

A FACTOR ANALYSIS OF SOCIALLY RESPONSIBLE INVESTMENT IN MEXICO AS A COMPETITIVENESS PRACTICE: A TEST AND THEORETICAL REVIEW

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RESUMEN

El presente trabajo es uno de los primeros estudios que prueba la eficiencia media-varianza de la inversión socialmente responsable (SRI). En el mismo comparo el desempeño del índice IPC sustentable contra los índices generales ICPcomp e IPC, al emplear el índice de Sharpe, una prueba ANOVA, así como un modelo CAPM estándar; una prueba CAPM de expansión, un modelo de desempeño multifactorial y una simulación Monte Carlo. Los resultados demuestran que los tres índices tienen desempeños estadísticamente iguales, sugiriendo que este tipo de estilo de inversión es un buen sustituto de la inversión convencional en el largo plazo. Esto se atribuye, específicamente, a temas de concentración similar en acciones de mediana y baja capitalización.

Palabras clave: Selección de portafolios, Valuación de activos, Simulación y pronóstico financiero, Inversión socialmente responsable, Desempeño de índices socialmente responsables.

ABSTRACT

The present paper is one of the first studies in Mexico that test the mean-variance efficiency of socially responsible investment (SRI). We compared the performance of the IPC sustainability index (IPCS) against the broad market IPC and IPCcomp indexes using daily Sharpe ratio levels in an ANOVA test, along with a standard CAPM model, a CAPM spanning test, a multi-factor market cap model, and a Monte Carlo simulation. Our results show that the IPCS index, the IPC and the IPCcomp have a statistically equal mean-variance performance, suggesting that this sort of investment style (SRI) is a good substitute of the broad market investment style in the long term. Among the causes of this finding is the fact that the IPCS and the IPCcomp indexes have almost the same large and small cap stock concentration.

Keywords: Portfolio selection, Asset pricing, financial forecasting and simulation, socially responsible investment, performance of socially responsible indexes.

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INTRODUCTION

Socially Responsible Investment (SRI) or sustainability² is a tried and true activity that comes from religious practices such as the ones followed by Muslim, Jewish or Puritan groups who apply religious and ethical codes for doing business and investing. This investment strategy was formally adopted by the US financial industry in the 1960's in the climate of political, social and anti-war movements. Since then, several statements about the appropriateness of SRI have arisen, such as "socially responsible investment is more profitable than common investment". From another perspective, several Modern Portfolio Theory (MPT) questions have been presented, such as the ones of Lengbein and Posner (1980) related to the mean-variance efficiency of the sustainable portfolio subset against a broader market investment universe³.

In the case of Mexico, SRI is a recent issue and started formally in 2011 when the Mexican Stock Exchange, in a joint venture with EIRIS-Ecovalores and the Anahuac University, launched the Sustainable IPC index with stock members from the broad market IPCcomp index. This is so by following a positive sustainability screening process that is similar to the ones followed in prestigious benchmarks such as the Domini 400 Social Index, the Dow Jones Sustainability Index or the FTSE4good. In the particular case of the Mexican index, the social screening process is executed with the Economic, Environmental and Social pillars as suggested by United Nations Millennium Declaration (Mexican stock exchange, 2006).

As will be mentioned in the literature review, almost all the Sustainable Investment papers have focused in the mean-variance efficiency property of either sustainable mutual funds or sustainable equity indices. To our knowledge there are no previous studies about SRI for the Mexican case, being this paper one of the first tests in the Mexican Stock Exchange that compares the performance of the IPC sustainability index (henceforth IPCS) against the 35 blue chip stock (large cap) IPC index, and the broader market (60 small, mid and large cap) IPCcomp.

Due to diversification issues that are the corner stone of MPT's theoretical assumptions and by following Langbein and Postner (1980) critique, it is not possible for a subset (portfolio), to be as mean-variance efficient as either the broader market portfolio (or index)⁴ or a larger set. Despite this, as Roll (1977) or Amenc et.al. (2012) suggest, not all the assumptions of MPT (as the market portfolio proxy's mean-variance efficiency) prove out in real life. For this reason two portfolios with different but similar cardinalities could lead to similar efficiency results even if they are not as efficient as the portfolios that belong to the efficient set (frontier).

² We will use the terms "Socially responsible" or "Sustainable" as synonyms in the present paper.

³ This critique assumes an elliptical multivariate distribution in the returns of all the portfolio assets. Assumption that we follow too.

⁴ Assuming that we know the real asset set of this theoretical portfolio.

Examples of previous research that perform this sort of test are Statman (2006) and Schröder (2007) where the conclusions show that the sustainable investment is as mean-variance efficient as the broad market one. Following this findings and the ones mentioned next in the literature review, the present paper tests the next general: “The IPC sustainability index is as mean-variance efficient as the IPC and IPCcomp indexes”.

Once that the aim and potential results in the paper have been mentioned, the structure of the present paper is as follows: a literature review will be presented next, followed by the empirical test and the observed results in order to end the document with the concluding remarks and the recommendations for further research.

LITERATURE REVIEW

Socially Responsible Investment (SRI) has been studied in different countries. Moskowitz (1972) realized one of the first studies that tests SRI mutual funds. His results suggest that their extra returns against broad market investment funds were due to the mispricing of social responsibility by market investors.

Statman (2000) tested the Domini 400 Sustainable index against the S&P500 and also studied the performance of SRI funds against common ones. He realized his study by using a statistic based in the Modigliani and Modigliani (1997) performance measure. What this study found is that even though the SI funds perform better than non-SI ones, no statistical proof exists to support this result. Boutin-Doufresne and Savaria (2004) also studied the performance of Canadian SRI funds against their common counterparts. They also compared this sort of funds against a broad market index (S&P-TSX index), finding similar results as in Statman’s study and noting that SI funds have less diversifiable risk.

With another performance measure, Schröder (2004) analyzed the performance of 56 SRI funds from the US, Germany and Switzerland along with 10 SRI benchmarks by using the Jensen’s alpha with data from 2000 to 2002. He tested the potential underperformance of the SI against the broad market funds and his results showed no statistical evidence to support his hypothesis.

By using the same performance measure in the Carhart (1997) multi-factor model, Bauer, Koedijk and Otten (2005) tested the German, US and UK SI funds against their respective market and SRI index. With their test, they found no over-performance against the broad market index and the SRI benchmark and observed that the US funds are highly concentrated in blue chip stocks whereas the UK and the German prefer small cap stocks. By using Carhart’s multifactor model and a standard CAPM one, Scholtens (2005) also studied the performance of Dutch SRI mutual funds against the

AEX market index. Like the two previous studies, he found no statistical significance in the Jensen's alpha.

In order to confirm his previous results, Schröder (2007) tested 29 SRI worldwide indexes by using the Huberman and Kandel (1987) spanning test with the next null hypothesis $H_0: \beta_1 = 0, \beta_2 = 1$. He also used his own version of the Fama-French (1992) model in a regression equation system solved with the Seemingly Unrelated Regression approach. With his tests, he didn't find any significant alpha of the studied sustainable benchmarks against the broad market indexes and noted that even though the risk level in SRI investment was higher against the broad market one, the performance was the same among them. He also concluded that, thanks to the spanning test results, the broad market indexes could not be used as a substitute of the SRI ones, suggesting that both indexes should not be used indistinctly in a stock portfolio.

To study the Dow Jones Sustainability Stoxx (DJSS) index, Consolandi et.al. (2008) created a surrogate non-sustainable index with the stocks that do not belong to the DJSS and are members of the Stoxx 600 index. Their results demonstrated that sustainable or socially responsible investment does not lead to a higher performance against the non-socially responsible one.

With a global perspective, Lee and Faff (2009) tested the DJ Global Index against the DJ sustainability index by creating leading and lagging social responsibility screened indexes and by testing two versions of the DJSI: one with the stocks that match with similar non SRI stocks, and the original index. This group of indexes was tested with a six-factor model that used the global market, book value, market cap, momentum, country, and sector indexes. The results found no positive and significant alpha with this model, suggesting that the market does not value the SRI status of a company.

By studying Morningstar's sustainable or socially responsible fund category in the 1990-2008 period, Blanchet (2010) tested the performance of SRI funds against similar non-SRI ones and ran a standard CAPM model with the Russell 1000 index. His results showed that no significant over-performance of the SRI funds against the non-SRI ones, and presented no significant alpha against the broad market benchmark.

In a parallel fashion and using a newer three-factor version of the Fama-French model, Ooi et.al. (2013) found a significant alpha in the performance of socially responsible funds, a result that is not attributed to a change in the selection of the market risk factors.

Finally, by using markov switching models to estimate the Conditional CAPM and the Carhart (1997) four factor model, Areal et.al. (2013) found that a SRI portfolio, contrary to a sin or vice portfolio, underperforms the S&P500 in the low volatility periods from October 1993 to September 2009 but also found that, in high volatility periods, the sin or vice portfolio has a worst underperformance than the SRI one.

In another perspective Valor, de la Cuesta and Fernandez (2009) studied the connection between SRI and the implementation of Corporate Social Responsibility (CSR) in Spanish listed companies. They noted that, at the time of their study, the impulse of CSR is a result of international SRI instead of a Spanish demand, given the lack of financial products that offer SRI as investment option⁵.

Also Duran and Bajo (2012) studied the performance of global SRI by using a cluster analysis of the performance of stocks in the DJ sustainability index and the FTSE4Good. They found that the price performance is strongly related with their country of origin and institutions (i.e. if they are from liberal economies or more restricted developing ones) or the activity that they develop. For example, they found that globally integrated activities such as finance, industrials or consumer goods tend to perform better.

In another perspective, by studying business diversification as sustainable growth strategy and its impact in profitability levels in U.S. public companies, De Andrés et. al. (2014) found that there's a "U" pattern in the relationship between diversification of business lines and profits. This result calls the attention that if the company get's too much businesses, its profitability could be reduced and then increase. This also suggests that attempting to include sustainable activities or businesses in conventional companies could lead not to a profit reduction but an observable increase of these in the long term.

Finally, Ahmed et.al. (2014) make a first study of the demand of SRI in Bangladesh and the performance of the listed companies that follow CSR standards.

As noted in this non-exhaustive literature review, almost all the studies about sustainable investment are focused either on the performance of SRI mutual funds or the SRI stock indexes. Almost every study concluded that no significant difference in the performance of SRI investment against either the broad market one. Also, as noted in the introduction, no similar studies have been made to the Mexican Stock Market and by the fact that only a couple of sustainable mutual funds exist in Mexico, the present paper will test the mean-variance efficiency of the IPCS against the IPC and the IPCcomp indexes with ex post and ex ante data. This will be done to determine if the SRI is equally efficient as the broad market index and, as a consequence, could be a good substitute of the latter as investment style in the equity component of a portfolio.

⁵ As is the Mexican case where there are only few SRI mutual funds.

Now that we have presented the theoretical background and some of the previous studies that motivate the present one, in the next section we will describe the test that will prove the general hypothesis.

DATA AND METHODOLOGY

In order to prove the general hypothesis “The IPC sustainability index is as mean-variance efficient as the IPC or the IPCcomp indexes”, we performed six tests⁶ with daily data of the three indexes (IPCS, IPC and IPCcomp) from November 28, 2008⁷ to August 28, 2013. In a first test, we performed a visual comparison of the simulated portfolios by using B100 index values from November 28, 2008, given the daily return $\%I_{i,t}$ of each index (I_i):

$$\%I_{i,t} = \frac{(I_{i,t} - I_{i,t-1})}{I_{i,t-1}} \quad (1)$$

Following this, we compared the standard deviation $\sigma(\%I_i)$ of $\%I_i$ in the last 30 labor days at t . We did this because we wanted to have a first answer to the statement “The investment in the sustainable subset leads to a higher degree of risk than the broad market strategy”. In a second test, these two measures were mixed in a mean-variance space by quantifying the daily Sharpe (1966) ratio given the next expression:

$$SR_{i,t} = \frac{(\%I_{i,t} - rf)}{\sigma(\%I_{i,t})} \quad (2)$$

The risk free rate (rf) is the daily 28 CETES rate published in the daily price vector provided by the Banco de Mexico (2013) and $SR_{i,t}$, as mentioned, is presented in daily values. The levels of this performance measure in each index were tested jointly with a one-way ANOVA test, using the next null hypothesis H_0 : “The Sharpe ratios of the IPCS, the IPC and the IPCcomp are statistically equal”. If H_0 holds, the test would give a first proof of the aforementioned paper’s general hypothesis.

⁶ Five in an ex post context and one in an ex ante one.

⁷ This is the date of inception of the IPCS in Mexico.

In a third test and following the Schröder (2004) and Blanchet (2010) studies, we used the Jensen's alpha performance measure in two standard CAPM models of the IPCS against the IPC and the IPCcomp⁸:

$$\begin{aligned} \%IPCS_t &= \alpha + \beta \%IPC_t + \epsilon_t \\ \beta \%IPCS_t &= \alpha + \beta \%IPCcomp_t + \epsilon_t \end{aligned} \quad (3)$$

We used this performance measure because we wanted to test if the mean-variance efficiency of the IPCS leads to a significant over-performance against the IPCcomp and IPC indexes. If we find a statistically significant alpha, we will find further proofs in favor to the SRI practice in Mexico (over-performance against broad market investment)⁹. If not, we will show that the performance between SRI and the broad market one is the same.

In order to strengthen this test and following Schröder (2007), we also run a fourth test with the Huberman and Kandel (1987) spanning test of the same two standard CAPM models in (3). We did this by testing the next null $H_0: \beta = 0, \alpha = 1$. With this test we wanted to confirm the result of the previous standard Jensen's alpha test and to check if the broad market index (IPCcomp) can replicate the performance of the IPCS. If the spanning test holds, we will find a proof that the IPCcomp (or IPC) and the IPCS can be used indistinctly, giving also a stronger support to the sustainable investment in Mexico by arguing that an investment strategy either in the IPCS or the IPCcomp leads to similar results and, therefore, it is preferable the use the IPCS without the loss of performance (i.e. mean-variance efficiency).

If the results of the Jensen's alpha and the spanning tests suggest a similar or better performance than the IPC or the IPCcomp, a review of the factors that cause this result will be a necessary task. To do this, we reviewed several multifactor approaches such as the ones in Bauer, Koedijk and Otten (2005), Scholtens (2005), or Lee and Faff (Lee & Faff, 2009). Following this review, we saw the Carhart (1997) multifactor model as an appropriate option to measure the performance of the sustainable investment in order to test if the results are due to the market capitalization of the stock members in the IPCS or by they rate of growth of their dividends i.e. by the fact that the IPCS is concentrated in growth or value stocks.

⁸ We, for all the regressions, used the Newey and West (1987) standard errors in the coefficients in order to control autocorrelation and heteroskedasticity.

⁹ One assumption about the presence of a significant alpha is that the markets are not pricing the mean-variance efficiency of the sustainable investment, leading to "atypical" returns or over performance against the broad market indexes. This argument could suggest the use of tests on the presence of informational efficiency. This sort test are outside of the scope in the present paper. Leaving this subject to further research.

By the fact that there are no growth or value indexes in México and because of this limitation, we cannot run the entire Carhart (1987) multifactor model. To solve this issue we ran, as an alternative and fifth test, a three-factor model by using the IPC large cap ($IPCLC_t$), IPC mid cap ($IPCMC_t$) and IPC small cap ($IPCSC_t$) indexes in a regression with the IPCS and the IPCcomp indexes¹⁰ as dependent variables:

$$\begin{aligned} \%IPCcomp_t &= \alpha + \beta_1(IPCLC_t) + \beta_2(IPCMC_t) + \beta_3(IPCSC_t) + \epsilon_t \\ \%IPCS_t &= \alpha + \beta_1(IPCLC_t) + \beta_2(IPCMC_t) + \beta_3(IPCSC_t) + \epsilon_t \end{aligned} \quad (4)$$

This model will give hints about the market capitalization style that has more influence in the behavior of each index and some explanation to the observed results in the previous tests.

These five aforementioned tests are appropriate to measure the performance of a portfolio or benchmark in an ex post fashion. In order to complement the results in an ex ante way, we ran a sixth and final test with a Monte Carlo simulation with 100,000 scenarios in a 5 years-forward window. From the 100,000 scenarios in each index, the median, the fifth and 95th percentiles of each simulated date were calculated for the IPCcomp index, and only the median for the IPCS and the IPC indexes. With these percentiles in the IPCcomp, a non-parametric 90% confidence interval was calculated in order to determine, in the long run, if the IPCS is statistically equal to the broad market index (IPCcomp). We applied this test because we want to prove that the ex post results will hold in the long-term. To prove this, the IPCS must lie between the non-parametric 90% confidence interval. The simulations and tests¹¹ were performed with data from Economatica (2012) and presented in a MXN base.

RESULTS AND DISCUSSION

In order to discuss the results that will prove the general hypothesis, it is necessary to observe the performance (ex post performance) of the three indexes in figure 1 (first test). As noted, the IPCS showed a better performance despite the financial and economic events in the 2008-2009 and 2010-2011 periods (i.e. the financial turmoil and global recession -2008 to 2009- and the impact of credit and economic events in the Euro area and the US -2010 to 2011-).

[Figure 1 lies here]

¹⁰ We excluded the IPC index in this test because this index is a Large cap index and, as consequence, has no mid or small cap stocks as members.

¹¹ The data and the MATLAB application are available at [author's web site if the paper accepted] upon request.

Figure 2 presents the daily returns determined with (1) and Figure 3 shows the historical 30-day standard deviation calculated with (2). As noted in both Figures, the IPC index has a more unstable behavior (more volatile) than the other two indexes. Among the possible explanations of this issue are 1) the IPC index is the most influential and most used benchmark in the Mexican Stock Market and 2) is a large cap (blue chip) index, suggesting a potential lack of diversification against the IPCcomp that invests in small, mid and large cap stocks. This leads to note that this index could not be as efficient as expected, strengthening the conclusions of Martinez, De la Torre and Bilbao (2010) and De la Torre and Martínez (2013a, 2013b), who proved the mean-variance inefficiency of the IPC index as a proxy of the market portfolio.

[Figure 2 lies here]

[Figure 3 lies here]

As mentioned previously, the IPCS and IPCcomp share a similar behavior and also similar volatility levels, a result that, as presented in Figure 3, suggests similar mean-variance efficiency (Sharpe ratio) levels as shown in Figure 4. In that figure, the historical Sharpe ratios share similar level in these two indexes and, as expected, the IPC index has more volatile values. Despite this issue, the one-way ANOVA test in Table 1 shows that the Sharpe ratio levels are statistically equal, a result that is consistent with the results of Statman (2000) and Schröder (2004, 2007). In spite the fact that these authors used another performance measure, this first result gives a first hint about the mean-variance efficiency of the Mexican sustainability index.

To confirm this result we complemented this third test with a long sample coupled Neyman-Pearson test. We used a two-tail 95% confidence interval, for the pairs given in table 2. As noted, the results in each pair accept the null hypothesis of equality in the Sharpe ratio levels.

In order to strengthen this efficiency result we also ran, as a fourth test, a one-factor model for the IPCS daily returns against the IPC and IPCcomp indexes and used the Jensen's Alpha as performance measure. To do so, we ran the one market factor regression model presented in (3) and present the analysis in Table 3.

The results in Table 3 reveal that the standard CAPM R-squared statistic has an important value (more than 0.90) and the beta value close to 1 is significant, suggesting an influence of this index in the IPCS and a practically equal behavior. Following this, it is noted that the IPCS has no significant Jensen's alpha (a probability of 14.02%) and therefore, there's no extra return (over-performance) in this investment style against the broad market one.

With the beta value of almost 1 in table 3, an interesting question comes across: we are assuming that the socially responsible investment (SRI) or the IPCS is preferable than the broad market one. But

can we use either the broad market or the SI investment indistinctly as investment style? i.e. Can we use SRI without a loss of performance against the IPCS? In order to answer this question, we used the Huberman and Kandel (1987) spanning test as in Schröder (2007). Table 4 shows the results accepts the null hypothesis $H_0: \beta = 0, \alpha = 1$ i.e. the IPCS and the IPCcomp have similar mean-variance efficiency and there are no extra returns in the IPCS against the IPCcomp. By accepting the spanning test¹², the IPCcomp and the IPCS can be used indistinctly in Mexico i.e. we can use a SRI strategy without the loss of performance against the IPCcomp by the fact that the latter can replicate the former.

Given the observed results, a natural question comes up: What are the drivers or factors that cause the statistical equality in the mean-variance efficiency in both indexes?

In order to give a first answer, we could have used the Carhart (1997) model as in Bauer, Koedjik and Otten (2005), or Scholtens (2005) but, unfortunately, there are no value or growth investment style indexes in Mexico, this being one of the most important drawbacks of the present paper. In order to solve this situation, we constructed a large, mid and small-cap multi-factor model for each of the IPCS and IPCcomp indexes. We excluded the IPC because it is a large cap (blue chip) stock index and the regression values weren't significant. For this last purpose we used the least squares regression model in (4).

Table 5 and 6 presents the regression values for the IPCS and IPCcomp respectively and show that the three factors and the alpha are statistically significant, suggesting that, by the fact that the IPCcomp is a broad market index with large, mid and small stocks, this three investment styles have a strong influence in the performance of both indexes. This results prove that the IPCS and the IPCcomp do not present market cap (small, mid or large) investment concentration.

From these two tables it is important to note that the IPCS has more favorable influence from this factors by the slightly higher negative influence of the small cap factor (-0.516 v.s. -0.465 of the IPCcomp). This last statement implies that when the broad market falls by the influence of negative external shocks, the IPCS is more stable than the IPCcomp because the small cap stocks (usually less liquid) have a higher offset effect.

Following this result and in order to answer the question "Will we see a higher performance of the SI investment in Mexico against the broad market one?" we run, as a sixth and final test, a daily five-year Monte Carlo simulation and we calculated a 90% non-parametric confidence interval of the IPCcomp performance¹³. This is done in order to estimate the future performance of the three indices.

¹² Contrary to Schröder (2004) results in several non-Mexican markets.

¹³ We used the standard assumption of a discrete geometric Brownian motion in the generating stochastic process in order to simulate the random paths.

The results are displayed in figure 5 and show that the IPCS (the boldest grey line) has statistically equal but slightly (non statistically significant) superior performance in an ex-post and ex-ante context, suggesting that even if its value lies within the upper and lower non-parametric limits (proving statistical equality), its simulated behavior is more preferable than the blue chip IPC or the IPCcomp indexes.

Up to this point we have performed six tests that lead to observe that the sustainable investment in Mexico is as mean-variance efficient as the broad market one. We resume our results next:

1. The performance of the IPCS is, ex post, marginally (but not statistically) higher than the IPC and the IPCcomp and the risk levels in the sustainable investment (IPCS) are practically the same than the broad market strategy if we use the IPCcomp as a proxy.
2. The results also suggest that there's no over-performance if we use the Sharpe ratio and the Jensen's alpha measures.
3. Despite the previous result, the spanning tests suggest that the IPCS and the IPCcomp share practically the same performance but it is possible to use the SRI as substitute investment strategy without the loss of performance against the broad market one.
4. A multifactor model with large, mid and small cap indexes as regressors suggest that the IPCS and IPCcomp do not present any concentration in any of these market-cap stocks and show that the SRI has an offsetting (positive) behavior with the small cap factor in moment of equity distress.
5. The Monte Carlo simulation confirms the observed ex post results: there is statistical equality between the SRI and the broad market strategy and there's no loss of performance in the long term.

CONCLUDING REMARKS

The results from our tests lead to a similar conclusion in almost all the studies presented in the literature review: Socially Responsible Investment (SRI) in Mexico is as mean-variance efficient as the common broad market one. In this paper we present one of the first studies about the efficiency of the sustainable investment in Mexico and we observe that despite the fact that our general hypothesis is proved, we support the use of SRI due to its social, economic and environmental scope and because we didn't find evidence of a loss of performance (mean-variance efficiency) against the broad market strategy in the long term.

To support our conclusions, we tested the IPC sustainability (IPCS), the IPC (blue chip and large cap) and the IPCcomp (broad market) indexes by using the Sharpe ratio and the Jensen's alpha in a standard CAPM model. We also used a spanning test of the same CAPM model, a multi-factor model

for the market cap investment style, and a Monte Carlo simulation. The results allow us to conclude that even if the IPCS had higher volatility levels than the broader IPCcomp, both indexes had a similar mean-variance efficiency and performance.

To support these results, we applied the Huberman and Kandel (1987) Spanning test ($H_0: \beta = 0, \alpha = 1$) and a Monte Carlo Simulation in order to prove that the SRI in Mexico (proxied with the IPCS) has an equal performance as the broad market one (IPCcomp), leading us to our final conclusion about the practice of socially responsible: “SRI is appropriate in the long term for the asset allocation step of Mexican institutional investors, like pension plans or similar, by the fact that the mean-variance efficiency of this strategy is statistically equal than the broad market one, leading to a better social, economic and environmental (socially responsible) development in Mexico”.

As guidelines for further research a more robust Monte Carlo simulation and a more detailed review of the factors that cause the mean-variance efficiency equality could be in the agenda. This could lead, as a parallel result, to create growth and value stock indexes in Mexico, along with the review of the proper broad market index proxy as necessary tasks.

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Table 1: One way ANOVA test results of the historical Sharpe ratios.

Source	Squared sum	Degrees of Freedom	Mean squared	F Statistic	Prob>F
Columns	0.158	2	0.079	0.068	93.381%
Error	4040.748	3489	1.158		
Total	4040.907	3491			

This table shows the one-way ANOVA test of the historical Sharpe ratios and test the hypothesis that the Sharpe ratio levels are statistically equal. The high probability value at the upper right corner accepts this hypothesis. Source: Data from simulations.

Table 2: A Neymman-Pearson test for each pair of the IPCS minus either the IPC or the IPCcomp indexes.

Pair	Sample Mean	Standard error	Z statistic	Lower limit	Upper limit	Hypothesis test
IPCS-IPC	-0.005	0.044	-0.123	-1.960	1.960	H ₀ accepted.
IPCS-IPCcomp	0.011	0.008	1.352	-1.960	1.960	H ₀ accepted.
IPC-IPCcomp	0.016	0.044	0.366	-1.960	1.960	H ₀ accepted.

This table presents the results of the Neyman-Pearson test of three differences (or pairs) of the three studied indexes with a two tail 95% confidence interval. Source: Data from simulations.

Table 3: IPCS spanning test with the IPC index as market benchmark.

Coefficient	Value	t-Statistic	Probability
□	0.000	1.446	14.022%
□(IPCcomp)	1.101	11.941	0.000%
F Statistic	17,067.117	F probability	0.000%
R-squared	0.935	Model Std Error	0.001%

The table presents the results of the spanning test ($H_0: a=0, b=1$) for the IPCS index with the IPCcomp as market benchmark. (Nominal returns were used). Source: Data from simulations.

Table 4: Standard CAPM model of the IPCS with the IPC index as market benchmark.

Coefficient	Value	t-Statistic	Probability
□	0.001	2.325	2.686%
□□□□□□	-0.007	-0.300	38.126%
F Statistic	0.090	F probability	76.421%
R-squared	0.000	Model Std Error	0.017%

This table presents the statistic results of a single factor model of the IPCS returns with the IPC index as market portfolio or benchmark (Nominal returns were used). Source: Data from simulations.

Table 5: Standard CAPM model of the IPCS with the IPCcomp index as market benchmark.

Coefficient	Value	t-Statistic	Probability
□	0.000	1.446	14.022%
□(IPCcomp)	1.101	130.751	0.000%
F Statistic	17067.117	F probability	0.000%
R-squared	0.935	Model Std Error	0.001%

This table presents the statistic results of a single factor model of the IPCS returns with the IPCcomp index as market portfolio or benchmark (Nominal returns were used). Source: Data from simulations.

Table 6: IPCS spanning test with the IPC index as market benchmark.

Coefficient	Value	t-Statistic	Probability
□	0.001	2.325	2.686%
□(IPC)	-0.007	-43.547	38.126%
F Statistic	0.090	F probability	76.421%

R-squared	0.000	Model Std Error	0.017%
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The table presents the results of the spanning test ($H_0: a=0, b=1$) for the IPCS index with the IPC as market benchmark. (Nominal returns were used). Source: Data from simulations.

Table 7: Large, mid and small cap multifactor model for the IPCS.

Coefficient	Value	t-Statistic	Probability
α	0.001	2.933	0.547%
α_1 (IPCLC)	0.993	33.039	0.000%
α_2 (IPCMC)	0.229	6.473	0.000%
α_3 (IPCSC)	-0.516	-23.447	0.000%
F Statistic	995.458	F probability	0.000%
R-squared	0.715	Model Std Error	0.005%

This table presents the results of the large, mid and small multifactor model that will test the influence of these three investment styles in the performance of the IPCS index. (Nominal returns were used) Source: Data from simulations, Economatica and the Mexican Stock Exchange.

Table 8: Large, mid and small cap multifactor model for the IPCcomp.

Coefficient	Value	t-Statistic	Probability
α	0.000	2.740	0.944%
α_1 (IPCLC)	0.972	41.624	0.000%
α_2 (IPCMC)	0.123	4.463	0.002%
α_3 (IPCSC)	-0.465	-27.136	0.000%
F Statistic	1,380.135	F probability	0.000%
R-squared	0.777	Model Std Error	0.003%

This table presents the results of the large, mid and small multifactor model that will test the influence of these three investment styles in the performance of the IPCS index. (Nominal returns were used). Source: Data from simulations, Economatica and the Mexican Stock Exchange.

Table 9: A resume of the results found in the six tests performed.

Ex post tests			
Test	Indexes tested	Conclusion	Does the conclusion supports the SI strategy against a broad market one?
Performance and standard deviation visual comparisson	IPCS, IPCcomp, IPC	The IPCS has a higher performance than the IPC and the IPCcomp and the IPCS and IPCcomp have a similar risk level between them but a lower standard deviation than the IPC	Yes
Sharpe ratio ANOVA and N-P tests	IPCS, IPCcomp, IPC	The Sharpe ratios are statistically equal	No
Jensen's alpha standard CAPM test	IPCS, IPCcomp, IPC	The IPCS has no significant alpha against the IPCcomp and a significant one against the IPC (the regresssion IPCS-IPC is spurious)	No
Spanning test	IPCS, IPCcomp, IPC	Holds for the IPCS-IPC regression but it is rejected for the IPCS-IPCcomp one. The IPCcomp and the IPCS can be used indistinctly without the loss of performance.	Yes
Large, mid, small cap factor model	IPCS, IPCcomp	It suggests that the small-cap stocks causes a marginal better performance (not significant) in the IPCS against the IPCcomp.	Yes
Ex ante tests			
Test	Indexes tested	Conclusion	Does the conclusion supports the SI strategy against a broad market one?
Monte Carlo 90% non-parametric interval	IPCS, IPCcomp, IPC	The IPCS and IPC have a similar performance than the IPCcomp but the former has marginally higher results than the IPCcomp	Yes

This table resumes the conclusions of the six test performed to compare the mean-variance efficiency i.e. performance of the sustainable investment (IPCS) in the Mexican Stock Exchange against the IPCcomp and the IPC indexes that are considered as broad market proxies. Source: data from simulations and data from the Mexican Stock Exchange.

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