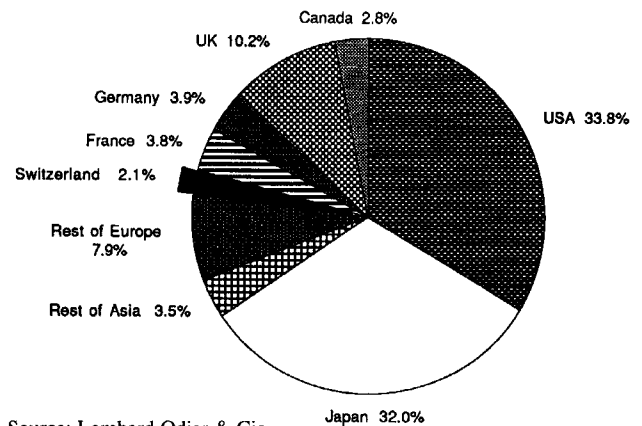


International Diversification for Swiss Pension Funds

A recent study by Intersec shows that total pension assets in the world amounted to \$4.4 trillions at the start of 1990 or more than 20% of the combined world market capitalization of bonds and equity. Only 7% of those assets are invested abroad. This figure varies greatly across countries. U.S. pension funds have only an average of 3% of their assets invested abroad while U.K. pension funds invest more than 25% abroad. Regulatory investment constraints of Swiss pension funds have recently been relaxed; they can now own 30% in foreign currency assets and 50% in equity, no more than half of this equity position invested in foreign stocks. However few Swiss pension funds have reached this foreign limit and the average position in equity tends to be well below the 50% ceiling. The purpose of this article is to defend the case for international diversification for a Swiss pension fund.

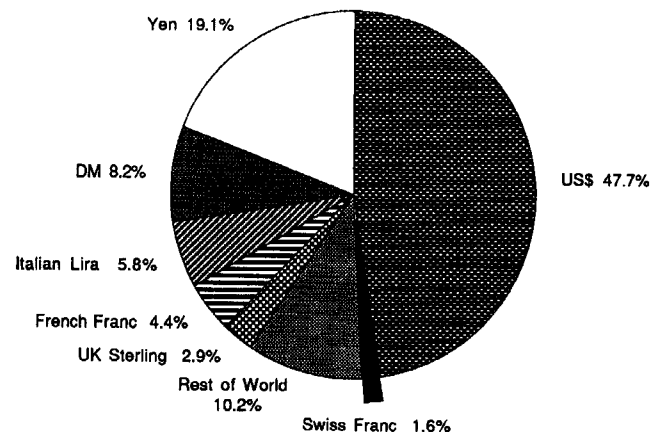
The Swiss bond and stock markets are quite large relative to the size of the economy, however their market capitalization represents less than 2% of the world market as shown in figure 1. One may reflect on the disproportion of the geographic asset distribution of Swiss pension funds relative to the world market capitalizations.

Figure 1a: Stock Market Capitalization (Sept. 1990, Total US\$ 7.8 Trillions).



Source: Lombard Odier & Cie

Figure 1b: Bond Market Capitalization (Jan. 1990, Total US\$ 10 Trillions).



Source: Lombard Odier & Cie

1. International Diversification: Risk and Return

A major argument for investing internationally is that it increases the profit opportunity while providing risk diversification.

It has been repeatedly demonstrated that international diversification reduces the total volatility of the portfolio, i.e. the risk of a large loss in any given quarter or month [1]. The traditional measure of volatility is the standard deviation of return or sigma. It is a well-known statistical measure of the amplitude of price swings. If we measure sigma in % per year, there is roughly one chance out of six of a loss (or negative deviation from the mean) equal to one sigma in any given year.

Of course a preliminary question ought to be the choice of the numeraire to measure return and risk. Tradition and regulation requires that a Swiss pension fund measures its assets in Swiss franc. This is not the obvious answer if the objective of the plan is to promise its pensioners a steady purchasing power at retirement late in the future. In theory one ought to optimize the real return/risk profile of the portfolio not its nominal Swiss franc profile. Because foreign goods represent some 30% of the Swiss consumption basket [2] as measured by the CPI, the purchasing power of Swiss pensioners is affected by foreign currencies and it would seem unwise to regard an investment in nominal Swiss franc deposits as risk free in terms of purchasing power. If we were to optimize the long term consumption risk structure of a Swiss pension plan it would seem wise to include foreign assets at least in proportion to their weight in the typical Swiss consumption basket. However the accepted practice is to optimize return in nominal Swiss franc terms and regard as risky holdings in other currencies. We will adopt this convention here and demonstrate that there is still a strong case for international diversification in foreign bond and stock markets.

1.1 Return and Risk

The performance in terms of return and risk of the various world markets for the past ten years [3] to

September 1990, is given in table 1. We chose a period of ten years to report long term results; similar conclusions could be reached if we had chosen a period of fifteen or twenty years. For each market, we first indicate the annualized average return calculated in Swiss franc. This is broken down between: capital gain in local currency, yield and currency contribution. The last two columns give an estimate of the volatility of the markets. We use monthly data to measure the standard deviation of returns in local currency ("risk in LC") and in Swiss franc ("total risk"). These volatilities are also expressed in per cent per year.

We also give the performance of regional stock indices for Europe, EAFE (Europe, Australia and Far East) and the world; these are market-capitalization-weighted indices of the various national stock indices. The stock indices come from Morgan Stanley Capital International. The bond indices are government bond indices calculated by Lombard Odier.

The Swiss bond market had an average performance of 3.3%, with an average yield of 4.9% but significant capital losses, and a volatility of only 3.4%. The other bond markets have been better performing but also much more volatile over the period; for example the US bond market had a volatility in US\$ of 10.2% which compounds to 15.1% in SFr when the exchange risk is taken into account. The Swiss stock market had an average performance of 10.2% with a higher volatility of 17.0%. This is a traditional result found on any long time-period and any market: stock investments are more risky but tend to provide a sizeable risk premium over the long run. Here the risk premium is equal to 6.9% per year; this makes a large difference when compounded over ten years. The performance of other stock markets varies greatly. The difference in national performance would have been more shocking if we had reported cumulative return over the ten-year period rather than annualized returns. Note that Japan is the best-performing market despite the 1990 plunge in the Yen and the Tokyo stock market. A final observation in this table 1. A Swiss investor who had passively invested in the international

Table 1: Total Performance in SFr and % per Year (Ten Years Sept. 1980 - Sept. 1990).

	ANNUAL RETURN %	CAPITAL GAIN %	DIV. YIELD%	CURR. GAIN %	TOTAL RISK %	RISK in LC %
STOCKS						
GERMANY	14.7	11.4	4.7	-1.3	21.9	20.7
BELGIUM	18.8	14.4	8.8	-4.4	21.8	20.6
DENMARK	19.4	20.1	3.3	-4.0	19.7	18.8
FRANCE	14.8	15.0	5.4	-5.6	23.6	22.2
ITALY	16.2	19.9	3.0	-6.7	28.5	27.5
NORWAY	14.0	15.2	4.1	-5.3	28.1	26.0
NETHERLANDS	16.9	12.4	6.3	-1.7	19.9	19.0
UNITED KINGDOM	14.4	14.0	5.7	-5.4	22.7	19.1
SWEDEN	25.6	28.9	3.9	-7.3	24.7	23.5
SWITZERLAND	10.2	7.3	2.8	0.0	17.0	17.0
AUSTRALIA	7.8	9.4	4.9	-6.6	30.3	23.6
JAPAN	19.6	15.7	1.3	2.6	23.1	18.0
CANADA	5.0	3.8	3.7	-2.5	22.8	17.8
USA	12.0	9.8	4.8	-2.6	21.5	16.3
SPAIN	17.3	14.3	9.5	-6.5	24.2	22.4
HONGKONG	8.9	11.6	5.1	-7.8	38.4	33.7
SINGAPORE	5.9	4.4	2.1	-0.6	30.9	26.9
GOLDMINES	3.1	-2.5	8.0	-2.4	49.3	49.6
EUROPE(\$)	15.0	12.5	5.2	-2.7	17.0	14.2
EAFE(\$)	16.0	15.6	3.1	-2.7	17.1	15.0
WORLD(\$)	13.7	12.3	4.0	-2.7	16.3	14.3
BONDS						
GERMANY	6.1	-0.6	7.8	-1.2	8.0	6.0
FRANCE	8.7	1.2	12.9	-5.3	11.1	8.2
NETHERLANDS	6.4	-0.5	8.4	-1.6	11.1	9.4
UNITEDKINGDOM	6.1	-0.5	11.5	-5.0	15.1	9.4
SWITZERLAND	3.3	-1.6	4.9	0.0	3.4	3.4
JAPAN	9.7	0.4	6.8	2.4	12.5	6.8
CANADA	9.0	-0.5	12.1	-2.6	16.2	11.5
USA	9.0	0.4	11.1	-2.6	15.1	10.2
GOLD	-6.6	-4.5	0.0	-2.2	19.1	19.6

stock portfolio represented by the world index would have borne a similar level of risk (volatility of 16.3% compared to 17% for a Swiss stock portfolio) with a much better performance. The volatility of the world stock portfolio would have been further reduced if all investments were fully hedged against currency risk. Although investing

abroad means buying some highly volatile markets (e.g. Far Eastern markets, Italy,...) and bearing some additional currency risks, it appears that many of these risks get diversified away because of their low correlation; the net result is an international portfolio with an attractive risk/return profile compared to that of a purely domestic Swiss stock

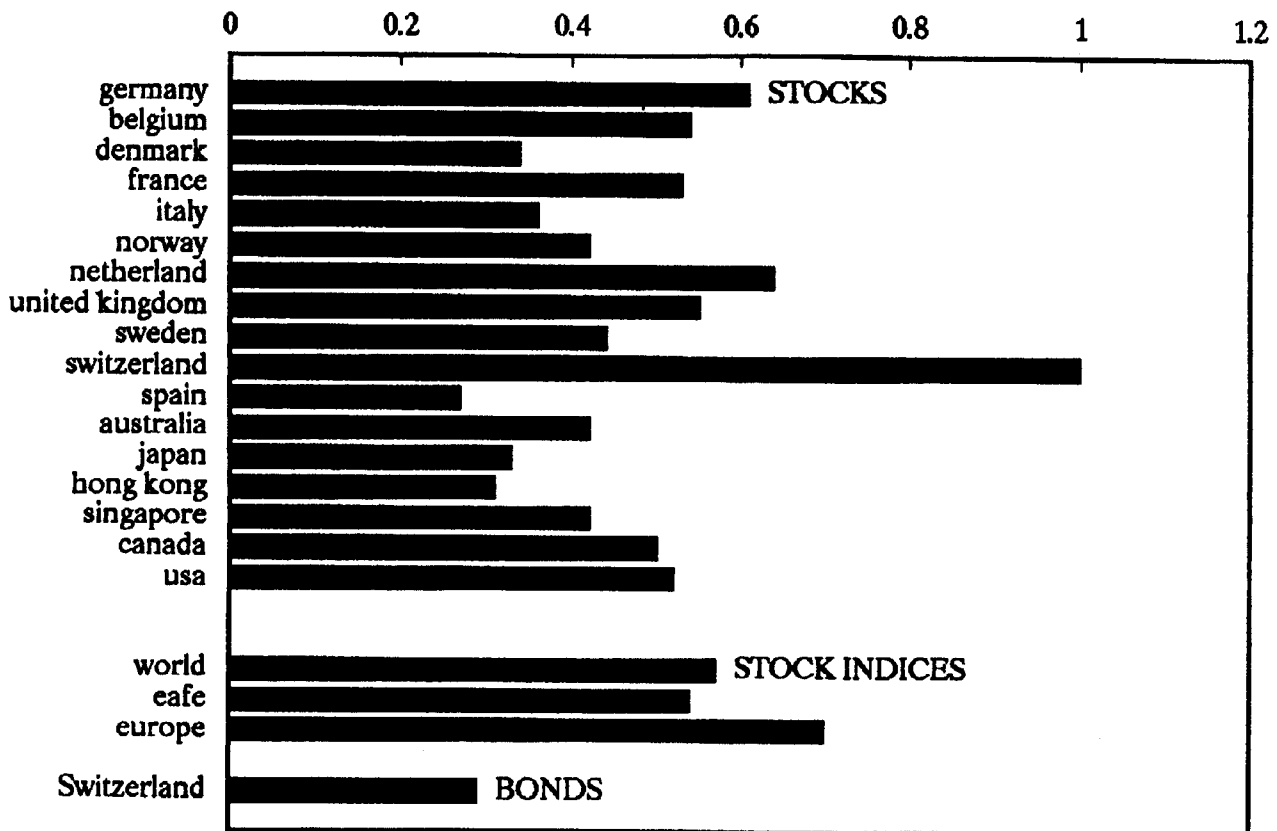
portfolio. Actually all foreign stock markets are more volatile than the Swiss stock market, especially when measured in Swiss francs, but the low correlation between national market movements allows to end up with a well diversified international portfolio of similar and even lesser volatility.

1.2 Correlation

The correlation of the Swiss stock and bond markets with other markets is reported in figures 2 and 3. The correlation coefficients vary somewhat across countries [4]. The correlation for stocks tend to be around 0.5, which mean that two markets have only 25% (the square of 0.5) of their movements explained by common factors. This figure is even lower for

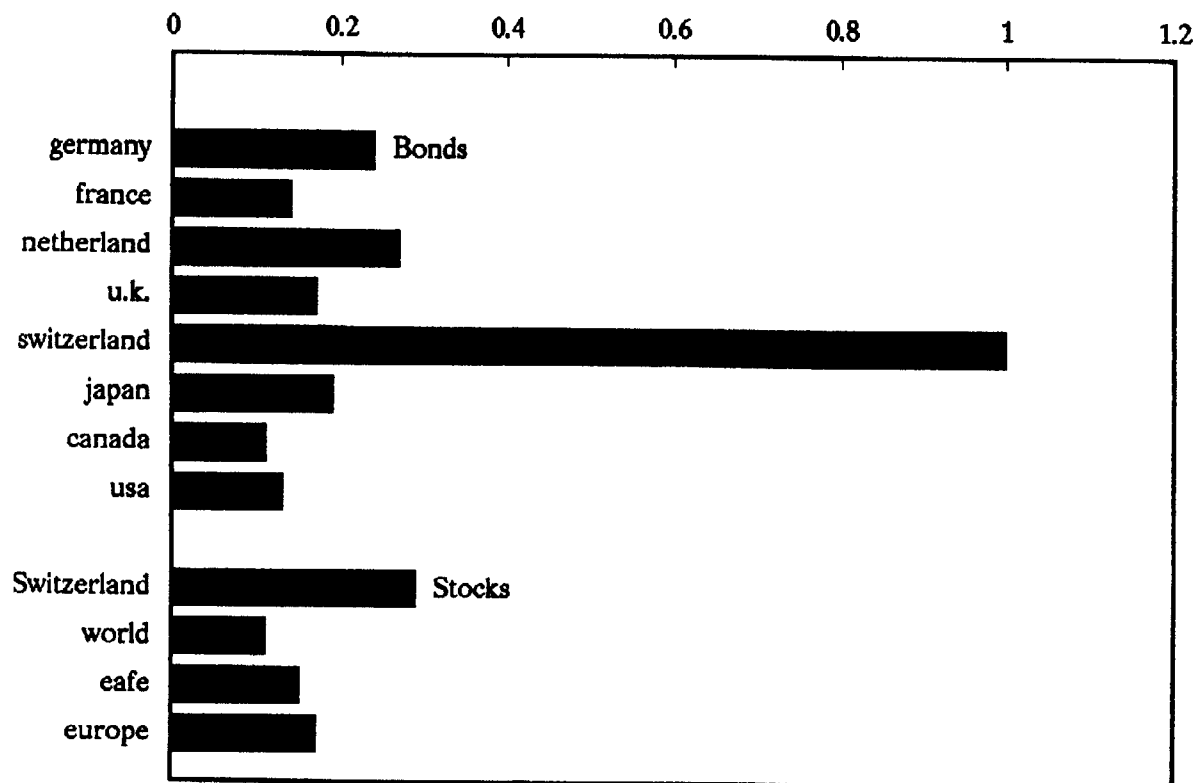
bond markets. Despite media talks monetary variables tend to vary quite independently across countries. This low correlation comes from the fact that national monetary policies are not fully synchronized. For example the growing Swiss inflation in the late eighties associated with rising Swiss interest rates and a weakening of the franc was not matched in other countries. The relative independence of monetary factors, influencing both currency and interest rate movements, lead to a surprisingly low correlation of the Swiss franc returns on the Swiss and foreign bond markets. Of course the correlation is larger among countries with strong economic and monetary ties. Altogether these correlations are surprisingly low and explain the good risk diversification benefits provided by international investment.

Figure 2: Correlation of Swiss Stocks (1970 - 1990 in SFr).



Source: Lombard Odier & Cie

Figure 3: Correlation of Swiss Bonds (1970 - 1990 in SFr).



Source: Lombard Odier & Cie

1.3 Currency Risk

Currency risk is a large component of the total risk of a bond investment. For example we can see in table 1 that currency risk adds about 50% to the volatility of an investment in U.S. bonds; the volatility in U.S. dollars is 10.2% while it goes up to 15.1% for a Swiss-based investor. Clearly the contribution of currency risk depends on the currency considered and is much lower for a German bond than for a yen bond. Currency risk is a smaller, but significant, component of the total risk of a stock investment. For example the domestic volatility of the U.S. stock market (16.3%) increases by 30% when measured in Swiss francs (21.5%). Again the contribution of currency risk varies with the countries considered and is very small for Germany and

a few other countries. This currency risk gets partly diversified away in a diversified international portfolio, but the risk of an appreciation of the Swiss franc against all or most currencies remains. Currency risk contributes about 15% of the volatility of the world stock index.

In the last section of this study, we will show that the importance of the monetary factor fluctuates widely over time. This means that monetary factors should be studied with great care and that they should be an important variable in the formulation of the global investment policy. It also implies that an active currency hedging policy could be valuable.

One should not forget that the objective of an optimal investment policy is not to minimize risk but to optimize the risk-adjusted performance of the fund. A systematic policy of complete currency

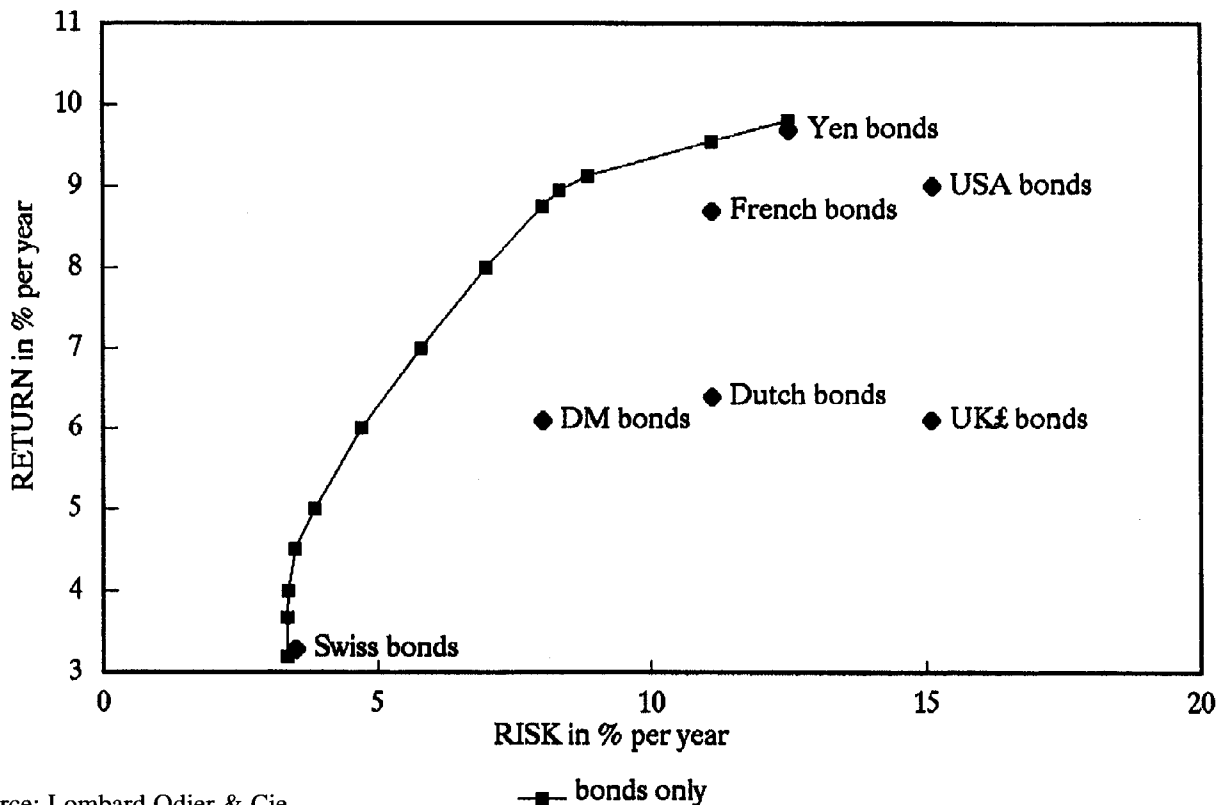
hedging would eliminate the contribution of currency risk on the total volatility of the portfolio but would also affect the return on that portfolio. This can be illustrated on a Japanese stock investment. Such an investment had a return of 17.0% in yen and 19.6% in Swiss francs (see table 1). The volatility in Swiss francs was 23.1% compared to only 18.0% in yen. A forward currency contract is equivalent to going short in the foreign currency and long in the domestic currency; hence one has to pay the short-term interest rate differential between the two currencies. This is often stated by saying that the forward currency basis (premium or discount) is equal to the interest rate differential. Over the period, the Swiss short-term interest rates were very low compared to interest rates in other currency. Hence a currency hedge of a Japanese stock investment would have cost over 3% per year before transaction costs. The volatility on a Japanese

stock investment would have been reduced to 18% but the return would have been reduced to 14%, i.e. the yen return on the Japanese stock investment of 17% minus the interest differential. This is a rather huge reduction in return (from 19.6% to 14%) for a reduction in currency risk that gets partly diversified away in the global portfolio. Hence a systematic full hedging policy may turn out to be fairly costly in terms of performance besides the transaction costs and the heavy administrative burden of constant rebalancing of the currency hedge [5].

2. Global Asset Allocation

We will now study the advantage, in terms of potential return and risk reduction, of a global asset allocation strategy that encompasses Swiss bonds and stocks as well as foreign bonds and stocks.

Figure 4: Efficient Frontier: International Bonds (Swiss Franc, 10 Years, Sept. 1980 - 1990).



Source: Lombard Odier & Cie

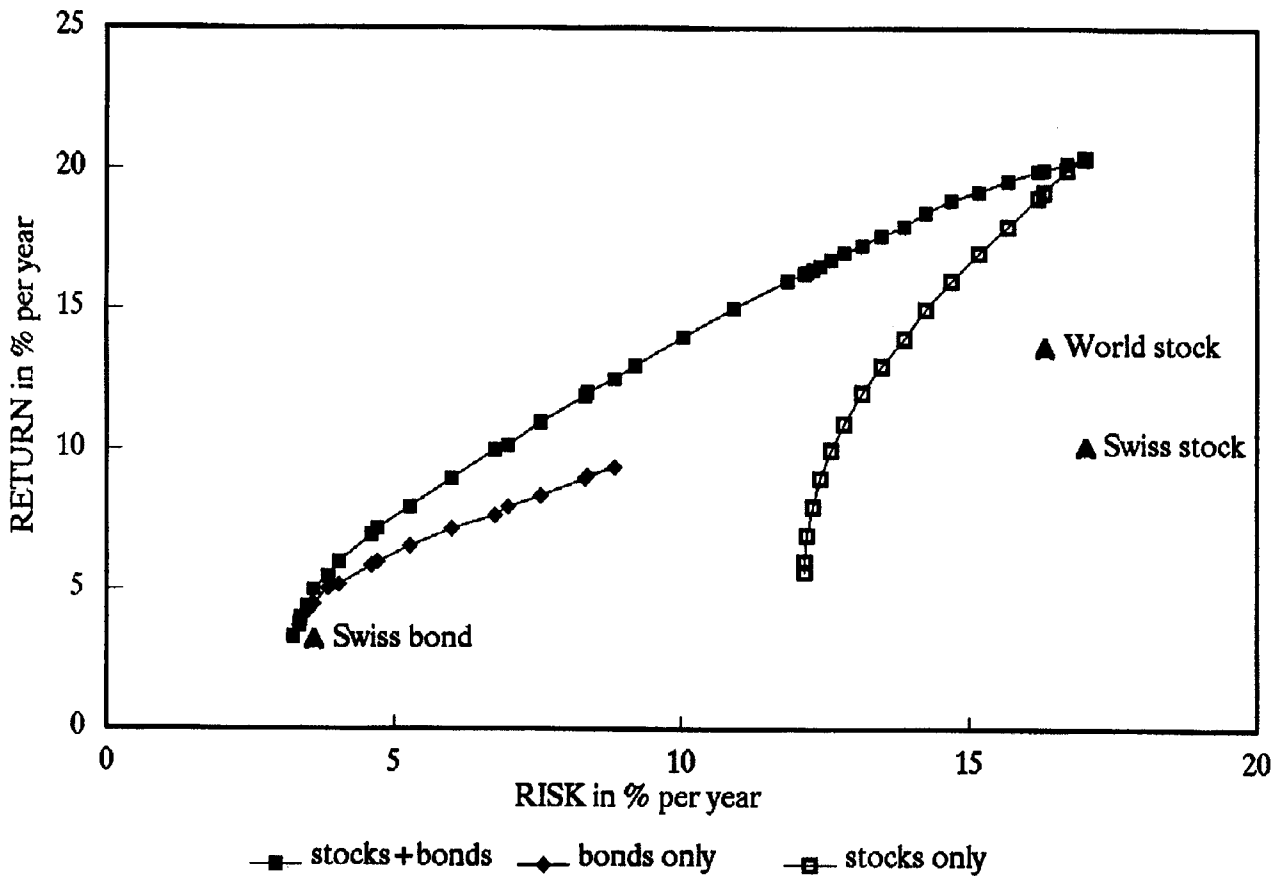
So far we have mainly been concerned with the risk diversification advantage of passive international diversification. But another major advantage of global asset allocation is to provide better profit opportunities and hence improve the risk/return trade-off. This is illustrated here by looking at the optimal asset allocations over the past ten years.

Swiss pension funds are mostly invested in bonds and we will first study the advantage of diversifying by adding foreign bonds to a Swiss bond portfolio. In figure 4, we provide the optimal international bond asset allocations for different risk levels [6] for the period 1980-1990. Each asset or portfolio is represented by one point on this graph. As noted above the Swiss bond market has a risk of 3.4% and a total return of 3.3%. Other bond markets are more volatile. By combining the various national bonds we get diversified portfolios whose return and risk can be calculated since we know the returns and covariances of all the assets. The well known idea popularized by the 1990 Nobel prices Markowitz and Sharpe, is that any investor will build a portfolio trying to obtain the best performance while attempting to minimize the risk of loss. This leads to selecting asset allocations that lie in the top-left part of the figure. The best achievable risk/return trade-offs, the optimal asset allocations, lie on the efficient frontier. As can be seen in figure 4, international diversification of a pure Swiss bond portfolio would have greatly enhanced the return on a bond-only portfolio without a large increase in risk. Actually, an international bond portfolio with the same risk level as a purely Swiss bond portfolio (risk of 3.4% per year) would have achieved an annualized total return of 4.5% compared to 3.3%. With a slight increase in total risk the increase in return is huge. The second question is whether stocks help improve the risk-adjusted performance of global asset allocations. The question addressed here is not whether one should prefer portfolios made up solely of bonds or solely of stocks but rather whether stocks should be added to a bond portfolio and follow a global investment strategy. Figure 5 gives the efficient frontier for a global asset allocation allowing for bonds and stocks, foreign and domestic.

No investment constraints other than no short-selling are applied; no currency hedging is included. To keep the figure readable, we do not plot individual bond and stock markets but only the Swiss bond and stock indices as well as the world stock index. Their relative position is conform to the theory. Swiss bonds had a low risk over the period and low performance. Over the long run riskier stock investments are compensated by a risk premium. Here the Swiss equity risk premium has been equal to 8.9% per year. This is a very large number. World stocks had slightly less risk and a better return than Swiss stocks. The optimal global asset allocations on the efficient frontier strongly dominate Swiss investments. A performance equal to that of the Swiss stock market (10.2% annualized) could have been achieved with one third of the risk. A domestic portfolio of Swiss stocks and bonds tend to have half the performance of that of an international efficient allocation with the same risk level. We also reproduce in figure 5 the efficient international frontier when we only invest in bonds (same as figure 4), as well as the efficient international frontier when we invest only in stocks. Clearly stocks bring a strong contribution in terms of risk/return trade-off to a bond portfolio since the bond-only efficient frontier is strongly dominated by the global efficient frontier. Similarly a stock-only efficient frontier is strongly dominated by a global strategy.

We have demonstrated here the large potential in terms of risk-adjusted performance of international asset allocation for a Swiss pension fund. Conclusions are derived from a study of the past ten years but similar results would hold for a longer time period. These lessons from the past are very useful to derive implications for a long term asset allocation strategy. The asset allocation strategy was kept constant over the whole period; the performance could be further improved by allowing tactical revisions of the asset allocation over time and selective currency hedging. The potential profits are large but require some forecasting skills. A major question is how much of this potential can be achieved thanks to superior management skills. But clearly the potential benefits

Figure 5: Efficient Frontier (Swiss Franc, 10 Years, Sept. 1980-1990).



Source: Lombard Odier & Cie

are huge and even if only 20% of the profits could be reaped, it would be very valuable in risk/return terms.

How active an international money manager should be to reap these benefits depends on his forecasting skills. The neutral position is some form of an international index fund. One may wish to deviate from this neutral position by setting a long-term strategic asset allocation; the empirical results presented above assumed this attitude with an optimal asset allocation fixed throughout the period. A more active policy would be to engage in a periodic tactical revision of the asset allocation. This is commonly practiced by money managers who attempt to use forecasts on markets and currencies in a consistent approach that maximizes the return on

a portfolio taking risk and investment constraints into account. An illustration of such a procedure followed at Lombard Odier is presented in figure 6. Finally one can engage in active market or currency timing and security selection.

3. What is Changing?

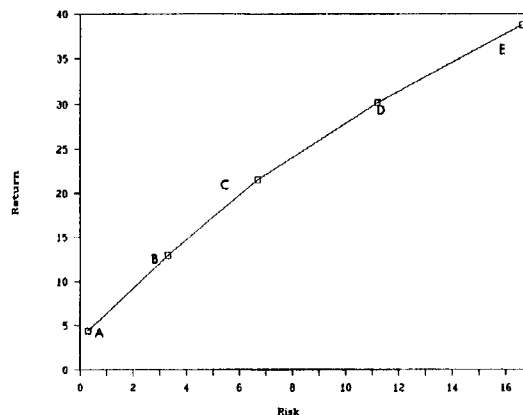
While the benefits of international diversification have been strongly established for the past 30 years [7], the financial markets and their environments are rapidly changing and one may wonder how these changes affect our conclusions. We will briefly touch three aspects.

Figure 6: Strategy Optimization Analysis of September 30th, 1990 (6 Months to March 31st, 1991).

1. Basic assumption		
Return:	LOC Institutional Asset Management 6 months expected returns to March 1991	
Risk:	Historical risk (1985-90)	
Constraints:	None	
ASSET CATEGORY	EXPECTED RETURN	RISK
1.Swiss cash	4.0	0.4
2.US cash	1.0	9.7
3.Japanese cash	15.8	5.8
4.German cash	6.7	3.1
5.Dutch cash	6.7	3.0
6.UK cash	9.8	6.4
7.French cash	7.5	3.5
8.Spanish cash	9.6	4.5
9.Italian cash	7.4	3.9
10.Swiss bonds	3.6	2.3
11.US bonds	3.4	11.0
12.Japanese bonds	20.6	8.3
13.German bonds	7.2	4.6
14.Dutch bonds	7.2	4.3
15.UK bonds	12.6	10.4
16.French bonds	13.5	5.4
17.Swiss stocks	11.0	14.2
18.US stocks	0.2	17.7
19.Japanese stocks	36.0	16.6
20.German stocks	18.5	18.3
21.Dutch stocks	12.2	13.9
22.UK stocks	16.1	17.3
23.French stocks	8.1	18.7
24.Spanish stocks	24.0	19.8
25.Italian stocks	13.6	18.7

ASSET CATEGORY	A	B	C	D	E
1.Swiss cash	92.7	37.5	0.0	0.0	0.0
2.US cash	0.2	0.0	0.0	0.0	0.0
3.Japanese cash	0.7	19.1	14.4	0.0	0.0
4.Dutch cash	1.5	0.0	0.0	0.0	0.0
5.Spanish cash	0.0	2.7	0.0	0.0	0.0
6.Swiss bonds	3.3	0.0	0.0	0.0	0.0
7.Japanese bonds	0.4	5.9	20.6	31.9	0.1
8.German bonds	0.5	0.0	0.0	0.0	0.0
9.French bonds	0.0	26.6	41.6	12.5	0.0
10.Japanese stocks	0.6	8.3	23.4	55.6	99.9

Efficient frontier without constraints



Efficiency ratio = $\frac{\text{Return} - \text{Risk-free return}}{\text{Risk}}$

PORTFOLIO SUMMARY		RISK-FREE RETURN 4.0%		
Portfolio	Return	Risk	Efficiency Ratio	Rank
A	4.4	0.3	1.3	5
B	13.0	3.3	2.7	1
C	21.6	6.7	2.6	2
D	30.2	11.2	2.3	3
E	38.8	16.6	2.1	4

3. Comments

- Cash is clearly favoured for low risk option.
- The highest the return, the higher the weighting must be in french bonds and / or japanese paper.

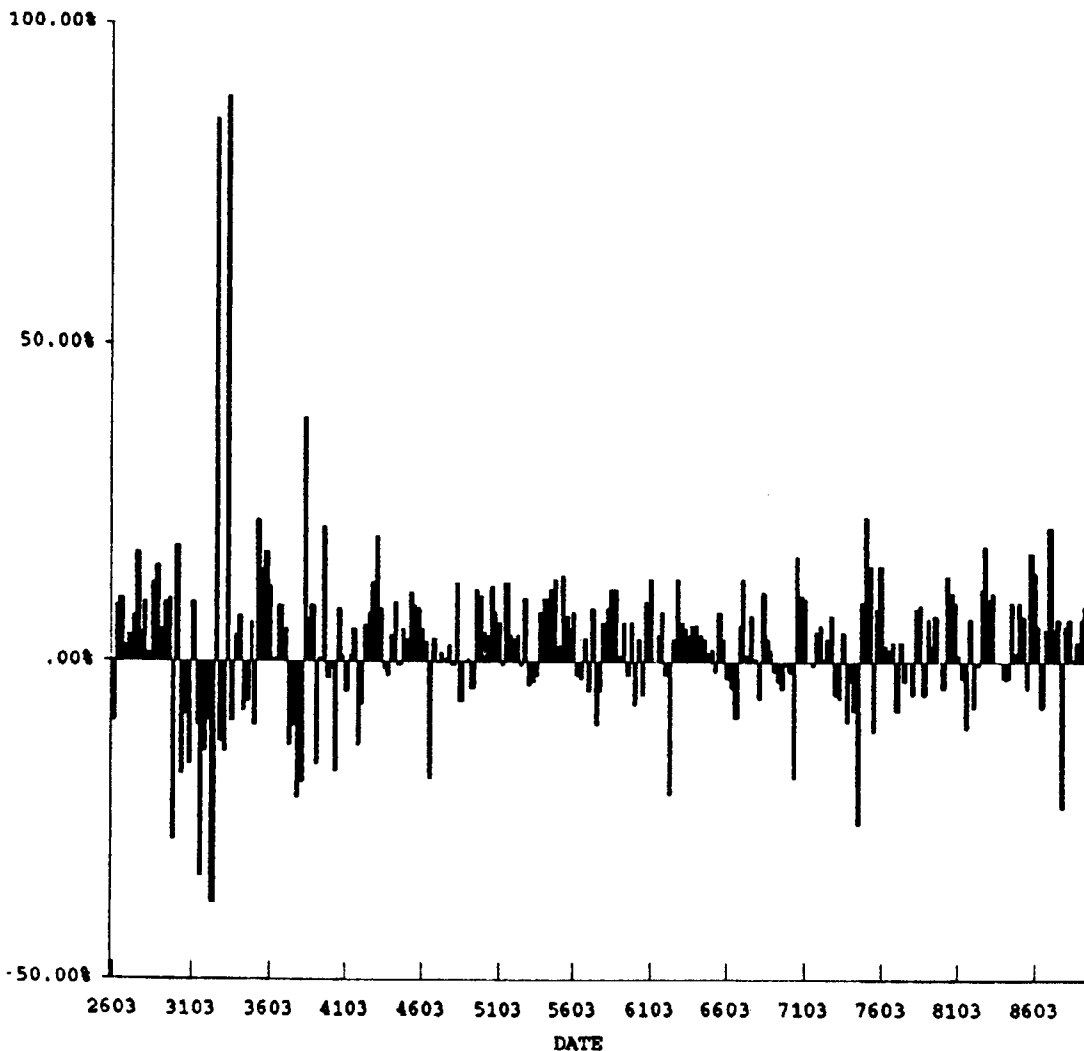
Source: Lombard Odier & Cie

3.1 Volatility

It is frequent to hear that markets are becoming much more volatile and unpredictable. Actually it is hard to remember a time when a money manager ever said that the markets were easy to predict and this is comforting if we believe in some degree of market efficiency. Rather than rely on emotive short-term impressions let's look at some statistics. Figures 7 and 8 reproduce quarterly returns of US stocks and bonds from January 1926 to December 1989. There is no clear-cut evidence of a secular increase in volatility for the stock market. While there exist some periods of strong volatility (1920s,

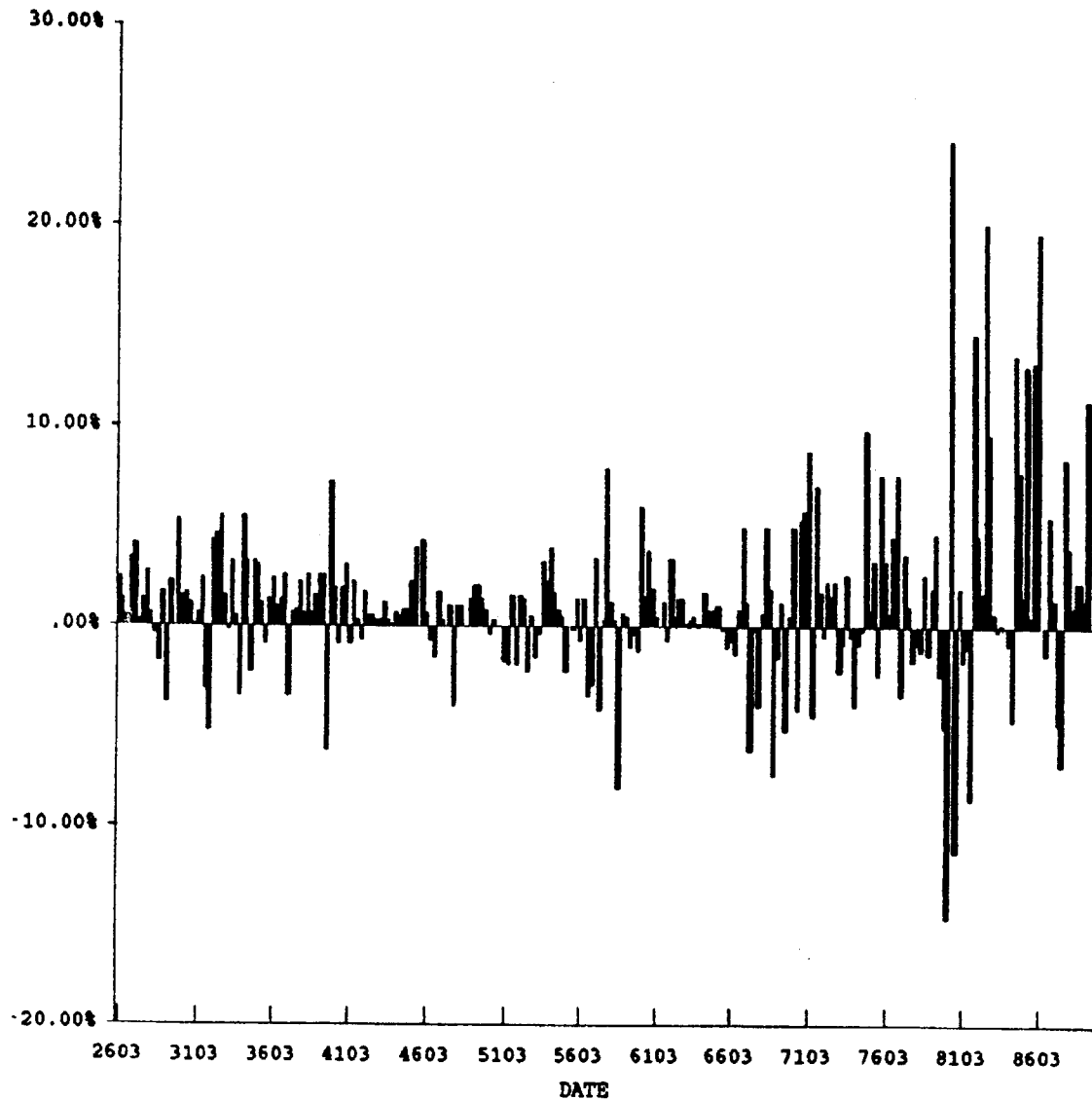
1930s, 1987), the market quickly returned to normal volatility levels [8]. On the other side the volatility of the US bond market increased dramatically in 1979 with the new monetary policies adopted by the US (and many other nations). Figures 9 and 10 report the volatility of the Swiss bond and stock market estimated over the period 1970-1980 for various sub-periods of ten, five and two years. Volatility is calculated as the standard deviation of monthly returns annualized. The message is the same as for the US markets. While the volatility of the Swiss bond market increased from the 1970s to the 1980s, this is not the case for the Swiss stock market.

Figure 7: Volatility of the U.S. Stock Market (Quarterly Returns 1926 - 1989 in US\$).



Source: Lombard Odier & Cie

Figure 8: Volatility of the U.S. Bond Market (Quarterly Returns 1926 - 1989 in US\$).



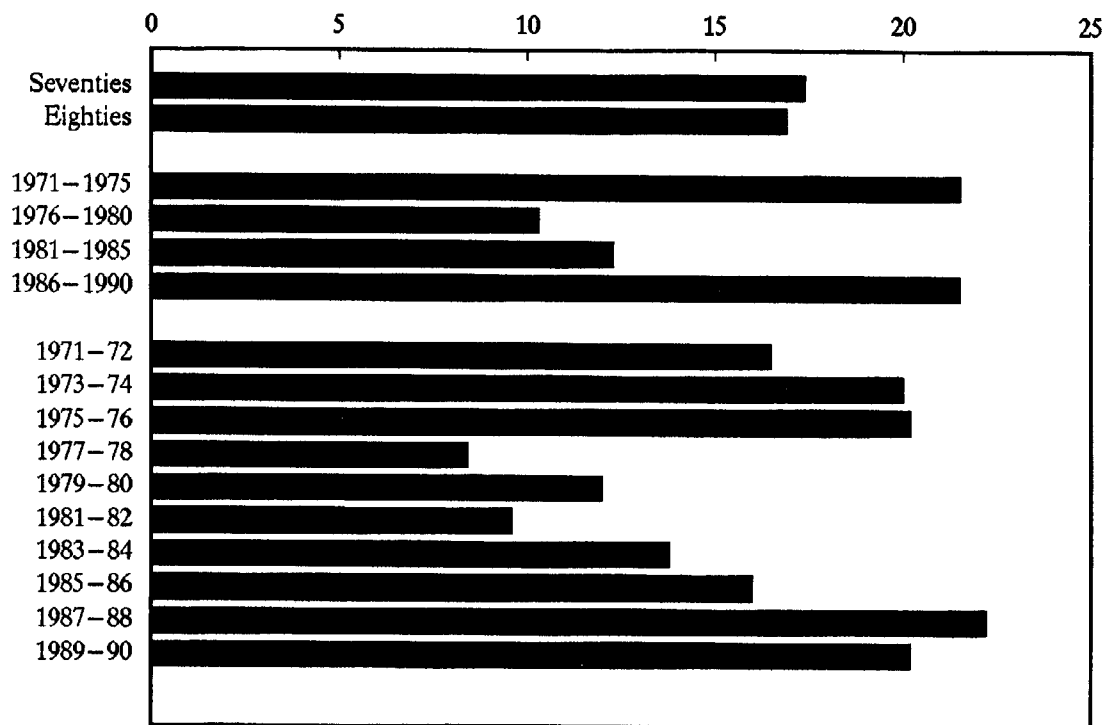
Source: Lombard Odier & Cie

3.2 Currency Risk

The currency contribution on the performance and risk of international portfolios is significant. If we view performance in purchasing power terms, the same conclusion holds true for a portfolio purely invested domestically. For example the depreciation of the Swiss Franc against most currencies in the late 1980s reduced the purchasing power of a Swiss portfolio solely invested in Swiss fixed income assets.

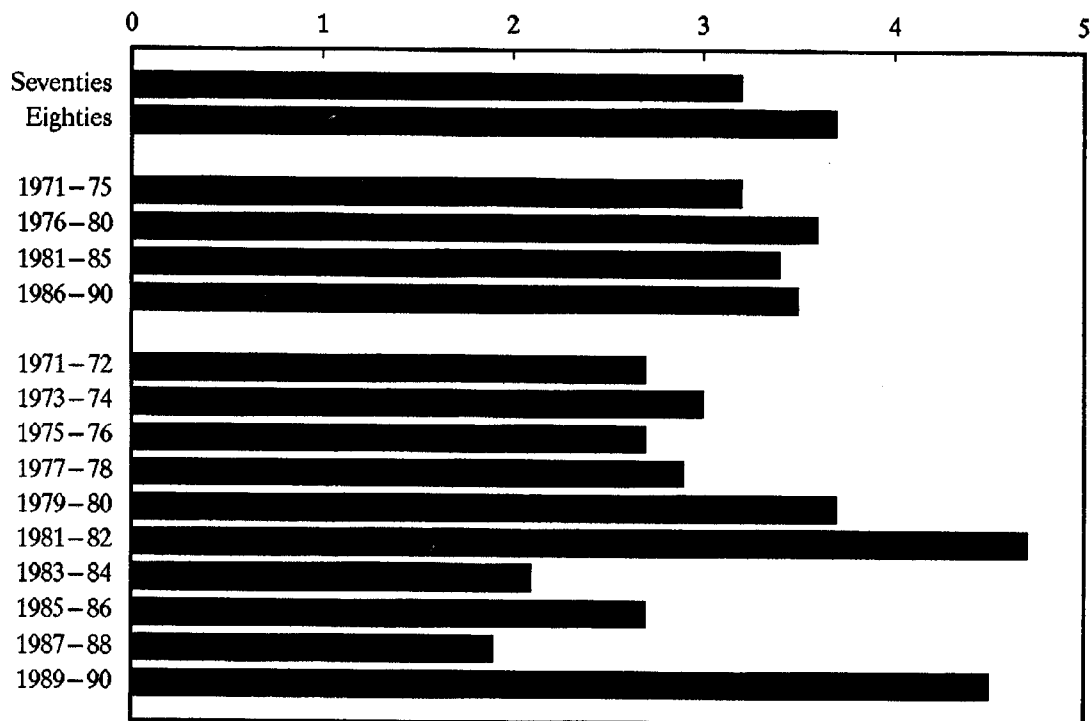
The contribution of monetary factors to return and risk over the past ten years can be estimated from table 1. A major question is whether we can detect changing trends. Figures 11 and 12 study the evolution of the volatility of the US stock and bond markets for a Swiss investor for the past twenty years. We report the volatility both in Swiss franc and in US dollar, so the difference is the contribution of currency risk. Several conclusions emerge by simply looking at the estimates for 1970s and 1980s. First currency risk is a much larger component of

Figure 9: Volatility of Swiss Stocks (in % per Year).



Source: Lombard Odier & Cie

Figure 10: Volatility of Swiss Bonds (in % per Year).



Source: Lombard Odier & Cie

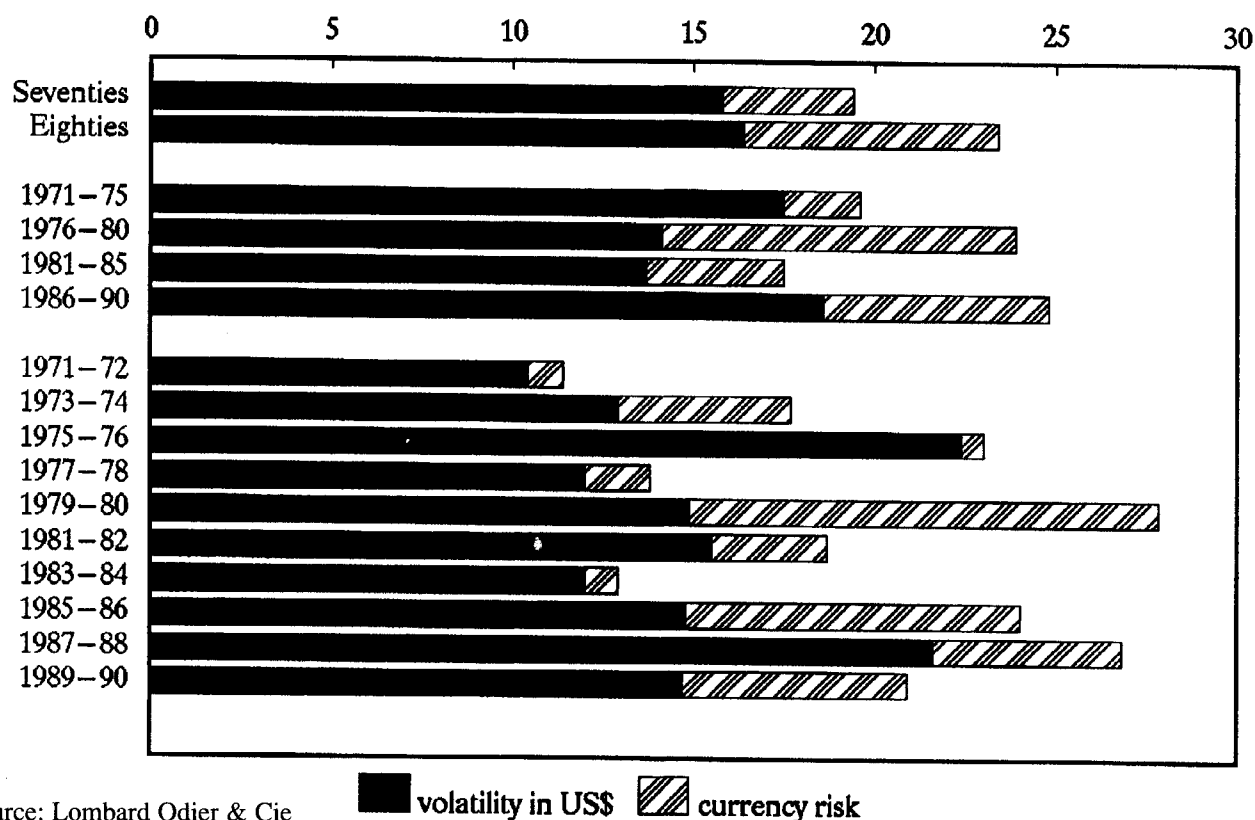
the risk of foreign bonds than of foreign stocks. This is not surprising but the magnitude of difference is striking. Second, we confirm that stock market volatility, in local currency, has increased only very slightly from the 1970s to the 1980s up to September 1990; however the currency risk on stocks has risen significantly. Third foreign bond markets have become quite volatile altogether, when measured in Swiss franc. Both interest rate risk and currency risk are monetary in nature so it is somewhat arbitrary to separate the two. For example in the early 1980s, the big rise in US interest rates (inducing huge losses on US bonds) lead to a strengthening of the US dollar, hence a low currency risk in those years as shown in Figure 9.

Of course, part of this currency risk gets diversified away in an international portfolio invested in many currencies. But clearly currency hedging has become an investment decision in its own right.

3.3 Correlation

It is often heard that financial markets are getting increasingly integrated across the world. This is certainly true for the physical integration of information systems as well as the growing harmonization of trading mechanisms and transaction processing. However the question relevant to investment management is whether financial markets move increasingly in common. This would certainly be bad news because it would reduce the diversification and profit potentials. Figure 13 reports the time variation of the correlation of the Swiss stock market with the world index; all calculations are in Swiss franc. A correlation coefficient is a statistical average of the degree of co-movement of two markets. In some period the Swiss market is influenced by international factors and just follows the rest of the world, in other times it is solely

Figure 11: Volatility of U.S. Stocks (in US\$ and SFr, in % per Year).



Source: Lombard Odier & Cie

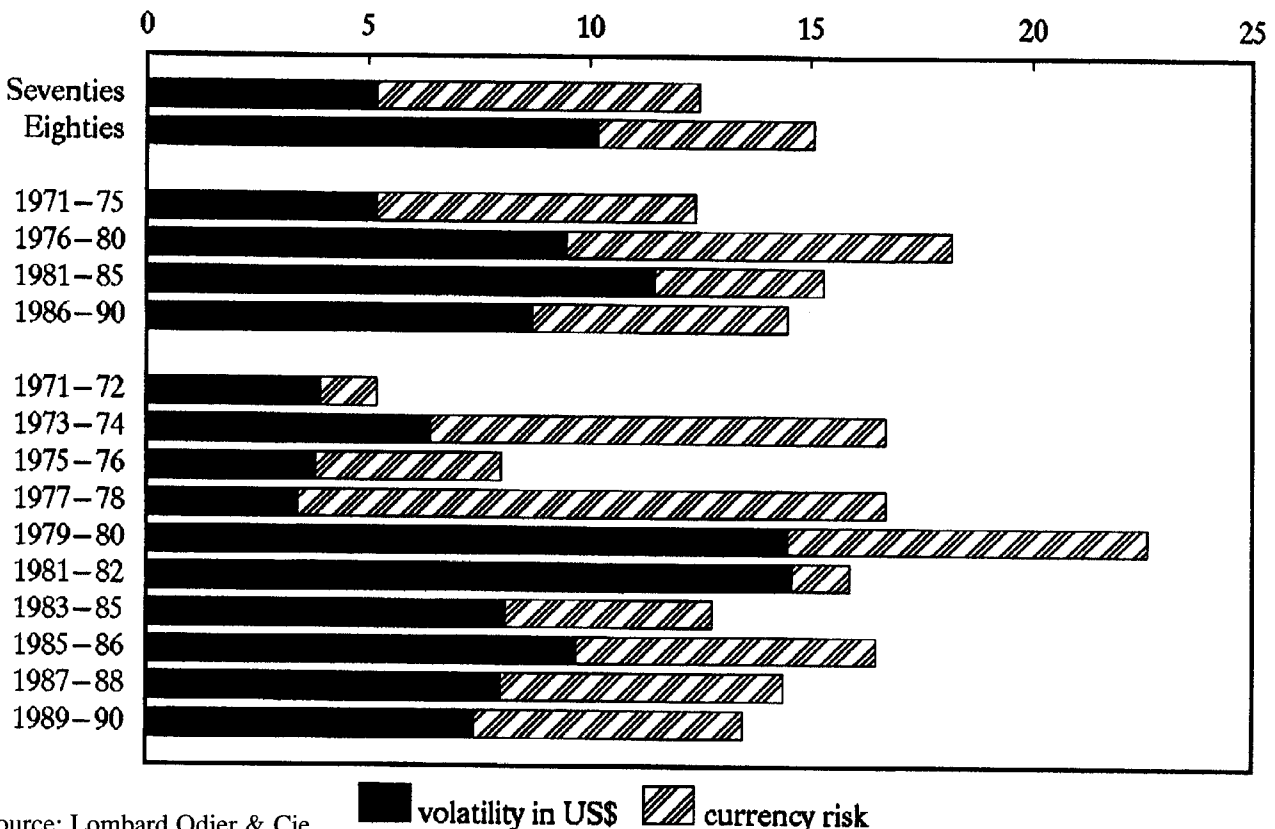
influenced by specific domestic factors. The correlation coefficients gives an estimate of the average link between the Swiss market and the rest of the world. When estimated over short periods of time, this correlation fluctuates widely as seen in figure 13. However there is no obvious trend towards growing correlation. Despite the painful moments of 1987 and 1990, the correlation has staid remarkably constant from the 1970s to the 1980s. The correlation of the Swiss stock market with the world index is almost the same in the 1970s and the 1980s. If we look at shorter sub-periods, we see that the correlation of the late eighties/early nineties is similar to that of the middle seventies. We have little evidence, here or in other studies, demonstrating an increased correlation between stock or bond markets. Despite the media insistence that interest rates are closely correlated across the world, the degree of correlation

of bond markets across the world, measured for example in Swiss franc, stays quite low. This low correlation may be partly explained by the importance of the monetary risk in bond investments as stressed above. While the correlation has not increased drastically, an unpleasant characteristic has appeared: the correlation seems to increase when markets are most volatile. In other words, the correlation is larger when the movements are large. This is bad news for a portfolio manager since it is precisely in periods of large down movements that diversification (and low correlation) is most needed.

4. International Diversification and Swiss Pension Funds

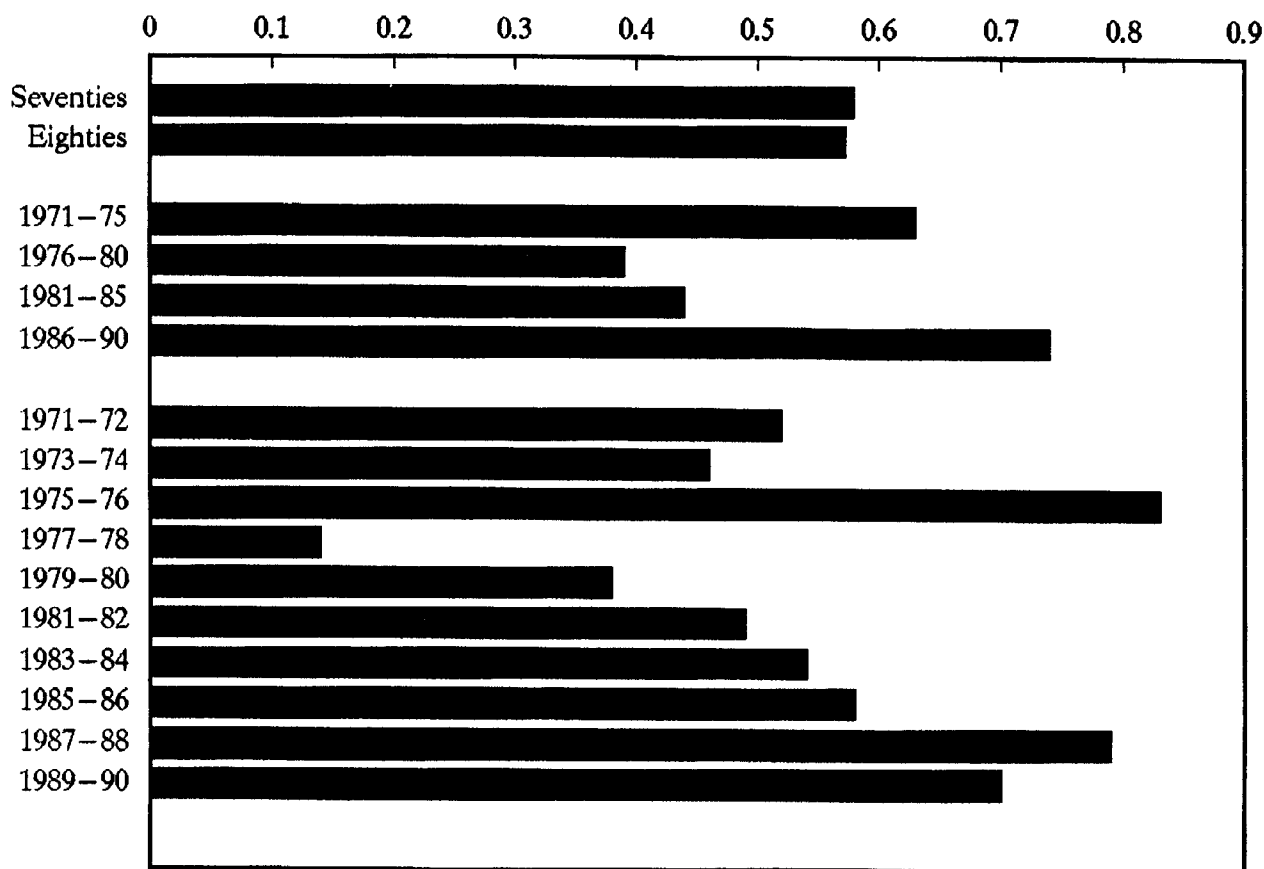
A major challenge faces Swiss pension fund managers in the 1990s:

Figure 12: Volatility of U.S. Bonds (in US\$ and SFr, in % per Year).



Source: Lombard Odier & Cie

Figure 13: Correlation of Swiss and World Stocks.



Source: Lombard Odier & Cie

- Federal pension-scheme investment regulations (BVG / LPP) have been meaningfully liberalized in the prime design of emphasizing equity ownership and foreign asset diversification. Hence the maximum portfolio equity exposure has been raised from 30% to 50% with the ownership limit of foreign shares being lifted from 10% to 25%. Further, investments denominated in foreign currencies (fixed-income securities and equities) may now amount to 30% of total assets, up from a previous maximum of 20%.
- On the legal side, the new BVG/LPP regulations assign priority to managing the asset/liability ratio in real rather than in nominal terms,

further increasing the pressure on foundation boards to make their plans' assets get a better performance and develop the necessary means to better master the potential scope and the risk level featured by the various investments.

Recent experience has shown that a conventional investment posture, dominated by fixed-income investments combined with property holdings, can fail to reach the ultimate goal of matching the long-term real wage growth. This is clearly demonstrated for the period 1960 to 1990 in figure 14 when growth in wages outperformed the return on Swiss bonds and mortgages. The pursuit of higher real returns for the benefits of pension-scheme partici-

pants requires the acceptance of a greater risk profile, such as by including a significant equity exposure.

Also, as we have seen earlier, foreign investment may represent one of the most powerful aspect of risk reduction through diversifying exposure while improving investment returns.

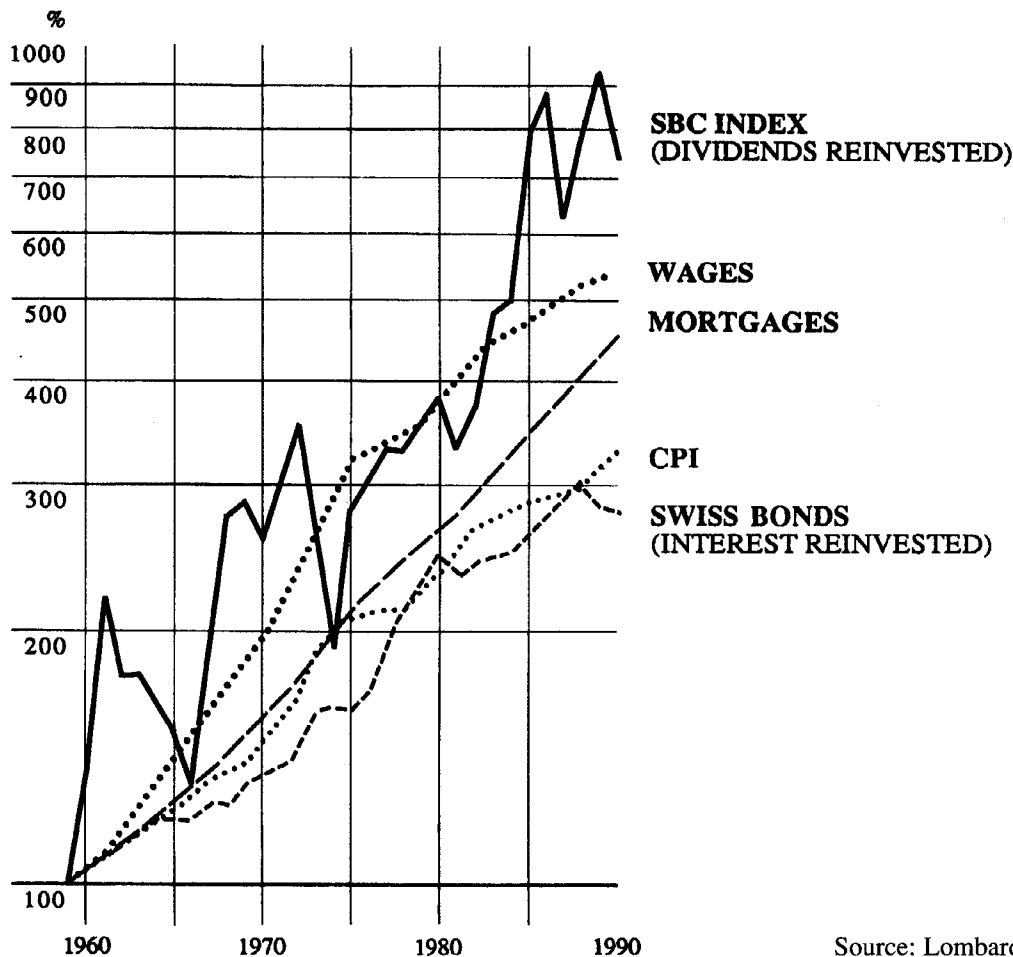
Following the relaxation of the investment constraints under which Swiss pension funds operate, the introduction of the analytical tools necessary for optimizing pension funds' asset structures in terms of the risk/reward trade-off will constitute a major challenge for Swiss pension funds in the coming years.

In figure 15 we reproduce the optimal asset allocations under various sets of investment constraints. Analysis

of the efficient frontiers derived from the old and new BVG/LPP guidelines on the one side and unconstrained global portfolios on the other side leads to the following conclusions:

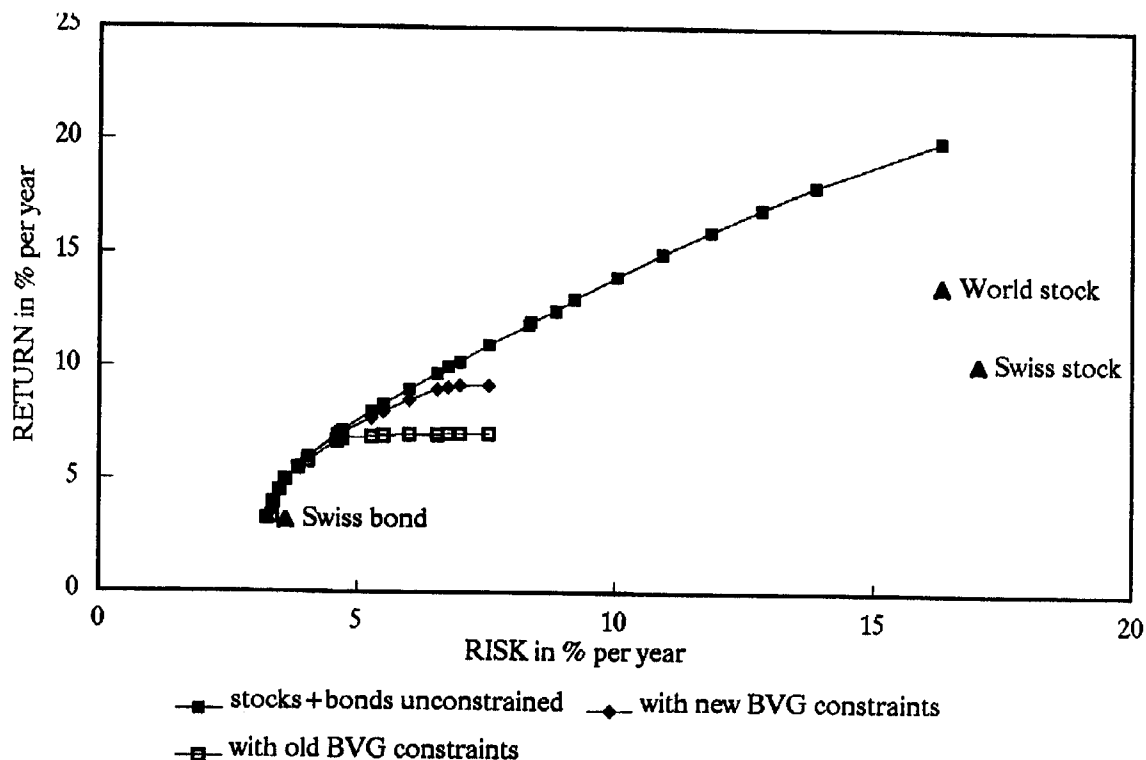
- For low risk levels, such as for volatilities ranging between 4% to slightly under 5%, efficient frontiers for constrained portfolios and unconstrained global portfolios are nearly identical. Hence, it appears that, for low risk levels, regulatory constraints do not affect optimal asset allocation much.
- However, as from the 5% volatility level, the three efficient frontiers start to diverge progressively as the constraints start to bite.
- Another striking observation is that regulatory constraints prevent taking a significant amount

Figure 14: Long-Term Returns versus Wages.



Source: Lombard Odier & Cie

Figure 15: Efficient Frontier (Swiss Franc, 10 Years, Sept. 1980 - 1990).



Source: Lombard Odier & Cie

of risk, with constrained efficient frontiers ending abruptly at a risk level between 6% (old constraints) and 8% (new constraints) [9].

Last but not least, analysis of the asset structure of efficient pension-fund portfolios at various risk levels along the efficient frontier strongly supports the case for international investment diversification (tables 2 - 4).

At the low end of the risk scale (table 2), efficient portfolios are greatly concentrated in fixed-income instruments and exclude Swiss equities, which feature a higher risk profile; the asset structure is very similar for all types of portfolio with a significant foreign exposure.

At a risk of 6% along the efficient frontier, the constraining effect of the federal investment guidelines on the efficient asset structure starts to be significant. As displayed in table 3, an unconstrained

portfolio includes a foreign bond and equity exposure of some 56% of total assets, against, the 30% maximum allowed in Swiss pension funds.

The benefits of spreading investments internationally are well documented at a risk level of 8%, which is as we have seen the upper risk limit for Swiss pension funds. In an unconstrained asset structure, exposure to Swiss assets is a mere 9% of total assets and is limited to bond positions. The optimized structure of a constrained portfolio takes advantage of the combination of an equity maximum of 50% and of a foreign currency maximum of 30%. Foreign equity is preferred to foreign currency bonds because of a higher return.

To summarize, the regulatory constraints on Swiss pension funds seem to meet their major objective in that they limit the total risk taken by the funds. Within a conservative investment profile, they also

Table 2: Efficient Asset Structure at a Risk Level of 4%.

Asset Classes	Unconstrained	Old BVG/LPP Constraints	New BVG/LPP Constraints
Swiss-Francis Bonds	71%	80%	71%
Foreign-Currency Bonds	19%	10%	19%
Swiss Equities	-	-	-
Foreign Equities	10%	10%	10%
	100%	100%	100%
Investment Return	6.0%	5.6%	6.0%

Table 3: Efficient Asset Structure at a Risk Level of 6%.

Asset Classes	Unconstrained	Old BVG/LPP Constraints	New BVG/LPP Constraints
Swiss-Francis Bonds	44%	60%	56%
Foreign-Currency Bonds	34%	10%	5%
Swiss Equities	-	20%	14%
Foreign Equities	22%	10%	25%
	100%	100%	100%
Investment Return	9.0%	7.0%	8.5%

Table 4: Efficient Asset Structure at a Risk Level of 8%.

Asset Classes	Unconstrained	Old BVG/LPP Constraints	New BVG/LPP Constraints
Swiss-Francis Bonds	9%	-	45%
Foreign-Currency Bonds	52%	-	5%
Swiss Equities	-	-	25%
Foreign Equities	39%	-	25%
	100%	-	100%
Investment Return	11.5%	-	9.3%

allow Swiss pension funds to garner the benefit of international diversification, though not very often to the fullest degree.

The forthcoming challenge facing Swiss pension fund managers will clearly be to develop the skills and technical means to integrate optimized pension fund strategies within well controlled risk profiles.

5. Conclusions

Several conclusions emerge from this study based on past long-term and recent experience:

1. Stocks ought to be a significant component of the investment strategy of a Swiss pension fund. This conclusion shows up even if we take into account the 1990 dramatic drop in stock prices.
2. International diversification would be beneficial to a Swiss pension fund in terms of risk and return. This is already true for passive international diversification but a strong case can be built for large potential reward for active international asset allocation.
3. The volatility of bond markets has been increasing somewhat but this trend is not clear for stock markets. The correlation between markets has not gone up significantly in the recent past.
4. Monetary considerations are an important determinant of the performance and risk of bond investments. This is less so for stock investments. Monetary risk tends to be increasing. This means that more effort should be devoted to this dimension and that careful consideration should be given to currency hedging and using new financial instruments to adapt the risk profile of the asset allocation.
5. The BVG/LPP regulatory constraints on Swiss pension funds seem to meet their major objective in that they limit the total risk taken by the funds. Within a conservative investment profile, they also allow Swiss pension funds to garner the benefit of international diversification, though not to the fullest degree.

Footnotes

- [1] An extensive discussion on the benefits of international investments is provided in SOLNIK (1991).
- [2] Since foreign goods are also extensively used in producing domestic consumption goods, foreign currencies also affect indirectly the purchasing power of the Swiss franc.
- [3] The period was chosen to be long and cover the troubled times of 1987 and 1990. Some results for the period 1970-1989 are also given.
- [4] Remember that a correlation coefficient lies between +1, perfect correlation, and -1, perfect acyclical variations. The square of the correlation or R-square is a good measure of the percentage of common variation of the two markets.
- [5] For a theoretical discussion on optimal hedging see ADLER/DUMAS (1983), BLACK (1989) and ADLER/SOLNIK (1990).
- [6] The calculation of the efficient frontier is based on the data presented in table 1. No short-selling is allowed. In Figure 4 we restrict the investment universe to bonds, no stock investments are allowed but no maximum constraint is set on foreign investments.
- [7] See for example SOLNIK (1974).
- [8] See also an interesting study of volatility by SCHWERT (1990).
- [9] Remember that there is roughly five chances out of six that an annual down price movement of one standard deviation (e.g. 8%) will not take place.

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