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Evaluating the tracking performance and tracking error of Hong Kong exchange-traded funds (ETFs)

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1. Introduction

The investment criterion for an exchange-traded fund (ETF) is simple - it aims to track the performance of an underlying market index. The ideal performance of ETFs is following Thus, it is believed that the ETF performance should follow an up- or downtrend of a particular index and provide a return as same as the index to investors. In 1993, the first ETF which tracks the S&P 500 index was launched and was named the S&P Depository Receipts. Over the past decadesSince then, ETFs have been an increasingly popular index trading investment product which is providing new choices for passive investment strategy to investors for diversification. throughout the world.

Prior academic studies and literature document the attractiveness of ETFs due to their low costs, potential tax efficiencies, and stock-like features - easy trading during trading hours and their ability to offer creative investment solutions (Leister, 2016). Given their passiveness as an investment, ETFs differ from mutual funds in terms of transparency as the specific stocks holding and subject matter is fully revealed by ETFsunlike a mutual fund, investors are aware of the specific stocks held by an ETF. The presence of ETFs within the investor's realm is increasingly growing, offering a medium for retail investors looking to participate in a tradable portfolio or basket products, and institutional investors exploring for sophisticated trading and hedging strategies. The flexibility of ETFs is high, where investors can short sell ETFs, write options and set trading market, limit, and stop-loss orders, coupled with their ability to be created on various assets and allow for leveraged or inverse exposures to the underlying index, undeniably places ETFs on the map for any general investor. Given the attractive properties of ETFs, many studies have explored the investment efficiency of ETFs, focusing on their performance and tracking error (TE). However, to this date it is seldom to

see a study focused on the Hong Kong ETF market. The objective of this research is to provide supplement and insight for ETFs investment advice for Hong Kong ETF market, thus, this study aims to fill that gap.

2. Methodology

The methodology is based on the mean-variance framework, the mean return from the data is used as return of ETFs, and the standard deviation is used to measure the total risk of portfolios. One way to compare the performance of an ETF is to examine its return and risk characteristics. I first evaluate the returns of the ETF and their underlying indexes from the ETF's inception date till current date, and then calculate the tracking error of the ETF. Using this information, I can observe Jensen's alpha and the market beta, coupled with the Sharpe ratio and information ratio to thoroughly examine the risk-adjusted performance of the ETFs. Finally, I compute the R-squared, a goodness-of-fit measure to measure the relationship between the ETF and its underlying index.

Return

Return computation is a way to track the performance of each ETF. If the returns of the ETF and the returns of its underlying benchmark index are the same, then the ETF tracks its underlying benchmark index perfectly.

$$R_{E,t} = \frac{P_{E,t} - P_{E,t-1}}{P_{E,t-1}} \qquad R_{i,t} = \frac{P_{i,t} - P_{i,t-1}}{P_{i,t-1}}$$

In this case, I use the prices at times t and t-1 to calculate the returns for both the ETF and its underlying benchmark index. Where $R_{E,t}$ is the return of the ETF and $P_{E,t}$ and $P_{E,t-1}$ are its prices at times *t* and *t-1*, respectively, whilst $R_{i,t}$ is the return of the underlying benchmark index and $P_{i,t}$ and $P_{i,t-1}$ are its prices at times *t* and *t-1*, respectively.

After calculating the returns of the ETF and the underlying index, I can compute other useful parameters to examine the return and risk characteristics of the ETF.

Tracking Error (TE)

$$TE = \sqrt{\frac{1}{n-1}\sum_{t=1}^{n}(R_E - R_i)^2}$$

The tracking error allows us to gather a rough idea of how well the ETF can track or mimic its underlying benchmark index – R_E represents the returns of the ETF and R_i represents the returns of the underlying benchmark index. It is defined as the divergence between the price behaviour of a portfolio, in this case the ETF, and the price behaviour of its underlying benchmark index. Tracking error is one of the most important measures used to assess the performance of a portfolio, as well as the ability of a portfolio or asset to generate excessive returns and beat the market or the benchmark. The lower the tracking error, the closer are the returns of the ETF to that of the index and vice versa.

Information Ratio (IR)

$$IR = \frac{R_E - R_i}{TE}$$

Information ratio represents the residual return of the managed ETF portfolio relative to its benchmarked index by every unit of tracking error – R_E represents the returns of the ETF and R_i represents the returns of the underlying benchmark index. Rather than using a risk-free investment for comparison purposes, the information ratio commonly measures the rate of return of a portfolio or stock against a benchmark index, thus it is usually used to evaluate the performance of a fund manager.

Jensen's alpha and beta coefficient

$$\alpha = R_E - \{R_f + \beta\left[R_i - R_f\right]\}$$

The first performance model I use is based on the classical capital asset pricing model (CAPM) developed by Sharpe (1964) and Lintner (1965). In this model, Jensen's measure, or

Jensen's alpha, is a risk-adjusted performance measure that represents the average return on a portfolio or investment per unit of systematic risk. Simply put, Jensen's alpha is the difference in how much a portfolio or in this case, the ETF returns versus the overall market. As defined above, R_E and R_i are the returns for the ETF and its underlying benchmark index, R_f is the daily risk-free rate proxy by the 3-month U.S Treasury bill rate. α represents the Jensen's alpha and β represents the beta of the ETF.

Beta (β)

$$\beta = \frac{Cov(R_E, R_i)}{Var(R_i)}$$

The aforementioned beta coefficient or market beta is a factor included in the capital asset pricing model (CAPM) – where $Cov(R_E, R_i)$ is the covariance of the returns of the ETF and its underlying benchmark index, and $Var(R_i)$ is the variance of the returns of the underlying benchmark index. It is widely accepted as an appropriate measure of the systematic risk - a measure of sensitivity or correlation of an asset or portfolio to movements in the overall market.

Sharpe Ratio (SR)

$$SR = \frac{R_E - R_f}{\sigma_E}$$

R_E represents the returns of the ETF, R_f is the risk-free rate measured by 3-month U.S Treasury bill rate, and σ_E is the standard deviation or volatility of the ETF.

Developed by Sharpe (1966), the Sharpe ratio is a well-known and well-reputed measure of risk-adjusted return on an investment or portfolio – used to evaluate the total performance of an aggregate investment portfolio or the performance of an individual stock compared to its

total risk. It is one of the characteristics of ETFs used to hedge the market volatility, it has a positive relationship to ETF's risk-adjusted returns.

R-squared value

$$R^2 = 1 - \frac{RSS}{TSS}$$

R-squared or R^2 measures the relationship between a portfolio or in this case the ETF, and its underlying benchmark index – in which RSS represents the sum of squares of residuals, and TSS represents the total sum of squares . It is expressed as a percentage from 1 to 100. R-squared is not a measure of the performance of a portfolio. Rather, it measures the correlation of the portfolio's returns to the underlying benchmark's returns.

3. Data and Results

As one of the leading ETF markets in Asia, the Hong Kong ETF market has grown more than threefold by AUM over the past 10 years (Securities and Futures Commission, 2018). This study examines five selected ETFs that track the most widely quoted indices in Hong Kong; namely Hang Seng Index, the recently incepted Hang Seng TECH Index, and the Hang Seng China Enterprises Index. The Hang Seng Index or HSI, is one of the earliest stock market indexes in Hong Kong - the HSI has become the most widely quoted indicator of the performance of the Hong Kong stock market. Recently launched this year, the Hang Seng TECH Index represents the 30 largest technology companies listed in Hong Kong that have high business exposure to technology themes such as cloud computing, e-commerce, and fintech. The Hang Seng China Enterprises Index serves as a benchmark that reflects the overall performance of Mainland securities listed in Hong Kong.

Amongst the five selected ETFs, two that track the Hang Seng Index, two that track the Hang Seng TECH Index, and one that tracks the Hang Seng China Enterprises Index will be examined

Figure 1. List of exchange-traded funds (ETFs)

ETF Name	ETF Inception Date	Ticker Symbol	Underlying Index
Tracker Fund	11/11/1999	2800.HK	Hang Seng Index
Hang Seng Index ETF	13/9/2004	2833.HK	Hang Seng Index
iShares Hang Seng TECH ETF	28/9/2020	3067.HK	Hang Seng TECH Index
CSOP Hang Seng TECH Index ETF	28/8/2020	3033.HK	Hang Seng TECH Index
HSCEI ETF	10/12/2003	2828.HK	Hang Seng China Enterprises Index

To give some brief background information on the ETFs I will examine, The Tracker Fund of Hong Kong launched the local exchange-traded fund industry in 1999. Today, it remains one of the largest and most liquid ETFs in Hong Kong. Managed by State Street Global Advisors, the Tracker Fund provides a cost-efficient mean of gaining exposure to Hong Kong equities for a range of investors, large and small. Moreover, the Hang Seng Index ETF is one of the earliest stock market indexes in Hong Kong and currently comprises 33 constituent stocks which are representative of the Hong Kong stock market. The launch of the iShares Hang Seng TECH ETF had prompted encouraging response from wealth clients and asset manager - the fund is the fourth ETF to track the in-demand Hang Seng TECH Index following the introduction of previous funds, notably the CSOP Hang Seng TECH Index ETF, which was the first ever ETF that tracked the Hang Seng TECH Index. Lastly, the widely-known HSCEI ETF, also named the H-Share ETF which aims to track the performance of the Hang Seng China Enterprises Index.

The data that will be collected include the daily closing price of the ETF and their underlying index, in which this will be collected from the period of Sept 28th 2020 to Nov 28th 2020. The reason for this specific period is because I want to ensure the consistency of sample size between each ETF, therefore, I must use the same timeframe that belongs to the ETF with the most recent inception date (iShares Hang Seng TECH ETF with the inception date 28th September 2020). Additionally, the risk-free rate is an important input in one of the most widely used finance models: the Capital Asset Pricing Model. Academics and practitioners tend to use either short-term Treasury bills or long-term Treasury bonds as the risk-free security without empirical justification. Thus, I will be following the convention by applying the U.S. 3-month treasury bill rate as my risk-free rate in my calculations. All raw data provided are collected from Yahoo! Finance, AAStocks, Investing.com, and the Federal Reserve Economic Data.

Underlying Index	**ETF Name**	**Mean (%)**	**SD (%)**	**Excess Kurtosis**	**Skewness**	**R-Squared**	**Jarque-Bera**
Hang Seng Index	Tracker Fund	0.1568	1.1766	4.8548	-1.2920	0.9341	59.2320
	Hang Seng Index ETF	0.2232	1.0459	1.2420	-0.1675	0.9713	3.2406
Hang Seng TECH Index	iShares Hang Seng TECH ETF	0.2349	2.1115	1.2684	-0.8214	0.9626	8.4358
	CSOP Hang Seng TECH Index ETF	0.2279	2.0743	1.6875	-0.7576	0.9834	10.0727
Hang Seng China Enterprises Index	HSCEI ETF	0.2187	1.0719	1.0357	0.4316	0.9812	3.5598

Figure 2. Descriptive statistics of exchange-traded funds (ETFs)

As shown above in Figure 2, I begin with analyzing various research instruments such as descriptive statistics consisting of mean, standard deviation, skewness, kurtosis, R-squared

value, and Jarque-Bera test to check normality of the data was applied. From the table, it can be inferred that the majority of the data is not normally distributed given most Jarque-Bera constants are larger than the Chi-squared value of 5.9915 at 2 degrees of freedom and 5% level of significance, this is rather expected considering that I utilized daily returns over a short time period. Furthermore, it can be found that ETFs that track the Hang Seng TECH Index attain the highest daily return mean, which is also where I can find the highest standard deviation as well. Interestingly, returns can vary even if the benchmarks of two ETFs are the same; for example for the Tracker Fund and Hang Seng Index ETF - I can see that the mean return vary significantly compared to their standard deviation, thus indicating that active portfolio management is applied in those ETFs. Different performances are shown even if they have the same underlying index, and in this case under the same index, investors can select their ETFs depending on their risk and return preferences. With an R-squared value above 0.9, all ETFs show a strong correlation to their underlying index, with CSOP Hang Seng TECH Index ETF and Tracker Fund displaying the strongest and weakest respectively. Most ETFs show a negative skewness, indicating that returns have a long left tail. All ETFs exhibit a positive excess kurtosis value, indicating that distribution was peaked relative to normal.

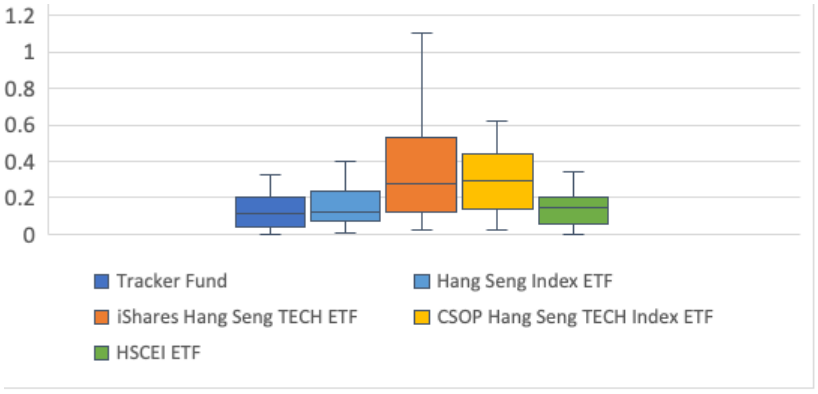
Underlying Index	**ETF Name**	**Tracking Error (%)**	**Information Ratio (%)**	**Sharpe Ratio**	**Jensen's Alpha**	**Beta**
Hang Seng Index	Tracker Fund	0.4227	-0.1329	-0.3787	-0.0445	1.0300
	Hang Seng Index ETF	0.2477	0.0008	-0.3626	-0.0181	0.9519
Hang Seng TECH Index	iShares Hang Seng TECH ETF	0.5868	-0.0105	-0.1741	-0.0393	0.9082
	CSOP Hang Seng TECH Index ETF	0.4018	-0.0328	-0.1806	-0.0452	0.9114

Hang Seng China Enterprises Index	HSCEI ETF	0.2173	-0.0333	-0.3580	-0.0390	0.9155

Figure 3. Statistical parameters of exchange-traded funds (ETFs)

Displayed in Figure 3, I first examined the tracking error and information ratio of the ETFs, in which I found that tracking error amongst all ETFs were relatively moderate, with HSCEI ETF exhibiting the lowest tracking error. Hang Seng Index ETF displayed the only positive information ratio compared to the rest, implying a degree of outperformance by the fund manager. It is ironically revealing that all ETFs have a negative Sharpe ratio and Jensen's alpha which indicate an overall underperformance as the risk-free rate is superior to the ETF's returns. Whilst it could be argued that investors would not invest in funds offering negative excess returns and hence the Sharpe ratio would provide no useful information in these situations, it can be interpreted that the Sharpe ratio should continue to be used even when excess returns are expected to be negative (McLeod & Vuuren, 2004). Lastly, beta results are all positive and close to 1, meaning that all ETFs perform considerably close to their underlying benchmark index.

Figure 4. Box plot of excess returns of exchange-traded funds (ETFs)



For further elaboration, I can visualise the tracking error of the ETFs by box plot shown by Figure 4 above, plotting the excess return (difference in the return of the ETF and its

underlying index) of each ETF in absolute value on a daily basis over my examined period. A higher active return of the ETF would indicate a rather poor performance of tracking its underlying benchmark. From the box plot, iShares Hang Seng TECH ETF is skewed most to the upper-end, coupled with the highest spread which means its excess return is on average the highest and varies the most, making it not an ideal selection amongst the others.

4. Summary & Conclusion

On the basis of overall analysis, it can be inferred that the majority of ETFs showed a degree of underperformance, especially highlighted by indicators like the Sharpe ratio and Jensen's alpha. As to the tracking error, some ETFs exhibit noticeable tracking errors whilst trying to replicate the performance of their underlying benchmark indices. With considerable levels of tracking errors, ETF investors should be aware that these ETFs perhaps may not be an ideal active trading vehicle (i.e day trading or high-frequency trading) and that ETF providers may look for guidance on where improvements may be possible. On average, the HSCEI ETF exhibited highest R-squared value and the lowest tracking error, displaying more ideal key characteristics compared to the other ETFs. Ultimately, individual and institutional investors tend to diversify their investments across different markets, thus the result of the study would be helpful for investors interested in portfolio diversification.

In terms of my limitations, one major limitation of my research is that due to restrictions, it only examined a considerably short period, so it would be interesting to include a longer timeframe to see if results would stay consistent, or even perhaps investigating a more specific period like the 2007-2008 financial crisis. Furthermore, another limitation is obviously the use of only Hong Kong equity funds. Hence, it would be useful to examine broader samples of ETFs from different geographic areas. In future research, it would be

interesting to investigate other more unorthodox measures of an ETF's investment efficiency – some investors may attach great importance to other features of the ETF, such as the expense ratio or liquidity (Hassine & Roncalli, 2013).

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