INVESTMENT PORTFOLIOS CONSTRUCTION FOR THE CHILEAN STOCK MARKET. A SHILLER PE RATIO ANALYSIS FOR THE PERIOD 2011-19

CONSTRUCCIÓN DE CARTERAS DE INVERSIÓN PARA EL MERCADO BURSÁTIL CHILENO: UN ANÁLISIS DEL RATIO SHILLER P/E PARA EL PERÍODO 2011-2019

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Resumen

Esta investigación determina la efectividad del ratio Shiller P/E como un criterio para identificar acciones en el mercado bursátil chileno que puedan incrementar su valor y, con ello, permitir la construcción de carteras de inversión, calculando dicho ratio para las acciones más representativas del mercado chileno. Con estos valores, se elaboran carteras de inversión para el período 2011-2019. El desempeño de estas carteras se compara con el índice general de la Bolsa de Comercio de Santiago (IPSA). La metodología se basa en un análisis de reversión a la media de las acciones estudiadas. Los resultados indican que las carteras construidas con este indicador generan rendimientos superiores a los del IPSA. No obstante, se observa reversión a la media en el 60% de los activos, cifra que coincide con la capacidad predictiva del indicador.

Palabras clave: ratio Shiller P/E; riesgo; valor en riesgo; rentabilidad; mercados financieros internacionales.

Abstract

This research establishes the effectiveness of the Shiller P/E ratio as a determinant to identify stocks in the Chilean stock market that can increase their stock market value and thus build investment portfolios, calculating the ratio for the most representative stocks in the Chilean market. With these ratios, investment portfolios are constructed for 2011-19. The performance of these portfolios is compared with the general index of the Santiago Stock Exchange (IPSA). The methodology is based on a mean reversion analysis on of the stocks under study. The results indicate that the portfolios constructed with the indicator generate higher returns compared to IPSA. However, there is mean reversion in 60% of the assets equivalent to the predictive capacity of the indicator.

Keywords: Shiller PER; Risk; Value at Risk; Profitability; International Financial Markets.

Introduction

The Shiller PER well known as CAPE (Cyclically Adjusted Price-to-Earnings Ratio) was developed by Robert Shiller in 2000. Its adaptation considers the PER adjusted for average inflation over 10 years which allows us to predict financial bubbles. This is an important tool in making investment decisions in stock market indicators (Kenourgios et al., 2021). Its application in financial markets is highlighted by several studies especially those on stock indices (Angelini et al., 2018). However, the use of Shiller's PER oriented towards the construction of investment portfolios is not well documented in the literature showing a huge gap in some studies, especially those on Latin American markets (Radha, 2020).

Hence, this study's aim is to determine he applicability of Shiller's PER in constructing of efficient investment portfolios capable of outdoing the benchmark's performance IPSA index in the Chilean stock market.

Our analysis shows that the performance of investment portfolios built using Shiller's PER far exceeds benchmark's performance. However, the percentage of assets analyzed which showed reversion to the mean did not exceed 60 %, which calls into question Shiller PER's analytical ability for the entire market.

Despite several studies found in the literature where the CAPE or similar models that incorporate earnings per share in their estimates have been applied, it is observed that there are very few studies on the subject in Latin America, under this context, analyzing the indicator for the case of emerging economies such as Chile makes sense since it becomes valid to explore the efficiency of the index in this type of markets. It is worth remembering that Chile is one of the economies that have shown the greatest growth in the last decades but, like the rest of the countries in the region, it has experienced economic bumps that have affected it, that is why it is important to have it as a reference in this research.

The Chilean economic scenario showed important variations due to political and economic events during 2011-2018. However, in 2011 it was affected by the global crisis, especially in European countries and, the detection of fraud in Polar's financial statements, which decreased the share price by 200 % (Fernández *et al*., 2015).

Despite a complicated international scenario, the Chilean economy rebounded in 2018 due to an increase in interest rates by the United States Federal Reserve (FED), which diverted investment capital to more developed countries. There was a 3.9 % growth thanks to the reactivation of domestic demand and more investments mostly in machinery and equipment. However, despite better results, unemployment persisted and stood at 7.2 %, continuing a growth process for more than three consecutive years (Banco Mundial, 2018). Despite the protest that led to the social crisis in 2019, Chile's GDP was 1.1 % showing an acceptable performance in the first three quarters, when the accumulated growth was 2.3 % (Centro de Estudios Latinoamericanos (CESLA), 2019). However, the riots forced the

government to reform the distribution of the budget, bringing a greater focus on social investments and reducing investment promotion. In general, the economy deteriorated, increasing the current account deficit by 0.3 % to 3.9 % due to a fall in exports. However, imports also decreased due to the lower domestic consumption. As a result of higher public spending and social pressures, the fiscal deficit also increased from 1.5 % in 2018 to 2.9 % in 2019, in addition to a fall in demand for copper (Banco Mundial, 2020).

In summary, Chile's GDP had considerable upward and downward trends over the last decade, reaching a peak in 2011 at 6.1 %. Since then, it has been on a downward trend and stood at 1.8 % in 2014 with a small upward correction in 2015 (2.3 %) to collapse again to 1.3 % in 2016.

Literature Review

The world is undergoing transformation at the political, economic, social, and environmental levels. This transformation is occurring in situations of change where there is no prior notice. Hence, the impact of these transformations increases uncertainty in the markets. From a financial point of view, these transformations have an important impact, specifically on equity investments which are made by individuals and companies to capitalize, since transformations bring uncertainty and increase the risks to which agents are exposed.

To respond to this stock, traders have the skills and financial instruments that allow them to predict an asset's possible future behavior in the market, seeking greater objectivity and confidence when making investment decisions. Within these instruments, there are indicators such as Moving averages which, according to Wang *et al*, (2022) help to establish at what time to buy or sell shares; Bollinger bands which, according to Chen, (2022), are indicators that identify trading signals and are composed of a moving average and the standard deviations of prices; Fibonacci, Manjunath, (2022), that analyzes future financial market trends and achieves a high level of accuracy in its predictions; as well as oscillators such as RSI, Maté, (2023) key to technical analysis which is basically used for trading in equity markets such as FOREX or stock markets., volume, George, (2022), which in stock market technical analysis is taken into account according to the number of shares traded for its prediction. And MACD (which also refers to the convergence and divergence of the rolling averages), which are used frequently and, according to Liang, (2022), are of great statistical importance for stock market forecasting.

There are also methods in the stock markets that allow calculating the value of shares; one of these is the index PER, also known as the P / E ratio, price-to-earnings ratio, or price-benefit ratio, which is the most used index in the relative valuation of shares. Its calculation refers to the quotient between a company's market capitalization and its net profits, which can be simplified as the price per share divided by the net profit per share (Graham, 1973).

Normally, the P/E ratio is used to forecast a stock market. However, this can be supplemented with other indicators to improve forecasts. Leibowitz et al. (2019) state that the P/E ratio alone does not consider higher equity returns, so an adjustment term g* must be added which can be viewed as a net return in addition to projecting growth considering withholding, reinvested returns, and earnings growth. A new indicator known as the cyclically adjusted price-to-earnings ratio (CAPE) or PER10 is an offshoot of the PER index. According to Feldman et al. (2015), PER10's calculation takes the prices of the S&P 500 which are divided by their average earnings in a time interval of 10 years. This factor is different from the conventional PER because it is applied to a longer period. In addition, this indicator also considers factors such as added value thus adjusting annual earnings for inflation using CPI. Robert Shiller and John Campbell took a 10-year horizon, considering most investors' interest in generating long-term returns. According to statistical evidence presented by Shiller and Campbell, the returns are more predictable. However, this methodology does not allow for forecasting an unexpected drop in the market as it predicts trends that will be generated continuously and successively.

CAPE is probably the most widely accepted metric when it comes to investing as it helps in determining whether a stock market is objectively valued. The CAPE index is well known due to its reversion power (Davis *et al*., 2018). According to Shelley et al. (2020), this index is used for forecasting long-term returns.

The CAPE index also measures the relationship between the current price of a share and a company's average net real profit (Dimitrov & Jain, 2018). Schuldt (2011) shows that the CAPE index's indicators work as a moving average thus helping in comparing it with the behavior of the PER and its historical average adjusted for inflation. In this way, if the index increases relevantly, future returns are low, and the opposite happens if the indicator is at levels below its average.

CAPE has been well studied and analyzed as an essential financial instrument in market valuations. T. Philips & Ural (2016) maintains that this indicator was tested to establish its ability to forecast the profitability of North American stock markets and for to analyze the relevance of their results. Based on this, Philips studied possible improvements in CAPE, especially in its construction and use for obtaining more accurate forecasts regardingof stock returns. These improvements vary according to markets. His study showed that CAPE could predict future returns in equity markets and that its greatest impact concerning past average earnings is a decrease in its variance and the adjustment of cyclicality, thus improving the prediction.

According to Dimitrov & Jain (2018), when CAPE is very low or very high, it is not significant for an investor. Hence, if an investor's decision is based on this indicator it can lead to high returns. For example, when CAPE was 27.72 it would lead to decisions of not investing. However, the returns on the shares during the next 10 years were 117 % because on average CAPE remained at 27.28 during that decade. During the study period, there

were two decades in which CAPE was at the extreme, so its relationship with the returns in the following 10 years were not consistent.

Davis *et al*. (2018) add that forecasting returns in the American stock market based on CAPE deteriorated in 1985 due to the strict hypothesis that the indicator returns to its long-term average. They clarify that the problem is not directly with the indicator, but with CAPE's regressions that assume that it mechanically corrects its long-term average. The authors propose a reversal of CAPE on real (non-nominal) bond yields, which reduces deviations in forecasts outside the sample by up to 50 % and additionally refers to a measure that improves the precision of forecasting between real rolling yields and those forecast for a 10-year horizon such as RMSE.

On the other hand, Shiller's PER has been studied and applied differently including making modifications to it concerning the original indicator. As mentioned earlier, this indicator uses an average of 10 years of real profits based on which it forecasts companies' profitability during an economic cycle. T. K. Philips & Kobor (2020) reduced this methodology by filtering and discarding the worst quarterly results of each year. He used the results of only one year to study how data from that year can be used for predicting the values of the returns better than using data for 10 years. Shiller found a relationship between the price and cyclically adjusted earnings (CAPE) and this relationship is very well associated with future equity profitability. Dimitrov & Jain (2018) presents two opposite conclusions to this theory. First, even when Shiller's PER is in its ninth decile, future 10-year equity returns are higher than future returns on US treasuries over the same time horizon. Second, in parallel with a risk-return relationship, CAPE is negatively related to future equity market variability.

Angelini *et al*. (2018) presented a model based on the forecasting capacity of the PER Shiller for long-term returns. They showed that the returns were driven by fundamental components and influenced by an autoregressive component that was affected by external random disturbances. Regarding the autoregressive component, the authors maintained that this originates from agents' perceptions of higher returns in markets with an upward trend as compared to the bear markets. The fundamentals change over time and are supported by the initial average of the price-earnings ratio. Thus, they confirm that a stock market price dynamics model should have the ability to determine if its trajectory is away from the fundamentals considering macroeconomic variables such as CAPE. At the time of our study, these authors still maintained that there is no evidence of models that take this into account.

Arnott *et al*. (2005) highlight the importance of fundamentals in the valuation of international stock markets. The indices are concentrated in assets with greater capitalization to a greater extent where they maintain the attributes in terms of liquidity and capacity compared to conventional capitalization-weighted indices where professionals use various valuation measures to estimate the value of a stock index.

One of these refers to Tobin's q which has an efficiency comparable to CAPE. Tobin relates the price and equity at replacement cost, which takes into account the impact of inflation which is very similar to the methodology used in CAPE. Hendrawan & Salim (2017) did a simulation of the formation of portfolios and valued the portfolios with the CAPE and Tobin indicators for the Indonesian Kompas Index 100. The simulation yielded a consistent value index of Tobin's q with low risks and returns above those of the IDX market. The returns test on each portfolio formed, valued it with CAPE and Tobin's q, showed that a 6-month active strategy had the highest return with a 1-year and 5-year passive strategy respectively.

Bunn *et al*. (2014) considered sectoral information from Shiller's Per since the 1980s to identify the overvaluation and undervaluation of stocks in each sector of the U.S. economy. Listed companies were taken to compare the CAPE according to after-tax profit and operating profit. The results show that the long-term CAPE performance is lower when operating profits are taken. It concluded that the improvement in profitability, associated with a sector rotation based on CAPE extends to European sectors, (Bunn et al., 2014).

Other studies provide a critique of Shiller's PER. They are very pessimistic equity return forecasts as they present distortions with respect to corporate profits and exaggerate forecasts for long-term returns. T. Philips & Ural (2016) came up with new methods of constructing the indicator that shield it from accounting biases and changes in stock market fundamentals by using econometric methods that take into account endogeneity, overlapping observations, and the presence of outliers. T. Philips & Ural (2016) confirms that a large part of these improvements do not have a relevant impact on CAPE and its forecasts in North American equity markets. However, it manifests its applicability in smaller markets and those that experienced significant modifications.

The pessimism in the projections of future equity returns based on the Shiller P/E ratio is confirmed since this indicator calculates GAAP earnings. Thus, when GAAP earnings are replaced by after-tax earnings from the National Income and Product Account (NIPPA), better equity forecasts can be obtained.

Siegel (2016) ratifies this pessimism in a projection of future stock returns under Shiller's PER. According to him, although CAPE has been one of the best predictors for measuring the future profitability of the stock market in the long term, these predictions may become pessimistic due to changes in the calculation of earnings according to GAAP in the United States. As they are consistent earnings after taxes, they are replaced by GAAP profits and so the forecasts are more encouraging, the predictive power of the CAPE model shows improvements, and forecasts for North American stock returns rise significantly. A change in the regulations for recording market results may change the outcomes generating an upward CAPE indicator (Siegel, 2016). For studying CAPE, a uniform series of data is required concerning the profits in the period analyzed. However, this premise is not fulfilled when reviewing the behavior of the S & P 500.

In other cases, CAPE has been compared with other predictive market indicators, measuring its degree of effectiveness where it has not been successful. Hence, Feldman et al. (2015) proposed three new stock trading strategies and compared them with four strategies already known the US Treasury yield curve, the 200-day simple moving average of the S&P 500, CAPE, and the profit yields of S&P 500 versus yields of the treasury. All these are taken as a reference point in the S&P 500 index. From Feldman et al.'s study. a new strategy called LEI (Leading Economic Index) emerged that could be the best stock trading strategy where the monthly returns generated by it are significant, thus exceeding the benchmark strategy (S&P 500).

Of the seven strategies studied, CAPE ranked last in terms of underperformance compared to the S&P 500 because it constantly implied an overvaluation of the United States stock market. Shelley et al. (2020) explored the capital allocation profitability forecast model and compared it with other well-known metrics like the Fed model, the yield differential (Yield Spread), Buffet's Ratio, and CAPE. According to Shelley, all these variables are related to long-term equity returns. However, only the stock allocation model together with the yield spread presents RMSE (root mean squared error) consistently less than a moving average. The author concluded that combining the capital allocation model with other indicated methods leads to more favorable results than those obtained with CAPE. In addition to the above, it is important to consider that during the study period, the country is experiencing a depressed economic situation, leading to a social crisis. This poses greater challenges for the assets under study, with implications related to the economic sector they represent and the global economic outlook.

Chile's Economic and financial behavior during 2011-19

On average, the IPSA index was 4,356.62 points, presenting an average profitability of 2.34 % and a variance of 14.41 %, which indicates a significant dispersion of the data concerning to the average, considering that four periods presented negative profitability. Figure 1 shows the behavior of GDP versus the IPSA index.

Figure 1. Behavior of GDP versus IPSA (2011-19)
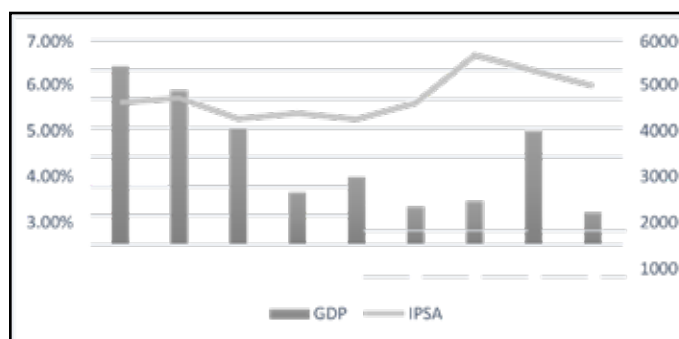
Note. GDP trend versus IPSA (2011 – 19). Authors' elaboration based on investing.com and data. worldbank.org.

According to Figure 1 (data as of December cut-off of each year), in 2011 despite presenting significant GDP growth of 6.1 %, the variation was negative for IPSA (15.22 %). This was mainly because the previous year there was a rebound due to the auction of shares such as LAN, CVA (Costa Verde Aeronáutica), and the company Punto Blanco, which made the index reach a profitability of 37.59 %. It was also explained by the good performance of all the companies included in the index.

These dynamics are presented considering the structure of the Chilean economy: 13.7 % comes from the primary sector, in which there are mining and agricultural products. 21.1 % comes from the industrial sector in which there are sectors like chemicals, food processing, wood, and textiles and industries established with mining; and 65.3 % comes from the service sector, which includes tourism, financial services, and retail sales. Considering that the country was the largest copper producer in the world in 2011- 16, its exports fell by 24.5 %, and by 2019 it still had not recovered to the 2011 levels. Exports in 2019 were 13.5 % lower than those in 2011 (Ministerio de Comercio, 2020).

Foreign direct investments (FDI) have been considerably affected in recent years because of the global economic slowdown and the trade war between the United States and China. In 2015, Chile's FDI amounted to $ 23.6 million dollars, in 2018 it decreased by 69.9 %, and in 2019 by 60.6 %. The recovery was not even 50 % of the FDI received before 2015. Besides that, there was an increase in income tax for external companies due to Law 20.848 (Fuerte, 2016). On the international scene, the decline in emerging economies was evident with the United States stimulating its economy, which led to an increase in the rate of public debt bonds by 100 %age points, attracting investors who previously had their money in emerging economies (Botero Garcia *et al*., 2015).

In 2013 the Chilean stock market showed volatility mainly due to US announcements of reducing the monetary stimulus that had been given since 2008 to give liquidity to the economy. Despite this, IPSA registered prices similar to historical ones (Banco Central de Chile, 2013).

In 2014 a lower GDP was perceived in the Chilean economy, which stood at 1.8 % because of a persistent decline in the price of copper. IPSA's profitability was quite low at 4.1 % thanks to the performance of the sector's shares. Companies such as ENDESA, LAN, and Falabella were affected by the uncertainty in 2014 due to new tax reforms. In 2015, the IPSA index had a negative growth of 4.43 % due to disagreements with tax reforms, and in general because of a decline in emerging economies because of decreasing prices of raw materials. In 2015, only 14 of the 40 shares that make up the IPSA showed profitability. In 2016 and 2017 there was a rebound in IPSA's profitability. In 2016 it closed with a 12.8 % rebound thanks to the retail and construction sectors' good performance. Following this dynamism, in 2017 the index had returns of 34.06 % (Román, 2018). In this year (2016), the economic slowdown continued, and the growth was 1.3 % mainly due to lower public spending and lower foreign direct investments, as well as lower domestic consumption, which generated lower imports of goods and services.

Since 2016, the Chilean economy has grown with a GDP growth of 3.9 % in 2018 to later close 2019 with a pronounced downward trend that reached 1.1 %. One of the reasons for this decrease in 2019 was related to the fall in the price of copper due to the trade war between China and the United States and protests by Chilean people claiming relevant changes such as a new constitution. According to López, (2014), the fluctuations experienced in the world stock markets due to the possible non-payment of China's foreign debt were the most important cause of copper devaluation, therefore, as long as the Chilean government does not apply a policy strategy for the sale of manufactured copper products, the country will continue to depend on the changes in the stock markets.

Figure 2. Market trends in copper prices (2011 – 19)
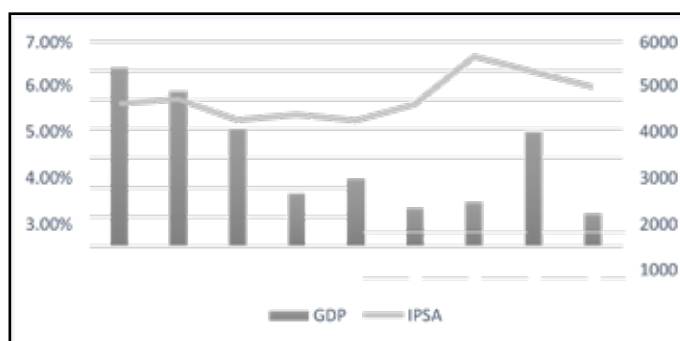
Note: Historical behavior of copper prices. Authors' calculations based on data from Investing.com

Finally, regarding inequality in wealth, the Chilean middle class presents high inequalities in opportunities due to the fragmentation in the supply of health and education services. Workers with fixed-term contracts have less social security and are not entitled to unemployment insurance. According to (Banco Mundial, 2017) the Gini coefficient between 2011 and 2017 oscillated between 46 and 44 (out of 100). The most recent data for 2017 shows it at 44.4, being among the highest in the region. In this regard, (Quijada *et al*., 2019) indicates that "the results of a comparative study of social inequality show that Chile has huge social gaps despite its economic growth is being characterized by indicators of social discontent".

Figure 3. The Gini coefficient (2011- 17)
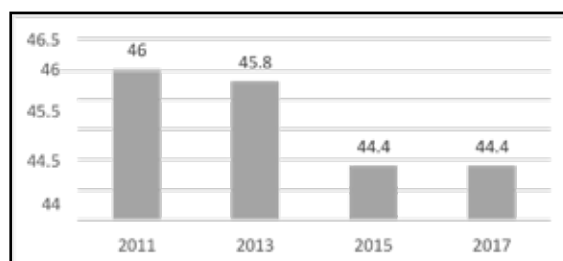
Note: Historical behavior of the Gini coefficient. Authors' elaboration using data from WorldBank.Org

Methodology

The methodology used in this study covers a series of steps for identifying efficiency in the construction of investment portfolios. The parameter for determining this efficiency is obtained by comparing it with a reference index or benchmark that in our case is the Santiago IPSA stock index. The study period is 2011-19 since at the time the investigation was initiated, it was the nine years immediately preceding and it complied with the period taken into account by the CAPE. This period is important because, in this period, Chile experienced economic situations that from a fundamental point of view, impacted the stock market, among others, the slow economic growth due to factors such as the fall in the price of copper, taking into account that its economy depends largely on this metal; the tax and educational reform that generated debate about the impact it would bring and in turn, monetary and fiscal policies; social problems that led to protests over aspects of equity and social security; the economic crisis that led to the creation of the Chilean economy.

A fundamental criterion used is given by the value at risk (VAR). It was assumed that the value at risk of each investment portfolio built was equal to or at least lower than the VAR of the benchmark index with a 95 % confidence level and based on three-year historical returns. Hence, the first step in the methodology involved calculating the VAR with a confidence level of 95 % for the IPSA index for each year from 2011 to 2019.

In the next step, the investment portfolios were built from a selection of assets that had registered a negotiation in at least 90 % of all rounds in 2010. From this filter, 39 actions were identified that met this condition; this means that any of these actions could be part of the investment portfolios for the years under study. The price-gain ratio (PER) was calculated for these actions and the extreme values were smoothed so that if the PER was negative, this value equaled zero and for each PER greater than 50 the indicator equaled this number. In other words, a relative weight was given to each stock within the index and based on this, the individual contribution to the index was determined, being constructed in the same way as a stock market index such as the Dow Jones or Colcap.

Baes on the price-earnings ratio, the Schiller PER was calculated for each share per year between 2011 and 2019. With these results, the following formula was applied to estimate the appreciation potential (PV):

$$PV = (PER - CAPE)/ CAPE \ (1)$$

Where, PER corresponds to the PER index of the stock at the end of year N-1 and CAPE corresponds to Shiller's PER calculated for the end of year N-1; in other words, for the selection of the assets forming part of the investment portfolios in 2011, the results of the indicators at the end of 2010 are taken. The purpose of applying this function was to identify the actions with a potential appreciation greater than 20 %. Table 1 shows the number of shares per year that had this appreciation potential.

Table 1. Shares with potential for improvements (2011-19)

Year	2011	2012	2013	2014	2015	2016	2017	2018	2019
Number of Shares	7	12	6	12	11	14	7	4	11

Note: Number of shares with improvement potential between 2011 and 2019. Authors' elaboration based on data obtained from (Economatica, 2020)

Efficient investment portfolios were constructed from this filter using the variance-covariance model with a confidence level of 95 %, in principle for 2011, and the same exercise was repeated every year till 2019. This was done in such a way that the investment portfolios adjusted year by year depending on the results of Shiller's PER.

To measure the performance of the investment portfolios, the starting point was a base portfolio of 10,000 Chilean pesos that was adjusted year by year based on the profitability of the investment portfolios.

In the construction of investment portfolios, there is a fundamental purpose aimed at ensuring that the VAR of the portfolios does not exceed the VAR of the benchmark index, for which the following conditions were applied in cases in which no equivalence was found in the value at risk analyzed: If the portfolio had a VAR higher than its benchmark, the lowest possible VAR was taken according to the efficient portfolio curve. If the investment portfolio had a VAR lower than its benchmark, the optimal VAR was taken as a reference according to the Sharp index for the period analyzed.

Based on these parameters, the value at risk for the investment portfolios was constructed and is presented in Table 2.

Table 2. Investment portfolios' Value at Risk versus the IPSA index

	VAR PORTFOLIO	VAR INDEX
2011	1,84 %	3,27 %
2012	2,93 %	2,94 %
2013	2,29 %	2,26 %
2014	1,31 %	0,86 %
2015	0,92 %	0,86 %
2016	0,75 %	0,76 %
2017	0,92 %	0,73 %
2018	1,39 %	1,63 %
2019	1,78 %	1,78 %
AVERAGE	1,57 %	1,68 %

Note: Comparison of value at risk of the portfolios under study versus the IPSA index. Authors'

elaboration based on data taken from (Economatica, 2020)

As can be seen from Table 2, the average value at risk of the investment portfolios was 0.09 % points lower than that of the Santiago IPSA. Hence, the hypothetical investments risk's profile is achieved.

Based on the application of the proposed methodology, the assets that formed a part of the investment portfolios for each year are presented in Table 3.

Table 3. Assets which formed a part of the investment portfolios (2011-19)

2011	2012	2013	2014	2015	2016	2017	2018	2019
Asset	Asset	Asset	Asset	Asset	Asset	Asset	Asset	Asset
Habitat	Iansa	Iansa	Habitat	Antarchile	Cuprum	Aesgener	Cementos	Antarchile
Enelam	Parauco	Enelam	Provida	Bsantander	Provida	Besalco	Colbun	Cap
Parauco		Nortegran	Cementos	Cementos	Aesgener	Cementos	Enelgxch	Ccu
Quinenco		Campos	Enelam	Copec	Antarchile	Colbun		Cmpc
			Enelgxch	Iansa	Cementos	Enelgxch		Copec
			Masisa	Enelam	Colbun	Ecl		Enelam
			Nortegran	Quinenco	Enelam	Falabella		Enelgxch
			Parauco	Falabella	Security			Parauco
			Campos	Campos	Parauco			
			Oro Blanco		Conchatoro			

Note: Companies which are a part of the portfolios under study between 2011 and 2019. Authors' elaboration based on data from (Economatica, 2020)

Based on the investment portfolios constructed, the profitability of the portfolios was compared with the Santiago IPSA benchmark index. This profitability was compared for each year and cumulatively.

Finally, as a review of the autoregressive component of the PER index of the assets analyzed, a mean reversion analysis was also done for which the 10-year moving average of the indicator for 2011-19 was used with the formula:

$$yn+1 = (yt+yn-1+yn-2+...+yn-k) / n \ (2)$$

Where, yt is the record of PER in period t and n is the number of observed records minus k lags, that is, 40 lags in 10 years. This degree of lag allows us to observe the long-term trend of the indicator. When the result obtained is lower than the P/E of the asset

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analyzed, we find that the asset is overvalued, on the contrary, when the result obtained is higher than the P/E of the asset, we could say that the asset is undervalued, i.e. the price of the asset has the potential to increase.

After carrying out the previous step, to evaluate the effectiveness of the Shiller P/E ratio in constructing investment portfolios, a detailed analysis was conducted using the Pearson correlation coefficient (r). This coefficient is essential for measuring the relationship between the original P/E ratio of the stocks and their 10-year moving average, thereby allowing us to analyze the indicator's trend and its potential mean reversion. Data selection focused on the quarterly records of the P/E ratio of selected stocks from 2011 to 2019. For each stock, a 10-year moving average of the P/E ratio was calculated to capture a representative measure of the long-term trend of the indicator.

The calculation of the Pearson correlation coefficient was performed using the standard formula that relates the deviations of each value from their means:

$$r = \sum (X\_i - \overline{X})(Y\_i - \overline{Y}) \; / \sqrt{(\sum (X\_i - \overline{X})^2 \, (Y\_i - \overline{Y})^2)} \quad (3)$$

In this formula, Xi represents the original values of the P/E ratio, and Yi represents the 10-year moving average of the P/E ratio. This calculation was carried out using specialized statistical software, which enabled precise values of "r" for each stock in each year of the study.

The results from calculating the Pearson correlation coefficient were used to compute the Percentage of Mean Reversion (PMR), a metric that indicates the extent to which a value tends to revert to its mean. The PMR is defined as follows:

$$PRM = 100 * (1 - |r|) \quad (4)$$

A high PMR suggests a strong tendency for to mean- revert, indicating a higher probability that the P/E ratio will return to its long-term moving average. Conversely, a low PMR would suggest a lesser tendency for reversion, implying that the values could remain deviate from the mean for extended periods. This analysis is vital for investors as it helps identify stocks that show significant mean reversion and, therefore, may have a greater appreciation potential within an investment portfolio.

For instance, applying this methodology to the stock "Habitat" in 2011, a Pearson correlation coefficient (in absolute value) of r = 0.42 was calculated. The corresponding PMR was 57,7%, indicating a moderate mean reversion for this stock during the analyzed period. This result suggests that, while the stock showed some tendency to revert to its long-term average, the strength of this tendency was not sufficient to guarantee complete predictability in its future behavior.

The application of this methodology demonstrates the usefulness of the Shiller P/E ratio in constructing portfolios that outperform the IPSA benchmark index and the inherent limitations in its predictive capacity due to the observed mean reversion. This approach provides a foundation for future research that could explore the integration of other complementary indicators or extend the analysis to more recent periods, such as years beyond 2019.

Results

The profitability achieved by the investment portfolios built from Shiller's PER was 115.75 %, which compared to a negative return of 5.19 % obtained by the IPSA index shows a very good performance. It is useful to use Shiller's PER for the construction of investment portfolios and even more so when the portfolios' VAR is compared with the benchmark index, which is 11 basis points lower.

Table 4. Profitability of investment portfolios versus the IPSA 2011-19 index

	Portfolio profitability (EA)	IPSA Profitability (EA)	Behavior
2011	-9,00 %	-15,22 %	Higher
2012	28,54 %	2,96 %	Higher
2013	-35,93 %	-14,00 %	Higher
2014	14,78 %	4,10 %	Higher
2015	37,60 %	-13,31 %	Higher
2016	22,40 %	12,80 %	Higher
2017	35,57 %	34,04 %	Higher
2018	10,05 %	-8,25 %	Higher
2019	-0,19 %	-8,49 %	Higher
Total Profitability	115,75 %	-5,19 %	

Note: Portfolio profitability versus the IPSA index during 2011-19. Authors' elaboration based on data from (Economatica, 2020)

Our results highlight that, in 8 of the 9 years analyzed, the profitability obtained exceeded the reference index, which shows an effectiveness of 89 % in the methodology used for the construction of investment portfolios. However, when an individual review of the performance of the assets that make up the investment portfolios is done, the results are not so favorable because the amount of assets that form a part of the investment portfolios that have positive returns during the period analyzed is 34 out of a total of 58. This shows that 58.62 % of the assets analyzed had positive returns in the study period when they were a part of the investment portfolios. In other words, the

good results obtained in the investment portfolios are not explained by a high number of assets with positive returns but, are explained by high returns on assets that performed positively during the period studied.

Table 5. Probability of Mean Reversion

Year	2011										
Asset	Habitad	Enelam	Parauco	Quinenco							
%Age	57,69%T	70,12 %	86,74 %	32,15 %							
Year	2012										
Asset	Iansa	Parauco									
%Age	78,51 %	95,68 %									
Year	2013										
Asset	Iansa	Enelam	Campos								
%Age	73,03 %	19,09 %	69,84 %								
Year	2014										
Asset	Habitad	Provida	Cementos	Enelam	Enelgxch	Masisa	Nortegran	Parauco	Campos	Oroblanc	Squib
%Age	77,21 %	39,86 %	91,13 %	57,46 %	46,78 %	0,99 %	99,68 %	80,73 %	70,36 %	86,58 %	16,36%
Year	2015										
Asset	Antarchile	Bsantande	Cementos	Copec	Iansa	Enelam	Quinenco	Falabella	Campos		
%Age	97,62 %	90,47 %	42,89 %	94,35 %	55,43 %	65,69 %	55,91 %	88,92 %	37,36 %		
Year	2016										
Asset	Cuprum	Provida	Aesgener	Antarchile	Cementos	Colbun	Enelam	Security	Parauco	Conchator	
%Age	80,82 %	96,85 %	76,98 %	81,64 %	96,83 %	84,73 %	92,62 %	54,41 %	87,32 %	94,55 %	
Year	2017										
Asset	Aesgener	Besalco	Cementos	Colbun	Enelgxch	Ecl	Falabella				
%Age	62,15 %	30,18 %	19,32 %	31,10 %	36,34 %	67,16 %	40,33 %				

Note: Probability of mean reversion in the portfolios under analysis in 2011-19. Authors' elaboration based on data from (Economatica, 2020).

Our analysis also showed that all the assets analyzed registered some percentage of reversion to the mean, therefore in all of them, the PER had an autoregressive component. However, when contrasting the calculated probabilities with the real behavior of PER for all the cases, it should increase its value for the year in which the asset was part of the investment portfolio. However, it has been found that this has only happened in 60 % of the cases which is in line with the previous analysis carried out on the number of assets that had positive profitability during the period under study.

On the other hand, the statistical existence of autoregressive components does not fully adjust to reality. For example, in 2011, the probability of reversion to the mean of the habitat PER was 57.69 % and the reversion to the real mean was 26.44 %. This implies that the model used helped to estimate the existence of reversion to the mean but did not allow establishing a statistically acceptable projected % of reversion to the mean.

Table 6 shows when the PER recorded reversion to the mean for each year and for each asset, to identify if there was a reversion to the mean in the PER, if there was a reversion it was assigned the number 1 and if there was not, it was assigned 0.

Table 6. Mean Reversion in the assets analyzed

Year	2013										
Asset	Iansa	Enelam	Campos								
Outcome	0	0	0								
Year	2014										
Asset	Habitad	Provida	Cementos	Enelam	Enelgxch	Masisa	Nortegran	Parauco	Campos	Oroblanco	Squab
Outcome	0	0	1	0	0	1	0	0	0	0	0
Year	2015										
Asset	Antarchile	Bsantander	Cementos	Copec	Iansa	Enelam	Quimenco	Falabella	Campos		
Outcome	1	1	0	1	1	0	1	0	1		
Year	2016										
Asset	Cuprum	Provida	Aesgener	Antarchile	Cementos	Colbun	Enelam	Security	Parauco	Conchatoro	
Outcome	1	1	0	1	1	0	1	1	1	1	
Year	2017										
Asset	Aesgener	Besalco	Cementos	Colbun	Enelgxch	Ecl	Falabella				
Outcome	1	1	0	0	1	1	1				
Year	2018										
Asset	Cementos	Colbun	Enelgxch								
Outcome	1	0	1								
Year	2019										
Asset	Antarchile	Cap	Ceu	Cmpc	Copec	Enelam	Enelgxch	Parauco			
Outcome	1	0	1	1	1	1	1	1			

Note: Presence or not of mean reversion of PER in the portfolios analyzed in the period 2011-19. Authors'elaboration based on data from Economatica (2020).

From Table 6 it can be seen that 2011, 2016 and 2019 were the years in which the PER index on registered assets showed the highest reversion to the mean. In these years the profitability on investment portfolios exceeded the benchmark. In contrast, in 2013 no assets were reverted to the mean. This is the only year in the period under study in which the return of the investment portfolios was lower than the Therefore, a portfolio in which the PER Shiller indicates a potential for valorization shows a high probability that the portfolio's yield would be higher than the reference index.

Discussion

This research presents strengths in terms of the contribution to new knowledge since there are few studies related to the Shiller's Per indicator in the region.

The index used is important because it has been tested in different studies, in which its predictive power has been established regarding the behavior of the stock market, as is to be expected, and as any indicator, there are supporters and detractors of it.

The results of the study contribute to market players who are interested in making investments in variable income, more precisely in shares, since it allows them to make decisions in a more objective manner and with greater knowledge of the possible behavior of a financial asset of this type.

As for weaknesses, this study focuses on a single indicator that, although compared with the Chilean benchmark index (IPSA), it is not evaluated with another stock prediction index, so this aspect remains unresolved in terms of this scope.

It is also worth testing the indicator following the study period, i.e. 2020 to 2024, taking into account its impact during the pandemic and post-pandemic period, due to all the economic and financial repercussions that this situation brought with it at a global level.

Relationships and discrepancies with previous publications

Proof that the Shiller's Per index is one of the most used indicators in the relative valuation of stocks is reflected in the results obtained in this research regarding the high effectiveness of the methodology used in terms of stock returns, these results are associated with what Shelley (2020) said regarding the use of this indicator in the prediction of long-term returns. In turn, this is reiterated with what was mentioned by Philips T. U. (2016) in his study where he proved the predictive potential of the Shiller Per in the prediction of future returns in equity markets on the other hand, the assets analyzed evidenced a certain level of reversion to the mean, which is in line with what was mentioned by (Davis, 2018) regarding the reversion capacity of the Shiller's Per.

Regarding the outstanding profitability obtained with the portfolios that were built, it is possible to prove the importance of considering this type of indicators when investing in equities, in this case, in a stock market of an emerging country such as Chile, this helps to make more objective decisions by reducing the level of uncertainty, this referring to the VAR in favor generated by such portfolios.

The 89% of the period analyzed (2011-2019), evidence that the constructed portfolios outperformed the Chilean benchmark index ratifying the effectiveness of the CAPE applied to this market. Despite of this, this result is not given by a constant and general profitability of all the assets immersed in the constructed portfolios but by a limited number of these. This means that it is necessary to analyze in depth the behavior of a portfolio since there may be assets immersed in these that contaminate, so to speak, others in the sense of not showing returns that promote an integral optimization of the portfolio as a whole and hence the importance of performing sensitivity analysis in an attempt to build portfolios that with the choice of assets that have a homogeneous and upward behavior lead to better results from the point of view of profitability.

The above is ratified since only a percentage of the assets presented an increase in the Per, the rest of the assets had a reversion to the mean. In practical terms, this is interesting now of trading in the Chilean stock market, since it allows us to determine at what moment a stock may be overbought or oversold, and with this, to make stock market investment decisions.

However, the method applied in the research does not allow determining a defined level of reversion to the mean, since no indicator that is infallible by itself , and to generate a greater degree of effectiveness it must be complemented with other indicators that complement it and allow, as far as possible, to approach the estimation of said such level of reversion, an example could be the Fibonacci series.

As in 3 of the 9 years calculated is where the portfolios constructed show a higher profitability with respect to the reference index, this gives rise to the establishment of improvement plans in the construction of investment portfolios that optimize this statistic through indicators or oscillators that complement the CAPE.

Although the Shiller Per has a high predictive power in the stock market, it is not clear when establishing a level of reversion to the mean, which makes it complex to determine at times when the indicator is above the mean, to what extent future returns will decrease, and the same when the indicator is below its mean, (Schuldt, 2011). To make up for this shortcoming, and as a recommendation, Shiller's Per can be modified, (T. Philips & Ural, 2016), or complemented with another indicator, (Leibowitz et al., 2019), such as the Fibonacci series, Manjunath, (2022), which traders apply to try to determine how far an uptrend will retrace, that is, how far the market will touch a support before bouncing or resuming that trend.

Another recommendation has to do with the behavior of the stocks that are part of the constructed portfolios, where, as mentioned, not all of them show a profitability throughout the period studied but only some of them, for this reason it is worth doing constant rebalancing, rotating the stock immersed with respect to the economic sectors that are rebounding at a certain time, this alluding to Bunn *et al.*, 2014.

Taking into account, Angelini, (2018), regarding that a stock price dynamics model should have the ability to determine if its trajectory moves away from fundamentals considering macroeconomic variables such as CAPE, we see that this is not given in the present study since for the year 2011 due to economic and financial fundamentals such as the world crisis and the frauds presented in Chile where the directors of the company La Polar made up the financial statements bringing as a consequence a decrease of 200% in the share price reflecting in the negative profitability of the constructed portfolio of - 9% for that year, it is evident that the market discounts everything and it is not true that a market trend moves away from the fundamentals that are presented at a certain time.

As future and possible practical applications, it would be interesting to apply and test the effectiveness of Shiller's Per in the period after this research (2020-2022), considering such strong fundamentals that impacted the economy and the financial sector worldwide, such as the pandemic, the war between Russia and Ukraine, currency devaluation and high inflation.

As possible routes for future research and according to Radha, (2020), who states that the use of Shiller's Per in relation to the construction of portfolios does not have strong literary documentation, generating gaps in some studies particularly in Latin American markets, it is worth considering the importance of applying future studies based on this indicator to determine its impact on the stock market in countries of the region and of course to continue with its application worldwide.

Conclusion

During 2011-19 the Chilean stock market had a discreet behavior in terms of financial returns, as the price of copper, tax reforms, and corruption scandals marked the dynamics of the market in which the general IPSA profitability was -5.19 % although in 2016 and 2017 the Santiago Stock Market achieved a valuation of more than 50 %. In this context of volatility and low financial returns, alternatives such as Shiller's PER become relevant for investors when building investment portfolios.

When applying the proposed methodology for the construction of investment portfolios, it was observed that the yield of the benchmark which for purposes of the research is represented by the Santiago IPSA index was widely exceeded. In fact, there was a 121 % differential between the profitability of the portfolios with respect to the performance of the benchmark index. It is remarkable that even in periods of higher profitability of the general index of the Santiago Stock Exchange, the performance of investment portfolios built from Shiller's PER surpassed this benchmark with a differential of almost 15 % points in 2016 and 2017. In other words, in the period analyzed Shiller's PER showed to be an adequate indicator for the construction of investment portfolios for the Chilean stock market.

On the other hand, when applying a mean reversion model on the PER index of the shares that were a part of the investment portfolios constructed, it was observed that there was a reversion to the in this indicator, which supports our results. However, only 60 % of the assets analyzed showed some percentage of reversion to the mean during the time that they were part of the investment portfolios. This means that the positive results obtained in the investment portfolios did not respond to a greater extent to a high percentage of assets with high returns, but to a large number of assets with positive returns at a time when they were part of the investment portfolios.

Although the performance of the investment portfolios exceeded the benchmark and most of the assets that were part of the investment portfolios registered positive returns in a mainly bearish market, the probability of a reversion to the mean does not adequately adjust to the reality of the behavior of the assets analyzed. Thus, it is recommended that further studies be conducted to make more predictions regarding the performance of the PER and its variant the shilller PER. Further research could take into account (T. K. Philips & Kobor, 2020), research where they adjust the earnings during the worst period of each

year by 40 % and seek to reduce the impact of outliers by finding an improvement in the predictive capacity of Shiller's PER. Likewise, it is worth applying other predictive models such as, (Shelley et al., 2020) model for the U.S. stock market to the Chilean market and benchmark with the results observed with Shiller's PER.

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