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Empirical evidence of the Eco-efficiency Theory on the water consumption of companies that in April 2021 were part of the S&P/BMV IPC Index

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***Abstract*—The doctoral thesis called "empirical evidence of the Eco-efficiency Theory about water consumption in Mexican companies" confirms that companies that improve their environmental performance improve their economic performance, by collecting, analyzing and interpreting information from 2018 to 2022 from the 35 stock companies that in April 2022 were part of the S&P/BMV IPC Index of the Mexican Stock Exchange, by calculating the "eco-efficiency formula" and obtaining eco-efficiency index of water consumption.**

Keywords: eco-efficiency theory, eco-efficiency index, water consumption.

I. INTRODUCTION

The article entitled "empirical evidence of the Eco-efficiency Theory on the water consumption of companies that in April 2021 were part of the S&P/BMV IPC Index", studies the phenomenon of eco-efficiency in the stock market issuers that make up the main index of the Mexican Stock Exchange, with the purpose of determining the impact of the improvement of environmental performance on economic performance.

The problem statement assumes the absence of empirical evidence of the postulate of the Eco-efficiency Theory, so documentary research is carried out to obtain the data of the variables related to economic and environmental performance, presented by the companies themselves according to the standards of the Global Reporting Initiative (GRI, n.d.) in the years 2018. 2019, 2020, 2021 and 2022.

The quantitative methodology applied in the study allows standardizing the data obtained through the generation of Index Numbers, to which the "eco-efficiency formula" was applied, with the year 2018 as the base year, to obtain the eco-efficiency index of water consumption for the years 2019, 2020, 2021 and 2022.

The analysis and interpretation of the eco-efficiency index of water consumption confirms the hypothesis of the research in a differentiated way for each of the companies studied. It also identifies the lack of sufficient information for a significant proportion of companies included in the sample.

The concept of eco-efficiency was introduced by Stephan Schmidheiny in his book Changing Course (Schmidheiny, 1992), which aimed to change the idea of industry from being part of the problem of environmental degradation to the reality of being an important part of the solution for global sustainability and development.

Schmidheiny (1992) reports that the goal was to develop a concept that would combine environmental and economic improvements with the purpose of making organizations aware of the conceptual challenge of sustainability. That concept is eco-efficiency.

The WBCSD argues that eco-efficiency is achieved through the provision of competitively priced goods and services that meet human needs and provide quality of life, while progressively reducing ecological impacts and resource intensity over their life cycle, to a level at least similar to the estimated carrying capacity of the Earth.

The Organization for Economic Co-operation and Development (OECD) (2008) argues that eco-efficiency is the efficiency with which ecological resources are harnessed to meet human needs.

On the other hand, the European Environment Agency (EEA) defines eco-efficiency as a strategy that promotes the decoupling of the use of nature to meet human needs (well-being) within carrying capacities, allowing equitable access to and use of the environment for current and future generations, giving more well-being with fewer natural resources.

According to Pache (2017), the idea of eco-efficiency was presented in 1990 in academic literature by Schaltegger and Sturm (1990), as a business link to sustainable development. It is worth mentioning that Pache (2017) is the author of the doctoral thesis entitled "The theory of eco-efficiency: effect on business performance", a degree granted by the University of Extremadura in 2017.

Then, in 1992, the concept was developed by the World Business Council for Sustainable Development (WBCSD), as a contribution to the World Summit on Sustainable Development in Rio de Janeiro, organized

by the United Nations (UN) in the same year. The WBCSD is made up of 200 international companies united by the common vision that "sustainable development must be achieved through economic growth, environmental balance and social progress" (WBCSD, 1997).

Pache (2017) refers to the lack of success of the Rio Summit, cited above, which resulted in an ineffective Kyoto Protocol, which, added to the negative attitude of the participating political leaders, caused frustration in business leaders, due to the absence of effective actions. It seems that the entrepreneurs themselves, through the WBCSD, decided to increase their particular actions to combat environmental degradation, giving place to the application of the Eco-efficiency Theory.

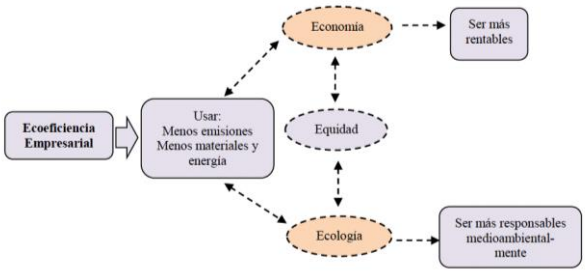
Pache (2017) states that "eco-efficiency is primarily based on creating more goods and services using fewer resources and generating less pollution, or in other words, creating more value with less impact or doing more with less". Therefore, eco-efficiency allows companies to reduce costs and create value, having minimized the impact on the environment.

Therefore, according to Pache (2017), the Eco-efficiency Theory can be framed within the Instrumental Theories, as it highlights the objective of maximizing the value of the company. It can also be framed in Ethical Theories, due to the focus on Sustainable Development.

Also, Eco-efficiency Theory is classified as an emerging socio-economic theory that investigates the possible relationships between Cleaner Production and the Economic and Financial Performance of enterprises, stating that it is possible to increase productivity and reduce costs while improving environmental performance. It is also considered a management philosophy or an administrative control process, combining environmental excellence and entrepreneurial business.

Bleischwitz (2003) mentions that despite the fact that the adoption of eco-efficiency is still very precarious, in the search to find an adequate definition, which includes the extent of ecology linked to the environment and the economy at the business level. For his part, Pache (2017) defines Business Eco-efficiency as a strategy that maximizes the value of the company while minimizing the consumption of materials and energy and reducing its emissions. Its main objective is to reduce the negative environmental impact by increasing the efficiency of the resources used and creating more value. This is how the so-called "3E" (Economy, Equity and Ecology) is fulfilled with a double objective: to be more economically and financially profitable and more environmentally responsible.

Pache (2017) developed a graphic that illustrates the objectives of Business Eco-efficiency and the concepts of "3E".



Source: Pache (2017).

Regarding the objectives and levels of eco-efficiency, Pache (2017) reports that, according to the WBCSD, eco-efficiency has three general objectives:

1. Decreasing the consumption of resources, reducing the consumption of energy, materials, water, and land, increasing recycling and product durability, as well as closing the cycle of materials.

2. Reduce the impact on nature by reducing emissions, dumping, waste disposal and the dispersion of toxic substances, including the sustainable use of natural resources.

3. Obtain more value with the product or service, giving more benefits to users through the functionality, flexibility, and modularity of the product, delivering additional services and focusing on selling solutions to customers' needs. Hence, the user satisfies their needs with a lower consumption of materials and resources.

Some organizations mention a fourth objective, referring to the implementation of environmental or sustainability management systems (Boada-Ortiz, Rocchi, & Kuhndt, 2012; WBCSD, 2000), integrated into its administrative management systems, with the aim of promoting eco-efficiency. An environmental management system is a means of ensuring that all sustainability-related risks and opportunities are identified and efficiently managed.

Some organizations mention a fourth objective, referring to the implementation of environmental or sustainability management systems (Boada-Ortiz, Rocchi, & Kuhndt, 2012; WBCSD, 2000), integrated into its administrative management systems, with the aim of promoting eco-efficiency. An environmental management system is a means of ensuring that all sustainability-related risks and opportunities are identified and efficiently managed.

Along with the three objectives, the WBCSD (2000) proposes seven critical aspects when applying the concept of eco-efficiency:

- Decreased demand of materials for products and services;
- Reduction of the energy intensity of products and services;
- Reduction of toxic substances;
- Enhanced recycling of materials;

- Optimization of the sustainability of renewable resources;
- Increasing the durability of the products and;
- Enhanced in the service intensity of products and services.

WBCSD (2000) argues that every company should be efficient. The added value would be even more significant if when creating economic value reduces environmental impact and resource use. From a business point of view, eco-efficiency is the most convenient way for countries to move towards sustainability.

Regarding the indicators of Eco-efficiency, Pache (2017) reports that, with the appearance of the Eco-Efficiency Theory, there is a need to measure and evaluate it, to have a quantitative view of its positive or negative effects (Leal, 2005).

In addition, the evaluation of eco-efficiency in its different perspectives can be carried out with the use of indicators, the basis of which was developed mainly by Verfaillie and Bidwell (2000), Müllller and Sturm (2001) and Sturm et al. (2002). These indicators would reveal the level of eco-efficiency and would be the parameters of eco-efficiency improvement strategies, checking progress as business activities are carried out.

Continuing with eco-efficiency indicators, WBCSD (2000) identifies two types of indicators. In one group there are indicators of general application, which are valid for all companies, considering the most common measurement initiatives of companies. However, there is a need for a second set of indicators that can be used by individual companies and that fit their context, called company-specific indicators.

According to Pache (2017), each company should self-evaluate to determine which specific indicators should be applied to maximize their usefulness in decision-making and communication mechanisms with their stakeholders, in addition to the indicators of general application.

The main indicators that appear in the studied literature relate environmental impacts to economic results and are obtained through the environmental performance and economic performance (Müller and Sturm, 2001).

Verfaillie and Bidwell, (2000), Müller and Sturm, (2001), Sturm et al., (2002), review that environmental impacts are represented by the consumption of water, energy resources and raw materials, as well as greenhouse gas (GHG) emissions, ozone-depleting substances, acidifying gaseous emissions and generation of liquid and solid waste.

The authors themselves state that, in their analysis, the economic performance generated is represented by the amount of goods produced or services offered to customers or the liquid sales of the company or by its production costs.

Maxime et al. (2006) recommend five steps for the development of eco-efficiency indicators: (1) identify the objective of the indicator; (2) select the inputs and outputs of the system to be analyzed; (3) choose the period of analysis; (4) identify and quantify relevant inputs and outputs and (5) Calculate the indicator.

Pache (2017) mentions that throughout the literature there are numerous works that establish the relationship between economic performance and environmental action, that is, between environmental performance and economic financial performance (Jaggi y Freedman, 1992; Walley y Whitehead, 1994; Shrivastava, 1995; Hamilton, 1995, Cohen, Fenn y Naimon, 1995; Feldman, Soyka y Ameer, 1997; Klassen y McLaughlin, 1996); que se reafirma por muchos investigadores en el siglo XXI (Wagner y Wehrmeyer, 2001; Murty y Kumar, 2003; Al-Tuwaijri et al., 2004; Elsayed y Paton, 2005; Aragón-Correa, Hurtado-Torres, Sharma y García-Morales, 2008; Molina-Azorín, Claver-Cortés, López-Gamero y Tarí, 2009; Menguc, Auh y Ozanne, 2010).

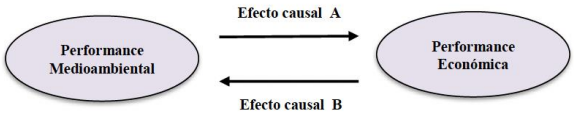
In the study of the relationship between environmental performance and economic financial performance, in the theory postulated by Porter and Van der Linde (1995), is stated that the pollution generated by companies is usually associated with the inadequate use of productive resources, poor efficiency in the factors of production or with energy losses. The authors mention that companies must decrease environmental impact and gain competitive advantages by reducing pollution.

In this theory, known by many authors as the win-win or win-win-win strategy, due to everyone wins: the company, the environment and even competitors, good management of productive resources generates economic and environmental benefits, reducing long-term environmental and production costs, which would lead to greater competitiveness and attracting new customers who are aware of environmental responsibility (Elkington, 1994; Walley and Whitehead, 1994; Florida, 1996; Sharma and Vredenburg, 1998; Majumdar and Marcus, 2001).

Schaltegger & Synnestvedt, 2002), develop two hypotheses related to the influence of environmental issues on a company's costs and revenues, firstly pointing out that there is a direct influence on economic success and, as a second hypothesis, the authors maintain that good economic performance drives environmental performance, based on the belief that good environmental performance and the quality of a company's product or service is obtained when a high level of economic success has been achieved.

Figure 2.

Causal Effects of Environmental Performance and Economic Financial Performance.



Source: Pache (2017) based on Schaltegger and Synnstvedt (2002).

The search for confirmation of the relationship between environmental performance and the economic performance of the companies studied, within the framework of the Eco-efficiency Theory, the research needs to be supported by a quantitative approach, accounting for the behaviors of the data of each of the companies, as well as analyzing the results of the research.

Heikkurinen, P., Young, W., Morgan, E. (2019), have stated that eco-efficiency can help sustainable development by integrating activities into any type of business, regardless of the size of the company or the economic situation, because it has generated economic savings in the maintenance of machines and tools, saved water, reduced the use of raw materials and energy, as well as some changes in product features.

II. METHOD

This research aims to contribute to the development of an experimental framework of the postulates of the Eco-efficiency Theory, which ensures that the improvement of environmental performance translates into better economic performance of companies. The study was developed with information from companies listed on the Mexican Stock Exchange, which, in 2018, 2019, 2020, 2021 and 2022, published their annual financial and sustainability results reports.

Therefore, this article objective is to obtain empirical evidence on the impact of improving environmental performance on the economic performance of business organizations, measured with variables that reflect eco-efficient performance, in other terms, using water consumption as an environmental variable and trying to achieve a direct relationship on economic performance.

The postulates made by the Eco-efficiency Theory are confirmed or rejected in the companies comprising S&P/BMV IPC Index of the Mexican Stock Exchange, from 2018 to 2022, precisely because these companies' shares belong to the most important stock market index of the Mexican financial market and regularly disclose sufficient information about their economic performance and environmental performance.

The main sources of information are the financial statements and sustainability reports of the companies comprising the aforementioned index. Sustainability reports have been widely published since 2018, following the standards of the Global Reporting Initiative (GRI, n.d.), which is an independent international organization that helps governments understand and communicate their impact on critical sustainability issues such as climate change, human rights, governance, and social well-being, among others.

Regarding this, GRI standards are those that most companies take as a reference to prepare sustainability reports, integrated reports, and Non-Financial Information Statements, known by their acronym EINF. These are the documents most used by organizations to report their sustainability data.

In the document titled "Consolidated GRI Standards" published by the Global Reporting Initiative (GRI, 2023), this international organization describes the thematic standard "GRI 303: Water and Effluents, content 303-5 Water Consumption," which business organizations must comply with when publishing their sustainability reports, specifying that "water consumption refers to the sum of all water that has been extracted and incorporated into a product, used for crop production, or generated as waste, has evaporated or transpired, or has been consumed by humans or animals, or is contaminated to such an extent that it is unusable for other users, hence cannot be returned to surface water, groundwater, seawater, or to third parties throughout the reporting period.

The question that synthesizes the research problem is: "According to the postulates of the Eco-efficiency Theory, what is the impact of the improvement of environmental performance on the economic performance of business organizations that in April 2021 were part of the S&P/BMV IPC index, 2018-2022 cohort?"

The following specific questions address the research problem: What environmental performance and economic performance variables can be gathered from the companies under study? Will the available data allow for the application of the Eco-efficiency Formula through systematic processes of compilation, analysis, and interpretation of the results from the companies under study?

The general objective of the study is to confirm what is postulated by the Eco-efficiency Theory through the collection of empirical evidence from the companies comprising the S&P/BMV IPC Index of the Mexican Stock Exchange, from 2018 to 2022. This theory considers consumption as the variable of environmental performance and operating profit generation as the variable economic performance of business organizations.

The specific objectives of the study are:

1. Compile and quantify the variables of environmental performance and economic performance to calculate the eco-efficiency formula defined by the Eco-efficiency Theory.

2. Obtain the results of the eco-efficiency formula with information from the companies included in the study.

3. Analyze the results of the eco-efficiency formula to confirm the postulates of the Eco-efficiency Theory in the companies that make up the S&P/BMV IPC Index of the Mexican Stock Exchange, from the years 2018 to 2022.

The working hypothesis (Hi) Is: the companies comprising the S&P/BMV IPC Index of the Mexican Stock Exchange, in the years 2018 to 2022, obtain better economic performance when they improve their environmental performance, positively correlated both variables.

The null hypothesis (H0) Is: the companies that make up the S&P/BMV IPC Index of the Mexican Stock Exchange, in the years 2018 to 2022, do not obtain better economic performance when they improve their environmental performance.

The alternative hypothesis (H1) Is: most of the companies that make up the S&P/BMV IPC Index of the Mexican Stock Exchange, in the years 2018 to 2022, obtain better economic performance when they improve their environmental performance, positively correlated both variables.

The variables embedded in the research problem, as well as in the working hypothesis, refer to the economic performance and environmental performance of companies, within the framework of the Eco-efficiency Theory and its formula:

$$\text{Ecoeficiencia} = \frac{\text{Valor económico del producto o servicio}}{\text{Impacto medioambiental}}$$

The dividend of the formula is the economic performance of companies, studying the behavior of the Operating Profit that companies periodically report to the stock market.

The divisor is environmental performance, studying water consumption that they also report periodically as part of their commitment to sustainability.

Ramos (2014) defines economic performance as the degree of ease that an entity has with respect to an expected goal. Economic performance can be measured and evaluated in terms of the attainment of an expected benefit or met needs with respect to the resources that were used for that achievement.

Regarding operating income, Corvo (2021) points out that operating income is a book value that quantifies the profit obtained by a company through its commercial operations, without including the reductions corresponding to interest and taxes. Operating income does not include gains made from investments, such as profits from other companies in which the company has a partial interest. Operating income is a subtotal of a company's income statement, after quantifying all general and administrative expenses, and before the recording of interest income and expense, as well as income taxes.

In table 1. the variables, concepts and data of economic and environmental performance that will be utilized to confirm the postulates of the Eco-efficiency Theory, which maintains that the improvement of environmental performance leads to better economic performance of companies, are listed.

Table 1.

Variables, concepts, and data of economic and environmental performance.

Variable	Concept	Datum
Economic performance	(1) Operating Profit	(1) Mexican pesos reported in the Income Statement
Environmental performance	Total Water Consumption	Water consumption reported in the Sustainability Report

Note: This table shows the variables, concepts, and data of economic and environmental performance.

The operationalization of the study variables is carried out in the following order: a) economic performance is expressed as the operating profit of companies in the years 2018, 2019, 2020, and 2022; b) the environmental performance is expressed with the water consumption of the same companies and years indicated and c) the eco-efficiency index is obtained from the calculation of the eco-efficiency formula, which is represented as follows:

$$Eco-efficiency = \frac{economic\ performance\ (operating\ profit)}{environmental\ performance\ (CO2\ emissions\ and\ energy\ and\ water\ consumption\ )}$$

The procedure and tasks to be carried out are listed as follows:

1. Obtaining data on the operating profit of companies, to form the variable of economic performance, by consulting the income statements for the years 2018, 2019, 2020, 2021 and 2022, published on the websites that each company registered on the Mexican Stock Exchange.

a. Location of operating profit data in the annual income statement reported by each company, expressed in Mexican pesos. Emisiones de CO2 y consumos de energia y agua

b. Recording of the data in the collection instrument designed for this purpose.

2. Obtaining data on water consumption from companies to form the environmental performance variable, through consulting the sustainability reports of the years 2018, 2019, 2020, 2021, and 2022, published on the websites registered by the companies with the Mexican Stock Exchange.

a. Location of water consumption data in the sustainability reports published by the companies, which were prepared following the GRI methodology.

b. Recording of the data in the collection instrument designed for this purpose.

3. Data analysis using the Index Numbers methodology, which allows data sets to be sorted and studied with methodological rigor.

a. Definition of the base or reference year: year 2018 is equal to 100.

b. Current periods: 2019, 2020, 2021 and 2022.

c. Type of index for the economic performance variable: simple index because it has one variable (operating income).

d. Type of index for the environmental performance variable: simple index because it has one variable (water consumption).

4. Application of the eco-efficiency formula to the time series of each company.

5. Calculation of Pearson's Correlation Coefficient to ensure the validity and reliability of the data obtained.

6. Analysis and interpretation of the results of the Eco-efficiency of companies.

a. Eco-efficiency of water consumption.

7. Presentation of results.

Considering the general objective of the research to "confirm the relationship between environmental performance and economic performance from 2018 to 2022 of the 35 companies comprising the 'S&P/BMV IPC' Index of the Mexican Stock Exchange," a non-experimental design was developed, consisting of:

- Identify the representative variables of environmental performance and economic performance that companies publish periodically,
- Collect the necessary data,
- Apply the eco-efficiency formula,

- Analyze the results and

• Confirm whether the relationship between the mentioned performances behaves as the Theory of Eco-efficiency establishes, establishing the positive or negative correlation of each company.

Table 2.

Variables, concepts, and data.

Variable	Variable	Datum
Economic performance	(1) Operating Profit or Earnings Before Interest, Taxes, Depreciation and Amortization (EBITDA)	(1) Millions of Mexican pesos reported in the Income Statement
Environmental performance	Total Water consumption	Cubic meters reported in the Sustainability Report

Using the methodology of Index Numbers, the evolution of the study variables was recorded with respect to a reference period.

- Base or reference period: 2018
- Current periods: 2019, 2020, 2021 and 2022.
- Type of index for economic performance: simple index, because it has one variable.
- Type of index for environmental performance: simple index, because it has one variable.

The research was conducted using a non-experimental design, considering the primary sources of information required for the study: the income statements and sustainability reports of the companies, to obtain the data of the variables of economic performance and environmental performance, respectively, from these documents.

The target population of the study is the set of companies listed on the Mexican Stock Exchange, and the selection of the sample corresponds to the 35 companies that comprised the "S&P/BMV IPC" Index in April 2021, whose selection methodology is defined and published by the Mexican Stock Exchange itself.

S&P Global (2022), describes the characteristics of the "S&P/BMV IPC" index of the Mexican Stock Exchange:

The Eligible Universe. The Selection Universe consists of all equity series listed on the BMV, excluding FIBRAs (Real Estate Investment Trusts), FIBRA Es (Energy and Infrastructure Investment Trusts), and Mortgage Trusts.

Selection Universe. All equity series from the Eligible Universe that meet the criteria outlined below as of the index reconstitution reference date:

- Floating Stock Factor (IWF). Stock series must have an IWF of at least 0.10.
- Floating Market Cap value calculated with the PPP (vwap fmc). Eligible stock series must have a VWAP FMC of at least 10,000 million Mexican pesos (8,000 million Mexican pesos for current components). The VWAP FMC of a stock series is the product of the number of shares outstanding times its Float Factor at the effective date of rebalancing by the VWAP of the three-month period preceding the rebalancing reference date.
- Operation History. The corresponding criterion is as follows:

o The share series must have a history of at least three months of operation on the stock market.

o The stock series must have 95% of the days traded in the last six months

o For stock series with a history of less than six months (e.g., Initial Public Offerings and corporate spin-offs), the criterion of 95% of trading days applies to the current history of the issuance

- Multiple Equity Series. If a company has more than one equity series that meet the eligibility criteria, the most liquid equity series as of the index reconstitution reference date according to the Median Traded Value Ratio (MTVR) of the previous six months is chosen.
- Component Selection. All equity series from the Selection Universe are evaluated based on the following liquidity criteria, using data as of the index reconstitution reference date: 10.
- The share series must have a Median Daily Transaction Value (MDVT) of at least 50 million Mexican pesos (30 million Mexican pesos for current components) during the previous three and six months.
- Shares must have an annualized Median Amount Traded Factor (MTVR) of at least 25% during the preceding three- and six-month periods.
- Current constituents of the index remain eligible to remain on the index if they have an annualized MTVR of at least 15% during the previous three and six months.
- The monthly MTVR is determined as follows:

1. Calculate the MDVT.
2. Calculate the days of operation for each month.
3. Calculate the FMC at the end of the month.
4. Calculate the MTVR for the month, where MTVR= (Step 1 Result * Step 2 Result) / Step 3 Result.
5. Add up the last three months and annualize them to get the quarterly MTVR. Follow the same procedure for the semi-annual calculation of the MTVR.

If there are more than 35 eligible equity series, they are ranked in descending order based on a combined score of VWAP FMC and MDVT over the last six calendar months. Stocks with the highest scores according to this ranking are excluded from the selection universe, thus limiting the index composition to 35 equity series.

If there are fewer than 35 eligible equity series, the stocks from the Selection Universe that do not meet the liquidity criteria are ranked in descending order based on a combined score of VWAP FMC and MDVT over the last six months. Stocks with the lowest scores according to this ranking are added to the index until the number of components reaches 35 equity series.

In cases where two or more stocks achieve the same combined score, the most liquid equity series based on its MDVT is chosen.

Component Weighting. The index is weighted based on the Market Capitalization Weighting Scheme Adjusted by Float, considering the following rules:

No stock series can have a weighting greater than 25% in the index.

The cumulative weighting of the five largest stock series cannot exceed 60% in the index.

Rebalancing. The index is reconstituted twice a year, with an effective date after the market close on the third Friday of March and September. The reference date for each reconstitution is the last business day of January and July, respectively. Additionally, regardless of the biannual reconstitution, the index is weighted with an effective date after the market close on the third Friday of June and December. The index share count is calculated using the closing prices of the twelve business days prior to the effective date of the March and September rebalances, and the seven business days prior to the effective date of the June and December rebalances.

The 35 companies that comprised the "S&P/BMV IPC" index in April 2021 are identified in Table 3.2. "Identification data of the companies that comprised the "S&P/BMV IPC" index in April 2021, listed alphabetically by their corporate name, sector, and industry according to the classification of the BMV itself, and the website that each company has available for publishing the information that it is required to share with the general public according to regulations."

Table 3.

Identification data of the companies that in April 2021 made up the "S&P/BMV IPC" index.

Company / company name	Sector	Industry	Website
Alfa S.A.	Industrial	Industrial Conglomerates	www.alfa.com.mx
Alsea S.A.	Consumer Discretionary	Hotels, Restaurants & Leisure	www.alsea.net
América Móvil S.A.B. de C.V.	Communication Services	Wireless Telecommunications Services	www.americamovil.com
Arca Continental, S.A.B. de C.V.	Essential goods	Beverages	www.arcacontal.com
Banco del Bajío, S.A.	Financial	Banks	www.bb.com.mx
Becle, S.A. De C.V.	Essential goods	Beverages	www.becle.com.mx
Bolsa Mexicana de Valores SA de CV	Financial	Capital Markets	www.bmv.com.mx
Cemex SA	Materials	Construction Materials	www.cemex.com
Coca-Cola Femsa SAB de CV	Essential goods	Beverages	www.coca-colafemsa.com
Controladora Vuela Compañía de Aviación S.A.B. de C.V.	Industrial	Airlines	www.volaris.com
Corporación Inmobiliaria Vesta, S.A.B. de C.V.	Real estate	Real Estate Management & Development	www.vesta.com.mx
El Puerto de Liverpool S.A.B. de CV	Consumer Discretionary	Multi-Line Retail	www.liverpool.com.mx
Fomento Económico Mexicano S.A.B. de C.V.	Essential goods	Beverages	www.femsa.com
Genomma Lab Internacional SA de CV	Health	Pharmaceuticals	www.genommalab.com
Gruma SAB	Essential goods	Food	www.gruma.com
Grupo Aeroportuario del Centro Norte, S.A.B. de C.V.	Industrial	Transport Infrastructure	www.oma.aero
Grupo Aeroportuario del Pacifico, S.A.B. de C.V.	Industrial	Transport Infrastructure	www.aeropuertosgap.com.mx
Grupo Aeroportuario del Sureste S.A.B. de CV	Industrial	Transport Infrastructure	www.asur.com.mx
Grupo Bimbo S.A.B.	Essential goods	Food	www.grupobimbo.com
Grupo Carso SAB de CV	Industrial	Industrial Conglomerates	www.carso.com.mx
Grupo Cementos de Chihuahua SAB de CV	Materials	Construction Materials	www.gcc.com
Grupo Elektra S.A.B. de C.V.	Financial	Banks	www.grupoelektra.com.mx
Grupo Financiero Banorte	Financial	Banks	www.banorte.com
Grupo Financiero Inbursa	Financial	Banks	www.inbursa.com
Grupo México SAB de CV	Materials	Metals & Mining	www.gmexico.com
Grupo Televisa SAB	Communication Services	Media	www.televisa.com
Industrias Peñoles	Materials	Metals & Mining	www.penoles.com.mx
Kimberly Clark de México S.A.B. de C.V.	Essential goods	Household Products	www.kimberly-clark.com.mx
Megacable Holdings SAB de CV	Communication Services	Media	www.megacable.com.mx
Operadora de Sites Mexicanos S.A.B. de C.V.	Communication Services	Diversified telecommunications services	www.telesites.com.mx
Orbia Advance Corporation SAB de CV	Materials	Chemicals	www.orbia.com
Promotora y Operadora de Infraestructura SAB de CV	Industrial	Transport Infrastructure	www.pinfra.com.mx
Qualitas Controladora S.A.B de C.V.	Financial	Insurance	www.qualitas.com
Regional, S.A. de C.V.	Financial	Banks	www.regional.com.mx
Walmart de México SAB de CV	Essential goods	Retail sales of food and basic commodities	www.walmex.com

Note: This table shows the identification data of the 35 companies comprising the 'S&P/BMV IPC' index as of April 2021.

To obtain the data of the variables of the study, inquiries were made to the websites of the 35 companies, retrieving the income statements and the sustainability report for each, for the years 2018, 2019, 2020, 2021 and 2022.

The income statement provided the operational profit amounts, which were recorded in the data collection instrument, whereas sustainability reports furnished the water consumption data.

The documentary research concluded upon capturing the amounts and quantities in the collection instruments.

It should be noted that, of the 35 companies investigated, complete information was obtained from 17 of them, as shown in Table 4. "Report of the information retrieved from the selected companies".

It is worth noting that complete information was obtained from 17 out of the 35 investigated companies, as depicted in Table 4, 'Report of Information Retrieved from the Selected Companies' Websites'.

Table 4.

Report on Information Retrieved from the Selected Companies' Websites.

Company	Economic and financial performance: Operating Income	Total Water Consumption
Alfa S.A.	Yes	Yes
Alsea S.A.	Yes	Yes
América Móvil S.A.B. de C.V.	Yes	Yes
Arca Continental, S.A.B. de C.V.	Yes	No
Banco del Bajío, S.A.	Yes	No
Becle, S.A. De C.V.	Yes	No
Bolsa Mexicana de Valores SA de CV	Yes	Yes
Cemex SA	Yes	Yes
Coca-Cola Femsa SAB de CV	Yes	Yes
Controladora Vuela Compañía de Aviación S.A.B. de C.V.	Yes	No
Corporación Inmobiliaria Vesta, S.A.B. de C.V.	Yes	Yes
El Puerto de Liverpool S.A.B. de CV	Yes	No
Fomento Económico Mexicano S.A.B. de C.V.	Yes	Yes
Genomma Lab Internacional SA de CV	Yes	Yes
Gruma SAB	Yes	No
Grupo Aeroportuario del Centro Norte, S.A.B. de C.V.	Yes	No
Grupo Aeroportuario del Pacifico, S.A.B. de C.V.	Yes	Yes
Grupo Aeroportuario del Sureste S.A.B. de CV	Yes	Yes
Grupo Bimbo S.A.B.	Yes	Yes
Grupo Carso SAB de CV	Yes	No
Grupo Cementos de Chihuahua SAB de CV	Yes	No
Grupo Elektra S.A.B. de C.V.	Yes	No
Grupo Financiero Banorte	Yes	Yes
Grupo Financiero Inbursa	Yes	No
Grupo México SAB de CV	Yes	Yes
Grupo Televisa SAB	Yes	Yes
Industrias Peñoles	Yes	No
Kimberly Clark de México S.A.B. de C.V.	Yes	No
Megacable Holdings SAB de CV	Yes	No
Operadora de Sites Mexicanos S.A.B. de C.V.	Yes	No
Orbia Advance Corporation SAB de CV	Yes	Yes
Promotora y Operadora de Infraestructura SAB de CV	Yes	No
Qualitas Controladora S.A.B de C.V.	Yes	No
Regional, S.A. de C.V.	Yes	No
Walmart de México SAB de CV	Yes	Yes

Data collection instruments

Two data collection instruments were designed: one to capture and document the economic performance of companies through the operational profit reported in the income statement, and another to obtain data related to environmental performance; the latter instrument was used to capture water consumption data.

Table 5.

Instrument for collecting data on economic performance.

Company	Operating Profit Millions of pesos				
	2018	2019	2020	2021	2022
Alfa S.A.	35,705	18,220	17,566	25,282	32,503
Alsea S.A.	3,293.59	4,570.89	-1,517.51	4,132.94	6,268
América Móvil S.A.B. de C.V.	139,557.17	154,840.54	165,354.91	166,132.64	170,870
Bolsa Mexicana de Valores SA de CV	1,864.73	1,874.45	2,114.51	2,176.95	2,283
Cemex SA CPO	1,397	986	-456	1,618	1,561
Coca-Cola Femsa SAB de CV UBL	24,133	24,480	22,756	27,071	25,787
Corporación Inmobiliaria Vesta, S.A.B. de C.V.	110.33	117.1	121.04	128.66	142.18
Fomento Económico Mexicano S.A.B. de C.V.	41,010	45,788	34,222	54,575	59,416
Genomma Lab Internacional SA de CV	2,301.10	2,330.82	2,768	3,046.55	3,245
Grupo Aeroportuario del Pacífico, S.A.B. de C.V.	7,244.65	8,012.24	3,819.99	8,857.19	13,814
Grupo Aeroportuario del Sureste S.A.B. de CV	7,778.97	8,481.3	3,276.18	8,657.67	14,688
Grupo Bimbo S.A.B.	18,509	20,419	25,408	34,126.43	53,696
Grupo Financiero Banorte	44,050	49,832	40,946	46,095	61,022
Grupo México SAB de CV	3,092.01	4,359.79	4,643.72	7,533.36	5,566.80

Note: This table shows the amounts of operating profit for the 17 companies reporting information related to operating income and water consumption.

Table 6.

Instrument for collecting data on environmental performance (water).

Company	Total Water Consumption Thousands of cubic meters				
	2018	2019	2020	2021	2022
Alfa S.A.	110,915	136,229	128,720	157,354	158,012
Alsea S.A.	2,673,269	3,869,262	2,574,562	3,039,091	2,671,765
América Movil S.A.B. de C.V.	4,576,650	3,856,385	2,300,000	3,577,678	3,000,000
Bolsa Mexicana de Valores SA de CV	14,122	12,412	12,241	8,527	12,074
Cemex SA CPO	65.6	59	53.7	57.2	58.7
Coca-Cola Femsa SAB de CV UBL	1.58	1.52	1.49	1.47	1.35
Corporación Inmobiliaria Vesta, S.A.B. de C.V.	138,593	107,047	59,041	62,758	100,402
Fomento Económico Mexicano S.A.B. de C.V.	33,456	34,832	31,939	34,298	37,210
Genomma Lab Internacional SA de CV	0.008166	0.008179	0.008956	0.0098573	0.0123
Grupo Aeroportuario del Pacifico, S.A.B. de C.V.	619,139	726,397	573,995	1,330,889	1,798,765
Grupo Aeroportuario del Sureste S.A.B. de CV	755,612	1,484,255	1,260,756	1,556,066	1,646,300
Grupo Bimbo S.A.B.	1,060,239	943,284	6,027,813	5,944,653	6,151,345
Grupo Financiero Banorte	668,223	714,835	509,599	673,596	954,778

Note: This table shows the thousands of cubic meters of water consumed by the 17 companies studied.

Table 7.

Validity and reliability of the instruments.

Company	Pearson's Correlation Coefficient Water
Alfa SA A	0.9840
Alsea SA	0.8135
America Movil SAB de CV L	-0.5896
Bolsa Mexicana de Valores SA de CV	-0.6884
Cemex SA CPO	0.8007
Coca-Cola Femsa SAB de CV UBL	-0.5005
Corporacion Inmobiliaria Vesta, S.A.B. DE C.V.	-0.7144
Fomento Economico Mexicano S.A.B. de C.V.	0.8143
Genomma Lab Internacional SA de CV	0.9856
Grupo Aeroportuario del Pacifico, S.A.B. de C.V.	0.7652
Grupo Aeroportuario del Sureste SAB de CV B	0.9788
Grupo Bimbo S.A.B.	0.7689
Grupo Financiero Banorte O	0.9711
Grupo Mexico SAB de CV B	0.2234
Grupo Televisa SAB CPO	-0.9791
Orbia Advance Corporation SAB de CV	-0.2886
Walmart de Mexico SAB de CV	-0.6355

Note: This table shows the results of the Pearson correlation coefficient for the 17 companies studied.

The main objective of the research was partially achieved by confirming, in 17 out of the 35 selected companies, the postulates of Eco-efficiency Theory. This was accomplished through the collection of empirical evidence from companies listed on the S&P/BMV IPC Index of the Mexican Stock Exchange, spanning from 2018 to 2022. The study considered water consumption as a variable of environmental performance and operational profit generation as a variable of the economic performance of business organizations.

Regarding the specific objectives, we can be assured that the variables of environmental performance and the variables of economic performance were compiled and quantified, with sufficient information from 17 companies to calculate the eco-efficiency formula defined by the Eco-efficiency Theory.

Furthermore, it was possible to obtain the results of the eco-efficiency formula using the information from the companies included in the study.

Finally, the results of the eco-efficiency formula were analyzed to confirm the postulates of Eco-efficiency Theory within the companies comprising the S&P/BMV IPC Index of the Mexican Stock Exchange, spanning from 2018 to 2022.

Processes and analysis of results

The eco-efficiency formula was applied to the datasets obtained from 17 companies, recalling that 2018 is the base year = 100:

Table 8.

Operating Profit Index 2019, 2021 and 2021 / Water Consumption Index 2019, 2020, 2021 and 2022.

	Eco-efficiency water			
Company	2019	2020	2021	2022
Alfa SA A	0.4155	0.4239	0.4991	0.639
Alsea SA	0.9588	-0.4784	1.1038	1.935
America Movil SAB de CV L	1.3167	2.3577	1.5228	1.868
Bolsa Mexicana de Valores SA de CV	1.1437	1.3082	1.9334	1.432
Cemex SA CPO	0.7848	-0.3987	1.3283	1.249
Coca-Cola Femsa SAB de CV UBL	1.0544	0.9999	1.2057	1.251
Corporacion Inmobiliaria Vesta, S.A.B. DE C.V.	1.3741	2.5753	2.5753	1.779
Fomento Economico Mexicano S.A.B. de C.V.	0.0013	0.0010	0.0015	0.002
Genomma Lab Internacional SA de CV	1.0113	1.0968	1.0968	0.938
Grupo Aeroportuario del Pacifico, S.A.B. de C.V.	0.9432	0.5688	0.5688	0.656
Grupo Aeroportuario del Sureste SAB de CV B	0.5550	0.2524	0.5404	0.867
Grupo Bimbo S.A.B.	1.2400	0.2415	0.3288	0.500
Grupo Financiero Banorte O	1.0575	1.2189	1.0381	0.970
Grupo Mexico SAB de CV B	1.4545	1.7158	2.5697	1.745
Grupo Televisa SAB CPO	0.0194	0.0225	0.0397	0.004
Orbia Advance Corporation SAB de CV	0.8698	0.7760	1.5573	1.477

Note: this table shows the results of the eco-efficiency formula applied to the operating profit and water consumption of the 17 companies studied.

Table 8 contains the results of eco-efficiency regarding water consumption, obtained by applying the eco-efficiency formula, recording the Operating Profit index in the numerator and the water consumption index of each of the companies in the denominator.

Analysis, interpretation, and discussion of results

Differentiated results were obtained when calculating and obtaining the eco-efficiency index for the water consumption variable of the 17 studied companies.

The eco-efficiency index of water consumption for the years 2019, 2020, 2021, and 2022 of 11 out of the 17 companies in the sample aligns with the postulate of Eco-efficiency Theory, which suggests that improvements in environmental performance correlate with improvements in economic performance. These companies include Alfa, Alsea, América Móvil, Cemex, Coca-Cola Femsa, Corporación Inmobiliaria Vesta, Fomento Económico Mexicano, Grupo Aeroportuario del Sureste, Grupo México, Orbia Advance Corporation, and Walmart México.

On the other hand, the eco-efficiency index of water consumption for the years 2019, 2020, 2021, and 2022 of 6 out of the 17 companies in the sample does not align with the postulate of Eco-efficiency Theory, which suggests that improvements in environmental performance correlate with improvements in economic performance. These companies include Bolsa Mexicana de Valores, Genomma Lab Internacional, Grupo Aeroportuario del Pacífico, Grupo Bimbo, Grupo Financiero Banorte, and Grupo Televisa.

Table 9.

2019, 2020, 2021 and 2022 eco-efficiency index of water consumption of companies that comply and do not comply with the postulate of the Eco-efficiency Theory, which holds that the improvement of environmental performance is reflected in an improvement of economic performance.

Company	Meets	Doesn't fulfill
Alfa SA A	Yes	
Alsea SA	Yes	
America Movil SAB de CV L	Yes	
Bolsa Mexicana de Valores SA de CV		No
Cemex SA CPO	Yes	
Coca-Cola Femsa SAB de CV UBL	Yes	
Corporacion Inmobiliaria Vesta, S.A.B. DE C.V.	Yes	
Fomento Economico Mexicano S.A.B. de C.V.	Yes	
Genomma Lab Internacional SA de CV		No
Grupo Aeroportuario del Pacifico, S.A.B. de C.V.		No
Grupo Aeroportuario del Sureste SAB de CV B	Yes	
Grupo Bimbo S.A.B.		No
Grupo Financiero Banorte O		No
Grupo Mexico SAB de CV B	Yes	
Grupo Televisa SAB CPO		No
Orbia Advance Corporation SAB de CV	Yes	
Walmart de Mexico SAB de CV	Yes	

Note: this table shows the companies that comply and do not comply with the postulate of the Eco-efficiency Theory regarding water consumption.

Hypothesis testing

The guiding question that synthesizes the research problem concerns determining the impact of environmental performance improvement on the economic performance of companies, as asserted by the Eco-efficiency Theory.

The alternative hypothesis (H1) ensures that most of the companies that make up the S&P/BMV IPC Index of the Mexican Stock Exchange, in the years

2018 to 2022, obtain better economic performance when they improve their environmental performance.

Similarly, the null hypothesis (H0) asserts that the companies listed on the S&P/BMV IPC Index of the Mexican Stock Exchange, from 2018 to 2022, do not achieve better economic performances when they improve their environmental performances.

Regarding this matter, Table 17, titled "Alternative and Null Hypotheses by Variable and by Company," consolidates the results of the eco-efficiency formula concerning the alternative and null hypotheses.

Table 10.

Alternative and Null Hypotheses by Variable and by Company.

Company	Eco-efficiency index of water consumption
Alfa SA A	H1
Alsea SA	H1
America Movil SAB de CV L	H1
Bolsa Mexicana de Valores SA de CV	H0
Cemex SA CPO	H1
Coca-Cola Femsa SAB de CV UBL	H1
Corporacion Inmobiliaria Vesta, S.A.B. DE C.V.	H1
Fomento Economico Mexicano S.A.B. de C.V.	H1
Genomma Lab Internacional SA de CV	H0
Grupo Aeroportuario del Pacifico, S.A.B. de C.V.	H0
Grupo Aeroportuario del Sureste SAB de CV B	H1
Grupo Bimbo S.A.B.	H0
Grupo Financiero Banorte O	H0
Grupo México SAB de CV B	H1
Grupo Televisa SAB CPO	H0
Orbia Advance Corporation SAB de CV	H1
Walmart de México SAB de CV	H1
Total de H1	11
Total de H0	6

Note: Authors' own elaboration. The table shows the results of the eco-efficiency formula with respect to the alternate hypothesis (H1) and the null hypothesis (H0) by variable and company.

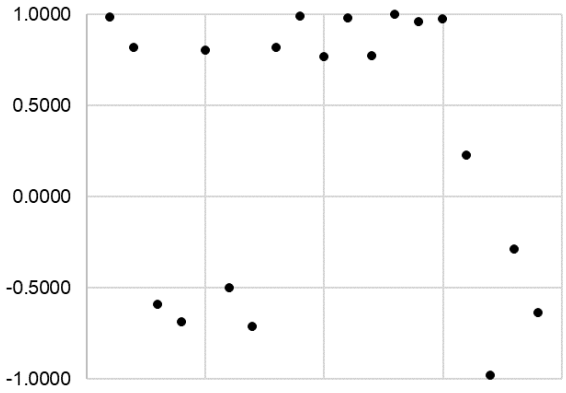
Regarding the level of statistical significance, the results of the Pearson's correlation Coefficient test show that 10 companies exhibit a positive correlation with the proposition of Eco-efficiency Theory, whereas 7 companies show a negative correlation with the postulate of the mentioned theory.

Thus, it can be concluded that the study's results confirm the working hypothesis: environmental performance improvement leads companies to achieve better economic performance.

The Pearson correlation coefficient graph of calculated eco-efficiency, related to water consumption (Water), confirms the validity and reliability of the data used.

Figure 1.

Pearson's correlation coefficient (Water).



Presentation of results

The study gathered sufficient empirical evidence to confirm what Eco-efficiency Theory posits, finding that 11 out of 17 companies did improve their economic performance by enhancing their environmental performance, equivalent to 64.7% of the companies studied.

Regarding the first specific objective of compiling and quantifying the environmental performance variables and economic performance variables to calculate the eco-efficiency formula defined by Eco-efficiency Theory, information was obtained from 17 companies out of a sample of 35 comprising the S&P/BMV IPC Index of the Mexican Stock Exchange, spanning from 2018 to 2022, collecting data and quantifying the variables of 48.5% of the sample companies.

The second specific objective, related to obtaining the results of the eco-efficiency formula using the information from the companies included in the study, was achieved in the 17 companies with sufficient data on their economic and environmental performance, calculating the said formula for 100% of the companies with available information.

Finally, the third specific objective of analyzing the results of the eco-efficiency formula to confirm what is postulated by the Eco-efficiency Theory in the companies that make up the S&P/BMV IPC Index of the Mexican Stock Exchange, in the years 2018 to 2022, alludes to the fact that 11 of the 17 companies studied do demonstrate that the improvement in environmental performance led to achieve better economic performance, corresponding to the 64.7% of the companies studied.

Conclusions

The question that synthesizes the research problem, "According to the postulates of Eco-efficiency Theory, is it possible to determine the impact of environmental performance improvement on the economic performance of the studied companies?" was answered positively by finding that in 75.0% of the studied companies, improved environmental performance was accompanied by better economic performance. The decrease in water consumption translated into higher operational profits.

Throughout the research, the environmental performance and economic performance variables were identified in 17 out of the 35 companies included in the study sample. Sustainability reports and financial statements from the years 2018, 2019, 2020, 2021, and 2022 of each company were collected to obtain the data that underwent the Index Numbers procedure to facilitate handling and apply the so-called "Eco-efficiency Formula."

The results of the aforementioned formula were individually analyzed and interpreted to obtain outcomes that confirm the research hypothesis within the studied companies.

Through a documentary review of the websites of the 35 companies included in the sample, information on the two study variables was obtained from 17 of them. This information was used to conduct the hypothesis test of the research, with the intention of obtaining empirical evidence regarding the main postulate of Eco-efficiency Theory. It is now known that 64.7% of the studied companies do improve their economic performance when they enhance their environmental performance, according to the calculation of the eco-efficiency index of water consumption for the year 2018 as the baseline and calculating the performances for the years 2019, 2020, 2021, and 2022.

It is also important to highlight that out of the 35 companies included in the sample, which comprise the S&P/BMV IPC Index of the Mexican Stock Exchange, environmental performance information elaborated with the methodology proposed by the GRI (s.f.) and published on the official websites of these companies was not found for 18 of them.

Therefore, it is pertinent to suggest conducting a new search exercise to gather the environmental information required for the doctoral study. Additionally, including data from subsequent years would provide a more robust time series, allowing for a better understanding of the observed phenomenon regarding the eco-efficiency of Mexican companies.

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