Teaching and Experiment with Global Currency–Hedging Strategies

Shanhong Wu

ABSTRACT

This paper presents a method in teaching currency hedging, in which we incorporate a novel strategy recently published in the Journal of Finance (Campbell et al. 2010). We design a project to implement a simple and intuitive version of the strategy that can help students deepen their understanding of diversification and currency hedging. By doing the project, students will learn how to execute the strategy and understand the underlying factors that affect the results. The project also gives students good practice in data collection and analysis. It is a good example of incorporating more advanced academic findings into undergraduate finance education.

Introduction

Textbook materials usually lag behind the latest findings in the academic literature. While some up-to-date academic findings might be too theoretical or too technical for undergraduate finance students to comprehend, most findings are creative applications of fundamental finance principles and therefore worth introducing in entry-level finance classes. (For example, financial institution and markets)

It is well known that to achieve diversified investments, individuals invest in global assets and portfolios that will bring efficiency in mean-variance space. However, these portfolios are subject to foreign currency risk. Therefore, a well-planned profitable venture could become a loss due to exchange rate fluctuation.

A recent paper “Global Currency Hedging,” published in the Journal of Finance by Campbell, Medeiros, and Viceira (2010), is an excellent example of a novel application of mean-variance efficiency and currency hedging. When teaching topics of diversification and currency risk management, we introduce the basic idea of Campbell et al.’s hedging strategy. We have also designed a project that allows students to implement such a basic strategy with real data. This pedagogy is similar to the methods for deeper learning suggested by Theodore and Miller (1997); Hull, Kwak, and Walker (2008); Mitchell et al.,

1 Department of Accounting, Economics and Finance, College of Business, University of Arkansas at Fort Smith, 5210 Grand Avenue, Fort Smith, AR 72913. (479)788-7764, Sharon.wu@uafs.edu. I would like to thank Richard Cebula and Robert Boylan for comments and helpful suggestions on previous drafts of this paper. I also would like to thank Bill Yang and a referee for helpful advice in revising the paper.
In the project, students are given the scenario that investors from Australia, the euro-zone, Canada, Japan, Switzerland, and the United Kingdom want to invest in the U.S. stock market. They must decide whether they should hedge their dollar position exposure and, if so, how much exposure they should hedge. In the project, students use Campbell, et al. strategies to develop an optimal currency exposure. The strategy takes into account the correlation between foreign exchange return and portfolio return. In the project, students collect the time-series data on foreign exchange rates, interest rates, and stock market returns and then run regressions to estimate the optimal dollar exposure. They evaluate portfolio performance from different hedging strategies by comparing the portfolio mean return, standard deviation, and the Sharpe ratio. The project allows students to acquire a deep understanding of concepts such as diversification, asset return correlation, currency exposure, currency hedging, efficient mean-variance portfolio, and the Sharpe ratio. It also allows students to practice data collection, analysis, and statistical software use. Equally important, students obtain a better understanding of theoretical strategies. The project helps students learn how to implement a strategy, the types of variables that could influence the result, and the type of underlying assumptions needed for the theoretical strategy to work.

Review Concepts of Diversification and Currency Hedging

Campbell, et al.’s (2010) results involve the comprehensive application of diversification and currency hedging. Their currency hedging strategies provide many teaching points that are conceptually important and practical.

Diversification, Correlation, and Risk Return Trade-Off

Because diversification and portfolio risk are important topics in investments, a quick review of the concept of the Markowitz efficient frontier is necessary here. We emphasize that, given the expected returns and standard deviation on the two assets, the shape of the investment opportunity set will depend on the correlations. The lower the correlation, the greater the possibility of a lower standard deviation portfolio.

Currency Hedging

Foreign exchange risk is a common topic in financial markets and institutions. It is worth going over with students the concepts of net currency exposure and forward-hedging strategies. Strategies using forward or futures contracts generally assume a fully hedged position with no net exposure to foreign currency. In theory, a fully hedged position is suboptimal since it ignores correlations between

---

2 Many investment textbooks cover this topic. It would be helpful to review the topic quickly with students before the project. We usually teach material from Jordan and Miller “Fundamentals of Investments – Valuation and Management,” 5th ed.

exchange rates and local returns.

Under the mean-variance optimization framework, empirical evidence supports that adding currency hedges to the menu of assets improves the performance of diversified portfolios of stocks and bonds.

**Overview of the CMV Strategy**

In their research, Campbell, et al. (2010) considered strategies for global equity or bond investors by taking into account the co-movement between some currencies and world equity or bond markets. The strategy is attractive to risk-minimizing global equity or bond investors.

**Principle**

The principle of CMV’s strategy is simple:

“If stock returns and exchange rates are positively correlated, the foreign currency tends to depreciate when the stock market falls. Thus, the investor can reduce portfolio return volatility by overhedging, that is, by shorting foreign currency in excess of what would be required to fully hedge the currency exposure implicit in her stock portfolio. Conversely, a negative correlation between stock returns and exchange rates implies that the foreign currency appreciates when the stock market falls. In this case the investor can reduce portfolio return volatility by underhedging, that is, by holding foreign currency.” (Campbell, et al. 2010, p.97)

**Unconditional Risk Management Currency Demand**

The CMV strategy offers a complex matrix derivation for general cases of optimal currency exposure. Here we present a simple case of using CMV strategy.

Consider that a domestic investor fully invests in a portfolio from country C (e.g., an investor from the euro-zone invests in a U.S. stock market index portfolio). In addition to the risk of the U.S. stock portfolio, the investor will also be subject to dollar exchange rate risk. Therefore, the investor should decide whether to hedge this currency risk and, if so, by how much. The goal is to achieve the mean-variance optimum of the overall portfolio. Using notation similar to the CMV strategy, the log portfolio excess return is approximately equal to

\[
\log \text{portfolio excess return} = (r_{t+1} - \mu) + \phi_t (\Delta S_{t+1} + \mu_t - \mu^d_t) + \frac{1}{2} \sum \sigma^2_t
\]

where \( r_{p,t+1}^h - \mu_t^d = (r_{t+1} - \mu) + \phi_t (\Delta S_{t+1} + \mu_t - \mu^d_t) + \frac{1}{2} \sum \sigma^2_t \) (1)

where \( r_{p,t+1}^h \) is the hedged portfolio log return, that is, \( r_{p,t+1}^h = \log(R_{p,t+1}^h) \) and \( R_{p,t+1}^h \) is the gross return of the hedged portfolio from the beginning to the end of period \( t+1; \mu_t^d \) is the log short-term nominal interest rate, that is, \( \mu_t^d = \log(1+I_t^d); I_t^d \) denotes the short-term nominal interest rate in the domestic country; \( r_{t+1} \) is the log return of the country C portfolio from the beginning to the end of period \( t+1; \mu_t \) is the log short-term nominal interest rate in country C; \( \Delta S_{t+1} \) is the change in log spot exchange rate,
that is, \( s_{t+1} = \log (S_{t+1}) \). \( S_{t+1} \) denotes the spot exchange rate in units of domestic currency per unit of foreign currency (the U.S. dollar in this case) at the end of period \( t+1 \).

Equation (1) provides an intuitive decomposition of the portfolio excess return. The first term represents the excess return on a fully hedged portfolio that has no exposure to currency risk (in this case, only U.S. stock portfolio risk). The second term involves the excess return on currencies; the net currency exposure is given by \( \varphi_t \). The third term is a Jensen’s inequality correction. Therefore, if \( \varphi_t = 0 \), then it corresponds to a fully hedged currency position in which the investor does not hold any exposure to currency from country C. When \( \varphi_t = 1 \), the portfolio is completely unhedged. The other values of \( \varphi_t \) mean that the investor holds some exposure to country C currency or in other words, that the investor does not fully hedge the currency exposure implicit in his/her position in country C.

The CMV strategy shows that \( \varphi_t \), which minimizes the one-period global variance of the log excess return on the hedged portfolio, is equal to

\[
\varphi^*_t = \frac{-\text{Var}_t \left( \Delta s_{t+1} + \bar{r}_t - \bar{r}_t^d \right) - \text{Cov}_t \left( (r_{t+1} - i_t), (\Delta s_{t+1} + \bar{r}_t - \bar{r}_t^d) \right)}{\text{Var}_t \left( \Delta s_{t+1} + \bar{r}_t - \bar{r}_t^d \right)}
\]

The subscription “RM” is added to emphasize that equation (2) describes risk management currency demands or simply to represent optimal currency exposure.

\( \varphi^*_t \) can be estimated by regress invested portfolio excess returns \( r_{t+1} - i_t \), on the currency excess returns \( \Delta s_{t+1} + \bar{r}_t - \bar{r}_t^d \) and switching the sign of the slopes.

**Interpretation of Optimal Hedging Strategy**

The CMV strategy can apply to three types of investments:

(a) A domestic investor invested in a single foreign country portfolio (e.g., stock or bond portfolio) and either over- or under hedging invested country currency to reduce the invested portfolio risk.

(b) A domestic investor invested in a single foreign country portfolio (e.g., stock or bond portfolio) and using a whole range of currencies (not limited to domestic and invested country currencies) to reduce the invested portfolio risk.

(c) A domestic investor invested in a global portfolio (e.g., equally or value-weighted multiple countries portfolio) and using a whole range of currencies to reduce the invested portfolio risk.

Campbell, et al. (2010) estimates the optimal currency hedging parameter using data from 1975 to 2005. We pick three examples from Table III and IV in Campbell, et al. (2010) to illustrate the currency hedging strategies. These examples cover the above three types of investment. However, it is worth to note that the optimal exposure might be sample-specific, the idea behind derivation is consistent. Table 1 lists the results to be interpreted in the following text.

---

4 The calculation of Jensen’s inequality correction follows the spirit in Campbell, et al. (2010):

\[
\sum_{\varphi} = \text{Var}_t \left( r_{t+1} + \Delta s_{t+1} \right) - (\varphi_t + 1) \left( \text{Var}_t (\Delta s_{t+1}) \right) - \text{Var}_t (r_{t+1} + i_t - i_t) + \varphi_t (\Delta s_{t+1} + i_t - i_t)
\]
Table 1: Interpretation of currency hedging strategy (Campbell, Medeiros, and Viceira, 2010)

<table>
<thead>
<tr>
<th>Interpretation</th>
<th>Stock Market</th>
<th>Currency</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Euro</td>
</tr>
<tr>
<td>(1)</td>
<td>Australia</td>
<td>0.39</td>
</tr>
<tr>
<td>(2)</td>
<td>Euroland</td>
<td>0.42</td>
</tr>
<tr>
<td>(3)</td>
<td>Equally Weighted Global Equity</td>
<td>0.32</td>
</tr>
</tbody>
</table>

Notes:
The numbers are picked from Campbell, Medeiros, and Viceira (2010) table III and IV.

"Euroland" stock market is defined as a value-weighted stock basket that includes Germany, France, Italy, and the Netherlands.

"Equally weighted global equity" is the case, in which investors are equally invested in seven stock markets:
Euroland, Australia, Canada, Japan, Switzerland, the United Kingdom, and the United States

Example Interpretation 1

Situation. A euro-zone investor fully invests in an Australian stock market portfolio and has access to the Australian dollar and the euro.

Correlation. The foreign currency, the Australian dollar, tends to depreciate when its stock market falls, in other words, the positive correlation exists.

Optimal hedging interpretation. The investor should buy a portfolio of euribills worth 1.39 euros per euro invested in the Australian stock market. He could finance this long position with a short position in Australian bills—that is, by borrowing Australian dollars. Hence, the investor should overhedge the Australian dollar exposure implicit in his Australian stock market investment and hold a net long 39% exposure to the euro.

Example Interpretation 2

Situation. A risk-minimizing investor holds a Euroland stock portfolio and has access to seven currencies.

Correlation. Some available currencies are positively correlated with the Euroland stock market, and some are negatively correlated. For instance, the euro tends to appreciate when the Euroland stock market falls (negative correlation), and the Australian dollar tends to appreciate when the stock market rises (positive correlation).

Optimal hedging interpretation. Net short exposures should be held for positively correlated currencies, and net long exposures should be held for negatively correlated currencies. Specifically, the investor should invest 78 euro cents in currencies for each euro invested in the stock portfolio. These 78 euro cents should be invested in euro bills worth 42 euro cents, Swiss bills worth 34 cents, and U.S. bills worth 2 euro cents. These purchases could be financed with proceeds from borrowing Australian dollars (10 euro cents),

---

1 In Campbell, et al. (2010), “Euroland” stock portfolio is defined as a value-weighted stock basket that includes Germany, France, Italy, and the Netherlands.

2 The seven currencies are Australia dollar, Euro, Canadian dollar, Japanese yen, Swiss franc, British pound and U.S. dollar.
Canadian dollars (40 euro cents), Japanese yen (19 euro cents) and British pounds (9 euro cents).

**Example Interpretation 3**

**Situation.** A risk-minimizing investor holds an equally weighted seven-country equity portfolio and has access to currencies in seven countries.

**Correlation.** Some available currencies are positively correlated with the equally weighted equity portfolio, and some are negatively correlated. For instance, the euro tends to appreciate when the value of equity portfolio declines (negative correlation), and the Australian dollar tends to appreciate when the value of equity portfolio increases (positive correlation).

**Optimal hedging interpretation.** Net short exposures should be held for positively correlated currencies, and net long exposures should be held for negatively correlated currencies. Specifically, the investor should invest 99 euro cents in currencies for each euro invested in the stock portfolio. These 99 euro cents should be invested in U.S. bills worth 40 euro cents, euro bills worth 32 euro cents, and Swiss bills worth 27 euro cents. These purchases could be financed with proceeds from borrowing Australian dollars (11 euro cents per euro invested in the stock portfolio), Canadian dollars (61 cents), Japanese yen (17 cents), and British pounds (10 cents).

**Project to Implement Optimal Currency Hedging Strategy**

**Project Scenario**

To implement the CMV strategy, students are presented with the following scenario. Imagine investors from Australia, the euro zone, Canada, Japan, Switzerland, and the United Kingdom want to invest in a U.S. S&P 500 Index stock portfolio. The investors must decide whether they should hedge the exposure in U.S. dollars and, if so, how much dollar exposure they should hedge (i.e., optimal hedging exposure).

The major result is reported on an investment horizon of a quarter, as in Campbell et al. (2010). We also ask students to perform a similar procedure for investment horizons of one month, six months, and one year to see the effects of trading frequency.

**Data Collection**

To implement the CMV strategy, students have to collect the following data: a) the foreign exchange rate of the dollar against the currencies from six intended countries, including the euro-zone; b) the short-term nominal interest rate in the United States; and c) the short-term nominal interest rate in six domestic countries—Australia, the euro-zone, Canada, Japan, Switzerland, and the United Kingdom.

The foreign exchange rate data can be collected from the Federal Reserve Board’s H.10 release, which contains foreign exchange rates for over 30 world currencies and trade-weighted indices. The

---

1Investors are equally invested in the seven stock markets included in the Campbell, et al. (2010) analysis: Euroland, Australia, Canada, Japan, Switzerland, the United Kingdom, and the United States.
database carries all of these foreign exchange rates in currency units per U.S. dollar (e.g., yen/$), and a few are also available in “inverted form” (e.g., $/pound). In the project, the U.S. dollar is treated as a foreign currency, and the currencies from the other six countries are domestic. The foreign exchange rates in currency units per U.S. dollar are used.

U.S. short-term nominal interest rates are based upon the Federal Reserve Board’s H.15 release that contains selected interest rates for U.S. Treasuries, private money markets, and capital market instruments. All rates are reported in annual terms. For quarterly, monthly, six-month, and one-year investment horizons, students can pick secondary market Treasury rates for four-week, three-month, six-month, and one-year rates. For both foreign exchange rates and U.S. government bill rates, we pick monthly frequency data.

The short-term nominal interest rates for the six domestic countries are not easy to find. To solve this problem, students can simulate the rates based on the mean and standard deviation of log three-month government bill rates provided in Campbell, et al. (2010). Students have to realize that this would not change the procedure of implementing the strategy; it would only influence the correlation coefficient between the excess portfolio return and excess foreign exchange rate return.

The S&P 500 Index stock portfolio return data can be collected from Yahoo Finance. Students should pick monthly returns to match the sample frequency of foreign exchange and short-term nominal interest rates.

In order to be comparable to the CMV results, the project sample period is the same as Campbell et al. (2010). The statistics of variables in the project are presented in Table 2.

The dollar exchange rate differs across countries. Among these rates, the Japanese yen shows the most dramatic change with respect to the dollar. The standard deviation is about 38% of the mean value. The minimum value of the yen is about 306 yen per dollar and the maximum is about 84 yen per dollar. The other currencies are less volatile against the dollar; their standard deviations are in the range of 15% or less of the mean value.

The excess return of currencies is the log currency excess returns for an investor who borrows one of the six domestic countries’ currencies to hold the U.S. dollar bill. The excess returns to currencies are small on average, which is similar to Campbell et al. (2010).

**Estimating the Optimal Net Foreign Exchange Exposure**

Students need to compare the investment performance among three strategies: a) optimally hedged using the CMV strategy to find net exposure to the U.S. dollar; b) fully hedged corresponding to a net zero position in the U.S. dollar; and c) an unhedged position corresponding to a net long position in the U.S. dollar equal to the S&P 500 Index holding.

The first step is to estimate the CMV strategy’s optimal hedge coefficient by running the following regression:

\[ r_{t+1} - i_t = a + b (\Delta S_{t+1} + i_t - i_d^d) + \varepsilon_t \]  

\(^3\) Four-week, six-month and one-year rates are not as complete as three-month rates.
### Table 2: Statistics of data for global currency hedging project

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Mean</th>
<th>Median</th>
<th>Standard Deviation</th>
<th>Min</th>
<th>Max</th>
<th>Q1</th>
<th>Q3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia/$</td>
<td>368</td>
<td>1.288</td>
<td>1.313</td>
<td>0.299</td>
<td>0.746</td>
<td>1.994</td>
<td>1.047</td>
<td>1.461</td>
</tr>
<tr>
<td>Euro/$</td>
<td>84</td>
<td>0.957</td>
<td>0.942</td>
<td>0.130</td>
<td>0.746</td>
<td>1.173</td>
<td>0.833</td>
<td>1.088</td>
</tr>
<tr>
<td>Canada/$</td>
<td>368</td>
<td>1.287</td>
<td>1.274</td>
<td>0.147</td>
<td>0.972</td>
<td>1.600</td>
<td>1.180</td>
<td>1.381</td>
</tr>
<tr>
<td>Japan/$</td>
<td>368</td>
<td>164.979</td>
<td>133.671</td>
<td>62.308</td>
<td>83.690</td>
<td>305.670</td>
<td>116.451</td>
<td>225.003</td>
</tr>
<tr>
<td>Switzerland/$</td>
<td>368</td>
<td>1.687</td>
<td>1.558</td>
<td>0.406</td>
<td>1.138</td>
<td>2.805</td>
<td>1.396</td>
<td>1.903</td>
</tr>
<tr>
<td>United Kingdom/$</td>
<td>368</td>
<td>0.602</td>
<td>0.608</td>
<td>0.082</td>
<td>0.414</td>
<td>0.915</td>
<td>0.550</td>
<td>0.652</td>
</tr>
</tbody>
</table>

U.S. Treasury Secondary Market (%)

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Mean</th>
<th>Median</th>
<th>Standard Deviation</th>
<th>Min</th>
<th>Max</th>
<th>Q1</th>
<th>Q3</th>
</tr>
</thead>
<tbody>
<tr>
<td>4-Week</td>
<td>54</td>
<td>1.797</td>
<td>1.655</td>
<td>0.869</td>
<td>0.830</td>
<td>3.840</td>
<td>1.060</td>
<td>2.220</td>
</tr>
<tr>
<td>3-Month</td>
<td>368</td>
<td>6.014</td>
<td>5.485</td>
<td>3.086</td>
<td>0.880</td>
<td>16.300</td>
<td>4.345</td>
<td>7.740</td>
</tr>
<tr>
<td>6-Month</td>
<td>368</td>
<td>6.145</td>
<td>5.645</td>
<td>3.046</td>
<td>0.920</td>
<td>15.520</td>
<td>4.430</td>
<td>7.720</td>
</tr>
</tbody>
</table>

S&P 500 (log of 3-month gross return)

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Mean</th>
<th>Median</th>
<th>Standard Deviation</th>
<th>Min</th>
<th>Max</th>
<th>Q1</th>
<th>Q3</th>
</tr>
</thead>
<tbody>
<tr>
<td>366</td>
<td>2.136</td>
<td>2.219</td>
<td>7.325</td>
<td>-35.910</td>
<td>22.200</td>
<td>-1.633</td>
<td>6.910</td>
<td></td>
</tr>
</tbody>
</table>

Dependant and Independent Variable for Optimal Currency Exposure with 3-month Window

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Mean</th>
<th>Median</th>
<th>Standard Deviation</th>
<th>Min</th>
<th>Max</th>
<th>Q1</th>
<th>Q3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excess Return of S&amp;P 500 (%)</td>
<td>365</td>
<td>0.643</td>
<td>1.073</td>
<td>7.358</td>
<td>-37.409</td>
<td>19.402</td>
<td>-3.169</td>
<td>5.431</td>
</tr>
<tr>
<td>Excess Return of Currencies (%)</td>
<td>365</td>
<td>-0.192</td>
<td>-0.672</td>
<td>5.018</td>
<td>-12.584</td>
<td>21.117</td>
<td>-3.212</td>
<td>2.474</td>
</tr>
<tr>
<td>Australia</td>
<td>365</td>
<td>-0.016</td>
<td>-0.447</td>
<td>5.355</td>
<td>-12.500</td>
<td>9.815</td>
<td>-5.892</td>
<td>2.948</td>
</tr>
<tr>
<td>Canada</td>
<td>365</td>
<td>-0.258</td>
<td>-0.049</td>
<td>2.653</td>
<td>-10.777</td>
<td>6.310</td>
<td>-1.714</td>
<td>1.655</td>
</tr>
<tr>
<td>Japan</td>
<td>365</td>
<td>-0.187</td>
<td>0.175</td>
<td>6.029</td>
<td>-17.781</td>
<td>17.291</td>
<td>-4.027</td>
<td>4.143</td>
</tr>
<tr>
<td>Switzerland</td>
<td>365</td>
<td>0.136</td>
<td>0.435</td>
<td>6.240</td>
<td>-17.223</td>
<td>15.016</td>
<td>-4.174</td>
<td>4.349</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>365</td>
<td>-0.339</td>
<td>-0.481</td>
<td>5.359</td>
<td>-13.133</td>
<td>22.623</td>
<td>-3.619</td>
<td>2.686</td>
</tr>
</tbody>
</table>

Notes: Data are monthly. Coverage extends from 1975:7 to 2005:12. Euro is from 1999:1 to 2005:12

According to CMV, the negative of regression coefficient b is the optimal exposure φ in equation (1) (i.e., the U.S. dollar exposure).

For a quarterly investment window, monthly regressions are run on overlapping quarterly returns.

**Comparison of the Performance of Different Strategies**

After estimating the optimal dollar exposure, equation (1) is used to calculate excess return of three hedging strategies: a) CMV optimal hedge with the estimated φ value; b) the fully hedged strategy.
with \( \varphi = 0 \); and c) the unhedged strategy with \( \varphi = 1 \). The results are presented in Table 3.

**Table 3:** Regression results for optimal dollar exposure and mean return, standard deviation, and Sharpe ratio for three strategies: a) CMV optimal hedge, b) fully hedged strategy, and c) unhedged strategy

<table>
<thead>
<tr>
<th></th>
<th>Australia</th>
<th>Euro</th>
<th>Canada</th>
<th>Japan</th>
<th>Switzerland</th>
<th>United Kingdom</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regression Coeff.</td>
<td>-0.1495 **</td>
<td>0.1330</td>
<td>-0.7379 ***</td>
<td>-0.0636</td>
<td>0.1067 *</td>
<td>0.0344</td>
</tr>
<tr>
<td>CMV Coeff.</td>
<td>-0.1400 *</td>
<td>0.1900 *</td>
<td>-0.7700 ***</td>
<td>-0.0300</td>
<td>0.1900 **</td>
<td>0.0900</td>
</tr>
</tbody>
</table>

Mean Return (%)

<table>
<thead>
<tr>
<th></th>
<th>Hedged Portfolio</th>
<th>Fully Hedged</th>
<th>Unhedged</th>
<th>Diff. test of Mean Return (p-value)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia</td>
<td>0.6064</td>
<td>0.6149</td>
<td>0.4514</td>
<td>Hedge vs. Unhedge 0.7914</td>
</tr>
<tr>
<td>Euro</td>
<td>-0.6677</td>
<td>0.6904</td>
<td>-1.8516</td>
<td>Fully Hedged vs. Unhedge 0.7809 **</td>
</tr>
<tr>
<td>Canada</td>
<td>0.4475</td>
<td>0.5957</td>
<td>0.3857</td>
<td></td>
</tr>
<tr>
<td>Japan</td>
<td>0.6276</td>
<td>0.6276</td>
<td>0.4568</td>
<td></td>
</tr>
<tr>
<td>Switzerland</td>
<td>0.6604</td>
<td>0.6926</td>
<td>0.7790</td>
<td></td>
</tr>
<tr>
<td>United Kingdom</td>
<td>0.6684</td>
<td>0.6612</td>
<td>0.3050</td>
<td></td>
</tr>
</tbody>
</table>

Standard Deviation (%)

<table>
<thead>
<tr>
<th></th>
<th>Hedged Portfolio</th>
<th>Fully Hedged</th>
<th>Unhedged</th>
<th>Diff. test of Standard Deviation(p-value)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia</td>
<td>7.3198</td>
<td>7.3582</td>
<td>8.4732</td>
<td>Hedge vs. Unhedge 0.0054 ***</td>
</tr>
<tr>
<td>Euro</td>
<td>7.2648</td>
<td>7.3582</td>
<td>9.4654</td>
<td>Fully Hedged vs. Unhedge 0.0072 *** ***</td>
</tr>
<tr>
<td>Canada</td>
<td>7.0929</td>
<td>7.3582</td>
<td>7.1269</td>
<td></td>
</tr>
<tr>
<td>Japan</td>
<td>7.3482</td>
<td>7.3582</td>
<td>9.2664</td>
<td></td>
</tr>
<tr>
<td>Switzerland</td>
<td>7.3280</td>
<td>7.3582</td>
<td>10.0690</td>
<td></td>
</tr>
<tr>
<td>United Kingdom</td>
<td>7.3558</td>
<td>7.3582</td>
<td>9.2111</td>
<td></td>
</tr>
</tbody>
</table>

Sharpe Ratio

<table>
<thead>
<tr>
<th></th>
<th>Hedged Portfolio</th>
<th>Fully Hedged</th>
<th>Unhedged</th>
<th>Diff. test of Sharpe Ratio (p-value)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia</td>
<td>0.1195</td>
<td>0.1204</td>
<td>0.0956</td>
<td>Hedge vs. Unhedge 0.0076 ***</td>
</tr>
<tr>
<td>Euro</td>
<td>-0.0556</td>
<td>0.1306</td>
<td>-0.1483</td>
<td>Fully Hedged vs. Unhedge 0.0054 ***</td>
</tr>
<tr>
<td>Canada</td>
<td>0.0986</td>
<td>0.1177</td>
<td>0.0898</td>
<td></td>
</tr>
<tr>
<td>Japan</td>
<td>0.1222</td>
<td>0.1221</td>
<td>0.0956</td>
<td></td>
</tr>
<tr>
<td>Switzerland</td>
<td>0.1268</td>
<td>0.1309</td>
<td>0.1277</td>
<td></td>
</tr>
<tr>
<td>United Kingdom</td>
<td>0.1276</td>
<td>0.1267</td>
<td>0.0792</td>
<td></td>
</tr>
</tbody>
</table>

Notes: ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

The first row shows the regression coefficients. To help compare them, the CMV result is placed under the project results. As we can see, the results are similar to the CMV result in terms of the sign and the magnitude of the optimal currency exposure. Note that we do not know exactly what kind of stock market index was used in the CMV result, and we have to simulate the government bill rates in six

---

9 The difference between optimal hedge and fully hedge is not significant for all cases. To save space, the result is not reported but is available upon request.
domestic countries. Therefore, our results are not exactly the same as those of the CMV’s.

In the following, the mean excess return and standard deviation are reported for each of the three strategies. As a performance evaluation measure, the Sharpe ratio is also reported.

Not surprisingly, the unhedged strategy has the highest standard deviation of excess return at the 1% significant level. While the standard deviation is slightly lower for the case of the optimal hedge than for fully hedged, it is not statistically significant. The unhedged strategy also shows the lowest mean return, but there is no significant difference among the three strategies. The Sharpe ratio\(^{10}\) indicates that the unhedged strategy delivers the worst mean return per unit of risk; the result is significant at the 1% level. However, there is no significant difference between the optimal hedge and the fully hedged strategy.

**Discussion**

The project result supports the findings of Campbell, et al. (2010) and some other studies that “for risk-minimizing…investors, the implication is that the currency exposures of international equity portfolios should be at least fully hedged,” (Campbell, et al., 2010, p.117)

The result does not clearly show that the optimal hedge delivers a better Sharpe ratio. One reason could be that we assume the correlation between S&P 500 return and excess exchange return of dollar is constant overtime.

The CMV unconditional optimal currency hedging simply assumes that the correlation of portfolio and currency return is constant overtime.

Students thought that this assumption was easily broken down under volatile market situations such as the current one. They noticed that the exchange rate and interest rate change constantly due to financial crises such as the European debt crisis, the U.S. budget crisis, and so on. The change could cause the correlation between portfolio return and currency return to be inconstant.

In addition, currencies whose short-term interest rates are higher than normal tend to appreciate relative to currencies whose short-term interest rates are lower than normal. This behavior contributes to the profits of the currency carry trade, which takes long positions in high-interest-rate currencies and short positions in low-interest-rate currencies.

To address the issue, we show further exploration by Campbell, et al. (2010). They discuss whether the conditional component of the carry trade is attractive to risk-minimizing investors, or whether such investors should avoid currencies with temporarily high interest differentials. The CMV strategy considers a conditional model for risk management currency demand that depends linearly on interest

\(^{10}\) The calculation of the Sharpe Ratio follows the Campbell, Medeiros and Viceira (2010) version of assuming high frequency returns or lognormality assumption:

\[
\frac{\text{mean}(r_{P_{t+1}|S_{t}}) - \text{mean}(r_{S_{t+1}})}{\sqrt{\text{var}(r_{P_{t+1}|S_{t}})}}
\]

The Sharpe ratio equality testing uses Leung and Wong (1997) Hotelling’s \(T^2\) statistics.
In our project’s setting, the currency risk management demand can be estimated by the following regression:

\[ r_{t+1} = \gamma_0 - \varphi_0 (\Delta s_{t+1} - t_{t+1}^d + i_t) (t_t - i_t^d) - \varphi_1 (\Delta s_{t+1} - t_{t+1}^d + i_t) (t_t - i_t^d - (t_t - i_t^d)) + \epsilon_{t+1} \]  

(3)

where \((t_t - i_t^d)\) is the unconditional expectation of interest differentials. The primary interest is to estimate the slope of \(\varphi_1\) and test whether it is zero. Notice that when it is zero, the regression model recovers exactly the unconditional risk management demand.

**Conclusion**

Undergraduate finance students do not have much exposure to up-to-date findings in academic finance journals. However, some findings are not only closely related to the fundamental finance principles that we teach in class but also could be practically useful for students who want to pursue careers as financial industry professionals.

Inspired by the pedagogical methodologies of Theodore and Miller (1997); Hull, Kwak, and Walker (2008); Mitchell et al. (2009); and Hunsader, Mitchell, and Parker (2011), we introduce students to the recent novel findings on global currency hedging by Campbell, et al. (2010). This material is introduced when we teach currency risk management for financial institutions. The CMV strategy is an excellent example of a comprehensive application of the principles of diversification and currency hedging. In addition to introducing a simple and intuitive version of the CMV strategy, we have also designed a project for students to implement the CMV strategy.

The project has many benefits for our students. It helps students deepen their understanding of how to apply principles of diversification and hedging currency risk. The project is a step-by-step process for students to implement a risk management strategy. In addition, students have the opportunity to practice data collection and analysis. An unexpected result was that students began to be interested in reading articles in academic finance journals.

**References**


