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International Investment and Exchange Rate Risk: An Experimental Analysis

Eine experimentelle Untersuchung zur internationalen Vermögensdiversifikation

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Summary

The experimental evidence gathered in this study indicates that a preference for domestic investments exists even under fixed exchange rates and in the absence of factors commonly understood to give rise to asymmetric portfolios. Adding exchange rate risk does not -- contrary to theory -- induce many individuals to hold more domestic assets. Non-professional investors in particular are prone to make choices at variance with the normative theory. This is traced back to misjudgments concerning the available risk-return trade-offs. It is also documented that flexibility of the exchange rate induces economic losses through inefficient portfolio choice. This even holds in a situation where exchange rate risk can be avoided by costless hedging.

Zusammenfassung

Experimentell gewonnene Daten weisen darauf hin, daß eine Präferenz für inländische Vermögensanlagen auch bei fixen Wechselkursen und in Abwesenheit bekannter Faktoren für asymmetrische Portefeuilles vorkommt. Wechselkursrisiko bewegt nur eine Minderzahl der Probanden dazu, mehr Inlandanlagen zu halten. Dieses Verhalten ist nicht mit rational optimierendem Verhalten vereinbar. Es kommt -- vor allem unter nicht-professionellen Anlegern -- zustande, weil die vorliegenden Risiko-Ertrag Tradeoffs falsch eingeschätzt werden. Der Aufsatz dokumentiert zudem, daß Flexibilität des Wechselkurses zu einem Effizienzverlust führt. Dies gilt selbst, wenn das Wechselkursrisiko kostenlos abgesichert werden kann.

1. Introduction

This article investigates international portfolio selection. The topics of main interest are *deviations from optimizing behavior* and the effects and costs of *exchange rate flexibility*. One issue addressed is the *home preference* of investment documented by French and Poterba (1991), Tesar and Werner (1992, 1995), and Cooper and Kaplanis (1994). A home preference means that investors tend to favor assets of their own

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country. Many authors use the term home *bias* in this context because the magnitude of home preference exceeds what optimizing behavior would demand. In the macroeconomic literature a related phenomenon, the so-called Feldstein-Horioka puzzle, has been documented. According to Feldstein and Horioka (1980) investment and savings in countries are too strongly correlated compared to what efficient portfolio allocation under perfect capital mobility would demand. Home bias and the Feldstein-Horioka puzzle are important for several reasons: if these regularities stem from limited international capital mobility then the design of optimal monetary and fiscal policies will be affected and, in addition, it cannot be taken for granted that private international capital flows put savings to their most productive uses. The study of the possible explanations of the observed regularities has made significant advances in the understanding of the circumstances under which the two related phenomena are the outcome of rational choice.[1] As demonstrated by Rötheli (1995) *exchange rate risk* can also induce home preference. However, there are cases where exchange rate risk has no such effect.

Regarding the role of exchange rate risk I mainly investigate two questions: First, can the effects described by Rötheli (1995) be replicated experimentally? Second, do elements of *bounded rationality* create effects not captured by theory based on the concept of optimization?[2] This is an obvious question since choosing an efficient portfolio is a difficult task, particularly under flexible exchange rates. One added dimension under flexible exchange rates is the problem of finding the *optimal hedging* of exchange rate risk. There are many opportunities for making misjudgments particularly when it comes to assessing risk-return trade-offs. In this perspective the Feldstein-Horioka puzzle may be in part the result of heuristics or rules of thumb used by individuals in a complex environment.[3] However, it is not clear from the outset whether bounded rationality influences portfolio choice toward or away from domestic assets and how exchange rate risk colors this picture. Under the heading of deviations from optimizing behavior we also analyze the *efficiency* of the portfolios chosen.

Most of the theory testing in the field of portfolio selection is done with historical data of asset prices and quantities. However, there is a growing experimental litera-

[1] Earlier writers attributed the preference for domestic investments to the larger risk associated with foreign investments. Examples are *Smith* (1805) and *Iversen* (1935). Another rationalization for asymmetric international portfolios is the existence of transactions costs. This was first established formally by *Black* (1974) and further investigated by *Niehans* (1992). *Stulz* (1981) showed that a desire to hedge against domestic inflation biases portfolios towards domestic assets. Likewise, *Eldor* et al. (1988) documented the role of uncertainty of nontraded goods prices. *Obstfeld* (1986) led the way to an understanding of the high saving-investment correlation as the result of developments in factors that affect both the accumulation and the allocation of capital such as population growth. *Bayoumi* (1990) found evidence for the hypothesis that policy reactions to changes in the current account help explain the reported correlation. *French* and *Poterba* (1991) reported one way of rationalizing home preference by way of cognitive bias. They calculated the subjectively expected returns necessary to generate the concentration of domestic assets in portfolios. *Gehrig* (1993) saw asymmetric information as the cause of home bias. While the finding that home bias is a rational response to circumstances or that high saving-investment correlations are the aggregate outcome of individual maximization does not imply that international capital allocation is efficient it helps put in perspective the regularities mentioned.

[2] *Simon* (1982) has made this point forcefully.

[3] See *Kahneman* et al. (1982) for effects of heuristics on judgment under uncertainty.

ture.[4] The present study follows this relatively recent tradition. The difference to existing work is that this study is mainly concerned with the international aspect of portfolio choice. One advantage of the experimental approach is the possibility to control for factors other than exchange rate risk that give rise to home preference. Hence, elements like transaction costs, asymmetric risk, asymmetric information, and subjectively skewed return expectations are controlled for. These possible causes of biased portfolio selection are not present in the experimental setting. The question here is whether home preference appears even in the absence of these forces.

2. The Experimental Task

The experiment was conducted in Switzerland as a survey. Subjects were given written instructions and solved the problem on their own. A flat fee of 20 francs was paid for every survey returned.[5] Subjects were instructed as follows:

1. You have a level of financial wealth of 100 000 Swiss francs. You should deal with this amount just as you would with your own money. You are interested in allocating this money so as to generate a return that contributes to your consumption. You cannot have a short position in any of the assets (i.e., there is no possibility to borrow).
2. The horizon of your investment is one year at a time. The returns indicated are annual returns.
3. You have four assets to choose from: a domestic equity, a foreign equity, a domestic bond, and a foreign bond. The bonds yield a fixed return. The return on equity is uncertain. In a good year stocks yield a high return while in a bad year they yield a low (in fact a negative) return. The levels of return under both conditions are known. What is not known is whether you have a good year or a bad year for the stock market ahead of you.
4. You are interested in the return on your portfolio in Swiss francs. The returns on the foreign investment are paid in foreign currency (called ECU). An appreciation (depreciation) of the Swiss franc vis-à-vis the ECU means that your return on the foreign investment measured in Swiss francs is diminished (increased).
5. The returns on the domestic and the foreign equities are not correlated and neither is the exchange rate correlated with any of these returns.[6]
6. Investment choices are demanded under three different scenarios. Tabel 1 summarizes the features of these scenarios. Under *scenario one* (S1) the returns on both domestic and foreign bonds are 2 %. The return on domestic and foreign equities is 14 % in a good year and − 3 % in a bad year (both states have a proba-

[4] See *Gordon* et al. (1972), *Kroll* et al. (1988), and *Weber* and *Camerer* (1992).

[5] The prospect of earning 20 francs was of minor importance for many subjects. Rather, doing a favor to the author and doing a good job seemed to be the major motives. Subjects were advised that they could ask questions and consult with people they would usually contact in matters of money. The time it took participants to return the survey ranged from 2 to 14 days. Three questionnaires remained unanswered and one subject's response could not be used because the task was misunderstood.

[6] The independence among equity returns and the exchange rate is illustrated in the instructions by referring to the tossing of three coins: a coin for the domestic equity, another coin for the foreign equity, and a third coin for the exchange rate.

Table 1: Returns and Exchange Rates Under the Different Scenarios

Scenario 1			
Asset		Return	
Domestic Bond		2 %	
Domestic Equity	14 % (with probability 0.5)		−3 % (with probability 0.5)
Foreign Bond		2 %	
Foreign Equity	14 % (with probability 0.5)		−3 % (with probability 0.5)
Exchange Rate		Francs per Ecu	
Spot Rate		1	
Scenario 2			
Asset		Return	
Domestic Bond		2 %	
Domestic Equity	14 % (with probability 0.5)		−3 % (with probability 0.5)
Foreign Bond		2 %	
Foreign Equity	14 % (with probability 0.5)		−3 % (with probability 0.5)
Exchange Rate		Francs per Ecu	
Spot Rate			
Beginning of Year		1	
End of Year	1.1 (with probability 0.5)		0.9 (with probability 0.5)
Forward Rate		1	
Scenario 3			
Asset		Return	
Domestic Bond		2 %	
Domestic Equity	14 % (with probability 0.5)		−3 % (with probability 0.5)
Foreign Bond		3 %	
Foreign Equity	14 % (with probability 0.5)		−3 % (with probability 0.5)
Exchange Rate		Francs per Ecu	
Spot Rate			
Beginning of Year		1	
End of Year	1.1 (with probability 0.5)		0.9 (with probability 0.5)
Forward Rate		0.99	

bility of 1/2).[7] The exchange rate remains fixed. Under *scenario two* (S2) the returns on equity and bonds are as under S1 but the exchange rate is flexible. With a probability of 1/2 the end-of-year price of ECU in terms of francs is 1.1 and 0.9, respectively. There exists a forward exchange market on which you can trade the two currencies. The forward rate of ECU in Swiss francs for exchange at the end of the year (when the returns are paid out) is 1. *Scenario three* (S3, again with a flexible exchange rate) differs from S2 in that the return on the foreign bond is 3 % and an ECU is worth 0.99 francs on the forward exchange market.

It was left to the subjects to infer that hedging under S2 is free while under S3 hedging costs 1 % of the amount of ECU hedged.[8] A total of 24 subjects participated in the study.[9] 14 subjects were without any university training in economics or finance. The subjects in this group are referred to as *people* (*P*). This group spanned a wide age and educational spectrum. The second group consisted of 5 economists (4 PhDs) who work as portfolio managers or investment consultants. The third group consisted of 5 economists either in graduate education or with a recent PhD. The second and third group are referred to as *portfolio managers* (*M*) and *economists* (*E*), respectively. The diversity of participants was chosen in order to shed light on a possible heterogeneity of behavior related to professional specialization. It is important to assess heterogeneity since portfolio managers allocate funds many times the size of their personal wealth. Thus, in sections 4 to 7 where the choices are compared to the *normative theory* I also trace differences between the three groups.

3. Efficient Portfolios

The efficient portfolios are found in the standard manner [see Markovitz (1959)]: we minimize the variance of the portfolio under the condition that the expected return be of a certain value. The combination of points which results from this procedure makes up the *efficient frontier* of all possible portfolios. The variance (σ_R^2) of the return (R) for any portfolio given the described conditions is

[7] The expected returns and variances used are related to empirical regularities documented by *Tolle* et al. (1994) who presented updated evidence from Wydler's study [see *Wydler* (1989)]. According to them Swiss stocks yielded an annual average return of 7.1 % in real terms while bonds earned 2.1 % over the years 1926 to 1993. The standard deviation for stocks was 20.1 % while the standard deviation for bonds was 5.6 %. This indicates that an additional point in expected return implies an addition to the standard deviation of 2.9 percentage points. Hence, an equity with an expected return of 5.1 % (a conservative stock) has a standard deviation which is by 8.7 percentage points higher than the standard deviation on bonds. Assuming for the experiment that the standard deviation on bonds is zero this implies that the stock return in a bad year is − 3.6 % and in a good year 13.8 %. These two numbers are rounded to the − 3 % and 14 % used in the experiment.

[8] It has to be pointed out that the risk difference between scenarios S2 and S3 on the one hand and S1 on the other hand concerns only exchange rate risk. In the real world it is possible that fixing the exchange rate induces variability in other variables like, for example, interest rates. Such compensatory variability, although potentially interesting, is not captured in the scenarios of the present experiment. This study then attempts to quantify the isolated effect of exchange rate risk.

[9] *Kroll* et al. (1988) conducted experiments on portfolio selection with as little as 12 subjects.

$$\sigma_R^2 = w^2[(x^2 + y^2)\sigma_r^2 + (y + z)^2\sigma_d^2], \tag{1}$$

where w is wealth, x is the fraction of wealth invested in the domestic equity, y is the fraction invested in the foreign equity, z is the fraction invested in foreign bonds, σ_r^2 is the variance of the equity returns (identical in both countries), and σ_d^2 is the variance of the exchange rate. The amount of exchange rate hedging can be summarized under the positions of domestic and foreign bond holdings: every ECU sold on the forward market is equal to a foreign bond debt combined with a domestic bond investment. The expected (and targeted) end of period return ($\overline{R}$) for any portfolio is

$$\overline{R} = w[x(\bar{r} - i) + y(\bar{r}^* - i) + z(i^* - i) + i], \tag{2}$$

where $\bar{r}$ is the expected return on the domestic equity, $\bar{r}^*$ is the expected return on foreign equity (in the experiment $\bar{r} = \bar{r}^*$), i is the domestic bond interest rate, and i^* is the foreign bond interest rate. The solution to the minimization problem under the specified restrictions leads to expressions for x, y, and z in terms of the targeted return relative to the return of a risk-free portfolio ($I = iw$):

$$\begin{aligned}
x &= \frac{\lambda\,(\bar{r} - i)}{2\,w\,\sigma_r^2}(\overline{R} - I), \\
y &= \frac{\lambda\,(\bar{r}^* - i^*)}{2\,w\,\sigma_r^2}(\overline{R} - I), \\
z &= \lambda\left(\frac{i^* - i}{2\,w\,\sigma_d^2} - \frac{\bar{r}^* - i^*}{2\,w\,\sigma_r^2}\right)(\overline{R} - I), \\
\text{where } \lambda &= \frac{2\,\sigma_r^2\sigma_d^2 w}{\sigma_d^2\,(\bar{r} - i)^2 + \sigma_d^2\,(\bar{r}^* - i^*)^2 + \sigma_r^2\,(i^* - i)^2}.
\end{aligned} \tag{3}$$

Under S1, where the exchange rate is fixed, domestic and foreign bonds are perfect substitutes and only x and y are determined. When the returns and variances under the three scenarios are inserted in the equations for x, y, and z we arrive at the following expressions:

$$x_1 = x_2 = y_1 = y_2 = 0.000143\ (\overline{R} - I),\ z_2 = -\,0.000143\ (\overline{R} - I), \tag{4}$$

$$x_3 = 0.000182\ (\overline{R} - I),\ y_3 = 0.000130\ (\overline{R} - I),\ z_3 = -\,0.000092\ (\overline{R} - I).$$

The subscripts indicate the scenario. The stated relationships simply indicate that under S1 and S2 equal investments go into domestic and foreign stocks. While the distribution of the funds not invested in risky assets is not determined under S1 (i.e., all combinations of domestic and foreign bond holdings are efficient) S2 demands that an amount equal to the foreign stock holdings but of negative value be held in foreign bonds, that means, S2 demands full hedging of the foreign equity position.[10]

[10] The fact that the optimal z is negative does not contradict the experimental instruction of no short positions. Subjects can reach the equivalent of a negative z by way of sales on the forward market.

This is not surprising given that hedging under S2 is free and that, without hedging, exchange rate risk adds to portfolio variance. Under S3 a larger share (i.e., 58 %) of risk funds (i.e., equity investment) goes into domestic equity than into foreign equity (i.e., 42 %). This indicates that exchange rate risk, if it is costly to hedge, moves efficient investment toward domestic equity. As to exposure to exchange rate risk, (4) indicates that optimal hedging under S3 is not full hedging. This can be seen from the fact that $|z_3|<|y_3|$. More precisely, in an efficient portfolio 71 % of foreign equity investment should be hedged. Table 2 shows the efficient portfolio shares under the three scenarios.

Table 2: Efficient Portfolio Shares Under the Different Scenarios

Scenario	1	2	3
Domestic Equity Investment as a Share of Total Equity Investments	50 %	50 %	58 %
Percentage of Hedged Foreign Equity Investment	–	100 %	71 %

It must be said that the $\overline{R}$ attainable under all scenarios has an upper limit of 5500 francs. At that level of $\overline{R}$ many portfolios with different levels of risk exist. Since risk neutral investors are indifferent between different levels of risk (and risk lovers prefer higher risk) we term all choices that yield an $\overline{R} = 5500$ as efficient.

4. Efficiency of Portfolios Chosen

In this section I describe the portfolios chosen by the subjects in the experiment and investigate whether these portfolios lie on the efficient frontier. It is clear that under S1 and S2 it is easier to structure an efficient portfolio. Under S1 the only requirement is for the risk funds to be allocated equally between domestic and foreign stocks. Figure 1 shows that this is what most of the subjects did. 16 of 24 portfolios lie on the efficient frontier. The circles indicate choices by the group *people*, triangles denote *portfolio managers*, and squares denote *economists*. Under S2 the same risk and return options are available as under S1. What is necessary, though, is that the foreign equity investment needs to be fully hedged.[11] Many subjects did not recognize this and suffered efficiency losses. This is visible in Fig. 2 where only 12 portfolios lie on the efficiency frontier. Most participants in the study under-hedged their foreign investment under S2. The investment task of S3 is clearly more difficult since the efficient amount of hedging is not intuitively assessable. Most subjects under S3 either refrained from hedging the exchange rate risk or chose full hedging. Both strategies are sub-optimal. Hence, only a modest number (i.e., 7) of portfolios are efficient as Fig. 3 shows. It has to be said that the expressions for x_3, y_3, and z_3 only apply to values of $\overline{R}$ (the target return) between 2000 and 5203 francs. A target return in

[11] Full hedging ($z_2 = -y_2$) does not eliminate exchange rate risk on the amount $wy_2(r^* - \bar{r}^*)$. Hence, scenarios S1 and S2 are only approximately equivalent. No participant in the study has raised concern regarding this approximation.

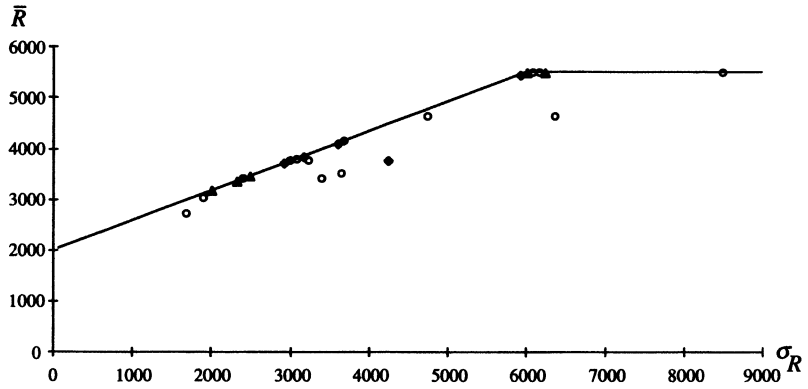

Figure 1: Risk/Return Choices under Scenario 1

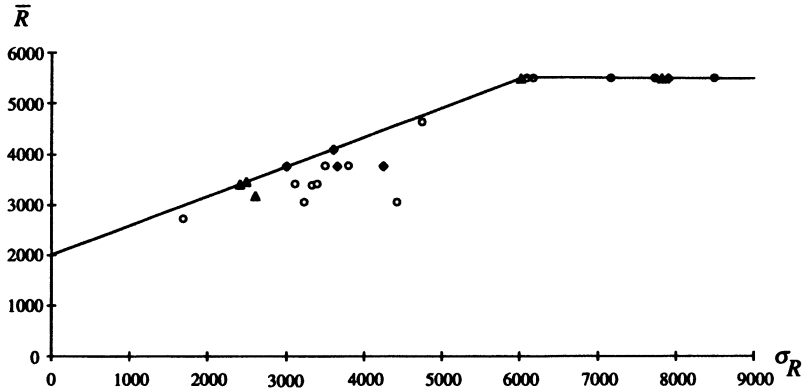

Figure 2: Risk/Return Choices under Scenario 2

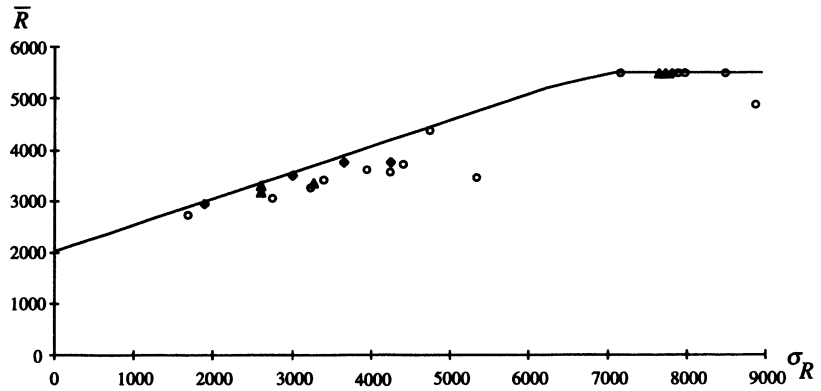

Figure 3: Risk/Return Choices under Scenario 3

excess of 5203 francs can only be reached by combining the optimally hedged portfolio (with $\overline{R}$ = 5203) with a pure unhedged equity portfolio. The fractions of domestic and foreign stocks of this latter portfolio are $x = 0.7$ and $y = 0.3$. These fractions minimize the variance of an unhedged equity portfolio. Combinations of the two equity portfolios produce the flatter upper section of the efficiency frontier in Fig. 3.

Efficiency losses due to exchange rate risk can readily be assessed by looking at the return that could be achieved evaluated at the individual levels of risk. Efficient choices generate the maximal return possible while inefficient choices generate returns short of the return possible. The average gaps (return loss) are 142 francs under S1 (*P*: 193; *M*: 0; *E*: 145), 273 francs under S2 (*P*: 364; *M*: 70; *E*: 221), and 258 francs under S3 (*P*: 356; *M*: 112; *E*: 132). Expressed in percent of the average portfolio return the efficiency losses are 3.4 %, 6.5 %, and 6.3 % under the three scenarios. From the fact that the losses under S2 and S3 are roughly similar I conclude that flexibility of the exchange rate as such causes efficiency losses in investment.

5. Efficiency of Chosen Hedging Strategies

Hedging by many subjects is inefficient both under S2 and S3. Optimal (in this case full) hedging under S2 is simpler to assess since hedging is free and no trade-offs have to be evaluated. Still, only half of the subjects in the group *people* and three fifths of the groups *portfolio managers* and *economists* hedged optimally. Under S3 a majority (14) of subjects chose not to hedge at all while 3 subjects hedged their foreign investment fully. Optimal hedging, however, lies between the two extremes and demands that 71 % of the foreign equity investment be hedged given the specified means and variances under S3.[12] Only one subject (from the group *people*) came very close to choosing this hedging ratio and two more subjects chose an efficient no-hedging strategy with an $\overline{R}$ of 5500. This shows that even professionals struggle with the quantification of adequate hedging.[13]

6. Consistency of Choice

The experiment also allows some simple tests of consistency of choice in the uncertain environment described. Since the choices under S1 and S2 are identical subjects with consistent preferences between return and risk (as measured by σ_R) and sufficient problem solving capacities would choose identical stock portfolios under S1 and S2. It turns out that only 4 out of 14 subjects of the group *people*, 3 out of 5 *portfolio managers*, and 3 out of 5 *economists* conformed to this consistency requirement. S3 provides a different risk-return trade-off than the other two scenarios and hence no consistency requirement in the x- and y-choices between S2 and S3 applies. However, we can combine the consistency requirement with the requirement of opti-

[12] As indicated earlier, optimal foreign equity holdings under S3 are 42 % of total equity holdings.

[13] See *Knight* (1991) for a competent treatment of hedging of international portfolios and a discussion of inefficient shortcuts.

mal hedging under S3. Based on this test we find that altogether 2 subjects (1 *P* and 1 *M*) made efficient and consistent choices throughout.[14]

7. Home Bias of Investment

Here, we are interested in whether subjects allocate wealth between the two countries according to theory or whether investment in the domestic country is favored in excess of what optimizing behavior would suggest. The focus is on equity investments. Figures 4, 5, and 6 plot the domestic equity choices against the targeted return under the three scenarios. The solid lines show efficient levels of domestic equity investment. While some participants underinvest in the domestic equity the deviations from the efficient choices are on average positive which indicates home bias. Under S1 the average home bias is 5062 francs, under S2 it is 3437 francs, and under S3 it is 62 francs. These numbers are calculated on the basis used earlier, that is, at a targeted return of 5500 francs many portfolios with different levels of risk are efficient. In the three figures this is indicated by the thin vertical lines. If we limit the set of efficient portfolios to those choices that minimize, at a certain $\overline{R}$, the level of risk (i.e., we look for deviations from the solid lines in Fig. 4, 5, and 6) then the above numbers for the home bias are modified. The modified home bias is 7146 francs under S1, 6562 francs under S2, and − 2777 francs under S3.

Interestingly, average home bias tends to diminish as we move from S2 to S3 (it stays fairly constant from S1 to S2, particularly according to the modified numbers). The bias is close to zero or even negative (depending on the definition of efficiency used) under S3.[15] There are two main explanations of this finding: First, the higher foreign bond rate induces a significant number of subjects to increase their foreign bond holdings under S3. The average z under S2 is 7708 francs and rises to 15791 francs under S3. If the foreign bond holdings under S3 are hedged they yield a return identical to that of domestic bonds and thus are an efficient investment. However, if the foreign bond holdings are not hedged (a frequent occurrence) then foreign bonds are not an efficient investment. The one percent extra return that foreign bonds yield over domestic bonds under S3 is just not high enough to compensate for the standard deviation of 10 % induced by the exchange rate risk. Hence, subjects choosing unhedged foreign bonds would fare better to increase either their domestic or their foreign equity holdings: both investments yield a better risk-return trade-off than foreign bonds. If the subjects who hold unhedged foreign bonds were removed from figure 6, five *P* and one *M* lying below the solid line would disappear. Thus, it is a judgement error that induces subjects to choose a portfolio under S3 that has less home bias and is more in accordance with standard theory. The second reason why

[14] This statement is contingent on the use of σ_R as the measure of risk. If instead, as an example, a worst-case return were used a portfolio with 60 % of wealth in domestic bonds and 40 % in domestic equity would yield a consistent choice under all three scenarios: it maximizes $\overline{R}$ under the condition that R is never negative. However, such a portfolio is not mean-variance efficient and implies a less smooth consumption pattern over time.

[15] This tendency also shows in the average x-choices which are identical under all scenarios ($\overline{x} = 0.37$). This runs counter to efficiency which demands that x rises from S2 to S3. When we look at the separate groups it is only the group *portfolio managers* that changes x in the right direction (S1: 0.31; S2: 0.31; S3: 0.35).

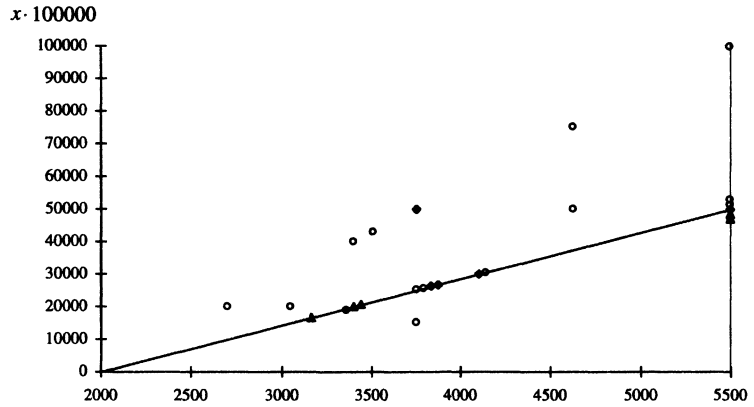

Figure 4: Investment in Domestic Equity under Scenario 1

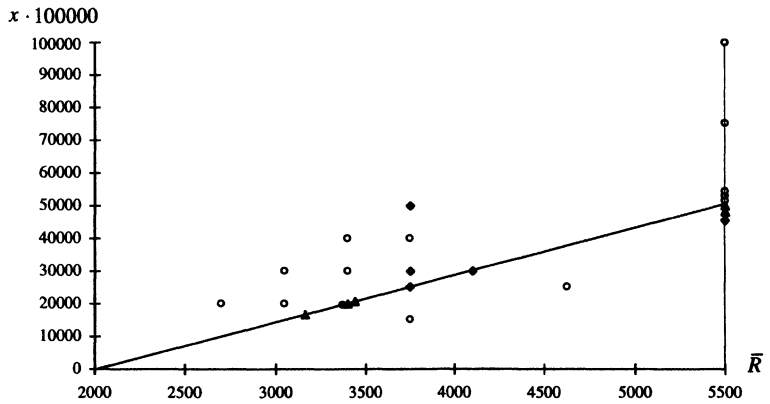

Figure 5: Investment in Domestic Equity under Scenario 2

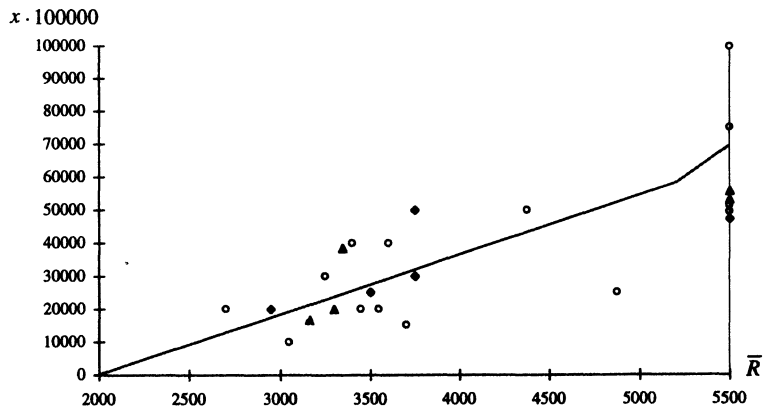

Figure 6: Investment in Domestic Equity under Scenario 3

the home bias sinks has to do with the benchmark. It is the benchmark that defines what part of home investment is excessive. With costly hedging rational wealth allocation demands a higher domestic equity investment. This is indicated by the fact that the solid line in Fig. 6 is rotated counter-clockwise compared to Fig. 5. Thus it is also the absence of an optimal response (i.e., a rather stable home preference) to costly hedging that reduces home bias under S3.

It is particularly interesting to look at home bias by groups of participants. The largest home biases are found with the groups *people* (S1: 6893; S2: 3750; S3: − 1480) and *economists* (S1: 5000; S2: 6000; S3: 3310) while *portfolio managers* (S1: 0; S2: 0; S3: 1129) show a smaller bias. The issue of home bias can also be addressed in a more restricted sense. Table 3 shows the domestic equity investment as a share of total equity investments reported by groups of participants. The figures in this table indicate that many investors prefer domestic equity over foreign equity in excess of what optimizing behavior would demand. The data of table 3 provide a narrow picture of home bias because they ignore foreign bond holdings which may be excessive (as witnessed under S3).

Since the experimentally induced home bias of investments is smallest among the subjects from the group *portfolio managers* a country's actual home bias is likely to fall as a greater amount of wealth is managed by professionals. It can also fall (or even become negative) under changing conditions because of erroneous judgments concerning risk-return opportunities. This indicates that the degree of home preference in equity investment induced by exchange rate risk as suggested by Rötheli (1995) is largely to be expected of professionally hedged portfolios.

Table 3: Domestic Equity Investment as a Share of Total Equity Investments by Groups of Participants

Scenario	1	2	3
Efficient Share	50 %	50 %	58 %
People			
Average	68 %	68 %	68 %
Standard Deviation	(25 %)	(25 %)	(27 %)
Portfolio Managers			
Average	50 %	50 %	60 %
Standard Deviation	(0 %)	(0 %)	(22 %)
Economists			
Average	60 %	62 %	65 %
Standard Deviation	(22 %)	(21 %)	(20 %)

8. Conclusions

The number of subjects participating in this study was rather small although well within the range of comparable studies. With this caveat in mind, this experimental study on international wealth allocation documents the following regularities:

- Flexibility of the exchange rate, more precisely the difficulties it adds to making optimal choices, induces economic losses through inefficient portfolio choice. This even holds in a situation where exchange rate risk can be avoided by costless hedging. This finding should not be taken as a final argument against flexible exchange rates since this study does not pursue the possibility that fixing the exchange rate may induce variability elsewhere. This study then has attempted to quantify the isolated effect of exchange rate risk.
- A majority of professional portfolio managers and academically trained economists choose efficient (i.e., full) hedging when it is costless. In the group of subjects without training in economics and finance efficient hedging is an exception. When hedging is costly only a very small number of all subjects in this study manages to hedge their foreign investments optimally. Apparently, intuition is a poor guide for assessing the risk-return trade-off implied in the hedging decision.
- A minority of investors makes choices under different circumstances that show consistency of choice in a risk-return framework.
- A positive home bias of investment is a normal occurrence in an environment where many possible causes of biased portfolio selection (like inflation risk, transaction costs, asymmetric information and subjectively skewed return expectations) are not present. However, portfolio managers are much less prone to invest in domestic securities in excess of what optimizing behavior demands. Hence, a professionalization of wealth management is likely to diminish the part of the home orientation of investment that is not in accordance with optimizing behavior.
- Home bias of investment by average investors (unlike the choices of portfolio managers) is not related to exchange rate risk as expected from standard theory. The preference of domestic over foreign assets exists both under fixed and flexible exchange rates. This home preference can abate in a condition where the hedging of foreign investment is costly, that is, when the foreign bond return exceeds the domestic bond return. This is in contrast to optimizing behavior [see Rötheli (1995)] which, in this case, would demand an increase in domestic investment. The shift towards foreign bonds observed in this case represents a misjudgment since the implied risk-return trade-off is less favorable than with the other risky assets available. Hence, one sort of misjudgment can mitigate the consequences of other elements of choice. From this perspective, historical stages with decreasing home bias in investment do not prove that investors have become more rational but may just be the result of mutually neutralizing biases of judgment.

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