Impact of Currency Translation and Hedging on Portfolio Risk

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Investors often hold portfolios across multiple geographic markets. It is a common practice for portfolio managers to translate their foreign-currency portfolios to home currency in order to analyze the return and risk characteristics of their portfolios. Many portfolio managers also try to eliminate the foreign-exchange (forex) currency risk through forex-hedging mechanisms such as forwards, currency swaps, options, etc. The process of translating portfolio returns to home-currency returns has an impact on the total portfolio risk, typically measured using the standard deviation of returns. Considering a home-currency portfolio as a two-asset portfolio consisting of the foreign-currency portfolio and the foreign-currency risk, one would expect that in all instances where the foreign-currency portfolio returns are negatively correlated to the foreign-currency risk, the home-currency portfolio would exhibit lower volatility as compared with the foreign-currency portfolio. However, this is not always the case. Furthermore, it has also been observed that hedging currency risk at times increases the portfolio risk despite eliminating the risk arising from currency translations. This research aims to delve deeper into the mathematical foundation behind these observations.

Key Takeaways

► This research aims to explain the phenomenon wherein we observed a hedged-currency portfolio exhibiting higher volatility than an unhedged-currency portfolio.

► Currency hedging should not be viewed as a direct mechanism to reduce the total portfolio risk. The purpose of hedging currency risk should be thought of as a process to ensure that the risk of the home-currency portfolio closely mimics the foreign-currency portfolio, by eliminating the impact on risk contributed by currency translations.

► The unhedged home-currency portfolio experiences risk from three main sources: the inherent risk of the foreign-currency portfolio, the risk associated with forex-rate movements, and the risk resulting from the interaction between foreign-currency portfolio returns and forex-rate movements.

► The unhedged home-currency portfolio can be considered a combination of two assets: a foreign-currency portfolio and foreign-currency risk. In some cases, despite a negative correlation between foreign-currency portfolio returns and foreign-currency returns (calculated in terms of units of home currency per unit of foreign currency), one can observe the unhedged home-currency portfolio exhibiting higher risk than the foreign-currency portfolio.

► Finally, in all cases where the unhedged home-currency portfolio exhibits lower risk compared with the foreign-currency portfolio, hedging the forex risk will increase the volatility of the portfolio.

Background

Investors are not limited to local investments. With a wide variety of global avenues available, international investing is the norm for most institutional investors. The byproduct of international investing is that investors are exposed to inherent foreign-currency risk in their portfolios. Foreign-currency exposure can have a significant impact on a portfolio's risk and return characteristics. It is therefore prudent to understand the impact of this foreign-currency exposure on an investor's portfolio, especially when expressed in their home currency.

It is also common practice for investors to hedge their foreign-currency exposure with the intention to reduce the currency risk of their portfolios. However, hedging currency exposures can have varying impact on the investor's overall portfolio risk depending on factors such as the volatility of the foreign-currency portfolio, the volatility of the foreign-currency returns, and the correlation between the foreign-currency portfolio and the foreign-currency returns. It is not always the case that reducing currency risk via hedging results in reduced total portfolio risk.

To understand the impact of foreign-currency translation and hedging on total portfolio risk, we have analyzed hedged and unhedged variants of the following Morningstar Indexes in different currency combinations:
► Morningstar US Treasury Bond indexes in USD, AUD, and AUD hedged variants
► Morningstar US High-Yield Bond indexes in USD, CAD, and CAD hedged variants
► Morningstar US Wide Moat Focus indexes in USD, AUD, and AUD hedged variants

Our observations from this analysis are highlighted below.

Morningstar US Treasury Bond Index

The risk-return characteristics of the Morningstar US Treasury Index calculated in USD, AUD, and AUD hedge variants are shown in Exhibit 1.[1]

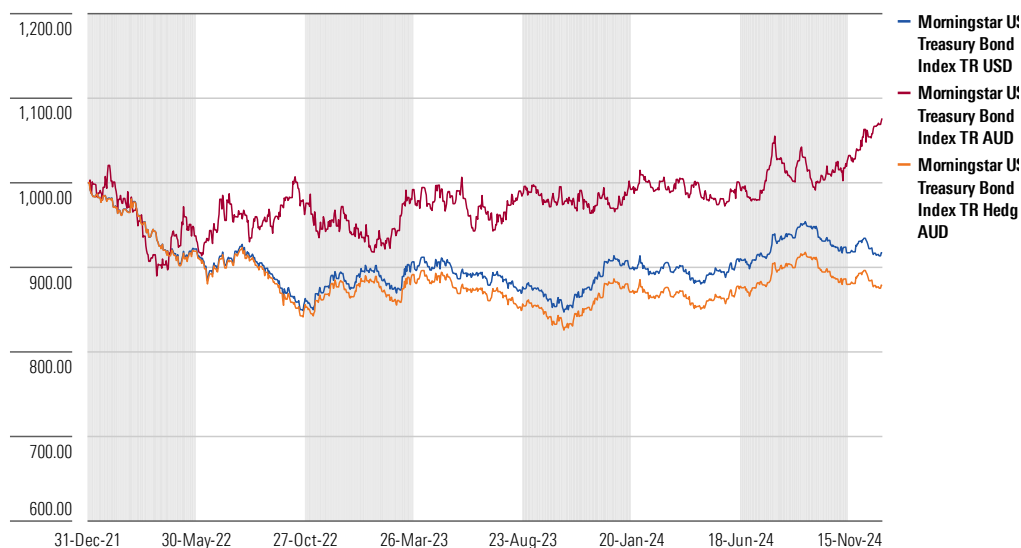**Exhibit 1** Risk-Return Characteristics of the Morningstar US Treasury Index

Parameters	Morningstar US Treasury Bond Index TR USD	Morningstar US Treasury Bond Index TR AUD	Morningstar US Treasury Bon Index TR Hedged AUD
Start Date	2021-12-31	2021-12-31	2021-12-31
End Date	2024-12-31	2024-12-31	2024-12-31
Return (%)	-2.86	2.48	-4.24
Risk (%)	6.64	8.52	6.63
Return/Risk	-0.43	0.29	-0.64
Sharpe-Ratio	-1.04	-0.19	-1.25

Source: Morningstar. Data as of Dec. 31,2024.

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1 Given Australian investors investing in the US, the AUD index is considered the home-currency portfolio, and the USD index is considered the foreign-currency portfolio.

The unhedged AUD variant of the Morningstar US Treasury Index exhibited much higher volatility than the USD variant, with the standard deviation of returns higher by approximately 200 basis points. Hedging the AUD currency risk helped reduce the portfolio risk of the unhedged AUD variant by about 200 basis points. The performance chart and correlation data are shown in Exhibits 2 and 3, respectively.

Exhibit 2 Performance Chart of the Morningstar US Treasury Bond Index

Legend:
— Morningstar US Treasury Bond Index TR USD
— Morningstar US Treasury Bond Index TR AUD
— Morningstar US Treasury Bond Index TR Hedged AUD

Source: Morningstar. Data as of Dec. 31, 2024.

Exhibit 3 Correlation Between Foreign-Currency Portfolio and the Forex Returns

Parameter	Value
Correlation between Morningstar US Treasury Bond Index USD and AUD/USD currency returns	-0.60

Source: Morningstar. Data as of Dec. 31, 2024.

The correlation between the returns of the Morningstar US Treasury Bond Index USD and the AUD/USD forex returns was negative 0.60, as can be seen from Exhibit 3. Despite the high negative correlations, it is observed that the AUD variant exhibited higher volatility. An interesting point to note is the significant difference in the returns between the home- and foreign-currency variants. This was because of the higher returns observed in the AUD/USD currency to the tune of about 5.80% annually, which helped elevate the unhedged portfolio returns.
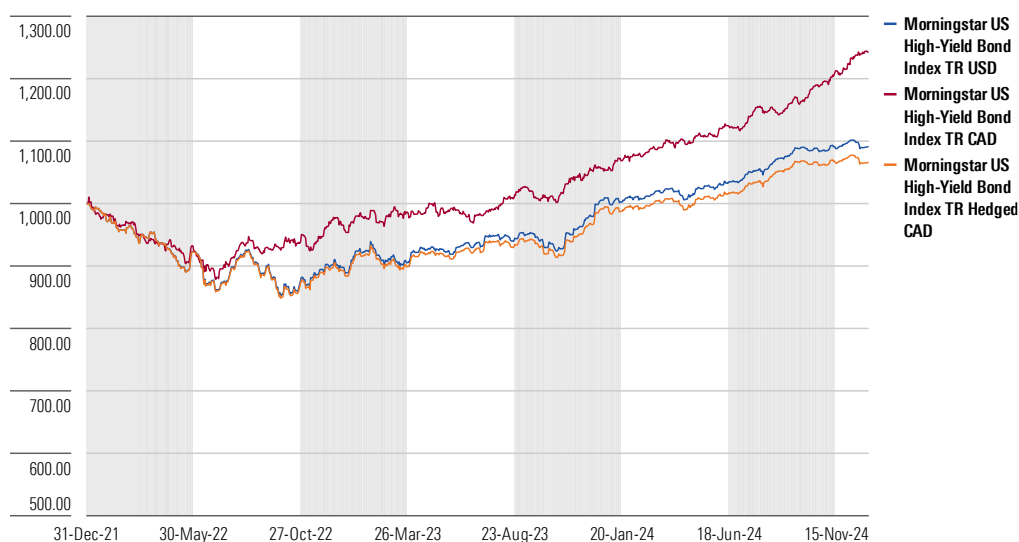
Morningstar US High-Yield Bond Index

The risk-return characteristics and performance chart of the Morningstar US High-Yield Bond Index calculated in USD, CAD, and CAD hedge variants are shown in Exhibits 4 and 5.[2]

Exhibit 4 Risk-Return Characteristics of the Morningstar US High-Yield Bond Index

Parameters	Morningstar US High-Yield Bond Index USD	Morningstar US High-Yield Bond Index CAD	Morningstar US High-Yield Bond Index Hedged CAD
Start Date	2021-12-31	2021-12-31	2021-12-31
End Date	2024-12-31	2024-12-31	2024-12-31
Return (%)	2.97	7.52	2.17
Risk (%)	8.54	6.49	8.55
Return/Risk	0.35	1.16	0.25
Sharpe-Ratio	-0.13	0.53	-0.22

Source: Morningstar. Data as of Dec. 31, 2024.

Exhibit 5 Performance Chart of the Morningstar US High-Yield Bond Index

Source: Morningstar. Data as of Dec. 31, 2024.

The unhedged CAD variant of the Morningstar US High-Yield Bond Index exhibited much lower volatility than the USD variant, with the standard deviation of returns lower by about 200 basis points. It is interesting to note that in this instance, hedging the currency risk has increased the volatility of the portfolio. The CAD-hedged variant exhibited a standard deviation of about 200 basis points higher than the unhedged CAD variant.

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2 Given Canadian investors investing in the US, the CAD index is considered the home-currency portfolio, and the USD index is considered the foreign-currency portfolio.

**Morningstar Wide Moat Focus Index**

The risk-return characteristics and performance chart of the Morningstar Wide Moat Focus Index calculated in USD, AUD, and AUD hedge variants are shown in Exhibits 6 and 7.[3]

Exhibit 6 Risk-Return Characteristics of the Morningstar Wide Moat Focus Index

Parameters	Morningstar Wide Moat Focus Index USD	Morningstar Wide Moat Focus Index USD Index AUD	Morningstar Wide Moat Focus Index Hedged AUD
Start Date	2021-12-31	2021-12-31	2021-12-31
End Date	2024-12-31	2024-12-31	2024-12-31
Return (%)	8.06	14.00	5.52
Risk (%)	19.3	13.92	19.3
Return/Risk	0.42	1.01	0.29
Sharpe-Ratio	0.21	0.71	0.08

Source: Morningstar. Data as of Dec. 31, 2024.

Exhibit 7 Performance Chart of the Morningstar Wide Moat Focus Index
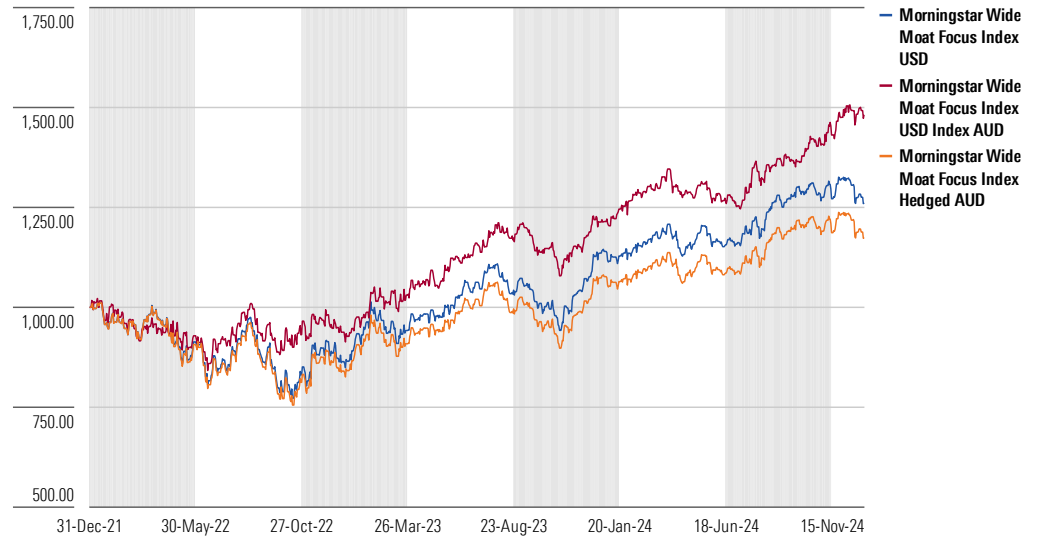
Source: Morningstar. Data as of Dec. 31, 2024.

3 Given Australian investors investing in the US, the AUD index is considered the home-currency portfolio, and the USD index is considered the foreign-currency portfolio.

The unhedged AUD variant of the Morningstar Wide Moat Focus Index exhibited much lower volatility than the USD variant, with the standard deviation of returns lower by about 500 basis points. Similar to what was observed earlier for the Morningstar US High-Yield Indexes, hedging the currency risk increased the volatility of the portfolio. The AUD-hedged variant exhibited a standard deviation of approximately 500 basis points higher than the unhedged AUD variant.

The following key highlights can be observed from the preceding analysis:

▶ The home-currency portfolio exhibited higher volatility despite the negative correlations between the foreign-currency asset and forex returns.

▶ Hedging currency risk may not always reduce portfolio risk. Hedging makes the home-currency portfolio resemble the foreign-currency portfolio, which can be observed from the very close similarities in the risk between the hedged- and foreign-currency portfolios.

▶ When the home-currency portfolio exhibited higher volatility than the foreign-currency portfolio, hedging the currency risk reduced the portfolio risk.

▶ When the home-currency portfolio exhibited lower volatility than the foreign-currency portfolio, hedging the currency risk increased the portfolio risk.

Theoretical Foundation

The following section aims to provide a theoretical foundation to explain the observations stated earlier. Let's consider an unhedged home-currency portfolio as a two-asset portfolio as shown below:

▶ Foreign-currency portfolio

▶ Forex rate (in terms of home currency per unit of foreign currency)

Considering this two-asset portfolio, the risk associated with the home-currency portfolio can be attributed to the following three sources of risk:

▶ Risk of the Foreign-Currency Portfolio: This source of risk will always have a positive impact on the risk of the home-currency portfolio. An increase in the foreign-currency portfolio risk will directly increase the volatility of the home-currency portfolio.

▶ Risk From Forex Rates: This source of risk will also always have a positive impact on the risk of the home-currency portfolio. An increase in the forex-rate risk will directly increase the volatility of the home-currency portfolio.

▶ Risk on Account of the Interaction Between Foreign-Currency Asset Returns and the Forex-Rate Returns: This source of risk can have either a positive or negative impact on the risk of the home-currency portfolio. This impact depends on the correlation between the foreign-currency asset portfolio returns and the forex-rate returns. Most literature highlights that a negative correlation would reduce the home-currency portfolio returns and vice-versa. However, as observed in Exhibit 1, a negative correlation does not ensure a reduction in home-currency portfolio risk. This phenomenon will be further delved into in the subsequent sections.

Exhibit 8 Sources of Risk in Home-Currency Portfolio
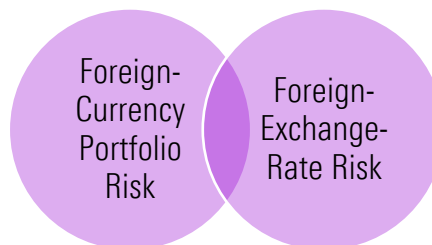
Source: Morningstar. Data as of Dec. 31, 2024.

Under the assumption of perfect forex markets with no lag, the act of hedging currency risk should eliminate both, the risk arising on account of forex rates and the interaction between the foreign-currency portfolio and the forex rates. This should imply that the hedged home-currency portfolio should exhibit risk characteristics similar to the foreign-currency portfolio.[4] This can be observed in Exhibits 1, 4, and 6, where the hedged home-currency portfolio has similar volatility as that of the foreign-currency portfolio (USD portfolio).

Another approach to understanding this observation would be to compare the returns of the hedged-currency portfolio and the foreign-currency portfolio. The hedged-currency portfolio would theoretically be equal to the aggregate of the return on the foreign-currency portfolio and the interest-rate differential that is incorporated into the forward currency rates due to the covered interest-rate parity.

$$R_{Hedged\ Portfolio} = R_{FC} + \Delta(r_H - r_F) \qquad\qquad (1)$$

Where:

$R_{Hedged\ Portfolio}$ = Return on hedged-currency portfolio

R_{FC} = Return on asset in foreign currency

r_H = Interest rate in the home country

r_F = Interest rate in the foreign country

Since the interest-rate differentials are slow-moving, these can be considered as a constant for short periods. Hence, the risk calculated as the standard deviation of returns would be equal for both the hedged-currency portfolio and the foreign-currency portfolio, as derived below.

$$\sigma(R_{Hedged\ Portfolio}) = \sigma(R_{FC} + \Delta(r_H - r_F)) \qquad\qquad (2)$$

$$\sigma(R_{Hedged\ Portfolio}) = \sigma(R_{FC}) + \sigma(\Delta(r_H - r_F)) \qquad\qquad (3)$$

$$\sigma(R_{Hedged\ Portfolio}) = \sigma(R_{FC})^5 \qquad\qquad (4)$$

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4 The hedged home-currency portfolio exhibiting risk characteristics similar to the foreign-currency portfolio is based on the assumption of perfect hedging. This may not always be the case owing to slight imperfections in hedging mechanisms in the forex market.

5 The standard deviation of (X + Constant) is equal to the standard deviation of (X).

Accordingly, using equation (4), it can be concluded that in instances where the hedged home-currency portfolio exhibited higher volatility as compared with the unhedged-currency portfolio, the foreign-currency portfolio also exhibited higher volatility than the unhedged home-currency portfolio.

This lays the foundation for the mathematical approach elucidated in the next section to explain the phenomenon stated earlier.

Mathematical Foundation

We calculate the return and volatility of a two-asset portfolio as shown below:

$$R_P = w_1 r_1 + w_2 r_2 \tag{5}$$

$$\sigma_P^2 = w_1^2 \sigma_1^2 + w_2^2 \sigma_2^2 + 2 * \rho * \sigma_1 * \sigma_2 * w_1 * w_2 \tag{6}$$

Where:
R_P = Portfolio return
w_1 = Weight of asset 1
w_2 = Weight of asset 2
r_1 = Return on asset 1
r_2 = Return on asset 2
σ_1 = Standard deviation of returns of asset 1
σ_2 = Standard deviation of returns of asset 2
ρ = Correlation between returns of asset 1 and asset 2

However, the direct application of equations (1) and (2) is not possible for currency-translated portfolios. This is because the returns of a currency-translated portfolio are compounded returns as opposed to the arithmetic returns shown in equation (1). The return calculation is shown below:

$$R_{HC} = (1 + R_{FC}) * (1 + R_{FX}) \text{-} 1 \tag{7}$$

We can calculate the approximate value of R_{HC} as below:

$$R_{HC} \approx R_{FC} + R_{FX} \tag{8}$$

Where:
R_{HC} = Return on asset in home currency
R_{FC} = Return on asset in foreign currency
R_{FX} = Return on currency (forex rate in terms of home currency per unit of foreign currency)

Based on equation (4), the portfolio risk formula for the home-currency portfolio can be calculated by modifying equation (2) as follows:

$$\sigma_{HC}^2 \approx \sigma_{FC}^2 + \sigma_{FX}^2 + 2 * \rho * \sigma_{FC} * \sigma_{FX} \tag{9}$$

Where:
σ_{HC} = Standard deviation of returns of the home-currency asset
σ_{FC} = Standard deviation of returns of the foreign-currency asset
σ_{FX} = Standard deviation of returns of the forex-rate returns (forex rate in terms of home currency per unit of foreign currency)

This research aims to explain two key observations:

► The home-currency portfolio exhibited higher volatility as compared with the foreign-currency portfolio despite a negative correlation between the foreign-currency asset and the forex rates.

► The hedged home-currency portfolio exhibited higher volatility than the unhedged home-currency portfolio.

From the theoretical foundation laid out in the previous section, in perfect hedging, the volatility of the hedged home-currency portfolio can be equated to the foreign-currency portfolio. Therefore, to explain the empirical observations shown previously, one must look at the conditions required for the home-currency portfolio to exhibit lower volatility as compared with the foreign-currency portfolio, as shown below:

$$\sigma_{HC}^2 < \sigma_{FC}^2$$

Using equation (5):

$$\sigma_{FC}^2 + \sigma_{FX}^2 + 2 * \rho * \sigma_{FC} * \sigma_{FX} < \sigma_{FC}^2 \qquad (10)$$

$$2 * \rho * \sigma_{FC} * \sigma_{FX} < -\sigma_{FX}^2$$

$$\rho < -\sigma_{FX}/(2 * \sigma_{FC}) \qquad (11)$$

The inequality in equation (11) states the condition required for the unhedged home-currency portfolio to exhibit lower volatility than the foreign-currency portfolio.

The following conclusions can be arrived at from the inequality derived in equation (11):

► Since the standard deviation of foreign-currency portfolio returns and forex-rate returns will always be a positive value, the right-hand side of the inequality in equation (11) will always be a negative value.

► The correlation between the foreign-currency portfolio and forex rates needs to be negative for the home-currency portfolio to exhibit lower volatility compared with the foreign-currency portfolio.

► However, a negative correlation between the foreign-currency portfolio and forex rates is not sufficient for the home-currency portfolio to exhibit lower volatility. The correlation needs to be lower than the inequality value in equation (11). Negative correlations that do not satisfy the inequality will still lead to higher volatility of the home-currency portfolio.

► Since the volatility of the foreign-currency portfolio can be equated to the volatility of the hedged home-currency portfolio, the inequality in equation (11) also states the condition for the unhedged home-currency portfolio to exhibit lower volatility compared with the hedged home-currency portfolio.

Validation

This section aims to validate the results obtained in the previous section, using the same Morningstar Indexes.

The volatilities of the foreign-currency portfolio, unhedged home-currency portfolio, and hedged home-currency portfolio along with their correlations are shown below for three Morningstar Indexes. We also show the results for the calculation from equation (11).

Exhibit 9 Morningstar US Treasury Bond Index (Period: 31/12/2021 to 31/12/2024)

Parameters	Value
Foreign Currency Portfolio Standard Deviation	6.64%
Unhedged Local Currency Portfolio Standard Deviation	8.52%
Hedged Local Currency Portfolio Standard Deviation	6.63%
Foreign Exchange Rate Standard Deviation	11.11%
Correlation between Foreign Currency Portfolio & Foreign Exchange Rates	-0.60
Inequality Value (Equation 11)	-0.84

Source: Morningstar. Data as of Dec. 31, 2024.

Exhibit 10 Morningstar US High-Yield Bond Index (Period: 31/12/2021 to 31/12/2024)

Parameters	Value
Foreign Currency Portfolio Standard Deviation	8.55%
Unhedged Local Currency Portfolio Standard Deviation	6.50%
Hedged Local Currency Portfolio Standard Deviation	8.55%
Foreign Exchange Rate Standard Deviation	6.46%
Correlation between Foreign Currency Portfolio & Foreign Exchange Rates	-0.60
Inequality Value (Equation 11)	-0.38

Source: Morningstar. Data as of Dec. 31, 2024.

Exhibit 11 Morningstar Wide Moat Focus Index (Period: 31/12/2021 to 31/12/2024)

Parameters	Value
Foreign Currency Portfolio Standard Deviation	19.03%
Unhedged Local Currency Portfolio Standard Deviation	13.74%
Hedged Local Currency Portfolio Standard Deviation	19.04%
Foreign Exchange Rate Standard Deviation	10.78%
Correlation between Foreign Currency Portfolio & Foreign Exchange Rates	-0.71
Inequality Value (Equation 11)	-0.28

Source: Morningstar. Data as of Dec. 31, 2024.

We can make the following observations from the validation exercise, which are in line with the expected results:

▶ Exhibit 9 shows that for the US Treasury Index, the correlation between the foreign-currency portfolio and forex rates did not satisfy the inequality in equation (11). The home-currency portfolio exhibited higher volatility compared with both the foreign-currency portfolio and the hedged-currency portfolio.

▶ Exhibits 10 and 11 show that for both the Morningstar US High-Yield Index and the Morningstar Wide Moat Focus Index, the inequality from equation (11) was satisfied. The hedged home-currency portfolio exhibited higher volatility compared with the unhedged home-currency portfolio.

The above validations were performed as a point-in-time validation of the cumulative time series. To delve deeper into the history, we analyzed the Morningstar US High-Yield Bond Index since its inception in 1999. The standard deviation for the three index currency variants (unhedged home currency, hedged home currency, and foreign currency) is calculated based on the index's monthly returns, using a rolling three-year period. Exhibit 12 presents the analysis of the 265 months falling in the analyzed period.

Exhibit 12 Morningstar US High-Yield Bond Index Historical Validation (Period: 31/12/1999 to 31/12/2024)

Equation 11 Inequality	Hedge Portfolio Risk > Unhedged Portfolio Risk	Hedge Portfolio Risk < Unhedged Portfolio Risk	Total
Satisfied	141	0	141
Not Satisfied	10	114	124
Total	151	114	265

Source: Morningstar. Data as of Dec. 31, 2024.

We observe from Exhibit 12 that in all instances where the inequality is satisfied, the unhedged home-currency portfolio exhibited lower volatility as compared with the hedged home-currency portfolio, that is, hedging the currency risk in the portfolio increased the risk as compared with the unhedged home-currency portfolio. Similarly, in most instances where the inequality was not satisfied, the home-currency portfolio exhibited higher volatility as compared with the hedged home-currency portfolio. We observed only 10 instances in the 25-year history where the hedged portfolio exhibited higher volatility than the unhedged portfolio despite the inequality not holding true. On closer examination, we observed that in these 10 instances, the risk of the hedged portfolio only marginally exceeded the risk of the unhedged portfolio (by a maximum of 25 basis points) and occurred between the period 1999 and 2004. We did not observe any such instances after 2004. These instances are caused because of the imperfections in hedging mechanisms in the forex market.

We also carried out a similar analysis on the Morningstar US Treasury Bond Index from its inception in 1999.

Exhibit 13 Morningstar US Treasury Bond Index Historical Validation (Period: 31/12/1999 to 31/12/2024)

Equation 11 Inequality	Hedge Portfolio Risk > Unhedged Portfolio Risk	Hedge Portfolio Risk < Unhedged Portfolio Risk	Total
Satisfied	0	0	0
Not Satisfied	0	265	265
Total	0	265	265

Source: Morningstar. Data as of Dec. 31, 2024.

From Exhibit 13, it is observed that throughout the 25-year history, the hedged home-currency portfolio always exhibited lower risk as compared with the unhedged home-currency portfolio, that is, hedging the currency risk in the portfolio helped in reducing the risk as compared with the unhedged home-currency portfolio. In all these instances, we observed that the inequality in equation (11) was not satisfied as expected.

Conclusion

Investors who wish to hedge the currency risk of their portfolios should be aware that reducing currency risk does not necessarily reduce total portfolio risk. This analysis has shown that:

▶ An investor's home-currency portfolio can exhibit significantly higher volatility compared with the foreign-currency portfolio despite a negative correlation between the foreign-currency portfolio returns and the forex rates. This will occur whenever the inequality in equation (11) is not satisfied.

▶ Hedging currency risk can increase the volatility of the portfolio. This will occur whenever the inequality in equation (11) is satisfied.

▶ The impact of currency translation and hedging on portfolio risk is asset class-agnostic.

About Morningstar Indexes

Morningstar Indexes was built to keep up with the evolving needs of investors — and to be a leading-edge advocate for them. Our rich heritage as a transparent, investor-focused leader in data and research uniquely equips us to support individuals, institutions, wealth managers and advisors in navigating investment opportunities across major asset classes, styles and strategies. From traditional benchmarks and unique IP-driven indexes, to index design, calculation and distribution services, our solutions span an investment landscape as diverse as investors themselves.

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