underperforming units could be reallocated to more profitable opportunities (Sarani et al., 2016).

The measurement of performance in the decision-making process, especially considering the growing importance of capital markets, remains a central topic in financial economics. Consequently, the role of financial and economic indicators in evaluating company performance is of utmost importance (Izadnia & Rasayan, 2010).

When evaluating the profitability of a product, the net profit is the first criterion that most investors consider. Given the diversity of products and the significant positive relationship between product diversification strategy and company profitability (Chen & Josephiu, 2012), companies should not focus solely on a single product. Instead, they should engage in the production and offering of a range of diverse and varied products to enhance the overall profitability of the economic unit. However, successful product diversification must involve the introduction of new technologies in products and services that lead to lower production costs, higher competitiveness, and ultimately increased profitability for the company (Christensen & Raynor, 2013). Research has also shown that product competitiveness serves as an important strategy for managers, as it encourages them to increase revenue for shareholders, thereby boosting the company's profitability (Ammann et al., 2013).

Hausmann & Hidalgo (2008) introduced a new perspective in economics, suggesting that economic development is driven by the production of competitive, diverse, and high-tech (complex) products. The long-term income of countries, they argue, is tied to the production of such products. In their 2011 study, Hidalgo and Hausmann examined the relationship between production diversity and its prevalence across different countries, concluding that an increase in production capacities correlates with greater product diversity. They found that only countries with high levels of production capacity can manufacture products that require a broad range of production capabilities. As a result, such products tend to be less common (more competitive), with only a few countries being able to produce them. These products, in turn, are likely to generate higher revenue and profitability (Javeed et al., 2020; Mubeen et al., 2020).

Products that are competitively produced by only a few countries often exhibit high economic complexity and higher profitability (Shahmoradi & Samandar, 2017). Given that investors typically seek to maximize their profit by selecting the most profitable high-complexity products, this perspective can be

used to compare the predicted profitability of different products and types of company activities. This approach helps in evaluating and forecasting the performance of economic units based on the profitability of companies, considering prevailing economic conditions.

It is important to note that investors are the primary users of financial information, and they pay close attention to accounting profits, which are key indicators in the capital market. Therefore, understanding the relationship between accounting profit and product complexity is crucial. This paper aims to introduce a new index to assist investors in making better-informed decisions. By optimizing the product mix and selecting the right product types to produce, companies can enhance their profitability, which will, in turn, contribute to broader economic growth and societal advancement.

3. Literature Review

Quantitative and empirical studies on the relationship between product diversification and company performance often yield conflicting results regarding the impact of diversification on company growth, profitability, and stability. Below, we summarize key domestic and international studies that primarily focus on the link between product diversification and profitability.

Liu et al. (2022) used annual data from companies listed on the Chinese stock market to explore the relationship between the competitiveness of manufactured products and company profits. Their findings suggest that a competitive product portfolio positively influences a company's profitability, linking higher competitiveness with higher financial performance.

Mayerodia et al. (2021) examined the cost factors associated with complexity arising from product diversification in manufacturing companies and their effects on product profitability. They argued that companies producing more complex and innovative products are able to charge higher prices, which leads to better profitability. Their study indicates that products requiring advanced and specialized production processes typically command higher prices, thus allowing companies to achieve higher profit margins. Consequently, investing in the production of complex products can significantly contribute to long-term profitability.

Westerman et al. (2020), in their study of performance and diversity in the energy sector, found that renewable energy companies tend to be more profitable than conventional energy companies. However, they also discovered a negative relationship between diversification strategy and company performance, suggesting that in some sectors, increasing diversification may lead to decreased profitability due to the challenges of managing multiple business activities.

Koen (2018) explored how product strategy and diversification impact company performance. He suggested that companies can improve operational performance by leveraging the benefits of production diversity, such as cost savings, risk reduction, increased market power, reduced transaction costs, and learning effects. According to Koen, improving and diversifying products can

enhance performance by internalizing business activities and creating synergies within the company.

In a study conducted by [Nwakoei & Augustine \(2018\)](#) on the financial performance of companies in Nigeria, they found that while there has been a considerable correlation between financial performance and related product diversity, business diversification was not seen statistically significant in predicting performance outcomes. This suggests that while diversification may influence performance, the specific type and extent of diversification play a critical role in financial success.

[Dost et al. \(2012\)](#) investigated the relationship between company diversification, information asymmetry, and their performance in 47 companies listed on the Tehran Stock Exchange. Their study used return on equity (ROE) to measure performance and entropy to assess diversity. The results indicated no significant relationship between product diversity and company performance, suggesting that diversification alone does not necessarily enhance performance. However, the study highlighted the importance of diversification in explaining future economic growth, suggesting that while not directly tied to immediate profitability, it may still have long-term predictive value for economic success.

These studies underscore the complexity of the relationship between product diversification and profitability. While many studies point to a positive correlation, especially when diversification involves high-value or innovative products, other studies suggest that diversification may not always lead to improved performance, particularly if not managed effectively. Therefore, the success of diversification strategies largely depends on the type of products, market conditions, and the firm's ability to manage the complexities associated with a diverse product portfolio.

4. Data and Methodology

According to the subject of the research, which is to provide a model for predicting profit based on the product complexity index and examining the relationship between the product complexity index, the product profitability index and the companies' profitability, it can be stated that in terms of the type of hybrid research and the research environment (type of research) in order to Finding out what the sample companies are by the "field" method, and collecting related theories and theories by the "library" method, and "documents" data collection method has been used.

The purpose of the research is "descriptive" and its statistical population includes the 500 most profitable companies in the world in 2018 on the Fortune website. The desired sample size is determined by the elimination sampling method according to the following conditions:

- 1- The end of the company's financial year is the end of December and it has not changed its activity or changed its financial year during the time period for data collection from 2014 to 2018 (62 companies were excluded from the selected statistical population).

- 2- The required information of the company should be available from the fiscal year 2014 to 2018 (78 companies were removed from the selected statistical population).
- 3- The selected company should not have experienced operational losses over a 5-year period (as a result, 54 companies were excluded from the selected sample of the statistical population).
- 4- In order to avoid exclusivity in each product code, the number of companies in each product code in the Harmonized System (HS) code that were less than 2 were removed (20 companies were removed from the selected statistical population).

After applying the above conditions, a total of 214 companies were removed from the 500 companies in Fortune's list from fiscal year 2014 to the end of 2018, and finally 286 companies were selected in 66 product code HS categories. Therefore, the final sample size is 1460 company-years, which have been used as the combined data in the tests. The required information for the companies' financial data was collected from their financial statements on the dedicated website of each company. Due to the use of the economic complexity approach, it is essential that the products under review be in the code HS format. Since the data related to the financial statements of the companies under review were in the format of ISIC code, therefore, in the first step, these codes have been converted into HS code. In the following, according to the product code, type of activity, manufactured products and services provided, the product complexity index code was extracted from the economic atlas site of Harvard University, and E-views12 software was used to analyze the data and extract descriptive statistics and inferential statistics.

5. Research Variables

5.1 Dependent Variable

Operating Profit (op-profit): In financial discussions, profit refers to a type of financial gain that occurs when the total revenues generated by an activity exceed the total costs incurred to earn those revenues. The surplus derived from the revenues and costs is the profit. In companies, the profit belongs to the shareholders, and it is they who decide whether to reinvest the profit back into the company's business or not. Operating profit represents the remaining profit after accounting for all the operating costs associated with the business unit. In addition to the cost of goods sold, administrative, general, and other expenses such as rent, insurance, transportation, and freight are considered in the calculation of operating profit.

In fact, all costs that are necessary to maintain the operations of the business unit must be included in the calculation of operating profit.

Operating Profit (Loss) = Gross Profit (Loss) - Selling and Administrative Expenses

5.2 Independent Variables

Product Complexity Index (PCI): To calculate the product complexity index, an index called the Economic Complexity Index is used, which measures the intensity of knowledge application in the economy. Economic complexity is expressed based on the composition of productive products of a country and reflects the structures that have emerged with the aim of combining knowledge. Hidalgo & Hausmann (2009) used the two principles of diversity and inclusiveness to construct the economic complexity index. Diversity means the number of distinctive products of a country and comprehensiveness of a product means the number of countries producing a specific product. Thus, the complexity index of a country can be considered as the result of the variety of products and the extent of production of those products in some other countries. Therefore, a country with a higher economic complexity index means that country's ability to produce more diversify and less inclusive products (Hidalgo & Hausmann, 2009). The mathematical method used for economic complexity index largely reflects these differences. For this purpose, we consider MCP as a matrix, which is the same matrix.

If country c produces product p , the number is 1, otherwise, we consider the number zero. Based on this, it is possible to easily calculate the diversity and comprehensiveness of goods by adding together the rows and columns of this matrix. In mathematical terms, it can be defined as:

$$\text{Diversity} = k_{c,0} = \sum_p M_{cp} \quad (1)$$

$$\text{Ubiquity} = k_{p,0} = \sum_c M_{cp} \quad (2)$$

To make an accurate measure of the number of capabilities available in a country, or the number of capabilities needed to make a product, it is possible to complete the information related to the above two criteria with the help of each other. This requires that for each country, we calculate the average prevalence of the goods that it exports, as well as the average diversity of the countries that produce them and the average prevalence of other goods that this country produces. This problem can be shown with the help of the following relations:

$$k_{c,N} = \frac{1}{k_{c,0}} \sum_p M_{cp} k_{p,N-1} \quad (3)$$

$$k_{p,N} = \frac{1}{k_{p,0}} \sum_c M_{cp} k_{c,N-1} \quad (4)$$

By inserting (4) into (3), we have:

$$k_{c,N} = \frac{1}{k_{c,0}} \sum_p M_{cp} \frac{1}{k_{p,0}} \sum_c M_{cp} k_{c,N-1} \quad (5)$$

$$k_{c,N} = \sum_c k_{c,N-1} \sum_{k_{c,0} k_{p,0}} \frac{M_{cp} M_{cp}}{k_{c,0} k_{p,0}} \quad (6)$$

If we name $\sum_{k_{c,0} k_{p,0}} \frac{M_{cp} M_{cp}}{k_{c,0} k_{p,0}}$ with the eigenvector $\widetilde{M}_{c\dot{c}}$, then we have:

$$k_{c,N} = \sum_c \widetilde{M}_{c\dot{c}} k_{c,N-1} \quad (7)$$

The relation (3) holds when $k_{c,N} = k_{c,N-2} = 2$ this eigenvector is \vec{M}_{cc} which is associated with the largest eigenvalue. Since this special vector is a vector of numbers 1. Does not contain better information; Thus, instead, we use the eigenvector corresponding to the second largest eigenvalue. This is the vector that reflects the largest amount of variance and is an indicator for measuring economic complexity; therefore, the economic complexity index can be defined as follows:

$$ECI = \frac{\bar{K} - \langle \vec{K} \rangle}{se(\bar{K})} \tag{8}$$

In this regard, the symbol $\langle \rangle$ represents the mean, se Standard Deviation Indicator, and \vec{K} is the eigenvector of the matrix \vec{M}_{cc} related with its second largest eigenvalue. In the same way, the product complexity index (PCI) would be calculated. Due to the similarity of the problem, it is easy to extract PCI as follows by replacing c (which represents the country) with the symbol p (which represents the goods) in the above relationships:

$$PCI = \frac{\bar{Q} - \langle \vec{Q} \rangle}{se(\bar{Q})} \tag{9}$$

In this relation, \vec{Q} the special vector of the matrix \vec{M}_{pp} associated with its second largest eigenvalue.

Estimation of the Product Profitability Index (CPI)

As discussed in the theoretical framework related to the model for predicting the profitability of the top profitable companies worldwide, there are various factors that can influence accounting profit and related policies. On the other hand, given the limitations of time-series data, in order to obtain accurate and acceptable results and prevent bias in estimated regressions, it was decided to use correlation analysis methods in this study.

Based on the results obtained, the following table and Fig.s estimate the Product Profitability Index for five different calculation functions, considering the impact of company size and financial leverage variables to compute the best estimate for this research.

$$CPI_p = \sum_c M_{cp} Size_c Op_Profit_c \tag{10}$$

$$CPI_p = 1/N_p \sum_c M_{cp} S_{cp} Op_Profit_c \tag{11}$$

$$CPI_p = 1/N_p \sum_c M_{cp} S_{cp} \frac{Op_Profit_c}{Size_c} \tag{12}$$

$$CPI_p = 1/N_p \sum_c M_{cp} S_{cp} Size_c Op_Profit_c \tag{13}$$

$$CPI_p = 1/N_p \sum_c M_{cp} S_{cp} Fin_Leverage_c \frac{Op_Profit_c}{Size_c} \tag{14}$$

Size of the company (Firm Size): The size of the company is obtained through the natural logarithm of sales. The use of the sales criterion instead of the total assets criterion is due to the companies' use of the accounting system based on the historical price. Also, the use of sales criteria instead of market value criteria is due to poor efficiency and low transaction turnover in the Tehran Stock Exchange (Sataish, Mumtazian, Behpour and Salehinia, 2014).

$$SIZE_{j,t} = \log(\text{Net sales}_{j,t}) \quad (15)$$

Debt-to-asset ratio (Fin-Leverage): This ratio is calculated based on dividing total liabilities by total assets. This ratio is potentially highly interpretable for predicting abnormal changes in stock prices; therefore, investors use this ratio to interpret the future situation of the company (Bahramfar & Shams Alam, 2004).

$$F.L = \frac{\text{Total Debt}}{\text{Total Assets}} \quad (16)$$

Return on Assets (ROA): This is an indicator of a company's profitability, relative to its total assets. The ROA provides an insight into the efficient management of assets in generating profit (productive assets). It is calculated by dividing the annual profit by the company's total assets. The return on assets is expressed as a percentage.

$$ROA = \frac{\text{Net Income}}{\text{Total Assets}} \times 100 \quad (17)$$

6. Research Findings

In this study, based on the research objective, the first step was to investigate whether there is a relationship between the two main variables: operating profit and product complexity index. In the second step, the aim was to explore the relationship between the calculated research variable, which is the product profitability index, and the product complexity index.

It is worth mentioning that in order to establish the relationships between the independent and dependent variables, all the classical assumptions of linear regression were tested. It was ensured that:

1. The mean of the errors was zero.
2. The variance of the errors was constant.
3. There was no correlation between the errors of the model.
4. The normality of the dependent variable's distribution was tested, and it was found to be normal. The detailed results of these tests are beyond the scope of this article.

Additionally, the bivariate correlation coefficient, specifically Pearson's correlation coefficient, denoted as r , was used. Pearson's coefficient indicates the degree of linear relationship between quantitative variables. The primary application of Pearson's correlation is when the variables are parametric, meaning they have a normal distribution and are measured at an interval/ratio level.

The correlation model for the research hypotheses is outlined as follows:

$$r_{xy} = \frac{n \sum x_i y_i - \sum x_i \sum y_i}{\sqrt{n \sum x_i^2 - (\sum x_i)^2} \sqrt{n \sum y_i^2 - (\sum y_i)^2}} \tag{18}$$

r_{xy} is the correlation coefficient in the first hypothesis variable x_i is the operating profit of 286 profitable companies and in the second hypothesis x_i is the product profitability index of the estimator calculated in the research for 66 product codes produced in 286 profitable companies and y_i is the product complexity index of the 286 profitable companies based on the product code It was fitted for each year from 2014 to 2018.

6.1 Descriptive Statistics of Variables

In Table 1, the standard deviation is obtained for the operating profit variable which is lower than its mean. This finding suggests a relatively normal distribution of this variable (as the dependent variable) and indicates the absence of significant fluctuations, which is important when analyzing its behavior through regression models. Thus, the median of this variable was very close to its mean, which may be an indication of low skewness and kurtosis, or in other words, the absence of severe fluctuations in the data distribution.

Table 1. Descriptive Statistics of the Research Variables.

Variable	Operating Profit	Financial Leverage	Firm Size	Return on Assets (ROA)	CPI1	CPI2	CPI3	CPI4	CPI5
Mean	6637.319	0.296893	4.027614	461.7527	49,910,272	1,101,791.602	206,066.8732	2,012,119.403	14,264.46932
Median	6637.320	0.3	4.03	459.81	49,533,391	1,091,548.6	204,086.67	1,995,887.9	14,218.53
Maximum	37,571.48	1.28	8.39	15,971.49	327,671,981.1	7,810,379.28	1,450,490.43	13,876,325.84	111,821.83
Minimum	0.2429683	-0.46	-0.33	-12,480.35	302.816,4	4,995,301	812,889.8	13,055,944	74,396.53
Standard Deviation	9,642.705	0.305562	1.359263	4,829.152	113,999,544.1	1,979,975.496	367,051.6394	4,869,397.801	28,790.6592
Skewness	0.00035315	0.022495	0.000127	0.010613	0.019171	0.025305291	0.031219899	-0.018640	0.023638587
Kurtosis	2.921841	2.856723	2.921980	2.888038	2.848526	2.977627554	2.958810246	2.847853678	2.975234456
Number of Observations	1,430	1,430	1,430	1,430	1,430	1,430	1,430	1,430	1,430

Source: Research finding

6.2 Fitting the Initial Regression Model

It is worth mentioning that, in accordance with the implementation of the relationships, all the classical assumptions for linear regression were tested, and it was ensured that:

1. The mean of the errors was zero.
2. The variance of the errors was constant.
3. There was no correlation between the errors in the model.
4. The normality of the dependent variable's distribution was tested and reported as normal. The detailed results of these tests are beyond the scope of this article.

To answer the first question, we first use the correlation test between the operating profit variable and the product complexity index. As shown in the results in Table 1, the correlation test between the two variables, operating profit and product complexity index, conducted separately for each year, shows a positive correlation coefficient above 0.6, with a significance level of less than 0.01%. This result is statistically significant.

Table 2. Correlation test between operating profit and product complexity index

Year	Correlation coefficient between operating profit variable and product complexity index	The significance level
2014	0.654	0.0000
2015	0.669	0.0000
2016	0.604	0.0000
2017	0.673	0.0000
2018	0.687	0.0000

Source: Research finding

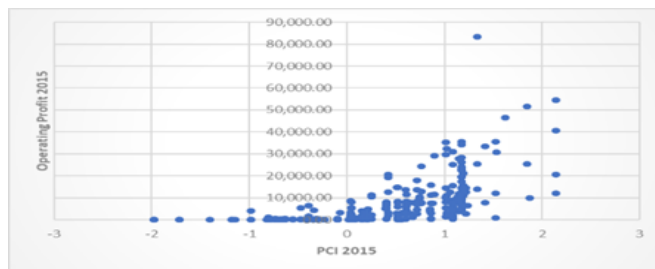
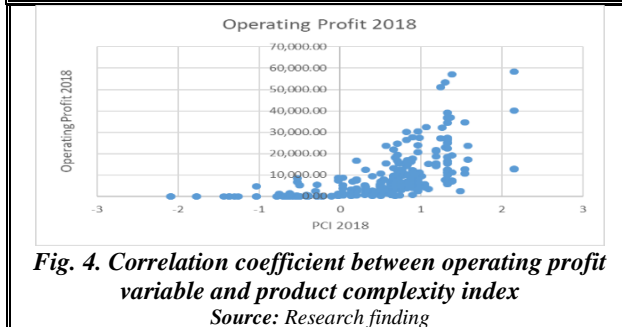
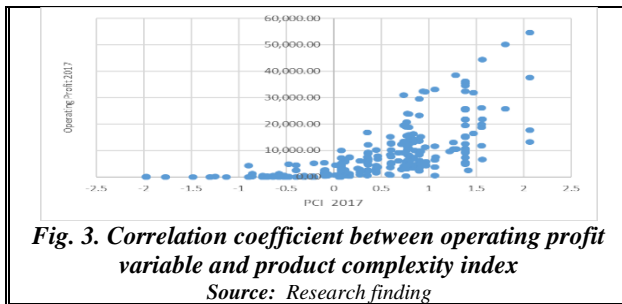
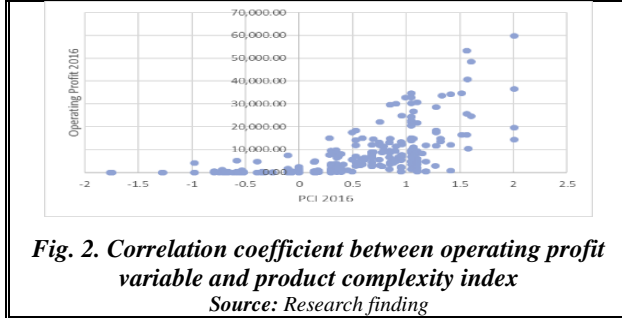


Fig. 1. Correlation coefficient between operating profit variable and product complexity index

Source: Research finding



According to the results of the above table and graphs, the operating profit of the companies has an upward trend with the increase of the product complexity index, it shows a positive correlation above 0.6% of the two variables of the operating profit and the product complexity index, and the relationship is significant. At the confidence level of 99%, it is now possible to estimate the profitability index of the product according to the calculation function of this research.

6.3 Presenting the model to predict the profit and the tests used to calculate the profitability index of the product

As presented in the theoretical discussions related to the presentation of the model for predicting the profit of the world's top profitable companies, there are several factors that can affect the accounting profit and related policies. On the other hand, due to the limitation of time series statistics, in order to achieve correct and acceptable results and to avoid skewing of estimated regressions, and more briefly in studies with correlation analysis method.

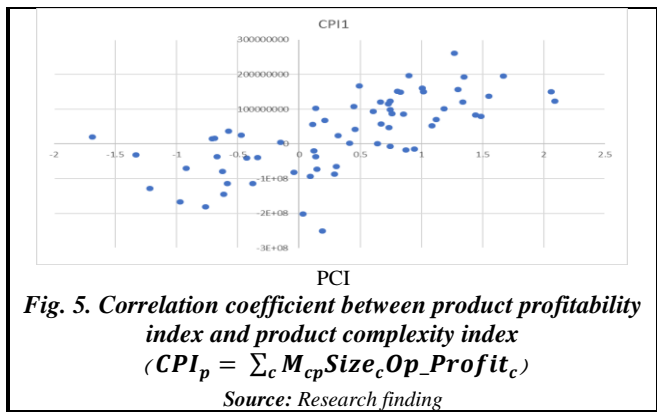
According to the results of the above table and graphs, in the following tables, the product profitability index was estimated for 5 different calculation functions with the effect of company size variables and financial leverage to calculate the best estimate in this research.

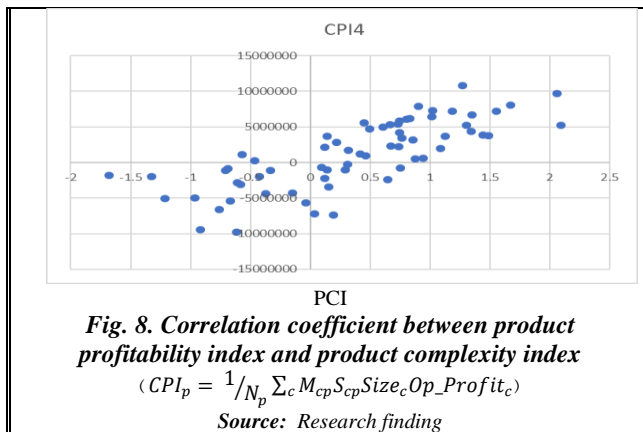
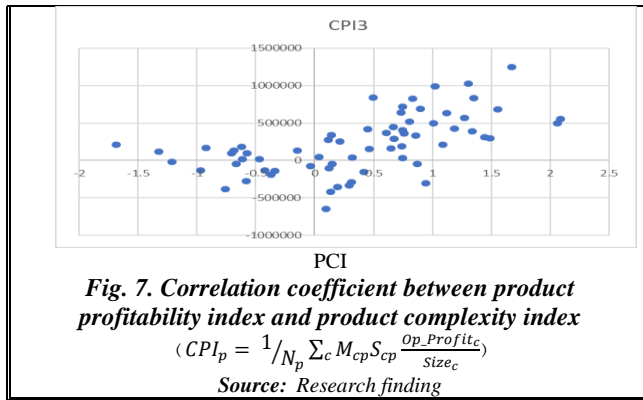
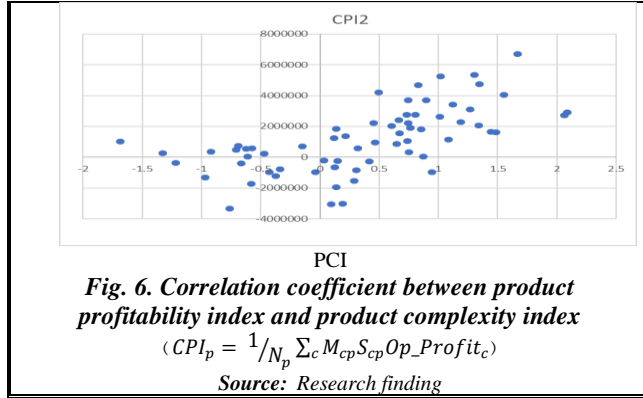
According to the results of different estimations, the correlation test between the product profitability index variable and the product complexity index was investigated separately in the period from 2014 to 2018 at a confidence level of 99%.

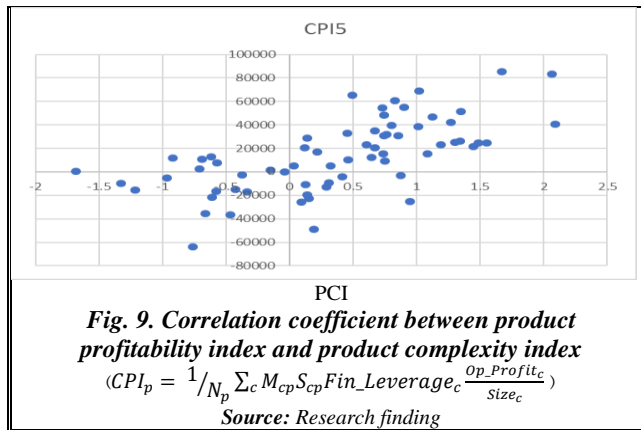
Table 3. Result of the correlation between product profitability index and product complexity index

Years	CPI1	CPI2	CPI3	CPI4	CPI5
Correlation coefficient between product profitability index and product complexity index					
2018	0.3832	0.6855	0.4864	0.4120	0.5011
2017	0.4292	0.6374	0.5287	0.4496	0.5238
2016	0.3861	0.6805	0.4727	0.4149	0.4680
2015	0.4278	0.6338	0.5270	0.4472	0.5291
2014	0.4654	0.6723	0.5687	0.4690	0.4052
	0.4183	0.6619	0.5167	0.4345	0.4854

Source: Research finding







The results of calculating the correlation between the CPI index and the PCI index for different functions and in each year separately in the above tables indicate a positive relationship at the 99% confidence level.

6.4 Determining how to use composite data

In this research, before estimating the model, it is necessary to choose on the appropriate method of using such data in our prediction. Firstly, it must be determined that there is a necessity to consider the structure of the data panel (fixed effects or ordinary least squares) or to combine the data of different companies and use it in model estimation, so to estimate the appropriate model from The Lymeria Chow test was used (Khanalizadeh and Ranj Andish, 2018).

Chow's test was used to estimate the choice of model estimation using the pooled least squares method or dummy variable least squares method. The assumptions of this test are as follows:

H_0 : The model is integrated least squares.

H_1 : The model is an imaginary least squares method.

Then, in order to select between the fixed effects model and the random effects model, the Hausmann test is used for estimation. The assumptions of the test are as follows:

H_0 : The random effects method is more efficient.

H_1 : Character fixed effects method.

that in both tests of the data at the confidence level of 99%, H_0 the assumption based on the pooled least squares method and the random effects method was rejected, and this means that in this model, the best test method is the fictitious least squares method with fixed effects, to put it simply. Combined data is against consolidated data.

The basis of the work in the hypothesis is based on the cumulative linear regression model. Cumulative regression means that research variables are calculated on average for the entire research period, and it is used to make a

general conclusion about rejecting or accepting the hypothesis. All regressions were performed using the mixed data method in E-views software. This model has been fitted in order to determine the effects of each of the independent variables (in the hypothesis of product profitability index, company size, financial advantage and asset return rate) on the dependent variable of operating profit at a significance level of 1%.

Table 4. The results of Limmer and Hausmann test for choosing the pooling or panel method

Model	H_o	The significance level	test result (operating profit dependent variable)
ndex			
CPI ₁	The model is based on the pooled least squares method and the random effects method is more efficient	0.0000	It is rejected and the panel method is chosen
CPI ₂	The model is based on the pooled least squares method and the random effects method is more efficient	0.0000	It is rejected and the panel method is chosen
CPI ₃	The model is based on the pooled least squares method and the random effects method is more efficient	0.0000	It is rejected and the panel method is chosen
CPI ₄	The model is based on the pooled least squares method and the random effects method is more efficient	0.0000	It is rejected and the panel method is chosen
CPI ₅	The model is based on the pooled least squares method and the random effects method is more efficient	0.0000	It is rejected and the panel method is chosen

Source: Research finding

As can be seen in the table, at the confidence level of 99%, the null hypothesis that all the fixed effects of the companies are equal has been confirmed, and this means that in this model, the data related to different companies was estimated by the panel method.

6.5 Testing the optimal regression model

In this research, after estimating the arrangement of the data in the model using the combined data method, in order to identify the best regression relationship between the research variables for all the different calculation functions of the product profitability index by removing and adding the research

Table 5. Estimation of Independent Variables Regression of Research in 4 Different Methods with Dependent Variable Operating Profit

Variable	p value (1)	p value (2)	p value (3)	p value (4)
CPI ₁	0.0000*	0.0000*	0.0000*	0.0000*
Financial Leverage		0.3039	0.0375	0.0221**
Firm size			0.0000*	0.0000*
Rate of return on assets				0.0000*
R-squared correlation	0.9427	0.9433	0.9632	0.9643
R-squared	0.9284	0.9290	0.9539	0.9552
Durbin-Watson Test	1.5873	1.6067	1.6406	1.7035
CPI ₂	0.0000*	0.0000*	0.0000*	0.0000*
Financial Leverage		0.2379	0.571	0.0262**
Firm size			0.0000*	0.0000*
Rate of return on assets				0.0000*
R-squared correlation	0.9376	0.9381	0.9610	0.9638
R-squared	0.922	0.9226	0.9511	0.9546
Durbin-Watson Test	1.5045	1.5242	1.5718	1.6929
CPI ₃	0.2025	0.0000*	0.0000*	0.0000*
Financial Leverage		0.2379	0.0381	0.0247**
Firm size			0.0000*	0.0000*
Rate of return on assets				0.0000*
R-squared correlation	0.9463	0.9381	0.9601	0.9642
R-squared	0.9326	0.9226	0.95	0.9551
Durbin-Watson Test	1.6335	1.5242	1.5467	1.6969
CPI ₄	0.0036	0.004	0.0000*	0.0000*
Financial Leverage		0.5289	0.0398	0.0016*
Firm size			0.0000*	0.0000*
Rate of return on assets				0.0000*
R-squared correlation	0.9466	0.947	0.96	0.9653
R-squared	0.933	0.9335	0.9499	0.9564
Durbin-Watson Test	1.639	1.6519	1.5354	1.6821
CPI ₅	0.0005	0.0007	0.0000*	0.0000*
Financial Leverage		0.9091	0.0008	0.0007*
Firm size			0.0000*	0.0000*
Rate of return on assets				0.0000*
R-squared correlation	0.9462	0.9372	0.9602	0.9639
R-squared	0.9325	0.9214	0.9502	0.9547
Durbin-Watson Test	1.6349	1.5073	1.5613	1.71

Source: Research finding

*Note: ***, **, * denote significance at 1%, 5%, and 10% level*

$$2) Y_1 = \alpha_0 + \beta_1 X_1 + \beta_2 X_2 + \epsilon$$

$$3) Y_1 = \alpha_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \epsilon$$

$$4) Y_1 = \alpha_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \epsilon$$

Regression variables include:

Y_i = Operating profit variable in the period from 2014 to 2018 for 286 sample companies

X_1 = The product profitability index variable is calculated for 5 different functions (CPI 1, CPI 2, CPI 3, CPI 4 and CPI 5) in the period from 2014 to 2018 for 286 sample companies.

X_2 = Financial leverage variable in the period from 2014 to 2018 for 286 sample companies

X_3 = Company size variable in the period from 2014 to 2018 for 286 sample companies

X_4 = Variable asset return rate in the period from 2014 to 2018 for 286 sample companies

As table (9) shows, the cumulative regression in the fourth method in all 5 different calculation functions of the product profitability index variable is significant at the 95% confidence level, and the coefficient of determination of the regressions also indicates that in the cumulative regression, 96% of the operating profit variable of the company's Profit is explained by independent variables.

Therefore, by examining the correlation relationships between the two main variables of the research, i.e. operating profit and product complexity index, it was fitted to examine profitability at the product level, and according to the output of the tests and the analysis of the results, the model presented in this research to evaluate the profitability index of the product according to The type of activity of the company and their manufactured products based on the very important principle of the model proposed by [Hartman et al. \(2017\)](#) which has paid much attention to the diversity and ubiquity of the products produced by the companies. The model according to relation 6 is suggested in the presented model to identify profitability at the product level. We consider the product profitability index as the average level of profitability of a manufactured product, whose weight is determined based on the importance of each product in the production portfolio of each company.

Therefore, according to the main purpose of the research, we show the product profitability index in the formula of CPI related to product p as follows:

$$CPI_p = \frac{1}{N_p} \sum_c M_{cp} S_{cp} Profi_c \tag{19}$$

In this case, $Profi_c$ the company's profitability factor is c. Also, if M_{cp} is equal to one, then company c producing product p has revealed a competitive advantage, and otherwise it will be equal to zero. S_{cp} is the production share of company c, which is expressed based on product p. N_p is also a moderating factor to ensure that product profitability indicators are the weighted average of profitability coefficients.

S_{cp} And N_p can also be calculated as follows:

$$N_p = \sum_c M_{cp} S_{cp} \qquad S_{cp} = X_{cp} / \sum_p x_{cp} \tag{20}$$

X_{cp} The total net profit of production of product p by company c

In fact, CPI is the weighted average value of the profitability coefficient of products that are competitive companies of the same product. The higher the CPI index of a product means that the companies producing that product have a larger PCI and vice versa, the lower the CPI index of the product, the less economic complexity the product has.

Therefore, with the presented model, according to the products produced by each company, based on the complexity of the product, by evaluating the profit, it helps the users of financial statements to judge the reliability of the current profit and to estimate the profitability of the produced product and the choice of the product type. Predict it for the future. Also, regarding the calculation and estimation of profitability of the companies and its comparison with both the industry and the groups of the types of products produced by the shareholders, regarding the announced performance report and the performance management method of that company, he measured and judged.

Therefore, according to the findings of the research, to investigate the relationship between economic complexity and the profitability of companies' products, an estimator will be introduced that determines the level of profitability that occurs due to the production of a specific product, and we call it the company's profitability index.

Therefore, according to the presented model, in order to evaluate the index that can determine the real profit of the companies based on the choice of the product type and its comprehensiveness compared to other producers, as well as the ability of the shareholders to predict and make decisions regarding the profitability of that product in choosing the type of activity for the company. Finally, after identifying the most profitable products and classifying the products based on product code and product complexity index, according to Fig. 11, the most profitable products in this research belong to companies with high complexity and technology and the lowest product profit in this research. It has been earned by companies with low complexity and high inclusiveness.

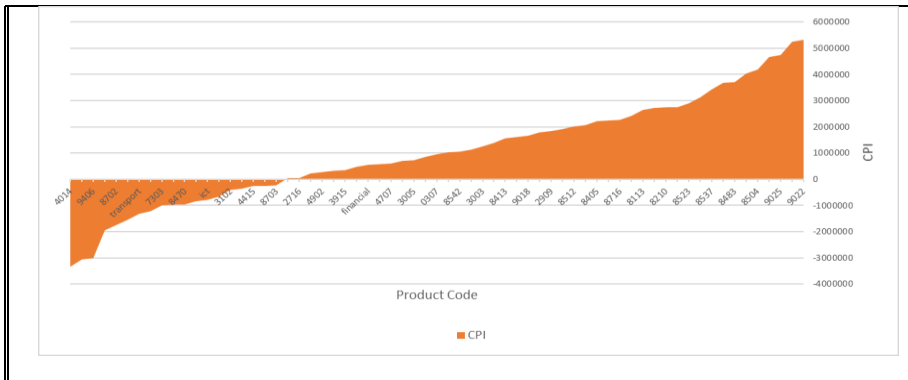


Fig. 10. The relationship between the product code and the CPI product profitability index (in the order of the product profit from the highest to the lowest from right to left)

Source: Research finding

Considering the correlation between the two variables of operating profit and the product complexity index, as well as the positive correlation between the two variables of the product profitability index and the product complexity index, as shown in Fig. 12, both the operating profit variables and the product profitability index are compared to the product code. Yes, the diagram shows that the products with high complexity have both the operating profit variable and the profitability index of their product, and vice versa, the point that is of interest in the diagram is that the line that displays the profitability index of the product. Because based on the product complexity approach, which considers the type of product, it has less volatility than the operating profit based on the company's financial information. This means that the product profitability index can be a suitable alternative to identify the products of companies.

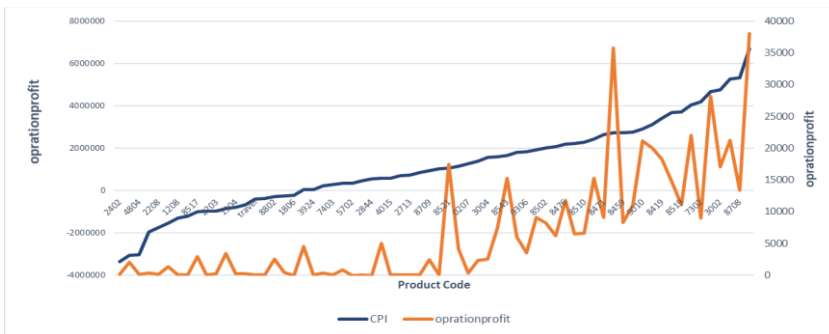


Fig. 11. Product code relationship with CPI product profitability index and operating profit

Source: Research finding

The results of calculating the correlation between the average of the product profitability index and the mean of product complexity index per the obtained function in the study time period indicate a positive relationship with a correlation coefficient above 0.5 at the 99% confidence level.

7. Conclusions and Suggestions

In this research, considering the defined objective, the key step is to understand the relationship between the two main variables of the study, namely operating profit and the product complexity index. The operating profit variable of the companies, extracted from the financial statements of sample firms for the period 2014-2018, was analyzed in relation to the product complexity index, which was obtained from the Atlas of Economic Complexity for each product code produced by the sample firms during the study period. Based on previous

studies such as [Kothari et al. \(2013\)](#), [Konchitchki & Patatoukas \(2014\)](#), and [Arabzadeh et al. \(2021\)](#), which indicate a relationship between accounting information and economics, the analysis revealed a positive correlation of above 0.6 at a 99% confidence level, confirming the direct relationship between the complexity of the products produced by companies and the profitability of those products. Therefore, it can be concluded that companies with high profitability produce products with relatively high complexity, and it is expected that companies focusing on the production of high-complexity products will continue to be profitable and experience growth in the future.

In the second step of this study, to calculate the product profitability index, the proposed model of [Hartmann et al. \(2017\)](#) was applied, taking into account previous studies and the effects of various relationships. A function for determining and calculating the profitability index of firms was introduced. The profitability index values for each product code (66 product codes, 286 companies) during the 2014-2018 period were calculated and measured according to the proposed relationship in the research. The results of the analysis, presented in Tables 2 to 6, indicated a direct and positive correlation between the calculated product profitability index and the product complexity index, with a correlation coefficient of above 0.6 at a 99% confidence level. Therefore, based on the results obtained, and considering the highest correlation coefficient, the research proposes that the highest product profitability index is associated with companies producing more complex products. This implies that higher product profitability indicates a larger product complexity index for the producers, and vice versa, lower product profitability corresponds to lower product complexity. Since producing complex products requires advanced technology and knowledge, it can be concluded that companies aiming for the highest profit and competitive advantage should focus on producing high-complexity products while utilizing the best technology. This approach will lead to greater profitability and enhanced profit potential in the future.

Based on the results obtained and the primary emphasis of advanced financial reporting on measuring profit as a performance indicator of a business unit's efficiency, selecting high-tech products and offering services with technological diversity significantly affects the current and future dividend trend. Therefore, all stakeholders, particularly common shareholders, are interested in optimal management efficiency in selecting the type of product. Since the company's net profit affects dividend distribution, shareholders often track the company's profit trends. Thus, product selection can significantly impact the profitability of various firms.

The findings of this study indicate that the profitability of products is directly related to their complexity. This suggests that shareholders, in making decisions regarding production or service provision, should focus on more complex products with low pervasiveness and high variety. In other words, the more

complex the product, the higher its profitability. The tables presented in the research support this claim.

By proposing the product profitability index, this study provides essential information for economic decision-makers regarding the performance and profitability capacity of business entities. Given the significant error in management's profit forecasts and earnings management in financial statements, this may lead to overvaluation of stock prices. As a result, stock prices may be overestimated, causing investors to incur losses when investing in such companies. Therefore, by obtaining and presenting the product profitability index, performance evaluation becomes feasible, and it helps assess profitability potential and predict future activities of the business. Additionally, managers, analysts, and investors will focus primarily on the reported profits of companies, as managers' rewards depend on the companies' profits.

Recommendations for Investors

- Based on our findings, we suggest that investors place greater emphasis on selecting high-complexity products. These products typically exhibit higher profitability potential, particularly in markets with broader reach.
- We also recommend that investors use the Product Complexity Index (PCI) as a supplementary tool to evaluate risk and return, enabling more informed investment decisions.

Recommendations for Corporate Managers

- Companies should steer their strategies toward developing high-complexity products. These products are not only more financially rewarding, but due to their innovation and differentiation, they provide a sustainable competitive advantage.
- Managers should pay close attention to entering new and diverse markets in order to capitalize on the profitability potential of complex products in different market environments.

Policy Recommendations for Government and Regulatory Bodies

- Policymakers can play a significant role in supporting firms that produce complex and innovative products. Creating favorable legal and financial environments to encourage research, development, and innovation can significantly contribute to economic growth.
- Additionally, supportive policies could be designed to help companies implement more complex and profitable production processes by leveraging new technologies.

Author Contributions

Conceptualization, all authors; methodology all authors; formal analysis, all authors; resources, all authors; writing—original draft preparation, all authors; writing—review and editing, all authors; supervision, Mohammadi, A. All authors have read and agreed to the published version of the manuscript.

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Conflicts of Interest

The authors declare no conflict of interest.

Data Availability Statement

The data used in the study were taken from [https:// Fortune.com](https://Fortune.com)

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Attached

Table 1. Estimation of Product Profitability Index in 2014

Table with 33 rows and 23 columns. Headers: Row, Product Code, PCI, CPI 1, CPI 2, CPI 3, CPI 4, CPI 5, Row, Product Code, PCI, CPI 1, CPI 2, CPI 3, CPI 4, CPI 5. Contains numerical data for 33 different product categories.

Source: Research finding

Table 2. Estimation of Product Profitability Index in 2015

Table with 33 rows and 23 columns. Headers: Row, Product Code, PCI, CPI 1, CPI 2, CPI 3, CPI 4, CPI 5, Row, Product Code, PCI, CPI 1, CPI 2, CPI 3, CPI 4, CPI 5. Contains numerical data for 33 different product categories in 2015.

Source: Research finding

Table 3. Estimation of Product Profitability Index in 2016

Row	Product Code	PCI	CPI 1	CPI 2	CPI 3	CPI 4	CPI 5	Row	Product Code	PCI	CPI 1	CPI 2	CPI 3	CPI 4	CPI 5
1	0207	0.182	8681.914	1818.005	708.555	3.000	374.237	34	8419	1.421	71708019.310	5257624.807	1086260.551	3705562.896	69583.309
2	0307	-1.738	32.350	12.738	6.823	0.002	0.049	35	8459	0.851	64946964.284	1769208.337	368499.544	1123492.799	29002.739
3	1208	-1.272	1.309	0.200	0.090	0.000	0.054	36	8470	0.217	4.480	0.382	0.082	0.013	0.052
4	1806	0.001	0.906	0.615	0.418	0.000	0.247	37	8471	1.105	79074710.741	1830587.119	345290.275	2048881.780	25126.086
5	1904	-0.337	5.505	0.355	0.117	0.005	0.031	38	8476	0.698	11764999.319	1072535.738	205865.599	899179.185	15717.441
6	2203	-0.515	6.601	0.288	0.122	0.001	0.040	39	8483	1.521	47929747.456	3884315.119	656470.004	3556065.675	3779.349
7	2208	-0.527	2.460	0.255	0.097	0.001	0.053	40	8502	0.686	9830952.058	472874.710	90738.890	327839.743	2689.113
8	2402	-0.712	1.211	0.145	0.058	0.000	0.005	41	8504	0.760	66599271.218	5655478.212	1074428.388	1223470.900	80517.233
9	2713	-0.612	35.820	4.028	1.282	0.015	0.819	42	8510	1.339	12475812.678	1213076.542	233293.279	5375420.165	2467.589
10	2716	-0.577	44.152	1.119	0.296	0.026	0.021	43	8512	1.644	37178463.397	758787.395	169043.969	114903.530	10221.878
11	2844	-0.659	3.134	1.664	1.777	0.000	0.973	44	8517	0.853	10.581	0.357	0.072	0.077	0.033
12	2909	0.753	2897920.074	338325.189	83864.533	12017.714	19242.565	45	8519	0.292	29812210.729	401508.841	921002.437	67327.564	36659.173
13	3002	1.288	136221603.315	6279724.785	1165135.687	2591917.913	46634.128	46	8521	0.575	229.415	17.076	2.984	14.226	2.020
14	3003	0.306	188102.690	2690.934	683.267	670.427	3.414	47	8523	1.053	373946809.281	2956835.112	523279.406	16120064.111	30590.097
15	3004	0.600	30521.403	6855.740	2193.346	27.892	198.356	48	8537	1.071	139891085.229	3870836.615	747175.523	7861215.940	5670.692
16	3005	0.589	15.026	3.347	1.498	0.001	1.149	49	8542	1.362	738.815	23.098	4.911	2.606	2.075
17	3102	-1.268	2.062	0.504	0.262	0.000	0.048	50	8543	1.575	1181947.617	65889.050	11685.671	36953.564	784.297
18	3915	-0.688	21.894	1.186	0.512	0.002	0.126	51	8702	0.398	3.574	0.376	0.094	0.014	0.070
19	3924	-0.783	1.727	0.746	0.345	0.001	0.032	52	8703	0.884	9.574	0.801	0.202	0.041	0.081
20	4014	0.002	3.050	0.154	0.037	0.011	0.028	53	8708	1.329	63202331.625	6228683.685	1278099.425	359493.117	5663.338
21	4015	-0.696	84.558	2.076	0.666	0.154	0.316	54	8709	0.353	95.201	5.149	1.175	0.123	0.679
22	4415	0.187	3.941	0.702	0.229	0.001	0.027	55	8716	0.501	25314952.211	1685057.652	32868.506	450212.811	24014.836
23	4707	-0.061	17.353	2.231	0.997	0.000	0.126	56	8802	0.957	16.563	0.590	0.126	0.135	0.077
24	4804	0.152	0.674	0.147	0.065	0.000	0.016	57	9010	2.430	26680577.478	2550261.515	488682.414	355404.744	26402.893
25	4902	0.781	12.213	1.426	0.389	0.008	0.331	58	9018	0.901	1843449.636	230532.807	57550.101	1465.870	15515.116
26	5702	-0.972	5.179	1.818	2.055	0.000	1.233	59	9022	1.613	139592394.882	12468705.635	2159188.763	6195522.060	112917.353
27	7302	0.374	7759037.544	4857479.882	116450.776	190373.348	81746.631	60	9025	0.914	638277.181	3.464	61616279.477	1309249.420	3861037.913
28	7303	-0.240	3.712	1.406	0.184	0.000	0.128	61	9306	-0.097	11898744.572	261744.100	63670.887	14359.023	12032.447
29	7403	-1.264	6.648	0.345	0.808	0.002	0.407	62	9406	0.163	5.967	0.178	0.052	0.004	0.031
30	8113	2.014	65300878.541	2523013.961	426351.386	14193023.676	122660.201	63	financial	0.358	41.793	2.125	0.447	0.315	0.258
31	8210	0.796	19795725.813	2384008.859	545197.143	439283.550	51248.302	64	ict	0.150	10.194	0.431	0.143	0.002	0.097
32	8405	0.619	12481666.473	1065913.068	207378.001	889339.175	19047.946	65	transport	-0.386	2.646	0.319	0.120	0.000	0.095
33	8413	1.572	600381.545	36063.929	6981.630	24117.891	3475.272	66	travel	-0.693	7.955	0.464	0.184	0.000	0.022

Source: Research finding

Table 4. Estimation of Product Profitability Index in 2017

Row	Product Code	PCI	CPI 1	CPI 2	CPI 3	CPI 4	CPI 5	Row	Product Code	PCI	CPI 1	CPI 2	CPI 3	CPI 4	CPI 5
1	0207	-0.049	12665.338	2699.785	766.506	34.161	433.760	34	8419	1.3899	7771771.364	5723598.363	1183814.714	3903214.110	75422.547
2	0307	-1.762	33.367	8.462	4.328	0.000	0.088	35	8459	0.6109	56270067.283	1837892.637	390837.450	667747.783	29786.863
3	1208	-1.473	1.846	0.301	0.129	0.000	0.050	36	8470	0.2957	4.882	0.450	0.095	0.015	0.064
4	1806	0.064	0.890	0.630	0.445	0.000	0.261	37	8471	0.9086	85163300.704	2004168.207	377085.624	2214748.146	27226.370
5	1904	-0.204	8.398	0.458	0.144	0.011	0.034	38	8476	0.9224	12790979.119	1131495.880	216636.814	927640.156	18526.350
6	2203	-0.306	9.703	0.686	0.265	0.003	0.046	39	8483	1.4783	64179696.762	3826593.877	644945.916	3317937.681	3888.540
7	2208	-0.565	3.763	0.322	0.118	0.001	0.070	40	8502	0.3714	1046338.085	508609.966	96810.858	298593.533	2746.683
8	2402	-0.845	1.146	0.234	0.097	0.000	0.007	41	8504	0.7730	59510450.427	4997518.057	951650.267	992640.237	48704.503
9	2713	-0.693	37.255	4.941	1.550	0.014	0.975	42	8510	0.9504	12365760.170	1266819.337	244696.933	5293949.857	2552.872
10	2716	-0.390	48.520	1.447	0.390	0.022	0.025	43	8512	1.3507	29143799.278	582776.626	130234.765	81630.175	8091.834
11	2844	-0.633	3.482	1.798	1.863	0.000	1.024	44	8517	0.7456	11.317	0.345	0.069	0.091	0.028
12	2909	0.865	2975681.125	352402.931	89106.959	7727.140	18296.683	45	8519	0.7984	35910223.731	4816192.135	1110291.000	72547.373	65404.284
13	3002	1.562	160248063.343	7388432.696	1368623.693	2941308.358	56008.071	46	8521	0.7824	277.535	17.641	3.080	18.415	1.953
14	3003	0.089	196572.837	2444.086	598.372	959.659	2.834	47	8523	1.3926	430059658.387	3133159.618	553419.571	17548025.741	33253.099
15	3004	0.779	35345.081	7817.048	2474.329	33.377	221.695	48	8537	0.7957	140331757.182	3787047.183	729845.147	6010859.097	54007.310
16	3005	0.826	17.778	3.907	1.732	0.002	1.384	49	8542	1.2042	775.056	25.775	5.460	2.697	2.502
17	3102	-1.295	2.235	0.553	0.293	0.000	0.046	50	8543	1.2942	1133380.151	60580.352	10718.661	34529.014	715.785
18	3915	-0.742	26.506	1.515	0.524	0.008	0.134	51	8702	0.4557	4.246	0.273	0.067	0.019	0.050
19	3924	-0.736	1.787	0.759	0.350	0.001	0.033	52	8703	0.9789	10.084	0.850	0.213	0.044	0.096
20	4014	-0.085	3.988	0.160	0.039	0.013	0.027	53	8708	1.2715	65411004.970	6637845.574	1387745.734	280761.485	5917.833
21	4015	-0.510	83.976	2.145	0.683	0.164	0.322	54	8709	0.6076	92.958	5.689	1.523	0.035	0.579
22	4415	0.282	4.895	0.476	0.151	0.001	0.045	55	8716	0.7645	27438078.656	1836111.393	357822.789	470653.118	27367.597
23	4707	-0.200	19.658	2.049	0.877	0.000	0.118	56	8802	0.3628	17.806	0.641	0.136	0.145	0.079
24	4804	0.024	0.748	0.161	0.071	0.000	0.018	57	9010	2.1217	33781762.597	3243308.885	617984.419	454682.789	35217.246
25	4902	0.722	12.975	1.448	0.388	0.009	0.325	58	9018	0.6913	2445579.862	303433.529	74343.509	2176.896	18705.616
26	5702	-0.885	6.375	2.132	2.145	0.000	1.162	59	9022	1.8113	141335115.916	13255891.720	2287896.075	6335787.745	140671.955
27	7302	0.469	79457182.155	5021772.102	1211261.067	181542.236	78347.706	60	9025	0.9713	721189092.679	7647894.295	1503911.553	4662162.737	99424.011
28	7303	0.081	3.788	0.409	0.195	0.000	0.124	61	9306	-0.0922	14358144.707	403739.809	90669.367	41861.456	11111.137
29	7403	-1.125	8.554	1.570	0.863	0.003	0.055	62	9406	0.1314	8.424	0.221	0.054	0.033	0.029
30	8113	2.076	64182856.490	2536874.098	429018.627	13977157.996	160182.134	63	financial	0.1707	42.579	2.139	0.444	0.350	0.244
31	8210	0.613	21063039.110	2478444.608	566591.975	452768.850	58923.963	64	ict	0.0806	11.548	0.475	0.156	0.002	0.109
32	8405	0.131	23386773.565	1351366.247	264554.024	1224046.840									

Row	Product Code	PCI	CPI 1	CPI 2	CPI 3	CPI 4	CPI 5	Row	Product Code	PCI	CPI 1	CPI 2	CPI 3	CPI 4	CPI 5
1	0207	0.042	14082.938	2229.778	629.946	4.030	382.519	34	8419	1.547	89564130.591	6644404.885	1149831.900	3952739.416	69456.443
2	0307	-1.760	35.651	9.177	4.765	0.000	0.106	35	8459	1.394	70366829.046	2142109.814	365893.189	1010406.850	24369.401
3	1208	-1.244	2.505	0.418	0.179	0.000	0.057	36	8470	0.373	6.272	0.476	0.083	0.019	0.058
4	1806	-0.098	0.887	0.627	0.444	0.000	0.262	37	8471	0.969	109524072.578	3442559.646	559610.606	2078015.414	38785.750
5	1904	-0.531	8.944	0.488	0.153	0.001	0.034	38	8476	0.884	17672222.543	1377936.471	221144.001	1271322.644	16554.814
6	2203	-0.400	16.537	0.828	0.226	0.006	0.051	39	8483	1.591	50275862.897	3445642.465	503420.733	2863794.172	2822.935
7	2208	-0.615	4.836	0.322	0.091	0.001	0.068	40	8502	0.674	13192892.241	540673.750	86347.655	323097.717	2349.196
8	2402	-0.741	2.028	0.282	0.083	0.000	0.006	41	8504	0.581	71324801.008	4877787.634	776614.984	1198166.259	42336.192
9	2713	-0.768	38.801	4.880	1.469	0.002	0.857	42	8510	1.070	12005008.716	1215731.378	234487.076	506475.257	2439.799
10	2716	-0.520	62.226	1.495	0.316	0.027	0.019	43	8512	0.902	32262456.291	620100.565	113667.293	81754.377	7058.182
11	2844	-0.630	3.619	1.815	1.839	0.000	1.004	44	8517	0.832	10.682	0.442	0.085	0.014	0.040
12	2909	0.498	3801985.246	352621.705	69843.760	9662.445	13662.704	45	8519	0.771	26364235.166	2645487.254	499010.702	46405.842	40577.445
13	3002	1.192	164619969.914	6402370.757	997624.110	2983702.829	39245.913	46	8521	1.099	347.505	21.787	3.772	2.450	2.634
14	3003	0.511	222484.198	2375.696	509.513	339.236	2.538	47	8523	1.332	56908480.889	3462785.865	519001.501	21324428.215	32775.695
15	3004	0.738	50941.941	10754.036	3371.644	4.864	292.747	48	8537	0.714	178548865.106	3891758.750	628417.794	6130138.059	48542.457
16	3005	0.763	25.217	3.833	1.170	0.002	0.944	49	8542	0.948	1048.185	27.316	4.699	4.396	1.962
17	3102	-1.361	2.732	0.425	0.148	0.000	0.027	50	8543	1.376	1025712.575	53117.264	9370.928	3001.172	706.369
18	3915	-0.670	42.660	3.117	0.894	0.006	0.109	51	8702	0.329	4.645	0.245	0.056	0.003	0.032
19	3924	-0.406	2.724	0.781	0.245	0.001	0.023	52	8703	1.050	13.156	0.875	0.175	0.053	0.083
20	4014	0.411	4.120	0.153	0.037	0.001	0.026	53	8708	1.195	87313084.247	7445209.861	1277205.925	395533.304	5176.267
21	4015	-0.384	99.359	2.179	0.620	0.038	0.271	54	8709	0.903	121.362	5.809	1.218	0.046	0.454
22	4415	0.161	4.886	0.458	0.144	0.000	0.048	55	8716	0.686	32479733.467	1841805.513	300110.508	526988.515	22478.397
23	4707	-0.276	20.100	2.091	0.887	0.000	0.114	56	8802	0.216	23.725	0.712	0.123	0.214	0.074
24	4804	0.311	1.105	0.162	0.049	0.000	0.015	57	9010	1.247	42727183.705	3359979.842	533024.600	623424.198	28970.482
25	4902	0.763	16.480	2.127	0.516	0.003	0.447	58	9018	0.781	4126995.815	403757.080	79373.849	3499.771	18486.133
26	5702	-1.020	5.297	1.707	1.612	0.000	0.960	59	9022	1.255	159852384.630	12875214.472	1887999.646	7110249.572	117860.132
27	7302	0.554	99550346.638	5058247.172	978271.526	230370.158	68213.911	60	9025	0.987	82684382.886	8453894.212	1423460.177	3799066.637	83642.695
28	7303	-0.206	3.919	0.373	0.174	0.000	0.109	61	9306	0.644	17755668.720	270322.558	53585.880	11804.755	17332.125
29	7403	-1.424	8.961	1.627	0.887	0.000	0.057	62	9406	0.150	8.958	0.246	0.060	0.004	0.030
30	8113	2.161	84878414.087	2832807.011	409032.185	17188701.996	162282.044	63	financial	-0.013	48.030	1.853	0.321	0.313	0.156
31	8210	0.798	30504635.146	2852500.675	532697.140	576828.037	57966.579	64	ict	0.040	13.256	0.441	0.135	0.000	0.073
32	8405	0.634	23934094.432	1165165.897	220013.845	168479.793	14445.816	65	transport	-0.494	4.422	0.359	0.096	0.000	0.071
33	8413	1.307	1004474.588	76298.940	13258.022	11081.332	6805.028	66	travel	-0.694	6.961	0.585	0.181	0.000	0.036

Source: Research finding

List of companies

ROW	Company	Industry	HS	ROW	Company	Industry	HS
1	Walmart	General Merchandise	8419	73	Deere	Construction and Farm Machinery	8709
2	Exxon Mobil	Petroleum Refining	8413	74	Hewlett Packard Enterprise	Computers, Office Equipment	8512
3	Apple	Computers, Office Equipment	8512	75	Philip Morris International	Tobacco	2402
4	UnitedHealth Group	Health Care: Insurance and Managed Care	3003	76	Twenty-First Century Fox	Entertainment	8523
5	McKesson	Wholesalers: Health Care	9025	77	AbbVie	Pharmaceuticals	3002
6	CVS Health	Health Care: Pharmacy and Other Services	3003	78	Abbott Laboratories	Medical Products and Equipment	3002
7	Amazon	Internet and Direct Marketing Retail	8523	79	Arrow Electronics	Wholesalers: Electronics and Office Equipment	8504
8	General Motors	Industrial Machinery	8716	80	Kraft Heinz	Food Consumer Products	1208
9	Ford Motor	Motor Vehicles & Parts	4014	81	Gilead Sciences	Pharmaceuticals	3002
10	Amerisource Bergen	Wholesalers: Health Care	3004	82	Mondelez International	Food Consumer Products	1806
11	Chevron	Petroleum Refining	2909	83	Northrop Grumman	Aerospace & Defense	9306
12	Cardinal Health	Wholesalers: Health Care	3005	84	Raytheon	Aerospace & Defense	9306
13	Costco	General Merchandisers	2208	85	Macy's	General Merchandisers	4015
14	Verizon	Banks: Commercial and Savings	8471	86	US Foods Holding	Wholesalers: Food and Grocery	1904
15	Kroger	Specialty Retailers	8523	87	Dollar General	Specialty Retailers	4015
16	General Electric	Industrial Machinery	9306	88	International Paper	Packaging, Containers	4415
17	Walgreens Boots Alliance	Food & Drug Stores	3003	89	Duke Energy	Utilities: Gas and Electric	8537
18	Alphabet	Internet Services and Retailing	8523	90	Marriott International	Hotels, Casinos, Resorts	travel
19	Home Depot	Specialty Retailers	8523	91	Avnet	Wholesalers: Electronics and Office Equipment	8504
20	Express Scripts Holding	Health Care: Pharmacy and Other Services	3003	92	Eli Lilly	Pharmaceuticals	3004
21	Boeing	Aerospace & Defense	9306	93	Amgen	Pharmaceuticals	3002
22	Phillips 66	Petroleum Refining	8413	94	McDonald's	Food Services	8210
23	Microsoft	Computer Software	8542	95	Starbucks	Food Services	8210
24	Valero Energy	Petroleum Refining	2909	96	Qualcomm	Semiconductors and Other Electronics	8519
25	Comcast	Telecommunications	8521	97	PBF Energy	Petroleum Refining	2713
26	IBM	Information Technology Services	8543	98	AutoNation	Automotive Retailing, Services	8702
27	Dell Technologies	Computers, Office Equipment	8512	99	Penske Automotive Group	Automotive Retailing, Services	8702
28	Johnson & Johnson	Pharmaceuticals	9022	100	Union Pacific	Railroads	7302
29	Target	General Merchandisers	2208	101	Southwest Airlines	Airlines	8802
30	Lowe's	Specialty Retailers	8523	102	ManpowerGroup	Temporary Help	ict
31	Marathon Petroleum	Petroleum Refining	8413	103	Thermo Fisher Scientific	Scientific, Photographic, and Control Equipment	9010
32	Procter & Gamble	Household and Personal Products	8510	104	Bristol-Myers Squibb	Pharmaceuticals	3003
33	UPS	Mail, Package, and Freight Delivery	transport	105	Halliburton	Oil and Gas Equipment, Services	2713
34	PepsiCo	Food Consumer Products	8419	106	Tenet Healthcare	Health Care: Medical Facilities	3003
35	Intel	Semiconductors and Other Electronic Components	8523	107	Lear	Motor Vehicles & Parts	4014
36	DowDuPont	Chemicals	8405	108	Cummins	Industrial Machinery	4804
37	Archer Daniels Midland	Food Production	1904	109	Micron Technology	Semiconductors and Other Electronic Components	2716
38	FedEx	Mail, Package, and Freight Delivery	transport	110	Nucor	Metals	3915
39	United Technologies	Aerospace & Defense	9306	111	Fluor	Engineering, Construction	9406
40	Albertsons Cos.	Food & Drug Stores	3003	112	Altria Group	Tobacco	2402
41	Sysco	Wholesalers: Food and Grocery	8419	113	Paccar	Construction and Farm Machinery	8709
42	Disney	Entertainment	8523	114	Kohl's	General Merchandisers	4015
43	Pfizer	Pharmaceuticals	3003	115	Western Digital	Computers, Office Equipment	8512
44	HP	Computers, Office Equipment	8512	116	Jabil	Semiconductors and Other Electronic Components	8523
45	Lockheed Martin	Aerospace & Defense	9306	117	Community Health Systems	Health Care: Medical Facilities	3003
46	Cisco Systems	Network and Other Communications Equipment	8517	118	Visa	Financial Data Services	8471
47	HCA Healthcare	Health Care: Medical Facilities	3003	119	Danaher	Medical Products and Equipment	8502
48	Energy Transfer Equity	Pipelines	7303	120	Kimberly-Clark	Household and Personal Products	4804
49	Caterpillar	Construction and Farm Machinery	8708	121	AECOM	Engineering, Construction	9406
50	American Airlines Group	Airlines	8113	122	CenturyLink	Telecommunications	8521
51	Best Buy	Specialty Retailers	8523	123	PG&E Corp.	Utilities: Gas and Electric	8537
52	Charter Communications	Telecommunications	8521	124	Synnex	Wholesalers: Electronics and Office Equipment	9010
53	Delta Air Lines	Airlines	8802	125	WellCare Health Plans	Health Care: Insurance and Managed Care	3003
54	Facebook	Interactive Media and Services	ict	126	Performance Food Group	Wholesalers: Food and Grocery	1904
55	Honeywell International	Electronics, Electrical Equip.	8502	127	Sears Holdings	General Merchandisers	3924
56	Merck	Pharmaceuticals	9022	128	CarMax	Automotive Retailing, Services	8702
57	Tyson Foods	Food Production	0207	129	CarMax	Automotive Retailing, Services	8702
58	United Continental Holdings	Airlines	8802	130	Freeport-McMoRan	Mining	7403
59	Oracle	Computer Software	8542	131	DaVita	Health Care: Medical Facilities	3003
60	Tech Data	Wholesalers: Electronics and Office Equipment	ict	132	Supervalu	Food and Drug Stores	3003
61	TJX	Specialty Retailers	8476	133	Gap	Specialty Retailers: Apparel	4015
62	American Express	Diversified Financials	8523	134	General Mills	Food Consumer Products	1208
63	Coca-Cola	Beverages	2203	135	Nordstrom	General Merchandisers	3924
64	Nike	Apparel	4015	136	Colgate-Palmolive	Household and Personal Products	8510
65	World Fuel Services	Energy	9306	137	American Electric Power	Utilities: Gas and Electric	8537
66	Exelon	Utilities	8537	138	XPO Logistics	Transportation and Logistics	transport
67	Rite Aid	Food & Drug Stores	3003	139	Goodyear Tire & Rubber	Motor Vehicles & Parts	4014
68	ConocoPhillips	Mining, Crude-Oil Production	8459	140	Omnicom Group	Advertising, marketing	4902
69	CHS	Food Production	0207	141	CDW	Information Technology Services	8470
70	3M	Chemicals	3005	142	Sherwin-Williams	Chemicals	8405
71	Time Warner	Entertainment	8523	143	PPG Industries	Chemicals	8405
72	General Dynamics	Aerospace & Defense	9306	144	Texas Instruments	Semiconductors and Other Electronic Components	8519

ROW	Company	Industry	HS	ROW	Company	Industry	HS
145	C.H. Robinson Worldwide	Transportation and Logistics	transport	217	Live Nation Entertainment	Entertainment	8523
146	WestRock	Packaging, Containers	4415	218	Xerox	Computers, Office Equipment	8512
147	Cognizant Technology Solutions	Information Technology Services	ict	219	Corning	Electronics, Electrical Equip.	8113
148	Newell Brands	Home Equipment, Furnishings	5702	220	Expedia Group	Internet Services and Retailing	8523
149	CBS	Entertainment	8523	221	Republic Services	[hotlink Waste Management hotlink]	4707
150	Aramark	Diversified Outsourcing Services	8476	222	Jacobs Engineering Group	Engineering, Construction	8113
151	Applied Materials	Semiconductors and Other Electronic Components	2716	223	Ally Financial	Diversified Financials	8471
152	Waste Management	[hotlink Waste Management hotlink]	4707	224	BorgWarner	Motor Vehicles & Parts	4014
153	DISH Network	Telecommunications	8802	225	Fidelity National Financial	Insurance: Property and Casualty (Stock)	8523
154	Illinois Tool Works	Industrial Machinery	8716	226	Sun Life Financial	Commercial Banks	8517
155	HollyFrontier	Petroleum Refining	2713	227	IQVIA Holdings	Health Care: Pharmacy and Other Services	3003
156	CBRE Group	Real estate	9406	228	Reliance Steel & Aluminum	Metals	3915
157	Textron	Aerospace & Defense	9306	229	Nvidia	Semiconductors and Other Electronic Components	2716
158	Ross Stores	Specialty Retailers: Apparel	4015	230	Voya Financial	financial	8523
159	D.R. Horton	Homebuilders	9406	231	eBay	Internet Services and Retailing	8523
160	Devon Energy	Mining, Crude-Oil Production	8459	232	Eastman Chemical	Chemicals	3102
161	AES	Utilities: Gas and Electric	8537	233	American Express	Diversified Financials	8523
162	Ecolab	Chemicals	8405	234	Steel Dynamics	Metals	3915
163	Becton Dickinson	Medical Products and Equipment	9018	235	Union Pacific	Railroads	7302
164	Loews	Insurance: Property and Casualty (Stock)	4415	236	Chesapeake Energy	Mining, Crude-Oil Production	8459
165	Kinder Morgan	Pipelines	7303	237	Mohawk Industries	Home Equipment, Furnishings	5702
166	Occidental Petroleum	Mining, Crude-Oil Production	8459	238	Quanta Services	Engineering, Construction	9406
167	Wacom	Entertainment	8523	239	Advance Auto Parts	Specialty Retailers: Other	8703
168	PayPal Holdings	IT Services	8470	240	Owens & Minor	Wholesalers: Health Care	1904
169	NGL Energy Partners	Pipelines	7303	241	United Natural Foods	Wholesalers: Food and Grocery	1904
170	Arcenic	Aerospace & Defense	9306	242	Tenneco	Motor Vehicles & Parts	4014
171	Kellogg	Food Consumer Products	1208	243	Conagra Brands	Food Consumer Products	0307
172	Las Vegas Sands	Hotels, Casinos, Resorts	travel	244	GameStop	Specialty Retailers: Other	8523
173	Stanley Black & Decker	Home Equipment, Furnishings	5702	245	Hormel Foods	Food Consumer Products	0307
174	Booking Holdings	Internet Services and Retailing	8523	246	Hilton Worldwide Holdings	Hotels, Casinos, Resorts	travel
175	Lennar	Homebuilders	9406	247	Fidelity National Information Service	Financial Data Services	financial
176	L Brands	Specialty Retailers: Apparel	4015	248	Boston Scientific	Medical Products and Equipment	2844
177	DTE Energy	Utilities: Gas and Electric	8537	249	O'Reilly Automotive	Specialty Retailers: Other	8703
178	Mastercard	Financial Data Services	8471	250	Charles Schwab	Securities and Asset Management	8471
179	Henry Schein	Wholesalers: Health Care	9025	251	Global Partners	Wholesalers: Diversified	8113
180	Stryker	Medical Products and Equipment	9018	252	PVH	Apparel	4015
181	ADP	Diversified Outsourcing Services	ict	253	Avis Budget Group	Automotive Retailing, Services	8702
182	Biogen	Pharmaceuticals	3003	254	Targa Resources	Pipelines	7303
183	United States Steel	Metals	3915	255	Navistar International	Construction and Farm Machinery	8708
184	Core-Mark Holding	Wholesalers: Food and Grocery	1904	256	AGCO	Construction and Farm Machinery	8709
185	Oneok	Pipelines	7303	257	Alaska Air Group	Airlines	8802
186	Leidos Holdings	Information Technology Services	ict	258	Interpublic Group	Advertising, marketing	4902
187	Ameriprise Financial	Diversified Financials	financial	259	Foot Locker	Apparel	4015
188	First Republic Bank	Financial Data Services	financial	260	Huntington Ingalls Industries	Aerospace & Defense	9306
189	Parker-Hannifin	Industrial Machinery	8716	261	Constellation Brands	Beverages	2203
190	Estee Lauder	Soaps and Cosmetics	4014	262	Adobe Systems	Computer Software	8542
191	State Street Corp.	Superregional Banks	financial	263	JetBlue Airways	Airlines	8802
192	Tesla	Motor Vehicles & Parts	4014	264	Oshkosh	Construction and Farm Machinery	8709
193	Netflix	Entertainment	8523	265	Dr Pepper Snapple Group	Beverages	2203
194	Alcoa	Metals	3915	266	Ralph Lauren	Apparel	4015
195	Discover Financial Services	Commercial Banks	8471	267	Rockwell Automation	Electronics, Electrical Equip.	2716
196	CSX	Railroads	7302	268	Intuit	Computer Software	8542
197	Xcel Energy	Electric and Gas Utilities	8502	269	Terex	Construction and Farm Machinery	8709
198	Unum Group	Insurance: Life, Health (stock)	7302	270	Coca-Cola Bottling	Beverages	2208
199	Universal Health Services	Health Care: Medical Facilities	3003	271	General Cable	Electronics, Electrical Equip.	8483
200	NRG Energy	Energy	2716	272	Zebra Technologies	Electronics, Electrical Equip.	8483
201	EOG Resources	Mining, Crude-Oil Production	8459	273	Storcycle	[hotlink Waste Management hotlink]	4707
202	Sempra Energy	Electric and Gas Utilities	8502	274	Monster Beverage	Beverages	2203
203	Group 1 Automotive	Automotive Retailing, Services	8702	275	SkyWest	Airlines	8802
204	Entergy	Utilities: Gas and Electric	8537	276	Brown-Forman	Beverages	2203
205	Molson Coors Brewing	Beverages	2208	277	Clean Harbors	[hotlink Waste Management hotlink]	4707
206	Ball	Packaging, Containers	4445	278	Citrix Systems	Computer Software	8542
207	AutoZone	Specialty Retailers: Other	8703	279	Kraft Heinz	Food Consumer Products	1806
208	MGM Resorts International	Hotels, Casinos, Resorts	travel	280	Sysco	Wholesalers: Food and Grocery	8419
209	Office Depot	Specialty Retailers: Other	8523	281	General Mills	Food Consumer Products	1208
210	Huntsman	Chemicals	3102	282	Southern Copper	Mining	7403
211	Baxter International	Medical Products and Equipment	2844	283	Coeur Mining	Mining	7403
212	Norfolk Southern	Railroads	7302	284	Hewlett Packard Enterprise	Computers, Office Equipment	8512
213	salesforce.com	Computer Software	8542	285	NCR	Computer Software	8543
214	Laboratory Corp. of America	Health Care: Pharmacy and Other Services	3003	286	PAR Technology	Computer Software	8543
215	W.W. Grainger	Wholesalers: Diversified	8517				
216	Qurate Retail	Internet Services and Retailing	8517				