KPATE ADJAOUTÉ AND NILS S. TUCHSCHMID*

Exchange Rate Dynamics, Currency Risk and International Portfolio Strategies

1. Introduction

It is well known since the work of GRUBEL (1968), LEVY and SARNAT (1970) or SOLNIK (1974) that investors benefit from international diversification. In other words, an internationally diversified portfolio outperforms a portfolio composed solely of domestic assets. Accounting for this result rests on the low correlations observed between national stock markets. In investing in international markets, investors also have to decide upon whether to hedge against currency risk. As a matter of fact, exchange risk is believed to be a principal component in international investment so that it should be properly handled.

To focus the analysis on stock portfolios, a standard approach has been to completely hedge away the exchange risk through the use of forward contracts. Moreover, this strategy is thought to enhance the portfolio performance as has been shown by number of authors, such as EUN and RESNICK (1988). EUN and RESNICK (1988) found that a complete hedging policy dominated its unhedging counterpart once investors are assumed to have a six-month holding period. In the same vein, FROOT (1993) shows that, over short horizons, the hedged portfolios outperform the unhedged ones[1]. This leads to the well-known free lunch argument first advanced by Perold and Schulman (1988) and which says that, as long as the forward rate is an unbiased estimate of the future spot rate, the hedging policy is costless in terms of returns while it reduces risk.

A more recent literature has taken an alternative view regarding the relevance of the free lunch argument. In particular, LEVY and LIM (1994) show that the performance of full hedging policy strongly depends on the sample period used. More precisely, they obtain the same results as EUN and RESNICK (1988) over their first subsample period 1981–1985 and then proceed to show that the conclusions are reversed for the second subperiod 1985–1988. The same observation has be made by ADJAOUTÉ and TUCHSCHMID (1994) who consider various time horizons, sample periods and the perspectives of both the US and Swiss investors. In fact, the discussion around the relevance of hedging currency risk can be cast on a wider ground of optimal portfolio strategies namely how to treat forward contracts in the portfolio composition problem. Indeed, in an international context, GLEN and JORION (1993), JORION (1994), RUDOLF and ZIMMERMANN (1994) suggest to introduce the forward contracts as additional assets in the portfolio optimizer instead of treating them on an ad hoc basis. Their

* We would like to thank an anonymous referee for his helpful comments and advice. The usual disclaimer applies. Ecole des HEC, University of Lausanne, 1015 Lausanne, Switzerland. Email: Nils.TUCHSCHMID @hec.unil.ch

results then indicate significant improvement in the risk-return relationship.

The objective of this paper is twofold. First, considering internationally diversified stock portfolios, we wish to demonstrate the weakness of the free lunch argument. Second, we show that the unitary or full hedging policy which is a „by-product" of the free lunch argument is inconsistent both theoretically and empirically. More precisely, in a Mean-Variance efficiency framework including forward contracts, it is shown that the systematic full hedging policy would be optimal only under two restrictive conditions. First, domestic asset returns and currencies changes must be uncorrelated. Second, the return of exchange rate has to be equal to zero. As far as the empirical analysis is concerned, the issues are addressed from the perspectives of the American and Swiss investors. Our results obtained over the period 1981–1994 are consistent with previous evidence that the performance of any systematic hedging policies strongly depends on the time period selected and the trend of depreciation or appreciation followed by the foreign currencies. The unbiasedness of the forward rate hypothesis is then challenged by showing that a simple „speculative" strategy in the forward currency market yields on average a positive return. Finally, we demonstrate that the combination of the latter strategy with the return of an international stock portfolio leads to significant improvement relative to the traditional systematic hedging policies.

The organisation of this paper is thus as follows. In section one, we present in a single asset case and in a portfolio context the theoretical foundations of the free lunch argument. We also demonstrate that a full hedging policy against currency risk is optimal only under very restrictive conditions which are rarely met in practice. In section two, we briefly present our sample and some descriptive statistics and then provide in-the-sample evidence on the performance of representative international portfolio strategies. Section three gives empirical out-of-sample results against the use of the full systematic hedging policy and reveals the importance of parameter estimation. Finally in section four, we show that the return on currency forward contract is on average positive which then leads us to use a simple approach to illustrate how forward contracts could be treated in the context of international asset allocation. We then conclude the paper by offering some directions for further research.

2. Theoritical foundations of the free lunch argument

2.1 The single asset case

Given the widely accepted evidence that international diversification pays, the question one has to answer is whether to hedge the currency risk exposure. Up to recently, the tradition has been to pursue a systematic and unitary or one to one hedging policy. The justification of such a strategy was based on the assumption that the forward rate is an unbiased estimate of the future spot rate. In this case, the expected spot rate change is equal to the interest rate differential. Restricting the analysis to a two country world and denoting by i_d and i_f the domestic and foreign interest rates respectively, one has

$$\frac{E[\tilde{S}_{t+1}]-S_t}{S_t}=\frac{i_d-i_f}{1+i_f} \qquad (1)$$

where S_t is the currency spot rate at time t and $E[\tilde{S}_{t+1}]$ its expected value at time t+1. This relationship, known as the „uncovered interest rate parity" is obtained either assuming that the International Fischer Relation and the Purchasing Power Parity hold or that the forward rate is an unbiased estimate of the future spot rate, that is,

$$F_{t,t+1}=E[\tilde{S}_{t+1}] \qquad (2)$$

and to plug it into the covered interest rate parity relationship. Indeed, if this assumption holds, the practical implication is that the hedging would be costless in terms of returns. Thus, as long as the use of forward contracts allows to reduce or eliminate the currency risk exposure, it seems clear that hedged portfolios will always outperform their unhedged counterparts. In fact, this can be easily demonstrated by looking at unhedged and fully hedged returns in a foreign investment. Let us take the case of a Swiss investor who holds a position on a foreign asset „i" traded in US dollar. When the position is not hedged, the total expected return (RUH) will have to be the return on the financial asset itself plus the change of the spot exchange rate. Measured in continuously compounded rate of return, we thus have

$$RUH = \ln\left(\left(1 + E\left[\tilde{R}_{i,\$}\right]\right) \times \frac{E\left[\tilde{S}_{t+1}\right]}{S_t}\right) = \mu_{i,\$} + \mu_S \quad (3)$$

where $\mu_{i\$}$ is the „dollar" rate of return expected on the risky financial asset „i" and μ_S is the expected change of the exchange rate. As a corollary, the risk is composed of three elements, namely, the asset „i" risk, the dollar risk and the covariance term between the financial asset returns and the dollar changes:

$$\sigma^2_{RUH} = \sigma^2\left(\tilde{r}_{i,\$}\right) + \sigma^2\left(\tilde{r}_S\right) + 2\rho_{i,\$}\sigma\left(\tilde{r}_{i,\$}\right)\sigma\left(\tilde{r}_S\right) \quad (4)$$

As far as the hedged return is concerned, we simply need to replace in the previous equation the expected spot rate by the contemporaneous forward rate[2]. The expressions of the return (RH) and the risk will look as follows:

$$RH = \ln\left(\left(1 + E\left[\tilde{R}_{i,\$}\right]\right) \times \frac{F_{t,t+1}}{S_t}\right) = \mu_{i,\$} + \mu_S \quad (5)$$

$$\sigma^2_{RH} = \sigma^2\left(\tilde{r}_{i,\$}\right) \quad (6)$$

where r_F is the forward exchange premium known at time t. Therefore, if the forward rate is an unbiased estimate of the future spot rate, then the expected return on the spot rate will be the same as the one on the forward contract ($\mu_S = r_F$). However, the risk measures look quite different. In fact, once the hedging policy is undertaken there is no longer any currency uncertainty and the only remaining risk is that of the foreign asset „i". Thus, the free lunch argument is justified in its own right. As long as

$$\sigma^2_{RH} < \sigma^2{}_{RUH}$$

the hedged portfolio will always be preferred since it offers the same expected return for a lower risk as stated by EUN and RESNICK (1988) „*Since the forward exchange premium is known to be a nearly unbiased predictor of the future change of the exchange rate, i.e., fi E(ei), this is indeed one of the rare occasions where risk can be reduced without adversely affecting return.*"
Notice that the first empirical results were in favour of this statement. For example, EUN and RESNICK (1988), based on stock index weekly returns of seven countries over the period 1980–1985, show that the Sharpe ratio of fully hedged portfolios is twice the one of portfolios which are not hedged against currency risk. However, it is possible to theoritically demonstrate the weakness of this argument starting from a standard mean-variance portfolio approach.

2.2 The multiple asset case

As mentioned previously, the free lunch argument is often invoked starting from the assumption that the forward rate is an unbiased estimate of the future spot rate. However, this assumption, although necessary to justify the full hedging strategy is not sufficient. In fact, it is quite easy to show that in order for the unitary hedging policy to be the optimal one, we need both the unbiased

forward rate assumption and the assumption that the local-market returns are uncorrelated with exchange rates. Following JORION (1994), we can indeed take the case of a „mean-variance" investor and study the optimal composition of his international portfolio. We thus suppose that the investor wishes to maximise a utility function defined over the expected excess return of his portfolio and its associated variance, assuming, for convenience and without loss of generality, that the risk free asset yields a zero return. The investment opportunity set is defined here to include both financial assets and foreign currencies whereas the return on the exchange rate is equal to the return generated by the forward contracts[3]. Consistent with the Mean-Variance framework, the problem reduces to solving the following programme where ω is the vector of asset weights in the portfolio including both the financial assets and the currency positions.

$$\text{Max } V\left(\mu_p, \sigma_p^2\right) = \underset{\omega}{\text{Max}}\ V\left(\omega'\mu, \omega'\Omega\omega\right) \tag{7}$$

μ and Ω are the vector of excess returns and the variance-covariance matrix respectively measured in the investor's reference currency. Starting from the first order condition, that is,

$$\frac{\partial V}{\partial \omega} = V_1\mu + 2V_2\Omega\omega = 0$$

where V_1 and V_2 are the derivative of the utility function with respect to the portfolio expected excess return and variance respectively, it is then straightforward to derive the optimal position as being equal to

$$\omega^* = \frac{-V_1}{2V_2}\left(\Omega^{-1}\mu\right) \tag{8}$$

which is nothing less than the usual investor's demand for risky assets in a mean-variance framework. Once the excess return vector, μ, and the variance-covariance matrix are partitioned into the financial assets, denoted here by „a", and the foreign currencies, f, one gets

$$\mu = \begin{pmatrix} \mu_a \\ \mu_f \end{pmatrix} \quad \text{and} \quad \Omega = \begin{pmatrix} \Omega_{aa} & \Omega_{af} \\ \Omega_{fa} & \Omega_{ff} \end{pmatrix}$$

where $\mu_f = E\left[\left(F_{t-1,t} - S_t\right)/S_{t-1}\right]$ and it can be shown that

$$\Omega^{-1} = \begin{pmatrix} \Omega_{a.f}^{-1} & -\Omega_{a.f}^{-1}\beta' \\ -\beta\Omega_{a.f}^{-1}\Omega_{ff}^{-1} & \beta\Omega_{a.f}^{-1}\beta' \end{pmatrix}$$

where $\beta = \Omega_{ff}^{-1}\Omega_{fa}$ and $\Omega_{a.f} = \Omega_{aa} - \beta'\Omega_{ff}\beta$. Therefore, splitting the optimal position, ω^*, in two subsets, one for the risky financial assets and the second for the currency positions, we simply get

$$\omega_a^* = \frac{-V_1}{2V_2}\left(\Omega_{a.f}^{-1}\mu_a - \Omega_{a.f}^{-1}\beta'\mu_f\right) \tag{9}$$

$$\omega_f^* = \frac{-V_1}{2V_2}\left(\Omega_{ff}^{-1}\mu_f\right) - \beta\omega_a^* \tag{10}$$

Although the expression of ω_a^* does not lead to an intuitive evaluation as of the consequences of the matrix and vector partitions, it nevertheless allows to have a clear and simple interpretation as far as the optimal hedging rules are concerned. The optimal demand for currencies has the usual structure encountered in financial theory. In fact, it is made of two components. The first one is the standard Mean-Variance demand. It reflects the risk-return attributes of the assets involved. The second component is truly a hedging demand. It represents the portfolio of financial assets whose returns are the most correlated with the currency changes.

As far as the unitary hedging policy is concerned[4], equation (10) allows us to point out the necessary conditions under which it would be op-

timal. Indeed, one sees that $\omega_f^* = -\omega_a^*$, which is by definition the full unitary position taken in the forward contracts, when $\mu_f = 0$ and $\beta = 1$. These two conditions are met if currency returns are expected to be zero and if the local-market returns (a') are uncorrelated with exchange rates (f), $\Omega_{fa'} = 0$, since, in this latter case, one gets

$$\Omega_{fa} = \Omega_{fa'} + \Omega_{ff} = \Omega_{ff} \Rightarrow \beta = 1$$

To cast the problem on a more general ground, one should stress that the free lunch argument has led to the separation between the investment decision in the risky assets and the decision to pursue a currency hedging policy. In fact, since hedging was assumed to be costless, one should first concentrate on choosing the best portfolio and then hedge on an ad hoc basis. However, as has been shown by GLEN and JORION (1993) and RUDOLF and ZIMMERMANN (1994), currency overlays (which offers the perfect example of separation between investment decision and the hedging policy) are suboptimal given the current setting. In fact, from equation (10), it is straightforward to see that currency overlays would be optimal only if β is equal to zero, a condition that is met only when the correlation between the national stock indices expressed in the investor's reference currency and the change of the exchange rate is zero. In the case the expected payoffs from positions in forward contracts are zero ($\mu_f = 0$), that is, the unbiasedness hypothesis is met, it is worthwhile noticing that currency overlays still remain suboptimal. Under this condition, recall that the optimal position in the forward contracts is a function of the correlation between the risky asset returns and the currencies. Therefore, the natural question which arises from the above analysis has to do with the robustness of the free lunch argument and in particular whether these two conditions are met. In the next sections, we address this issue from an empirical perspective.

3. Some results on international stock portfolio performance

Seven countries are considered in this study. For each of them, we collect monthly observations on a representative stock index[5]. Three different continents or zones of economic activity are represented with Canada and the USA for North America, Japan for Asia, and France, Germany, Switzerland and the United Kingdom for Europe. The choice of countries to be included in the study has been restricted to those with large stock markets and actively traded currencies. The data span the period February 1981 to August 1994. Finally, we collect monthly data for the spot and one month maturity forward exchange rates against the US dollar and the Swiss franc respectively[6].

3.1 Descriptive statistics

The correlation matrix given below in panel A of table 1 clearly shows the low degree of correlation between national stock markets over the entire time period. These low correlations are the source of the benefits of international diversification. In other words, in a Mean-Variance framework, investors are better off when the set of investment opportunity increases as long as the correlations among assets are not perfect. Currencies themselves are positively correlated and obviously close to unity for countries with common exchange rate regime – see panel B –. This in turn implies that the exchange rate risk can not be fully diversified for an investor with positions in these foreign stock markets[7].

In table 2, we also provide statistics on the returns and standard deviations both in the local currency and in Swiss franc[8]. Not surprisingly, the Swiss franc has appreciated against all the currencies in the sample but the Japanese Yen. The maximum appreciation rate is 5.5% on annual basis against the British pound while the minimum is attained against the German mark with an average of half a

Table 1: Correlation Matrices

Table 1 gives in panel A the correlations between market indices. Panel B reports the correlations between currencies. Finally, panel C gives the correlation coefficients between market indices and currencies. The figures are obtained over the full period 1981–1994 with 162 monthly observations.

A	Can	France	Germany	Japan	Switzerland	UK	USA
Canada	1.00						
France	.47	1.00					
Germany	.43	.63	1.00				
Japan	.28	.32	.21	1.00			
Switzerland	.60	.61	.73	.27	1.00		
UK	.62	.60	.61	.35	.68	1.00	
USA	.77	.57	.49	.34	.68	.66	1.00

B	CAD	FRF	DMK	JPY	GBP	USD
CAD	1.00					
FRF	.42	1.00				
DMK	.38	.81	1.00			
JPY	.50	.31	.28	1.00		
GBP	.53	.43	.44	.28	1.00	
USD	.94	.39	.38	.53	.49	1.00

C	CAD	FRF	DMK	JPY	GBP	USD
Canada	.27	.21	.08	.17	.25	.18
France	.24	.19	.23	.18	.22	.21
Germany	.25	.19	.15	.12	.17	.24
Japan	.02	–.06	–.01	.15	.08	.01
Switzerland	.35	.24	.13	.24	.19	.34
UK	.37	.27	.17	.31	.25	.34
USA	.22	.15	.13	.11	.19	.17

percentage per year. Comparing the variances, one can see that the level of risk for the returns in the reference currency is always higher than the one obtained in local currencies. This is in no way surprising because the correlations between indices and currencies reported in panel C of table 1 are all positive or, when negative, too close to zero to expect a total risk that would be lower than the one expressed in the local currency. Looking at panel B of table 2, we can see that, at the extreme, exchange rate fluctations amount to more than 30% of the total variance expressed in Swiss franc, as it is the case for the Canadian and the U.S dollars, while the covariances with the local stock market returns represent a maximum of 10.8%. The effect of exchange rate movements is therefore far from being negligible.

Table 2: Statistics on Return and Variance Decomposition

Table 2 gives in panel A, for the entire sample period 1981–1994, the average annual rates of return continuously compounded expressed both in local currency (R_i) and in Swiss franc (R_{iSF}) and the rate of return of the exchange rate (R_S). Panel B gives, on an annual basis, the total risk or variance of return expressed in local currency, $Var(R_i)$, in Swiss franc, $Var(R_{iSF})$ and the variance of the exchange rate, $Var(R_S)$, and its covariance with the domestic stock market rate of return, $Cov(R_i, R_S)$.

A	$\overline{R}_i$ (in %)	$\overline{R}_S$ (in %)	$\overline{R}_{i,SF}$ (in %)
Canada	4.29	–3.85	0.44
France	12.23	–3.46	8.77
Germany	9.84	–0.53	9.31
Japan	9.14	2.47	11.61
Switzerland	7.41	–	7.41
UK	12.23	–5.50	6.73
USA	9.28	–2.76	6.52

B	$Var(R_i)$	$Var(R_S)$	$Cov(R_i,R_S)$.	$Var(R_{i,\,SF})$
Canada	26.51	20.45	6.45	59.58
France	43.74	3.37	2.37	51.85
Germany	40.21	2.15	1.41	45.18
Japan	38.47	9.30	2.83	53.42
Switzerland	36.53	–	–	36.53
UK	37.68	9.68	4.73	56.81
USA	23.35	19.40	3.73	50.21

3.2 In-the-sample performance analyis

In this subsection, we derive the efficient frontiers and provide a set of results on two portfolios. For the in-the-sample analysis, we will report the results only for the Swiss investor's perspective. Following the discussion in section 1, we look at three strategies. The first one, referred as the unhedged policy, is the one in which the investor forms his portfolio with the input paramaters expressed in his reference currency. Hence, the mean returns used in the first strategy is simply the returns in local currency converted in Swiss franc and the associated variance covariance matrix is determined according to equation (4). The second strategy, labeled as the full hedging policy, is the one in which the investor composes his portfolio over returns expressed in local currency and then sells (buys) forward the expected proceedings of his long (short) positions on the foreign stock markets. In other words, it is implictly assumed that a „perfect" hedged is possible since the input parameters are only due to stock markets movements expressed in local currency. Finally, we study a strategy where the returns of long forward positions are included in the optimization problem. In this latter case, the set of assets is expanded from seven to thirteen, that is, seven stock markets and six currencies. This strategy, termed as the optimal one, follows the theoritical analysis presented in the previous section. For all strategies, we choose not to impose the non negativity constraint on the portfolio weights so that the performance of each strategy can not be affected by some binding constraints.

Once we look at graph 1 in which are reported the three efficient frontiers, it follows that all the strategies clearly dominate the domestic investment policy. Indeed, for a same level of standard deviation of 19.2% a year, the average return for the domestic investor is 7.4% while the returns achieved with the unhedged, the fully hedged and the „optimal" are 14.6%, 17.3% and 21.6%, respectively. Clearly, these differences are of economic significance and illustrate the well known benefits of international diversification. As far the strategies themselves are concerned, the unhedged and fully hedged policies lead to efficient portofolios which are somehow close even if in our particular sample the latter one seems to dominate. On the other hand, the „optimal" strategy clearly dominates both the unhedged and fully hedged policies. The same conclusion is reached in terms of the sharpe ratios given in table 3 along with the portfolio weights of the minimum variance (MV) and tangent (TG) portfolios. As usual, the tangent portfolio leads to more severe biases towards markets with either the highest or the lowest expected returns for a given level of risk. This stan-

dard result is also obtained with the „optimal" portfolio strategy. Notice however that the weights of unhedged and fully hedged portfolios are not extreme compared to thoses of the „optimal" portfolios. Moreover, it is worthwhile noticing that the inclusion of forward contracts in the optimization problem leads to results which are not in line with standard hedging practice. Indeed, in this latter case, the forward positions include not only an hedging position, function of the correlation structure, but also a speculative demand as shown in equation (10). In some cases, the same position is taken in the stock market and the forward currency market like for Germany – where the Swiss investor is long in both the stock market and the German mark –. In other cases, the positions are opposite and can lead to any hedge ratio. Only in U.S in the minimum variance case, do we observe opposite positions of almost the same size.

However, the dominance of the optimal strategy has to be taken with caution for two reasons. First, the shift of the efficient frontier follows from the inclusion of a new set of assets, the foreign currencies. In fact, it is well-known that the adjunction of assets in the optimizer necessarily translates into an upward shift of the efficient frontier[9]. Second, it is an „in-the-sample" effect

Graph 1: Efficient Frontiers

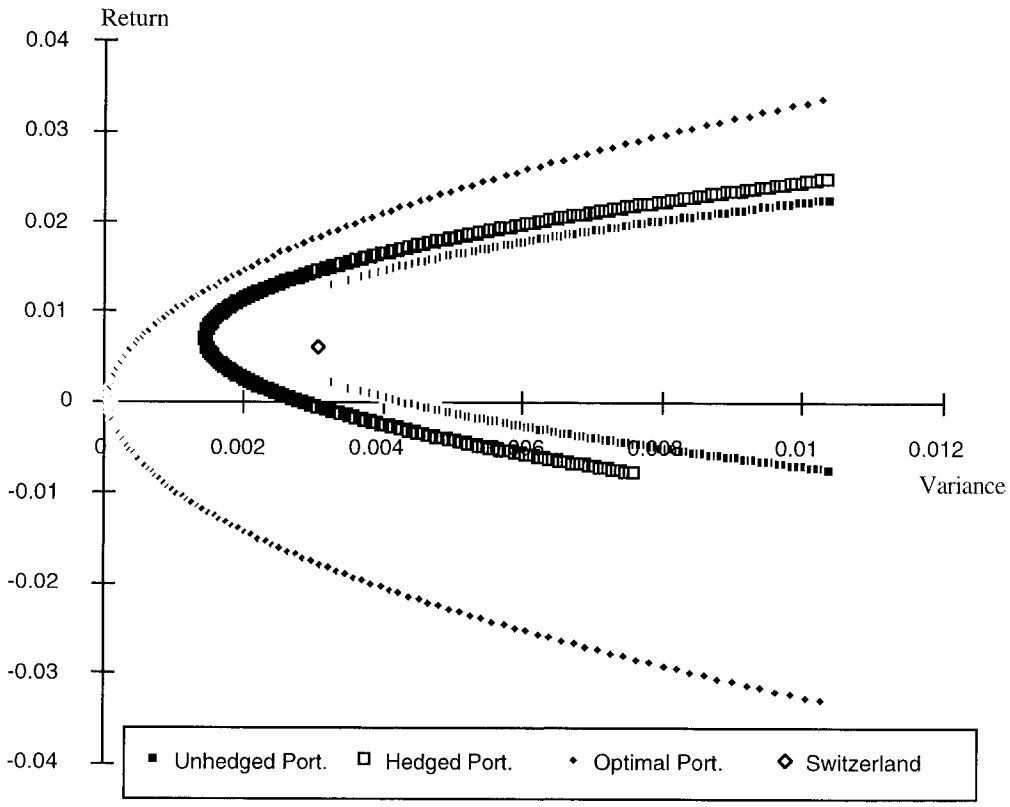


Table 3: Efficient Portfolio Composition

Table 3 reports the composition of the Minimum Variance (MV) and Tangent (TG) portfolios for each strategy, that is, the unhedged strategy (UH), the fully hedged strategy (H) and the „optimal" one (OP) obtained over the period 1981–1994. It also gives for each portfolio its mean monthly rate of return (R), its standard deviation (σ) and its associated sharpe ratio.

	MVUH	TGUH	MVH	TGH	MVOP	TGOP
Canada	3.52	–127.29	23.72	–83.23	4.70	–260.71
France	8.13	9.88	0.18	14.34	3.48	–19.73
Germany	20.09	41.52	22.02	38.66	6.67	75.86
Japan	32.30	60.52	26.70	25.01	2.30	81.70
Switzerland	34.39	13.53	–9.18	–61.52	–12.34	–27.27
UK	–5.67	6.62	–1.35	61.60	4.23	7.18
USA	7.25	95.23	37.90	105.14	6.66	235.73
CAD	–	–	–	–	12.98	–434.21
DEM	–	–	–	–	55.86	627.26
FRF	–	–	–	–	0.02	–711.11
GBP	–	–	–	–	10.78	–22.76
JYP	–	–	–	–	10.38	81.09
USD	–	–	–	–	–5.68	466.97
$\overline{R}$	0.75	1.57	0.69	1.44	0.03	3.58
σ	4.74	6.86	3.81	5.49	0.91	10.78
Sharpe	0.16	0.23	0.18	0.26	0.03	0.33

that is, the shape of an efficient frontier is very sensitive to the input paramaters. The results in appendix 1, obtained over different subperiods, show indeed that the compositions of both minimum-variance and tangent portfolios change dramatically. This in turn implies that an out-of-sample analysis is necessary to reach a firmer conlcusion regarding the performance of each strategy.

4. Hedging policies and out-of-sample analysis

As mentioned previously, the move of the efficient frontier is a standard „in-the-sample" issue. The more important the number of assets included in a Mean-Variance optimizer, the larger the shift will be. Obviously, this is of little relevance for an investor wishing to know if he should hedge his investment in international stocks. Assessing the performance of the hedging has to be done in a „out-of-sample" context. Therefore we need to set rules for portfolio selection whose performance will be analysed ex-post. Since we focus on the relevance of full unitary currency hedging as opposed to the unhedging and the „optimal" ones, we restrict our attention to three simple portfolio selection strategies and look at the results both from an American and a Swiss investors' perspective[10]. First, we assume that investors select the optimal portfolio as being the tangent one inlcuding the seven countries for the unhedged or fully hedged strategy to which are added the six forward contracts for the „optimal" strategy. Second, the global minimum variance portfolio is considered with the same sets of assets. Finally, the equally weighted portfolio which is the simplest or the most naive way to benefit from international diversification is analysed. All the portfolios are constructed and the performance studied out-of-

sample. More precisely, the tangent and global minimum variance portfolios are constructed on the basis of the preceding 30 monthly observations measured in local currency for the fully hedged and in the investor's reference currency – the U.S dollar or the Swiss franc – for the two other strategies[11]. We therefore follow the same approach as the one used for the in-the-sample analysis. In this sense, the methodology is quite different from the one applied by EUN and RESNICK (1988) or LEVY and LIM (1994) who used historical hedged returns defined as the past local rate of returns plus the forward premia or discounts which implies that the hedging decision is based on a set of weights which already incorporates the effect of the past hedging decision. We finally assume that the investors have a holding horizon of one-month and decide for the first two strategies to fully hedge against currency risk by selling forward contracts or not to do so[12]. In the former case, it is assumed that the full amount of the expected proceeds from foreign investment is hedged and rounding problems are negligible. The process is then repeated by moving one month ahead and by using once again the 30 previous observations. Thus, the first out-of-sample return is obtained in September 1983 and the last one in August 1994. Hence, we end up with 132 out-of-sample monthly returns which have to be viewed as those attained by 132 investors – either American or Swiss – who have pursued static one-month investment strategies over 1981–1994. The results are reported in table 4 below.

Over the entire sample period and focusing on the standard full hedged and unhedged strategies, the results clearly indicate that the fully hedged policy is dominated by its undhedged counterpart. This is true whatever the portfolio composition strategy – the minimum variance, the tangent and the equally weighted portfolios – and the reference currency. This first results are in sharpe contradiction with those obtained in-the-sample and presented in the previous section. If we now look at the results over the subperiods, the performance of each strategy diverges according to the reference currency selected. In the U.S dollar case, the results over the first subperiod which covers a well-known trend of appreciation of this currency, are consistent with EUN and RESNICK (1988) results in that the full hedged policy outperforms the unhedged one. However, in the next two subperiods, in line with the findings of LEVY and LIM (1994) for instance, the conclusions are reversed. As far as the Swiss franc is concerned, there is no clear pattern. In the first subperiod, the unhedged policy dominates while the performance over the next two subperiods greatly depend on the strategy selected. Overall, the out-of-sample results favor the unhedging policy in terms of sharpe ratios.

To summarize, our results obtained on the hedged and unhedged strategies are fairly opposed to early empirical findings, i.e. EUN and RESNICK (1988) or Perold and Schulman (1988) and point out the time dependent feature of the free lunch argument. Without being central to this paper, one should mention that the performance of the three portfolio strategies under consideration (the minimum variance, tangent and equally weighted portfolios) for a given hedging or unhedging policy are remarkably different. The results on the tangent portfolios are unsatisfactory compared to the other ones. This clearly illustrates the estimation risk problem associated with the expected return parameters. Indeed, the tangent portfolio strategy is the only one which requires the use of expected returns whose simple historical means are known to be poor predictors and vary a lot. This leads to take substantial and volatile positions in some foreign assets and generates poor volatile returns. As opposed to the tangent portfolio, the minimum variance portfolio strategy does not require the estimation of expected returns and hence is unaffected by this problems. In this sense, the equally weighted portfolio strategy does not suffer from the above mentioned problems and, hence, one can judge the performance of the hedging policy based on it. A closer look at the performance of these portfolio results in table 4 then reveals that the costless assumption

Table 4: Out-of-sample Performance

Table 4 gives the mean, standard deviation and Sharpe ratio for out-of-sample results when Swiss investors select their portfolio as being the tangent portfolio (TG), the minimum variance portfolio (MV) or the equally weighted portfolio (EW) using 30 previous monthly observations and close their positions one month later. The table gives the results on a monthly basis for unhedged (*UH*) strategy, the fully hedged (*H*) strategy and the optimal one (OP). The results are given for the entire out-of-sample period starting from september 1983 to August 1994 and for the subperiods September 1983–December 1985, January 1986–December 1989, January 1990–August 1994. It also reports for the entire out-of-sample 132 observations, the median of the ex-post returns and the percentage of positive performance. Panel A reports the results for the Swiss investor and panel B for the U.S one.

A CHF			8-83/12-94			83/85	86/89	90/94
	$\overline{R}$	σ	SHARPE	Median	R>0	SHARPE	SHARPE	SHARPE
MVUH	0.63	5.80	0.108	1.66	60.90	0.539	0.189	–0.101
TGUH	3.36	28.85	0.117	1.61	57.14	0.490	0.087	0.140
EWUH	0.63	5.24	0.120	1.12	59.40	0.418	0.125	–0.004
MVH	0.43	4.70	0.091	0.92	60.15	0.501	0.152	–0.151
TGH	–4.83	33.16	–0.146	–0.25	48.87	0.280	0.095	–0.259
EWH	0.58	4.32	0.134	0.89	62.41	0.413	0.127	0.029
MVOP	–0.09	1.17	–0.081	–0.27	45.11	–0.077	–0.102	–0.068
TGOP	–4.17	40.12	–0.104	–0.30	47.37	–0.176	–0.158	–0.126
EWOP	–0.31	2.32	0.134	0.48	62.41	0.413	0.127	0.029

B USD			8-83/12-4			83/85	86/89	90/94
	$\overline{R}$	σ	SHARPE	Median	R>0	SHARPE	SHARPE	SHARPE
MVUH	0.46	4.67	0.099	0.51	54.89	0.266	0.290	–0.178
TGUH	2.95	25.95	0.114	0.99	51.88	0.260	0.249	0.087
EWUH	1.00	4.37	0.229	1.24	60.90	0.433	0.272	0.086
MVH	0.56	4.75	0.118	1.08	60.15	0.577	0.236	–0.202
TGH	–4.69	33.22	–0.141	0.32	50.38	0.312	0.146	–0.259
EWH	0.71	4.35	0.163	1.08	63.91	0.512	0.188	–0.008
MVOP	–0.14	1.31	–0.108	–0.07	46.62	0.301	–0.245	–0.175
TGOP	1.38	15.12	0.091	–0.20	48.12	0.323	0.199	–0.201
EWOP	0.38	2.34	0.163	0.58	63.91	0.512	0.188	–0.008

in terms of returns and the automatic risk reduction effect on which is based the free lunch argument are not apparent. With one exception in each reference currency, the mean return of the hedged portfolios are lower whereas their standard deviation is almost at the same level as that of the unhedged portfolios. This has led MADURA and TUCKER (1992) to assert that the expected risk reduction induced by the full currency hedging is not guaranteed. Indeed, these authors show that around the 1987 stock market crash a hedged portfolio would have exhibited a much greater risk than the one of a portfolio with open positions.

If we now turn to the optimal portfolio strategies, one has to acknowledge, that its performance is on average far below the one achieved by the other competive strategies. It is also at the opposite of the in-the-sample performance previously

pointed out[13]. This disappionting results can be accounted for by mainly estimation risk problem in the input parameters which is greatly exacerbated for two reasons. First, the number of assets, and hence the number of input parameters has been pushed up by the inclusion of long forward positions. Second, the estimation risk problem in the case of currencies is critical not only for the expected return parameter but for the variance-covariance matrix as well. Indeed, this matrix is especially volatile over time in the case of currencies. This is reflected, for example, by the extreme variation of the weights in the minimum variance portfolio which only depend on the value of variances and covariances and the results of which are reported in appendix 2.

In conclusion, although our results do not support a simple fully hedged strategy, the theoritical optimality of the asset allocation where currencies are treated as asset is challenged as well out-of-sample. Therefore, if currencies have to be inlcuded as a class of assets, as has been suggested by a number of authors, there remains the question of how to deal with this estimation risk problem. In the final section, we use the theoritical argument in section 1 and the empirical out-of-sample results to suggest a simple asset allocation strategy that could be implemented in international context to circumvent the full hedging policy and the estimation risk problem.

5. Exchange Rate Dynamics and International Portfolio Strategy

Even though our previous out-of-sample results do not rank the „optimal" portfolio strategy as the best one, they do not favour the full hedging neither. Independently of any estimation risk problem, we already know that the full hedging policy would be theoritically justified only under the absence of correlation between domestic asset returns and currencies changes on one hand and assuming expected zero rates of return on exchange rates on the other hand. As far as the first requirement is concerned, one easily sees from panel C of table 1 that it can not be met. Our estimates of the correlation matrix between the currency spot rates and the market indices reported for the Swiss perspective in this table indicates that the no-correlation hypothesis is unsustainable[14]. Obviously, the same conclusion can be reached if one considers the US dollar perspective. Under this condition, a full hedging policy is suboptimal since β is different from one. In other words, unitary hedging leads to an „over-protection" of the international stock portfolio.

Regarding the second condition, one has to recognise that several studies in the foreign exchange literature have shown that the return to forward speculation is positive on average. In other words, a zero investment strategy involving buying currency forward contracts and selling them spot or vice versa leads to a non zero return. In this line, we may cite among others Sweeny (1986), TAYLOR (1990), EAKER and GRANT (1990), BACKUS et al. (1993), CHOIE (1993) and GLEN and JORION (1993). An illustrative example is a strategy where one sells or buys the forward contract according to the following rule:

- The forward contract is sold each time we observe a premium
- The forward contract is bought when there is a discount.

The justification underlying this strategy is due to the well-known empirical observation that the forward exchange rate has the tendency to overestimate the rate of depreciation or appreciation of the foreign currency. For instance, LEVY and LIM (1994) show that, on average, forward rates of six major currencies against the US dollar overestimate both the rate of depreciation and the rate of appreciation[15]. Therefore, we can expect the above strategy to be profitable. From an academic viewpoint, there is an active debate on whether such positive return can be interpreted as compensation for the risk incurred or if it evidences market inefficiency. However, while of interest, this issue is not in the scope of this paper.

As far as the return from this strategy is concerned, we thus have in natural logarithm:

$$r_t = F_{t-1,t} - S_t \text{ if } F_{t-1,t} > S_{t-1} \quad (11)$$

$$r_t = S_t - F_{t-1,t} \text{ if } F_{t-1,t} < S_{t-1} \quad (11')$$

To implement this strategy, we consider the same sample of one-month maturity forward exchange rates over the period January 1981 to August 1994. The results are reported in table 5 below. Like the correlation structure between stock indices and currencies, there is also evidence that the return in foreign exchange market is not zero. The average returns are positive whatever the currency and the investor's perspective with one exception for the British pound against Swiss franc whose negative return is almost equal to zero. More interesting are the associated Sharpe ratios whose values are very similar to those reported in the finance literature for equity investing. Notice however that these results should not be considered as stemming from a riskless strategy. The return on trading forward contracts is sample dependent and moreover highly volatilte as can be seen from figure 1 given in appendix in which is reported the speculative return on the US dollar from the Swiss franc perspective.

To summarize, the two assumptions on which relies the full or unitary hedging policy are clearly violated. In other words, the free lunch argument based on the unbiasedness hypothesis can be clearly challenged and the necessary zero correlation hypothesis is empirically rejected. Following the above discussion, we know that the proper way to deal with currency risk in internationally diversified stock portfolios would be to consider the currencies as a subset of assets to be included in the optimal portfolio choice problem. However, the out-of-sample results reveal that the introduction of this new class of assets compound the estimation risk problem, that is, the choice of the appropriate parameters based on past observations so that the realised return of the portfolio does not deviate from the expected one. Consequently and based on the results of appropriately investing in forward contracts, we provide below a simple example where forward exchange rates are combined to an investment on stock market indices. The goal is to illustrate that satisfactory investment outcome can be achieved despite the ad-

Table 5: Return to Trading Currency Forward Contracts

Table 5 gives the mean, standard deviation and SHARPE ratio on the speculative strategy using monthly observations on the one-month forward contracts over the period February 1981–August 1994.

Swiss Investor	CA $	FFR	DMK	US $	GBP	JPY
r	0.005963	0.001909	0.002201	0.001547	–0.00009	0.006284
σ_r	0.041268	0.016292	0.013512	0.040633	0.028251	0.027805
SHARPE	0.144536	0.117192	0.162873	0.038073	–0.03141	0.225991

US Investor	CA $	FFR	DMK	SFR	GBP	JPY
r	0.001699	0.0060593	0.000399	0.000952	0.007228	0.000267
σ_r	0.013302	0.0363040	0.037769	0.034088	0.035915	0.035766
SHARPE	0.127751	0.1669037	0.010571	0.023294	0.201245	0.2007471

Table 6: Out-of sample performance and trading forward contracts

Table 6 reports the mean returns, the standard deviations and the sharpe ratios on portfolio in which Swiss (CHF) or U.S (USD) investors take equal positions on seven stock markets and six currency forward contracts following the strategy described in equation (11).

	8-3/8-4			8-3/12-5	1-6/12-9	1-0/8-4
	$\bar{R}$	σ	SHARPE	SHARPE	SHARPE	SHARPE
CHF-EW	0.46	3.21	0.142	0.384	0.134	0.031
USD-EW	0.61	2.64	0.232	0.538	0.282	0.087

junction of new assets and the estimation risk problem which arises. More precisely, the return on equity investing is combined with the return achieved on trading forward currencies based on an equally portfolio composition[16]. Investors are thus assumed to implement over one month the same „speculative" strategy by buying or selling forward contracts according to the discount or premium observed at the time the portfolio is composed. The results are reported in table 6 below. Compared to the performance of the previ ous strategies reported in table 4, we notice that this simple rule of investing dominates all other equally weighted portfolio performance but one. Indeed, only for the period corresponding to the dollar appreciation of 1983 to 1985 is this latter strategy dominated by the others for the Swiss franc perspective. More generally, this strategy is ranked in terms of sharpe ratio either at the top or as the second – the only exception being once again the subperiod 1983–1985 for the Swiss franc base –. Therefore, there are strong reasons to believe that, if the domestic currency is not subject to a persistent trend as has been the case of the US dollar, any asset allocation strategy treating currencies as a class of assets will yield superior performance with an appropriate control of the estimation risk.

6. Conclusion

In this paper, we study both the relevance of the free lunch argument and the optimality of the full systematic hedging policy. In-the-sample portfolios for alternative allocation strategies indicate that there is no clear evidence in favour of the full hedging policy whereas the inclusion of currency forward contract in the optimisation problem significantly shifts upward the efficient frontier. Moreover, out-of-ample results indicate that the free lunch argument is highly time dependent and that the hedged portfolios are generally dominated by their unhedged counterpart. These results are in line with recent empirical evidence which casts strong doubt on the sustainability of the systematic hedging policy which in turn rests on the assumption that the return risk is costlessly reduced. However, the out-of-sample results reveal that although the adjunction of currencies in the optimizer is highly desirable, it compounds the estimation risk problem so that the ex-post portfolio performance is disapointing. To circumvent the latter problem, we implement a portfolio strategy where currencies are treated as a class of asset and show that the performance of this strategy is on average better than those of the hedged and unhedged portfolios.

The main implication of the paper is that any full hedging policy is theoretically and empirically suboptimal. As a corollary, it is shown that currencies have to be included in the portfolio opti-

misation problem as long as we stay in the Mean-Variance framework. Therefore, our results lead to two main issues which have to be addressed in future research. First, the inclusion of forward contracts compounds the estimation risk problem which has to be dealt with carefully if one wishes to get the desired ex-post performance. Second, our results have been derived in a static setting and it should be interesting to recast them in the more realistic dynamic framework in which economic agents revise their investment decision and act for longer time horizons.

Appendix 1: Efficient Portfolio Composition

The table reports the composition of the Minimum Variance (MV) and Tangent (TG) optimal portfolios obtained over the period 1981–1985; 1986–1989; 1990–August 1994.

	1981–1985		1986–1989		1990–1994	
	MV	TG	MV	TG	MV	TG
Canada	4.72	–24.99	–4.82	–85.02	12.15	–1377.00
France	3.17	–2.30	1.68	24.24	1.96	–371.94
Germany	6.21	29.09	8.48	–0.95	6.38	392.62
Japan	3.84	35.17	6.61	77.87	0.39	–606.64
Switzerland	–5.87	48.23	–9.73	–9.93	–11.27	812.59
UK	8.98	–3.40	1.54	–30.59	1.31	–127.04
USA	3.55	–2.92	4.73	53.48	9.43	1829.44
CAD	28.36	–25.99	–1.16	–269.03	7.83	–672.04
DEM	23.82	1.21	118.34	433.75	54.83	6541.10
FRF	21.11	–23.76	–49.62	–458.00	–2.43	–6603.89
GBP	14.89	30.08	–4.74	–60.35	10.49	–675.68
JPY	26.87	72.39	29.19	159.71	–1.60	–2422.61
USD	–20.64	–33.29	–0.52	264.83	10.52	3381.09

Appendix 2: Statistics on out-of-sample optimal portfolio weights

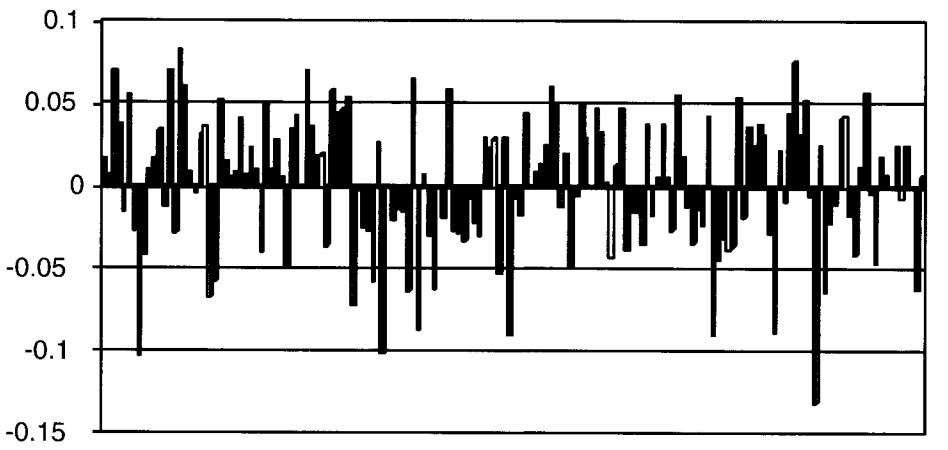
The table reports the means and standard deviations of the weigths of the minimum variance (MV) and tangent portfolios (TG) for a Swiss investor's perspective. The statistics are measured on 132 out-of-sample observations.

	Mean MV	St. dev MV	Mean TG	St. dev TG
Canada	4.43	10.51	33.45	425.24
France	3.25	4.03	–3.21	106.79
Germany	4.87	5.36	–5.56	100.08
Japan	1.80	5.74	–4.36	83.38
Switzerland	–7.52	8.66	40.37	672.43
UK	4.06	3.97	17.10	281.93
USA	5.21	6.37	26.04	211.94
CAD	17.96	14.09	145.43	1450.73
DEM	59.18	48.77	–30.72	1918.50
FRF	–11.29	45.12	–7.37E	1024.71
GBP	12.08	9.07	–26.54	329.95
JYP	16.21	18.98	19.30	341.76
USD	–10.25	12.20	–69.73	608.27

Appendix 3: Return on trading currency forward contracts

The figure reports the monthly returns based on a strategy in which the forward contract is sold each time we observe a premium and bought when there is a discount over the period 02/81–08/94.

Figure1: US dollar / Swiss franc return to speculation



Footnotes

[1] FROOT (1993) however shows that the conclusions are reversed for long horizons.

[2] Notice that we implicitly assume that the amount to be received from the investment is known so that the appropriate position is taken on the forward contract. This, by itself, is not too restrictive since deviation from the true amount received should remain marginal.

[3] Our paper voluntarily focuses on a static Mean-Variance analysis, thus ignoring the more complex problem of international portfolio choice in which investors have a wide set of financial assets available and act intertemporarily (see, e.g., ADLER and DUMAS 1983). For an extensive survey of optimal currency hedging policies in a continuous time setting, the reader is referred to ADLER, GRANITO and LEE (1990).

[4] Notice that the unitary hedging policy is a special case of any systematic currency risk hedging strategy. In other words, if the unitary policy is not optimal, a systematic 50% hedging policy, for instance, would not be more effective unless, by luck, the investor sets the systematic hegde ratio close to the optimal weights, ω_f^*.

[5] The indices are the Financial Time Actuaries Index and are taken from Datastream at CEDIF Lausanne University. They are value weighted indices expressed in local currency. These indices are well representative of each national market in terms of the number of stocks included.

[6] All the data on spot and forward rates taken from Datastream are quotes from Midland Bank. Since the quote was given from a British pound perspective, we used the non triangular arbitrage condition to obtain quote in US dollar and Swiss franc.

[7] In general, it would be impossible to diversify away the exchange rate risk if the exchange rate changes covary with any real variable which affects investor's utility.

[8] For the sake of brievety, we choose not to report the figures measured on a US dollar basis.

[9] Notice that it is possible to measure the significance of the shift of the efficient frontier by means of test like the one designed by GIBBONS, ROSS and SHANKEN (1989). In our case, based on annualised SHARPE ratios, the GIBBONS, ROSS and SHANKEN statistic is 6.82 which implies a significant shift of the efficient frontier at a percentage level of 5%.

[10] In other words, we voluntarely ignore any estimation risk problem.

[11] The equally weighted portfolio obviously does not require the use of historical observations.

[12] Obviously, the decision to hedge does not have to be considered for the „optimal" strategy since the weights invested in each currency is directly given by the optimizer or are part of the equally weighted portfolio.

[13] Notice that the SHARPE ratios of the fully hedged and the „optimal" equally weighted strategies are the same. This stems from the fact that by construction the fully hedged return is equal to the local return plus the forward premium or discount while the optimal return is defined as the local return plus the exchange rate return and the return of a long forward position. Grouping the last two elements yields therefore the foward premium or discount and hence the SHARPE ratios for equally weighted portfolios.

[14] The statement is true for all countries since exchange rate are reciprocal and continuously compounded returns have been used.

[15] The currencies are the Canadian dollar, the French franc, the German Mark, the Japanese Yen, the Swiss franc and the British pound.

[16] A different version of such a strategy can be found for example in GLEN and JORION (1993).

References

ADJAOUTÉ, K. (1994): „On some Parametric and Non-parametric Characterisations of Exchange Risk Premia", Ecole des HEC, Lausanne University, working paper no 9504.

ADJAOUTÉ, K. and N. S. TUCHSCHMID (1994): „The Relevance of Hedging Currency Risk in Internationally Diversified Stock Portfolios", Ecole des HEC, Lausanne University, working paper no 9506.

ADLER, M. and B. DUMAS (1983): „International Portfolio Choice and Corporation Finance: A Synthesis", Journal of Finance 38, pp. 925–84.

ADLER, M., M. GRANITO and A. LEE (1990): „Should International Portfolios be Permanently Hedged?", in: LEE R Thomas III (Ed.), The Currency-Hedging Debate, IFR Publishing Ltd, London.

BACKUS, D., GREGORY A. and C. TELMER (1993): „Accounting for Forward Rates in Markets for Foreign Currency", Journal of Finance 48, pp. 1887–1908.

BLACK, F. (1990): „Equilibrium Exchange Rate Hedging", Journal of Finance 45, pp. 899–907.

CHOIE, K. S. (1993): „Currency Exchange Rate Forecast and Interest Rate Differential", Journal of Portfolio Management 19, Winter, pp. 58–64.

DANTHINE, J-P. and N. S. TUCHSCHMID (1996): „Couverture Optimale et Equilibre sur les Marchés à Terme", Encyclopédie des Marchés Financiers, Economica, Paris, forthcoming.

EAKER, M. and GRANT D. (1990): „Currency Hedging Strategies for Internationally Diversified Equity Portfolios", Journal of Portfolio Management 17, Fall, pp. 30–32.

EUN, C. and B. RESNICK (1988): „Exchange Rate Uncertainty, Forward Contracts, and International Portfolio Selection", Journal of Finance 43, pp. 197–215.

GIBBONS, M., S. ROSS and J. SHANKEN (1989): „A Test of the Efficiency of a Given Portfolio", Econometrica 57, pp.1121–1152.

GLEN, J. and P. JORION (1993): „Currency Hedging for International Portfolios", Journal of Finance 48, pp. 1865–86.

GRUBEL, H. (1968): „Internationally Diversified Portfolios: Welfare Gains and Capital Flows", American Economic Review 58, December, pp. 1299–1314.

FAMA, E. (1984): „Forward and Spot Exchange Rates", Journal of Monetary Economics 14, pp. 319–338.

FRANKEL, J. and K. FROOT (1987): „Using Survey Data to Test Standard Propositions Regarding Exchange Rate Expectations", American Economic Review 77, March, pp. 133–43.

FROOT, K (1993): „Currency Hedging over Long Horizons", NBER working paper series, No 4355.

JOBSON, J. and B. KORKIE (1981): „Performance Hypothesis Testing with the Sharpe and Treynor Measures", Journal of Finance 36, pp. 889–908.

JOBSON, J. and B. KORKIE (1982): „Potential Performance and Tests of Portfolio Efficiency", Journal of Financial Economics 10, pp. 433–66.

JORION, P. (1985): „International Portfolio Diversification with Estimation Risk", Journal of Business 58, pp. 259–78.

JORION, P. (1986): „Bayes–Stein Estimation for Portfolio Analysis", Journal of Financial and Quantitative Analysis 21, pp. 279–92.

JORION, P. (1989): „Asset Allocation wit Hedged and Unhedged Foreign Stocks and Bonds", Journal of Portfolio Management 15, Summer, pp. 49–54.

JORION, P. (1994): „Mean/Variance Analysis of Currency Overlays", Financial Analyst Journal 50, May/June, pp. 48–56.

LEVY, H. and K. LIM (1994): „Forward Exchange Bias, Hedging and the Gain from International Diversification of Investment Portfolios", Journal of International Money and Finance 13, pp. 159–170.

LEVY, H. and M. SARNAT (1970): „International Diversification of Investment Portfolios", American Economic Review 60, September, pp. 668–675.

MADURA, J. and A. TUCKER (1992): „Hedging International Stock Portfolios: Lessons from the 1987 Crash", Journal of Portfolio Management 18, Spring, pp. 69–73.

PEEL, D. (1993): „Nonlinear Risk Premia", Applied Financial Economics 3, pp. 201–204.

RUDOLF, M. and H. ZIMMERMANN (1994): „An Algorithm for International Portfolio Selection and Optimal Currency Hedging", Swiss Institute of Banking and Finance, University of St. Gallen.

SOLNIK, B. (1974): „Why not Diversify Internationally Rather than Domestically?", Financial Analyst Journal, July–August, pp. 48–54.

SWEENEY, R. (1986) „Beating the Foreign Exchange Market", Journal of Finance 41, pp. 163–82.

TAYLOR, S. (1990): „Rewards Available to Currency Futures Speculators: compensation for risk evidence of inefficient pricing?", Economic Record, Special issue on futures markets.