Improving the Market Model: The 4-State Model Alternative

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Abstract

The present paper conducts an empirical study by examining the Market Model and the three versions of the 4-State Model (translated, rotated and unrotated) in a mean-beta framework. Using daily returns from the CAC 40 Index's assets, we find that the explanatory power of the 4-State Model is greater than the one of the Market Model and this effect is improved by rotation. A reduction in the non-systematic risk is also observed when switching from Market Model to 4-State Models. Surprisingly, the betas are more stable when using any version of the 4-State Model. this could have a strong impact on portfolio diversification and call widely held opinion into question.

1 Introduction

Testing of asset pricing models has been developing steadily over the past three decades. These tests relate to the capital asset pricing model (CAPM) and the arbitrage pricing theory (APT) either in conditional or unconditional contexts. The restrictive assumptions underlying the CAPM, multivariate normal returns or quadratic preferences, together with Roll's (1977) critique (the market portfolio is unobservable), seriously challenge these studies (see Shanken (1982)). The APT allows for more than one factor but unfortunately the specification of factors that affect asset's returns is another challenge. Nevertheless, Chen, Roll and Ross (1986) find that the residual market factor has an insignificant risk premium in the case of U.S. securities. They used the Fama-Mac Beth (1973) procedure. Black (1972) derives a more general version of the CAPM when the risk free asset is not available. Recall that the CAPM can be viewed as a linear relation between the expected returns on one hand and the beta on the other hand. This formulation raises the problem of the quality of the test and the stability of the betas. Even if Baesel (1971) shows that beta stability increases with the length of estimation period, there are very poor evidence of beta stability especially for individual stock betas. For example, Blume (1971), Levy (1971), or Levitz (1974) find that only portfolio betas are stable whereas

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individual security betas are highly unstable. This conclusion can make the use of beta in portfolio management less useful.
Other drawbacks can be add to this critic like those revealed by Fama and French (1992) who suggest that returns on U.S. securities cannot be explained by betas, and then in 1993 show that market factor, size factor and book to market ratio explain U.S. stock returns from 1963 up to 1990. In fact, the coefficient on size is significant and negative (higher expected returns are associated with small firm's stocks) and the coefficient on book to market ratio is also significant and positive (higher returns are expected with firms with large book to market ratios). Harvey. and Siddique (2000) reconsider the asset pricing model by incorporating conditional skewness. They find that expected returns should include a component attributed to conditional coskewness. Their approach outperforms the usual CAPM. In another vein, Chan and Lakonishock (1993) point out the difficulty of making unambiguous inferences from the ever-changing environment generating stock returns. They used the Fama-MacBeth (1973) procedure to test the CAPM with CRSP data from 1926 to 1991 and their estimated SML is not flat. Black (1993) documents several reasons which prove that Fama and French (1992) misinterpret their own data and the former results related to empirical studies of the CAPM. For instance, Black says that Fama and French do not give any theoretical framework to support their results and Black also criticizes the use of the book to market ratio. Finally, Black (1993) highlights the fact that some so-called anomalies can arise due to data mining (Shanken (1992)).

The aim of our study is to compare two kind of models based on betas, one with a continuous risk-reward relation and the other with a discontinuous relation. The fact that usual CAPM fails to explain the relation between risk and return suggests this relation is not continuous. Therefore, in our framework, we expect that the use of a partition, which authorizes this relation to be discontinuous, will lead to a higher explanatory power. The theoretical attractiveness of the betas lies in their professional application. Thus, the empirical study of the betas are necessary and this paper adds a new perspective to this important subject by highlighting the advantage of the proposed partition.

The paper written by Norsworthy *et al.* (2001), proposes an alternative to the market model by examining the relationships between the return and the risk through a particular segmentation of the assets. The assets are distributed among four categories according to their relative performance and to the market return. The same authors show the superiority of the explanatory power of the model suggested, namely the 4-State Model, compared to the Market Model by using daily returns of hundred individual assets over the period 1984-1998: all the assets composing the industrial DJ 30, a sample of 30 assets of the S&P mid-cap and 40 assets of the S&P small-cap. Norsworthy *et al.* then apply their results to the "prospect theory". However, with the CAPM framework, they show that the 4-State Model outperforms the Market Model and this result is improved by rotation. They address the explanatory capability of the 4-State Model through time and find strong evidence that the aforementioned model outperforms the classical Market Model. They also show that the 4-State Model implies that more than 60 percent of asset risk is undiversifiable within their data.

Our France based study exhibits similar conclusions to those obtained by Norsworthy *et al.* We introduce a third version of the 4-state model by using a translation operation rather than a rotation as per. Northworthy *et al.* Furthermore, we analyze the diversification effect by studying the standard deviation of the standard error of estimate and its variability. The advantage of our approach is that it allows us to work directly with the four state dependent betas in relation to the co-movement of the asset considered and the market, rather than requiring that these betas be aggregated into one indicator which is the beta of the market model.

Our paper is organized as follows. Section 2 presents the framework by discussing the Market Model and the three versions of the 4-State Model. The objectives of section 3 are twofold. It is devoted to the description of the existing tests that are briefly revisited. Then we apply these tests to examine the improvement of the explanatory power, the reduction of the non-systematic risk, and the increase in the beta's stability when moving from the Market Model to the 4-State Model. Section 4 places emphasis on our main results. The last section presents our conclusion.

2 4-State Model : Unrotated, Rotated and Translated

Most tests of the CAPM start from the following equation:

$$r_{At} = \alpha + \beta r_{Mt} + \varepsilon_{At}, \tag{1}$$

where r_{At} denotes the return on any asset A at time t, r_{Mt} denotes the return on the market at time t, and ε_{At} represents the residual term and $\varepsilon_{At} \rightsquigarrow N(0, \sigma)$. α is the intercept for asset A, and β is the beta of that asset.

The estimated equation above is a linear relationship between the asset's returns and the market's returns for any individual asset. This equation is known as the Market Model.

Let us now present the 4-State Model. Following Norsworthy *et al.* we partition the observations in four sets according to the signs of the asset and the market returns. We thus define four states as follows:

- State 1 corresponds to observations when both the sign of the asset return and the sign of the market return are non negative

- State 2 is related to a positive sign of the market return and a negative for the asset return

- State 3 corresponds to observations where both the sign of the asset return and the sign of the market return are negative

- State 4 groups all the other observations.

We summarize the partition in the following table:

State	Sign of Asset Return	Sign of Market Return
1	$r_A \geq 0$	$r_M \geq 0$
2	$r_A < 0$	$r_M \geq 0$
3	$r_A < 0$	$r_M < 0$
4	$r_A \geq 0$	$r_M < 0$

In fact we add bull and bear asset conditions to the classic bull and bear market definition (Chen (1982) and Wiggins (1992)[1]).

Given an asset, for each state, we have a single market model described as follows:

[1] There exist other possibilities to define a bull and bear market: returns above or below median return on the market portfolio (Bhardwarj and Brooks (1993)) or returns higher(lower) than 1.5 times its standard deviation (Fabozzi and Francis (1977)) or as Granger and Silvapulle (2001) with a threshold define by the VaR of the asset.

$$r_{iAt} = \alpha_i + \beta_i r_{Mt} + e_{At} \qquad i = 1, ...4 \tag{2}$$

The 4-State Model itself is obtained by taking into account the last four equations:

$$r_{At} = \sum_i \alpha_i I_i + \sum_i \beta_i r_{Mt} I_i + e_{At} \qquad i = 1, ...4 \tag{3}$$

where $I_i = \begin{cases} 1 \text{ if } r_A \text{ and } r_M \text{ are in state } i \\ 0 \text{ otherwise} \end{cases}$.

"*The 4-State Model thus has six additional terms that capture the effects of partitioning based on the asset and market returns*" (Norsworthy *et al.* p.11).

The rotated version of the 4-State Model is introduced like in Norsworthy *et al.* by considering the expected asset return and the expected return of the market, and by rotating the abscises axis in order to pass through the expected point given by the two expected values. This rotation leads to a new partition with the same observations but the observations are now in the expectation quadrants. In fact, the observations in this case are partitioned according to the sign of their distance towards the expected value. We expect the rotation to improve the knowledge of the relationship between the risk and the return. Figure 1 presents the rotation.

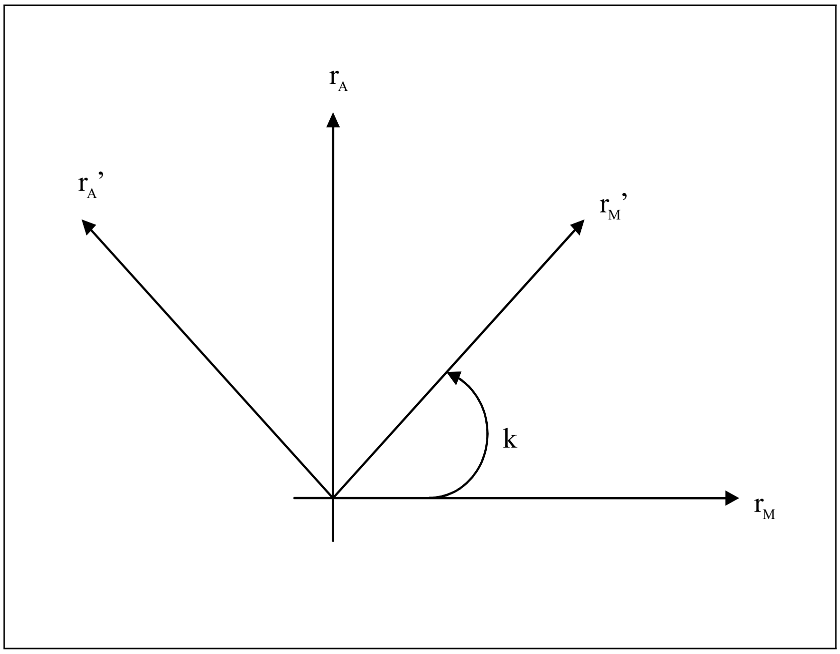

Figure 1: Rotation of the Coordinate Axes

The rotation is characterized by its center and its angle given by the following equation:

$$k = \arctan(\mu_A/\mu_M) \tag{4}$$

From the original observations, we can determine the new coordinates with respect to the new axis. They are given by:

$$\rho_A = (-r_M \sin(k) + r_A \cos(k)) \tag{5}$$

$$\rho_M = (r_M \cos(k) + r_A \sin(k)) \tag{6}$$

At this stage, from their respective expected values and according to the signs of the deviation of the asset returns and the market returns, we define four new states. The conditions become the following:

State	Sign of Asset Return	Sign of Market Return
1	$\rho_A \geq 0$	$\rho_M \geq 0$
2	$\rho_A < 0$	$\rho_M \geq 0$
3	$\rho_A < 0$	$\rho_M < 0$
4	$\rho_A \geq 0$	$\rho_M < 0$

With the initial observations and according to the new states, we use the 4-State Model procedure and we obtain the rotated version of the 4-State Model. The rotated 4-State is expected to be more efficient than the unrotated version.

We can also define a third version of the 4-State Model by relocation of the observations. This version is obtained by changing the origin: the coordinates of the new origin are exactly the expected values of the returns. Thus the new coordinates of each observation is given by:

$$r'_M = r_M - E(r_M) \tag{7}$$

$$r'_A = r_A - E(r_A) \tag{8}$$

We define the new four states in the following manner:

State	Sign of Asset Return	Sign of Market Return
1	$r'_A \geq 0$	$r'_M \geq 0$
2	$r'_A < 0$	$r'_M \geq 0$
3	$r'_A < 0$	$r'_M < 0$
4	$r'_A \geq 0$	$r'_M < 0$

We then use the 4-State procedure and obtain the relocated 4-State Model (Translated).

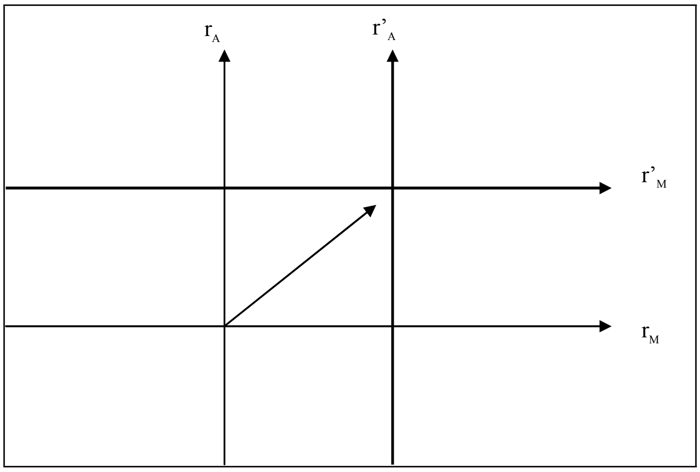

Figure 2: Translation of the coordinates axes.

3 Data and Methodology

Our study is based on the totality of the assets constituting the French CAC40 Index on 17 July 2002. All data, consisting of closing daily returns of these stocks adjusted for dividends and equity offerings, were calculated from the Fininfo database since 18 February 1997. We also use the CAC40 Index as a proxy for the market portfolio. In total, we have used quotes from the previous five and a half years. In order to work with homogenous data, the six stocks quoted after the beginning of our study were dismissed from our sample. Finally we use 34 stocks for which we indicate the main statistics in the annex.

From those quotes we calculated the daily log-return. Alcatel exhibits the lowest daily return (-48.46%) and TF1 shows the highest (+18%). We can also verify on the second table of the appendix that the volatility seems to be higher in bear market periods (25) than in the bull ones (9). From our four state partition we can't be so affirmative: 14 of the higher standard deviations are observed during state one and 19 over state three. Schneider is the only stock that have a higher standard deviation in state two (bull market and negative return). We pointed out that lower volatility takes place during bull markets (24 lower standard deviations are relative to state 2 and 10 to state 4)[2].

As displayed in figure (3), we identify two periods. The French Index has shown an increase of 280% from the beginning of our sample until September Y2K (other than the three months between July and October 1998). After this date, the CAC40 decreased by 50%. For this period, the mean return of the market index is only $8.72.10^{-5}$ and we observe 25 stocks presenting a positive mean return and 9 a negative one.

In order to obtain the different parameter estimates, we use the Ordinary Least Square (OLS) . We deal with heteroskedasticity by constructing a consistent estimate of the variance matrix as per White (1980). This well-known approach constitutes a good alternative to the Weighted Least Square when the form of heteroskedasticity is unknown and when we want to avoid imposing any arbitrary form. Thus, we replace

[2] Complete results could be obtained upon request.

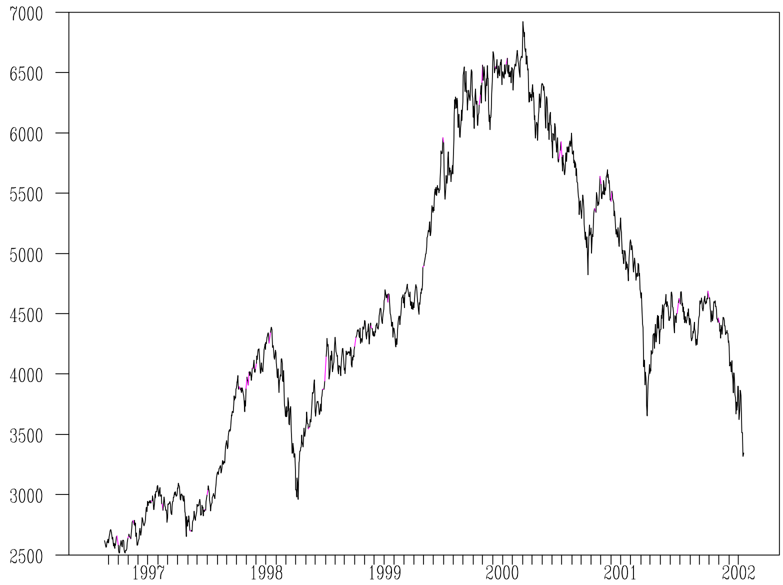

Figure 3: Evolution of the CAC40 index between 18 February 1997 and 17 July 2002.

the variance of errors by the square of the last. So we have for the variance of any partial regression coefficient $\hat{\beta}_j$ the following formula:

$$Var(\beta_t) = \frac{\sum \hat{w}_{ti}^2 \hat{\varepsilon}_i^2}{\left(\sum \widehat{w}_{ti}^2\right)^2}, \tag{9}$$

where $\hat{\varepsilon}_i$ are the residuals taken from the regression 3 and $\hat{w}_t$ represents the residuals obtained from the regression of the regressors r_{Mt} on the remaining regressors in 3. This result converges to

$$\frac{\sum w_{ti}^2 \sigma_i^2}{\left(\sum \widehat{w}_{ti}^2\right)^2}. \tag{10}$$

So we can verify that we don't need to know the real form of heteroskedasticity.

Our first goal is to check the explanatory power of the four models. This will be done by studying the adjusted coefficient of determination and simultaneously considering an increase in the number of regressors.

For each model we also estimate the diversification effect which is given by the standard error of estimates. In fact, the model with the lowest standard error will be associated with the best level of diversification.

Finally we test for parameters stability using an alternative to the classical Chow test on two arbitrary chosen sub-periods. We divide our sample into two equal sub-samples, each containing 706 observations (from 18 February 1997 to 2 November 1999 for the first one and from 3 November 1999 to 17 July 2002 for the second). In fact, the main drawback of the Chow test is that we cannot determine whether the difference between the two regressions is due to change in intercept terms or in slope coefficients. Indeed we construct a dummy approach. Each dummy variable is set at 1 if the observation corresponds to the considered state and 0 otherwise. This approach has two main advantages. The first one is that we can use the White heteroskedasticity correction procedure. The second consists in the ability to test stability not only for the complete regression but also for each parameter. This method induces an increase in the number of regressors (only two dummies for the market model but eight dummies for the 4-State Models) that could be detrimental in case of few data. Fortunately this wasn't the case. We also note that the joint test no longer corresponds to a Fisher test but to a χ^2 test.

4 Empirical results

Table [1] exhibits the explanatory power of the 4 models tested in our study. As anticipated, the Market Model has the worst explanatory power with an average adjusted R^2 (thereafter $\bar{R}^2$) of 27.47% whereas the use of the 4-State Model increases the explanatory power to 61.74%, and to 63.7% with the rotated 4-State Model. The translated 4-State Model shows also better results than those of the market model and are among those obtained for the two other versions of the 4-State Model. As all the results obtained for the Market Model are under 0.5, it means that we should consider that asset returns are mainly driven by intrinsic factors. This is obviously not the case if we use one of the three versions of the 4-State Model.

	Market Model	**4-State Model**	**Rotated**	**Translated**
Mean	0.2747	0.6174	0.6370	0.6182
Min	0.0429	0.5454	0.5679	0.5532
Max	0.4771	0.7127	0.7512	0.7116

Table 1: Explanatory Power

In fact, we know that the more we introduce parameters in the regression, the better the adjustment quality obtained. But we can also verify that by using rotation we better fit the data. For instance, figure 4 indicates results obtained with the two models with Cap Gemini. On this figure, we can observe that the transformation we propose has stretched the data and then has made them more linear.

With our sample, the best adjustment for the Market Model was obtained with Axa (0.4771) and it is lower than the worst $\bar{R}^2$ obtained with the three other models (0.5454 for Vinci with the 4-State Model, 0.5679 for AGF with the rotated version and 0.5532 for Vinvendi for the translated one). The max criterion also concludes to a best explanatory power with the rotated model. The adjusted R-square obtained for Alcatel is the highest with 0.7512. The complete results are reported in appendix B. Figure 5 presents one example of improvement of the quality adjustment with Cap Gemini Stock.

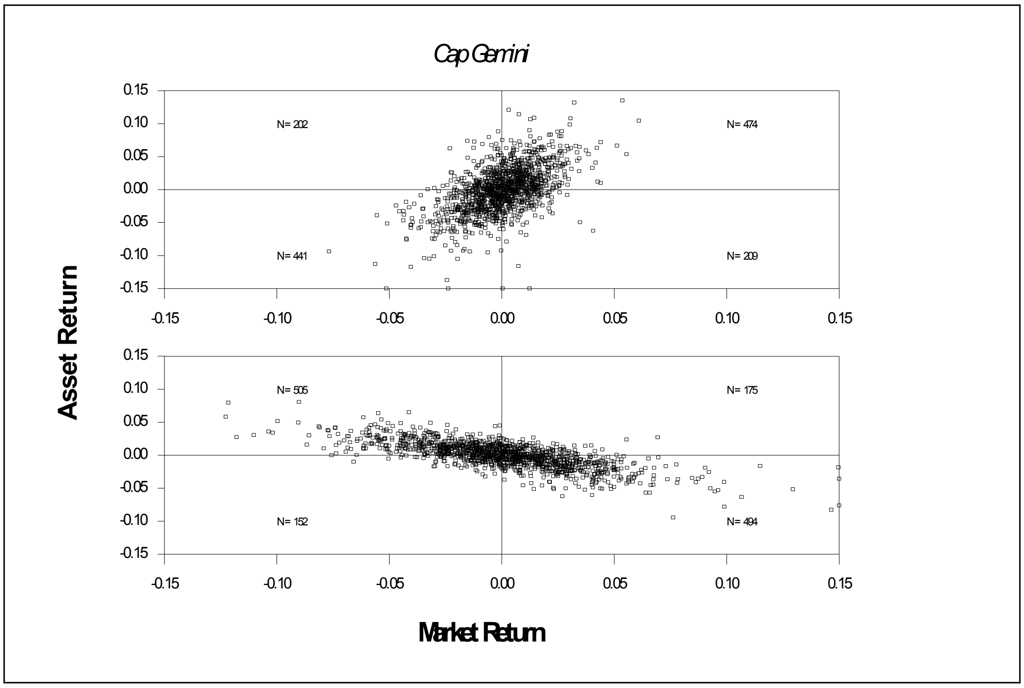

Figure 4: Scatter Plot: Market Model and Rotated 4-State Model for Cap Gemini.

We easily verify with this figure that the 4-State Models perform better than the traditional Market Model which is common sense.

	Market Model	**4-State Model**	**Rotated**	**Translated**
Mean	0.0213	0.0154	0.0091	0.0159
Min.	0.0143	0.0105	0.0071	0.0105
Max	0.0303	0.0224	0.0168	0.0378
$\boldsymbol{\sigma}$	0.0042	0.0031	0.0024	0.0049

Table 2: Diversification Effect

We now turn to the diversification effect. The same comparison between the different models is made and the results are summarized in Table [2] . The following conclusions emerge from Table [2] which summarizes the results of the analysis of the non-systematic risk by the use of the standard error of estimate as a proxy of the aforementioned risk. Firstly, the 4-State Model always reduces the unsystematic risk. Secondly, the rotated version improves the former results, as expected. We can see that using the 4-State Model leads to a lower non-systematic risk than the Market Model. In fact, the reduction is by 27.7%. This percentage becomes 57.28% when the rotated version of the model is used. The variability of the standard error of estimate with the Market Model is about 0.016 while the 4-State Model gives 0.0119. Therefore, moving from the Market Model to the 4-State Model reduces the range of the non-systematic risk. We notice again an improvement of this result with the rotated version which diminishes the value to only 0.0091. The standard deviation of the standard error of estimate also diminishes. To summarize, we find a decrease in the idiosyncratic risk with the three versions of the 4-state Model. More

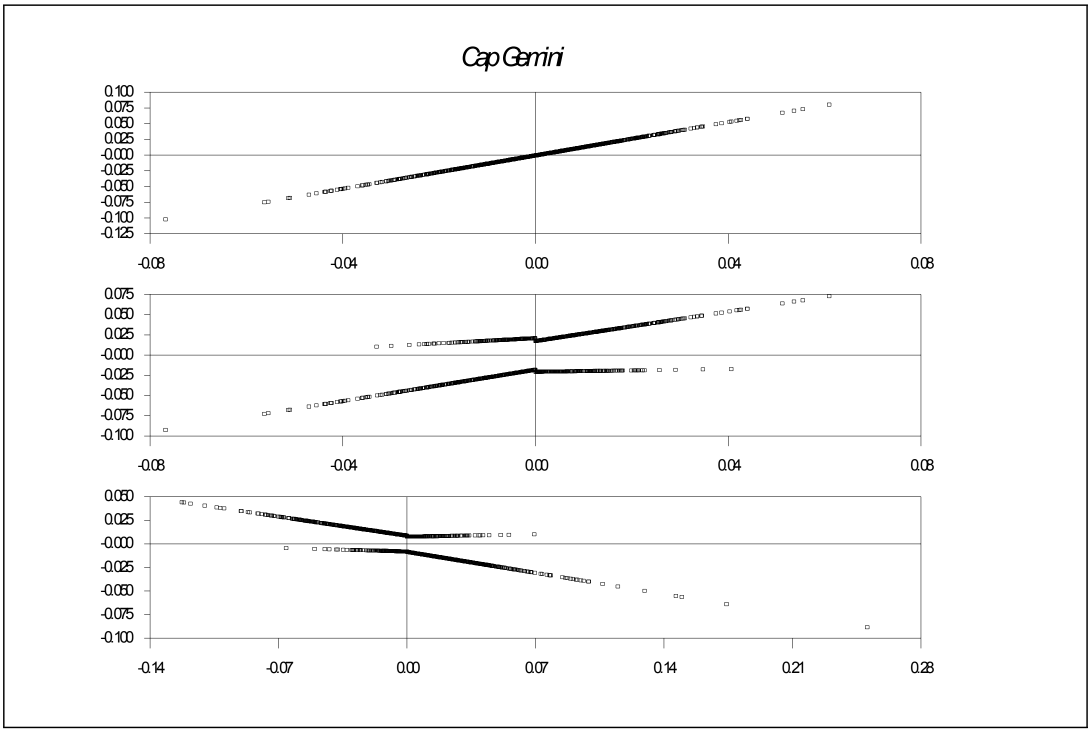

Figure 5: Fitted Values : Market Model, Unrotated and Rotated 4-State Model.

specifically we can observe that AGF cause the highest diversification effect for the Market Model (0.01427), for the 4-State Model (0.01052) and for the translated model (0.01052). For the rotated 4-State Model, Societe Generale stock presents the lowest undiversified risk. On the other hand, we can't find any single asset that exhibits the highest idiosyncratic risk in several models. Dassault (0.3035), TF1 (0.0224), Schneider (0.01678) and Alcatel (0.03778) have generated the worst diversification effects for the Market, 4-State, Rotated and Translated Models respectively. We can also notice that the results obtained for the 4-State Model and for its translated version are very close to each other. This is due to the fact that the $\bar{R}^2$ for those two models are also close. But even if there is obviously a strong relationship between the adjusted R-square and the standard error of estimate, we cannot substitute those two measures.

The final effect we want to analyze corresponds to an improvement of the parameters' stability. As reported above, one of the main problems with the Market Model is the fact that the β's are unstable.

Before we discuss stability phenomenon, we first begin with an analysis of the parameters' level. We focus our analysis on the betas as all the alphas were non significant in each regression. Under the market model assumption, we obtain betas ranging from 0.4316 and 0.1947 for Vinci for the two periods to 1.3910 to 1.9628 for Alcatel. It's very instructive to note that the same stocks exhibit the lowest and the highest betas over the two sub-periods we have considered. In our sample, twelve betas are superior to unity in the first period and ten in the second. For this last period which integrates the largest numbers of the negative returns estimated, only ten betas increase. Thus we can think that the sensibility of the asset return to the market return generally decreases when the market is bearish. This empirical result infirm those obtained by Fabozzi and Francis (1977) with 700 stocks over 72 months between January 1966 to December 1971, who find that risk and abnormal returns are not significantly affected by bear and bull markets.

While the β's were all significant for the Market Model, the 4-State Models exhibits more insignificance. All the β_1 and β_3 were highly significant, except the β_1 obtained for Casino or Vinci in the first period. On the other hand, most of the time we could not conclude that β_2's and β_4's are different from zero with the unrotated 4-State Models and β_1's and β_3's with the rotated one. All the individual results can be found in Appendix D. We now focus our analysis on the stability of the different parameters over the two sub-samples.

The 4-State Model requires an analysis of four betas for each of the two periods of estimation. So we add to the previous 4-State Models another dummy (D) defining first and second period by taking the value 1 for observations after 25/10/99 and 0 otherwise. The new regression is now:

$$r_{At} = \sum_i \alpha_i I_i + \sum_i \beta_i.I_i.r_{Mt} + \sum_i \delta_i.D.I_i + \sum_i \gamma_i.D.I_i.r_{Mt} + \varepsilon_{At}.$$

So we analyze if the γ_i parameters are significant. If it is the case, we can conclude that β_i have change between the two sub-periods.

	Market Model	**4-state Model**				**Rotated**				**Translated**			
Parameters	β	β_1	β_2	β_3	β_4	β_1	β_2	β_3	β_4	β_1	β_2	β_3	β_4
Individual	10	24	27	30	32	30	33	28	32	23	28	29	32
Simultaneous	10	18				23				16			

Table 3: Parameters Stability

Table [3] summarizes parameters' stability within our two sub-periods. We distinguish between two kinds of stability. The first is an individual parameter's stability. This criterion makes less sense with multifactorial models. Therefore, we analyze the simultaneous stability of all the betas for each model (Chow's test). We can see that in the case of Market Model only 10 betas over 34 were stable. We conclude there is better stability using 4-State Model because it increases this number to 18. We also conclude there is better modelization with the rotated version of the 4-State Model with 23 stable betas.

From the above explanation we are able to rank the four models that we tested. As we can see on the table [4], the Rotated 4-state model succeeds in all the three performance conditions we have tested for whereas the traditional market model appears to be the worst.

Even if we take care of heteroskedasticity by using White's correction but, we have verify that this heteroskedasticity is mainly due to ARCH(1) effects. So we have indicated in the annex, the results we obtained for the Market Model in the context of an ARCH(1) process[3], for which the conditional variance of the residuals

[3] The same process was also used by dillen and Stolz (1999) to estimate market model parameters on twenty stocks quoted on the Stockolm Stock Exchange from March 1980 to June 1994.

	Market Model	4-state Model	Rotated	Translated
Explanatory power	4	3	1	2
Diversification effect	4	2	1	3
Stability	4	2	1	3

Table 4: Ranking of the four models

is given by :

$$\sigma_t = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2.$$

We can notice that the results indicated on table [7] of the appendix, are very closed to the ones obtained with the classic Ordinary Least Squares assumptions (homoscedasticity and normality of the residuals), perhaps because only one half of our assets are concerned by an ARCH process. Nevertheless, the change is sufficient to reduce the number of stable parameters from ten to six. We also find that the constant is still insignificant. So we have wanted to check if the use of an ARCH process (i.e. that gives a better standard error for each parameter), modifies the previous results. As the Rotated 4-State Model has exhibited the best results we only consider the maximum likelihood estimation of this model with ARCH distributed errors. Those results are given on table [9] in the appendix and improve the previous results. If we calculate the mean of the absolute value[4] of the ratio between the return of each asset over the second period less the return obtained from the estimated parameters of the first period divided by observed return[5], we can observe impressive results. For example, the average error is 7.73% for Casino whereas it would have been 133% if we suppose the stability of the beta in the market model. For Bouygues, the average error is 1300% with the market model and only 11% with the rotated 4-State Model, etc.

We claim the proposed model allows us to better explain the betas' stability. We can directly use the betas to predict the two possible expected returns on the assets. However in order to choose between these two outcomes we need to know the evolution of both market and asset. In our case, the use of the 4-State Model requires knowledge of the level of the market return together with the value of the asset return. That is we need to know the value that we want to predict ! Therefore, in order to correct this drawback we propose incorporating a memory effect into the aforementioned model. This could be done by changing the definition of our four states. The different states will be defined as follows:

in state 1, the return on the market is non negative and the asset is bullish;
in state 2, the return on the market is non negative and the asset is bearish;
in state 3, the return on the market is negative and the asset is bearish;
in state 4, the return on the market is negative and the asset is bullish.

[4] We use the absolute value to prevent from compensation between positive and negative results.

[5] $r = \frac{|\hat{r}_2 - \hat{r}_1|}{\hat{r}_2}$ with $\hat{r}_i$ corresponding to the estimated return on the period i ($i = 1, 2$), and $|x|$ denoting the absolute value of x.

Knowing that the asset is bearish or bullish, the values of the different betas, and the expected return on the market, our model can directly predict the expected return on the asset. This procedure will be used and tested in a next paper. Other complements are of interest. For example, it would of interest to test this model with a smaller frequency data (daily or monthly) and to analyze the stability on shorter periods.

5 Conclusion

This paper extends to the French case the results obtained by Norsworthy *et al.* in the U.S. case when comparing the asset pricing model with a four-way partition of daily returns (4-State Model) and the usual Market Model.

Results of our empirical study suggest there is a strong evidence to support our claim that there is an increase in the explanatory power when switching from Market Model to 4-State Model. The adjusted R^2 is multiplied by 2.5 on average. We also record an improvement of the diversification effect. With our sample, 4-State Model (rotated and unrotated) always leads to a better diversification effect. Our sample exhibits a gain in betas stability when switching from Market Model to 4-State Model. As previously suggested the rotation also improves the results.

Our analysis identifies areas where improvement is possible and this improvement generates more diversification and therefore reduces non-systematic risk.

References

Baesel, J. (1971): "On the Assessment of Risk: Some Further Considerations," *Journal of Finance*, pp. 1491–1494.

Bhardwarj, R., and L. Brooks (1993): "Dual betas from bull and bear markets: Reversal of the size effect," *Journal of Financial Research*, 16, 269–283.

Black, F. (1972): "Capital Market equilibrium with restricted borrowing," *Journal of Business*, 45, 444–454.

——— (1993): "Beta and return," *Journal of Portfolio Management*, 20, 8–18.

Blume, M. (1971): "On the Assessment of Risk," *Journal of Finance*, pp. 1–10.

Chan, L., and J. Lakonishock (1993): "Are the reports of beta's death premature?," *Journal of Portfolio Management*, 19, 51–62.

Chen, S. (1982): "An Examination of Risk Return Relationship in Bull and Bear Markets using Time Varying Betas," *Journal of Financial and Quantitative Analysis*, 17, 265–285.

Chow, C. (1960): "Test of equality between sets of coefficient in two linear regressions," *Econometrica*, 28, 591–605.

dillen, H., and B. Stolz (1999): "The Distribution of Stock Market Returns and the Market Model," *Finish Economic Papers*, 12, 41–56.

Fabozzi, F., and J. Francis (1977): "Stability tests for alphas and Betas over bull and bear market conditions: an empirical examiniation," *Journal of Finance*, 32, 1093–1099.

Fama, E., and J. M. Beth (1973): "Risk return and equilibrium: empirical tests," *Journal of Political Economy*, 81, 607–636.

Fama, E., and K. Fench (1993): "Common risk factors in the returns of stocks and bonds," *Journal of Financial Economics*, 33, 3–56.

Fama, E., and K. French (1992): "The cross-section of expected returns," *Journal of Finance*, 47, 427–465.

Granger, C. W., and P. Silvapulle (2001): "Capital Asset Pricing Model, Bear, Usual and Bull Market Conditions and Beta Instability: A value at Risk Approach," .

Harvey., C., and A. Siddique (2000): "Coniditional skewness in asset pricing tests," *Journal of Finance*, 55, 1263–1295.

L. Chen, R. R., and S. Ross (1986): "Economic forces and the stock market," *Journal of Business*, 59, 383–403.

Levitz, G. (1974): "Market Risk and the Management of Institutional Equity Portfolios," *Financial Analysts Journal*, pp. 53–60.

Levy, R. (1971): "Stationarity of Beta Coefficients," *Financial Analysts Journal*, pp. 55–62.

Northworthy, J., and alii (2001): "Asset pricing and prospect theory," Rensselaer Polytechnic Institute.

Roll, R. (1977): "A critique of the asset pricing theory's tests part 1: On past and potential testability of the theory," *Journal of Financial Economics*, 4, 129–176.

Shanken, J. (1982): "The arbitrage Pricing Theory: Is it testable," *Journal of Finance*, 37, 1129–1140.

——— (1992): "On the estimation of the beta-pricing model," *Review of Financial Studies*, 5, 1129–1140.

White, H. (1980): "A heterocedasticity consistent covariance matrix estimator and a direct test of heteroscedasticity," *Econometrica*, 48, 817–838.

Wiggins, J. (1992): "Betas in Up and Down Markets," *The Financial Review*, 27, 107–123.

A Stocks and Index statistics

	Nb obs	$\overline{x}$	$\boldsymbol{\sigma}$	**Min**	**Max**
Cac40 Index	1363	4498.07	1165.83	2514.52	6922.33
Accor	1363	40.9027	6.9858	23.2942	54.0279
AGF	1354	51.8479	9.9739	25.5962	74.0000
Air liquide	1363	122.2154	15.8560	90.9972	159.0000
Alcatel	1361	32.3512	18.6201	5.6700	97.0500
Aventis	1363	58.9725	19.6642	26.5414	94.3000
Axa	1363	27.1926	8.0356	12.7460	43.1250
BNP	1362	39.7705	11.5238	16.9218	61.2500
Bouygues	1363	32.6058	20.7465	7.0610	93.5939
Cap Gemini	1363	128.8866	60.5327	33.8500	350.0000
Carrefour	1362	58.8944	13.1428	35.5969	96.6000
Casino	1343	82.5103	21.0848	36.2397	124.9486
Crédit lyonnais[1]	*769*	*39.7895*	*5.6850*	*25.9100*	*50.2000*
Danone	1363	120.0529	27.1193	61.6656	172.4000
Dassault	1363	48.7122	21.2363	23.2485	119.1000
Dexia	1362	13.9041	3.0980	7.7444	19.3500
EADS[2]	*513*	*18.4544*	*3.8329*	*9.6500*	*24.9000*
France Telecom[3]	*1196*	*75.3334*	*41.1820*	*9.0000*	*219.0000*
Lafarge	1363	84.5856	16.4235	49.8606	113.7000
Lagardere	1363	46.5755	17.6933	22.1051	110.0000
L'Oréal	1363	62.5355	18.3460	27.9439	93.5000
LVMH	1363	52.5966	19.8089	20.0956	96.5000
Michelin	1363	41.8293	7.7069	24.9200	62.3364
Orange[4]	*361*	*8.3639*	*1.8030*	*4.3600*	*11.9000*
Peugeot	1363	33.5973	12.6341	13.8729	60.3000
PPR	1363	154.3999	46.8749	64.6689	262.5000
Renault	1363	42.2606	10.9128	18.2177	63.4000
Saint Gobain	1363	38.1343	5.1386	24.9254	48.7500
Sanofi	1363	45.3584	18.7820	18.2558	85.8000
Schneider	1361	60.2316	10.3953	40.0000	83.9000
Société Générale	1361	50.0970	15.5933	20.4282	80.5000
Sodhexo	1363	40.3503	8.3099	24.0284	59.6500
St Microelectronics	1363	29.7377	19.2441	5.1579	74.3333
Suez	1361	30.7346	6.2607	15.7327	39.9400
TF1	1363	30.8288	21.5714	7.4243	94.2000
Thalès	1362	36.7648	7.7898	22.1203	57.0000
Thomson[5]	*686*	*42.0155*	*14.9844*	*13.2182*	*79.9078*
Total Fina Elf	1363	129.7118	31.2858	67.6111	186.0000
Vinci	1361	46.8386	16.7444	17.8975	76.0000
Vivendi Environnement[6]	*506*	*41.5918*	*5.6190*	*26.25*	*50.637*
Vivendi Universal	1361	64.5858	22.9381	13.9000	141.6000

[1] Since 08/07/99 [2] Since 10/7/00 [3] Since 20/10/97
[4] Since 03/11/99 [5] Since 3/11/99 [6] Since 20/07/00

B Individual Returns Statistics

Company name	All years			Bull			Bear		
	N	$\overline{x}$	σ	N	$\overline{x}$	σ	N	$\overline{x}$	σ
CAC40	1326	0.000087	0.015074	683	0.011225	0.009135	643	-0.111743	0.010401
Accor	1326	0.000370	0.024929	683	0.009146	0.022812	643	-0.008952	0.033681
AGF	1324	-0.000071	0.015908	676	0.004800	0.0147947	638	-0.05232	0.015421
Air liquide	1326	0.000248	0.020533	683	0.007748	0.019188	643	-0.007718	0.018858
Alcatel	1323	-0.000856	0.037774	683	0.018634	0.028807	640	-0.021656	0.035027
Aventis	1326	0.000490	0.023022	683	0.009287	0.021534	643	-0.008853	0.020773
Axa	1326	-0.000231	0.022956	683	0.011251	0.019339	643	-0.012427	0.020130
BNP	1324	0.000422	0.024640	681	0.011663	0.021563	643	-0.011484	0.021970
Bouygues	1326	0.000727	0.029103	683	0.012095	0.026353	643	-0.011348	0.026959
Carrefour	1324	-0.000138	0.022099	683	0.009427	0.019573	641	-0.010330	0.019991
Casino	1303	0.000349	0.018315	669	0.004849	0.017984	634	-0.004399	0.017454
Danone	1326	0.000304	0.019108	683	0.005658	0.018141	643	-0.005384	0.018469
Dassault	1326	0.000405	0.035506	683	0.014314	0.032271	643	-0.014368	0.032729
Dexia	1324	0.000340	0.018680	681	0.006249	0.016599	643	-0.005918	0.018733
Cap Gemini	1326	-0.000421	0.035918	683	0.013934	0.032324	643	-0.015670	0.033175
Lafarge	1326	0.000259	0.022326	683	0.006785	0.020923	643	-0.006672	0.021685
Lagardere	1326	0.000270	0.029626	683	0.012401	0.026587	643	-0.012615	0.027160
L'Oréal	1326	0.000452	0.023739	683	0.011667	0.020518	643	-0.011460	0.020973
LVMH	1326	-0.000078	0.025818	683	0.012031	0.023192	643	-0.012940	0.021968
Michelin	1326	-0.000332	0.032570	683	0.006701	0.021641	643	-0.007804	0.021102
Peugeot	1326	0.000727	0.022201	683	0.008350	0.020062	643	-0.007370	0.021498
PPR	1326	0.000067	0.023112	683	0.010056	0.020727	643	-0.010542	0.020668
Renault	1326	0.000504	0.028386	683	0.010035	0.026017	643	-0.009619	0.027288
Sanofi	1326	0.000654	0.024342	683	0.008351	0.024153	643	-0.007521	0.031753
Schneider	1322	-0.000060	0.026924	683	0.009236	0.025955	639	-0.009997	0.024278
Soc. Générale	1322	0.000395	0.024804	679	0.011350	0.021451	643	-0.011172	0.022783
Sodhexo	1326	0.000130	0.022642	683	0.005890	0.021938	643	-0.005989	0.021771
Saint Gobain	1326	0.000157	0.021547	683	0.007666	0.019700	643	-0.007819	0.020547
St Microelec.	1326	0.000471	0.037041	683	0.019228	0.032195	643	-0.019452	0.030963
Suez	1322	0.000117	0.019080	682	0.007801	0.017148	640	-0.008072	0.017580
TF1	1326	0.000463	0.033418	683	0.0120295	0.031081	643	-0.011822	0.031386
Thalès	1325	0.000279	0.028560	682	0.009636	0.026758	643	-0.009645	0.027124
Total	1326	0.000429	0.021733	683	0.008801	0.019055	643	-0.008463	0.020866
Vinci	1324	0.000813	0.021972	682	0.003998	0.020928	642	-0.002572	0.022556
Vivendi	1322	-0.00060	0.027774	682	0.011134	0.021789	640	-0.013105	0.027943

C Adjustment quality

Company name	Market Model	4-State Model	Rotated	Translated
Accor	0.270582	0.632112	0.641847	0.631796
AGF	0.194740	0.562285	0.567875	0.562383
Air liquide	0.257985	0.635854	0.604959	0.629229
Alcatel	0.460122	0.634354	0.751216	0.633431
Aventis	0.275343	0.612005	0.639371	0.614561
Axa	0.477061	0.686639	0.746179	0.683597
BNP	0.408155	0.651857	0.658577	0.654232
Bouygues	0.233020	0.597358	0.605893	0.601681
Carrefour	0.323096	0.631789	0.673956	0.631776
Casino	0.118334	0.580876	0.603385	0.579824
Danone	0.161068	0.582345	0.619063	0.583919
Dassault	0.269419	0.620393	0.600944	0.623936
Dexia	0.201040	0.609231	0.635156	0.609432
Cap Gemini	0.308725	0.625032	0.724266	0.624597
Lafarge	0.192616	0.621656	0.622739	0.621645
Lagardere	0.307738	0.620743	0.60657	0.622062
L'Oréal	0.406963	0.689669	0.648653	0.688150
LVMH	0.410756	0.656320	0.663535	0.656183
Michelin	0.189329	0.568469	0.641272	0.568633
Peugeot	0.264216	0.601915	0.655944	0.606296
PPR	0.364274	0.634756	0.659705	0.636581
Renault	0.240913	0.629215	0.628403	0.626908
Sanofi	0.189406	0.622818	0.625387	0.622780
Schneider	0.239986	0.617621	0.624772	0.617406
Soc. Générale	0.386385	0.642531	0.649158	0.643470
Sodhexo	0.125346	0.573459	0.628616	0.574532
Saint Gobain	0.250023	0.621210	0.614965	0.622908
St Microelec.	0.427428	0.712708	0.599757	0.711576
Suez	0.294002	0.626695	0.572765	0.628096
TF1	0.185983	0.550669	0.585507	0.553247
Thalès	0.209784	0.587011	0.625067	0.587215
Total	0.288228	0.655004	0.617660	0.655012
Vinci	0.042922	0.545365	0.599464	0.558446
Vivendi	0.366446	0.552828	0.713737	0.553151

Table 5: Quality Adjustment

D Diversification effects

Company Name	Market Model	4-State Model	Rotated	Translated
Accor	0.021291	0.015121	0.007584	0.015127
AGF	0.014275	0.010524	0.012253	0.010523
Air liquide	0.017687	0.012475	0.007702	0.012503
Alcatel	0.028028	0.019854	0.007336	0.037774
Aventis	0.019665	0.014340	0.007927	0.014293
Axa	0.016600	0.012912	0.010358	0.012913
BNP	0.018956	0.014539	0.007130	0.014489
Bouygues	0.024984	0.018467	0.013519	0.018368
Carrefour	0.018182	0.013410	0.012417	0.013410
Casino	0.017197	0.011857	0.008668	0.011872
Danone	0.017502	0.012349	0.008195	0.012326
Dassault	0.030349	0.021876	0.007955	0.021774
Dexia	0.016697	0.011677	0.007971	0.011674
Cap Gemini	0.029863	0.021994	0.010374	0.022007
Lafarge	0.020061	0.013732	0.007899	0.013723
Lagardere	0.024649	0.018285	0.007574	0.018213
L'Oréal	0.018281	0.013224	0.007364	0.013257
LVMH	0.019818	0.015135	0.015559	0.015139
Michelin	0.020321	0.014827	0.010684	0.014824
Peugeot	0.019043	0.014007	0.008091	0.013930
PPR	0.018428	0.013968	0.008568	0.013952
Renault	0.024731	0.017285	0.008028	0.017338
Sanofi	0.021916	0.014950	0.008475	0.014950
Schneider	0.023472	0.016649	0.016777	0.016654
Soc. Générale	0.019430	0.014830	0.007100	0.014811
Sodhexo	0.021187	0.014788	0.00871	0.014769
Saint Gobain	0.018660	0.013261	0.00747	0.013231
St Microelec.	0.028028	0.019854	0.00734	0.0198929
Suez	0.016032	0.011658	0.00735	0.011636
TF1	0.030150	0.022401	0.00860	0.022336
Thalès	0.025423	0.018379	0.00792	0.018375
Total	0.018336	0.012766	0.00802	0.012765
Vinci	0.021495	0.014815	0.009292	0.014600
Vivendi	0.022078	0.018548	0.009427	0.018541

E Parameters Stability

	Market model (OLS model)			
	1st period	2d period	Regression Stability	β Stability
Accor	0.9806	0.7592	*	*
AGF	0.4799	0.4527	*	*
Air liquide	0.8506	0.5602		
Alcatel	1.3910	1.9628		
Aventis	0.9963	0.6550		
Axa	1.0081	1.0870	*	*
BNP	1.3701	0.7683		
Bouygues	0.6186	1.3055		
Carrefour	0.9118	0.7664	*	*
Casino	0.4381	0.3996	*	*
Danone	0.7387	0.3143		
Dassault	0.8363	1.5569		
Dexia	0.6565	0.4708	*	
Cap Gemini	1.0560	1.5502		
Lafarge	0.8707	0.4636		
Lagardere	0.9441	1.2191	*	
L'Oréal	1.2711	0.7810		
LVMH	1.0527	1.1376	*	*
Michelin	0.9490	0.4028		
Peugeot	1.0106	0.5438		
PPR	1.0236	0.8396	*	*
Renault	1.2419	0.6542		
Sanofi	0.8353	0.5933	*	
Schneider	1.1564	0.6356		
Soc. Générale	1.1772	0.8920		
Sodhexo	0.6061	0.4669	*	*
Saint Gobain	0.8786	0.5775		
St Microelec.	1.3798	1.8021		
Suez	0.7586	0.6251	*	*
TF1	0.4359	1.3991		
Thalès	0.9949	0.7662	*	*
Total	0.9466	0.6294		
Vinci	0.4316	0.1947	*	
Vivendi	0.7164	1.4483		

Table 6: Estimate of the Market Model Beta from OLS

* correspond to 5% stability.

Market model (Arch- model)			
	1st period	2d period	Stability (5%)
Accor	1.000188	0.774535	
AGF	0.475764	0.401133	*
Air liquide	0.852442	0.557260	
Alcatel	1.294538	1.986241	
Aventis	0.989759	0.631473	
Axa	0.939690	1.037922	*
BNP	1.320018	0.780493	
Bouygues	0.603341	1.281926	
Carrefour	0.901391	0.730446	*
Casino	0.404862	0.409632	*
Danone	0.737030	0.321885	
Dassault	0.791719	1.538287	
Dexia	0.641757	0.473205	
Cap Gemini	1.049996	1.511163	
Lafarge	0.907702	0.465169	
Lagardere	0.967646	1.239371	
L'Oréal	1.221861	0.764713	
LVMH	1.042969	1.020824	*
Michelin	0.927028	0.368773	
Peugeot	0.961372	0.561983	
PPR	1.001646	0.907840	
Renault	1.182919	0.705979	
Sanofi	0.816934	0.594891	
Schneider	1.144986	0.624944	
Soc. Générale	1.165806	0.928593	
Sodhexo	0.592057	0.449429	*
Saint Gobain	0.889554	0.573793	
St Microelec.	1.375123	1.778635	
Suez	0.744192	0.611960	
TF1	0.399818	1.322042	
Thalès	1.023578	0.762455	
Total	0.943269	0.656112	
Vinci	0.466030	0.224757	
Vivendi	0.718792	1.252108	

Table 7: Estimate of the Market Model Beta from an ARCH process

4-State Model

	1st period				2d period				β stability			
	β_1	β_2	β_3	β_4	β_1	β_2	β_3	β_4	β_1	β_2	β_3	β_4
Accor	0.7191	0.4254	0.8475	*-0.1283*	0.7038	*-0.3250*	0.8281	0.2740	*		*	*
AGF	0.1674	*0.0174*	0.3860	*0.1010*	0.5436	*-0.0258*	0.6430	*0.1132*		*	*	*
Air liquide	0.5787	*0.1315*	0.4273	*0.1357*	0.5776	-0.3129	0.5089	*0.2172*	*		*	*
Alcatel	0.8981	*-0.1650*	1.5957	*-0.3851*	1.4956	*-0.2848*	1.0962	*0.5579*		*	*	*
Aventis	0.6911	*-0.1325*	0.6107	*0.3961*	0.4299	*-0.3529*	0.4779	*0.0051*	*	*	*	*
Axa	0.7553	*0.2812*	0.7876	*0.2504*	0.8603	*0.1241*	1.0221	*-0.0363*	*	*	*	*
BNP	1.1338	0.4158	1.1647	*-0.1271*	0.4895	*0.0425*	0.7701	*0.0462*				*
Bouygues	0.4554	*0.1593*	0.4641	*-0.4165*	1.0132	*0.1059*	0.9054	0.4307		*		
Carrefour	0.5848	*0.0303*	0.6657	*-0.1101*	0.2918	*-0.2132*	0.4909	0.4714	*	*	*	
Casino	*0.2067*	*0.0524*	0.4452	*0.0523*	0.3007	*0.1448*	0.3044	*0.0152*	*	*	*	*
Danone	0.4084	*0.0508*	0.5927	*0.0581*	0.2620	*-0.1017*	0.3906	*-0.0910*	*	*	*	*
Dassault	0.3296	*0.1333*	0.7022	*0.2435*	1.2485	*-0.1908*	0.8319	*0.3835*		*	*	*
Dexia	0.4955	*-0.0870*	0.5667	0.0264	0.2716	*-0.0005*	0.4964	*0.0467*	*	*	*	*
Cap Gemini	0.8494	*0.4805*	0.8215	0.4181	0.9524	*-0.3102*	1.0560	*-0.1208*	*	*	*	*
Lafarge	0.6237	*-0.0197*	0.5938	*0.2351*	0.4593	*-0.0066*	0.3848	*0.0908*	*	*	*	*
Lagardere	0.6291	*0.1428*	0.7450	*-0.1838*	0.7951	*-0.2706*	0.8118	*0.0827*	*	*	*	*
L'Oréal	1.0528	*-0.0288*	0.9615	0.2076	0.5088	*-0.0208*	0.7568	*0.1430*		*	*	*
LVMH	0.8654	*0.1400*	0.7412	*0.0005*	0.9695	*-0.0704*	0.9123	*-0.0867*	*	*	*	*
Michelin	0.6131	*-0.0972*	0.6623	*0.2474*	0.3213	*0.0056*	0.3702	*-0.0496*	*	*	*	*
Peugeot	0.5431	0.4387	0.9098	*-0.1509*	0.5317	*0.0899*	0.4768	*-0.0408*	*	*	*	*
PPR	0.9627	*0.0480*	0.7127	*0.2065*	0.5339	*0.1163*	0.8100	*0.0605*		*	*	*
Renault	0.8231	0.6688	1.0120	*0.2053*	0.5570	*-0.4749*	0.6724	*0.1248*	*		*	*
Sanofi	0.6969	*0.0750*	0.5216	*-0.1043*	0.3310	*-0.0901*	0.4814	*0.0838*	*	*	*	*
Schneider	0.6268	*-0.0262*	1.0741	*-0.3070*	0.3014	*-0.0911*	0.6110	*0.1935*	*	*		*
Soc. Générale	0.8259	0.6314	0.9561	-0.6137	0.6894	*0.0053*	0.8175	*-0.0743*	*		*	*
Sodhexo	0.5600	*-0.0740*	0.3047	*0.2012*	0.3529	-0.2046	0.4026	*-0.1375*	*	*	*	*
Saint Gobain	0.6356	*-0.0478*	0.6963	*-0.3764*	0.3125	*0.1209*	0.5606	*-0.1101*		*	*	*
St Microelec.	0.8627	*0.3218*	1.1838	0.2929	1.5512	*-0.5105*	1.0940	*0.1868*			*	*
Suez	0.6171	*-0.0908*	0.5026	*0.0050*	0.5945	*0.0866*	0.6354	*0.0920*	*	*	*	*
TF1	0.0418	*-0.1502*	0.5608	*0.0986*	0.8631	*-0.2458*	0.7363	*-0.1492*	*	*	*	*
Thalès	0.4408	*0.0403*	0.7815	*-0.0789*	0.5264	*-0.0298*	0.4702	*0.2397*	*	*	*	*
Total	0.6852	*0.0783*	0.6849	*0.0188*	0.4657	*-0.0444*	0.4566	*0.0799*	*	*	*	*
Vinci	*0.1566*	*-0.0041*	0.3525	*-0.0381*	*-0.1384*	*-0.1176*	*0.1481*	*0.1643*	*	*	*	*
Vivendi	0.4800	*0.1916*	0.4262	*0.2294*	1.1273	-0.5074	1.6205	0.0954				*

The estimates in *italics* are non significant at the 5% level

Translated 4-State Model

	1st period				2d period				β stability			
	β_1	β_2	β_3	β_4	β_1	β_2	β_3	β_4	β_1	β_2	β_3	β_4
Accor	0.6982	0.4123	0.8670	*-0.0758*	0.6716	*0.3364*	0.8015	*0.2212*	*		*	*
AGF	0.1651	*0.0346*	0.3905	*0.0938*	0.5464	*-0.0257*	0.6430	*0.1085*		*	*	*
Air liquide	0.5563	*0.1878*	0.4609	*0.0934*	0.5859	*-0.2222*	0.4746	*0.1583*	*		*	*
Alcatel	0.9315	*-0.2225*	1.5957	*-0.2451*	1.4447	-0.6149	1.0809	0.6511		*	*	*
Aventis	0.6920	*-0.1369*	0.6320	*0.3367*	0.4671	*-0.17771*	0.5177	*0.0745*	*	*	*	*
Axa	0.7555	*0.3051*	0.7903	*-0.2470*	0.8550	*0.1086*	1.0155	*-0.0529*	*	*	*	*
BNP	1.0762	0.3331	1.1832	*-0.1882*	0.4723	*0.04033*	0.7841	*0.0879*		*		*
Bouygues	0.4534	*0.1971*	0.4897	*-0.3996*	1.0144	*0.0995*	0.9339	0.5316		*		
Carrefour	0.5812	*0.0311*	0.6659	*-0.1199*	0.2895	*-0.2002*	0.4952	0.4661	*	*	*	
Casino	*0.1869*	*0.0466*	0.4490	*0.0011*	0.2772	*0.0915*	0.2985	*-0.0268*	*	*	*	*
Danone	0.3700	*0.0294*	0.5977	*0.0557*	0.2219	*-0.1433*	0.3853	*-0.1306*	*	*	*	*
Dassault	0.3241	*0.1237*	0.7348	*0.3067*	1.1801	*-0.3204*	0.8514	*0.4243*		*	*	*
Dexia	0.4637	*-0.1051*	0.5488	*0.2883*	0.2358	*-0.0191*	0.4897	*0.0120*	*	*	*	*
Cap Gemini	0.8591	*0.4907*	0.8196	0.4332	0.9454	*-0.3281*	1.0552	*-0.1682*	*	*	*	*
Lafarge	0.6321	*-0.0229*	0.5616	*0.1842*	0.4330	*-0.0253*	0.4110	*0.1060*	*	*	*	*
Lagardere	0.6054	*0.0811*	0.7910	*-0.0207*	0.7522	*-0.3481*	0.8167	*0.0530*	*	*	*	*
L'Oréal	1.0259	*-0.1018*	0.9268	*0.2201*	0.4856	*-0.0640*	0.7650	*0.1810*		*	*	*
LVMH	0.8756	*0.1443*	0.7396	*0.0295*	0.9695	*-01349*	0.8969	*-0.0867*	*	*	*	*
Michelin	0.6089	*-0.1481*	0.6539	*0.2401*	0.3180	*0.0056*	0.3565	*-0.0848*	*	*	*	*
Peugeot	0.5369	0.4643	0.9200	*-0.0489*	0.4944	*0.0314*	0.4858	*-0.0711*	*	*		*
PPR	0.9458	*0.0671*	0.6963	*0.0834*	0.5243	*0.1630*	0.8219	*0.0488*		*	*	*
Renault	0.7689	0.5877	1.0453	*0.1448*	0.5014	-0.5713	0.6504	*0.0711*	*		*	*
Sanofi	0.6802	*0.0636*	0.5236	*-0.1366*	0.3013	*-0.1469*	0.4961	*0.0959*		*	*	*
Schneider	0.6413	*-0.0504*	1.0643	*-0.2187*	0.3032	*-0.0974*	0.6062	*0.1976*	*	*		*
Soc. Générale	0.8099	0.6978	0.9929	*-0.5647*	0.6738	*0.0064*	0.8485	*-0.0252*	*		*	*
Sodhexo	0.5325	*-0.0503*	0.3311	*0.2198*	0.3564	*-0.1724*	0.3936	*-0.2233*	*	*	*	*
Saint Gobain	0.6280	*-0.0296*	0.7246	*-0.3322*	0.2781	*0.0859*	0.5919	*-0.0531*		*	*	*
St Microelec.	0.8549	*0.3072*	1.1314	0.3167	1.5156	*-0.6402*	1.1002	*0.1967*			*	*
Suez	0.5880	*-0.1077*	0.5147	*-0.0169*	0.6085	*0.0865*	0.6389	*0.1082*	*	*	*	*
TF1	0.4844	*-0.0878*	0.5455	*0.1240*	0.9011	*-0.0909*	0.7577	*-0.1691*	*	*	*	*
Thalès	0.4082	*0.0642*	0.8112	*-0.0941*	0.5847	*0.0162*	0.4630	*0.2340*	*	*	*	*
Total	0.6786	*0.0960*	0.6930	*0.0462*	0.4581	*-0.0589*	0.4567	*0.0567*	*	*	*	*
Vinci	*0.1115*	*0.0111*	0.4059	*-0.0744*	*-0.1265*	*-0.0721*	*0.1561*	*0.1595*	*	*	*	*
Vivendi	0.4775	*0.2063*	0.4301	*0.2163*	1.1269	*-0.4792*	1.6203	*0.1014*				*

The estimates in *italics* are non significant at the 5% level

Rotated 4-State Model (OLS)

	1st period				2d period				β stability			
	β_1	β_2	β_3	β_4	β_1	β_2	β_3	β_4	β_1	β_2	β_3	β_4
Accor	*0.0416*	-0.1144	*-0.0122*	-0.2209	0.0193	-0.1644	0.1557	-0.1482	*	*		*
AGF	*0.5639*	*-0.5247*	*0.6998*	-0.4555	0.0839	-0.2397	0.1701	-0.2874		*		*
Air liquide	0.1240	-0.1118	*0.0432*	-0.2146	0.0542	-0.1597	*0.0710*	-0.1655	*	*	*	*
Alcatel	*0.0816*	-0.2482	*0.0521*	-0.2893	-0.0239	-0.2633	*-0.0474*	-0.2970	*	*	*	*
Aventis	0.0751	-0.1170	*0.1032*	-0.2615	-0.0237	-0.1618	*0.0849*	-0.2702		*	*	*
Axa	-0.4778	-0.7762	*-0.1998*	-0.6429	-0.0043	-0.7047	-0.0723	-0.6382		*	*	*
BNP	*0.0640*	-0.0800	*-0.0681*	-0.1681	-0.0967	-0.1702	*-0.0408*	-0.3086		*	*	
Bouygues	*0.0683*	-0.0994	*0.0043*	-0.1183	0.0359	-0.0926	-0.0062	-0.1250	*	*	*	*
Carrefour	*0.1112*	-0.7048	*0.0849*	-0.5817	*-0.1395*	-0.4256	*-0.1195*	-0.5585	*	*	*	*
Casino	*0.0999*	*-0.1135*	*0.0537*	-0.2328	*0.0342*	*-0.0950*	*-0.0256*	-0.2430	*	*	*	*
Danone	*0.0656*	-0.1833	*0.1595*	-0.2635	0.1460	-0.1282	*0.0693*	-0.2833	*	*	*	*
Dassault	*0.0603*	*-0.0723*	*0.0598*	-0.1014	*0.0316*	-0.0596	*0.0407*	-0.1086	*	*	*	*
Dexia	*0.0778*	-0.1624	*0.1488*	-0.3019	*-0.0256*	-0.2017	*0.1010*	-0.2227	*	*	*	*
Cap Gemini	*-0.0323*	-0.2740	*-0.0705*	-0.3200	*0.0841*	-0.3467	*-0.0506*	-0.2633	*	*	*	*
Lafarge	*0.0661*	-0.1057	*0.0375*	-0.2297	0.0371	-0.1158	0.1343	*-0.1236*	*	*		*
Lagardere	*0.0791*	-0.0924	*0.0565*	-0.1097	0.0904	-0.0752	*0.0547*	*-0.0800*	*	*	*	*
L'Oréal	*0.0628*	-0.1905	*0.0556*	-0.2359	*0.0237*	-0.1468	*0.0585*	-0.2409	*	*	*	*
LVMH	*-0.1274*	-0.6164	*0.2167*	-0.8929	*-0.0640*	-0.8868	*-0.2015*	-1.0938	*	*	*	*
Michelin	*-0.0296*	-0.3561	*-0.1003*	-0.3461	-0.1335	-0.3163	*-0.0663*	-0.1904	*	*	*	*
Peugeot	*0.0098*	-0.1365	*-0.0500*	-0.2639	0.1296	-0.2108	*-0.0142*	-0.2818	*	*	*	*
PPR	*0.3353*	0.0073	*0.2186*	-0.0928	0.3059	0.0679	0.4014	*-0.0055*	*	*		*
Renault	*0.0410*	-0.1037	*-0.0265*	-0.1501	*0.0613*	-0.1159	0.1361	-0.1664	*	*		*
Sanofi	*-0.0089*	-0.1193	0.1037	-0.2380	*0.0108*	-0.1042	*0.0703*	-0.2638	*	*	*	*
Schneider	*0.2208*	-0.6772	*-0.0404*	-0.6758	*0.0058*	-0.7696	*0.2818*	-0.6128	*	*	*	*
Soc. Générale	*0.0893*	-0.0880	0.0804	-0.1701	*0.0517*	-0.1772	*0.0332*	-0.1904	*	*	*	*
Sodhexo	0.1757	*-0.0152*	0.1825	*-0.0872*	0.2016	*-0.0468*	0.1715	*-0.0432*	*	*	*	*
Saint Gobain	0.0829	-0.0880	*0.0659*	-0.1256	0.1593	-0.1232	*0.0762*	-0.1457	*	*	*	*
St Microelec.	*-0.0456*	*-0.0458*	*-0.0295*	-0.1296	*-0.0172*	-0.0793	*0.0088*	-0.0895	*	*	*	*
Suez	0.0986	*-0.0168*	*0.0537*	-0.1043	0.2140	*-0.0180*	0.1297	0.0396	*	*	*	
TF1	*0.0403*	-0.0440	0.0919	*-0.0400*	0.0460	-0.0445	0.0570	-0.0585	*	*	*	*
Thalès	0.0711	*-0.0488*	*0.0369*	-0.1074	0.0567	*-0.0334*	0.0818	-0.1145	*	*		*
Total	0.1101	-0.1529	-0.0027	-0.1307	0.1278	-0.1957	0.0567	-0.2462	*	*	*	*
Vinci	0.0702	-0.0504	-0.0275	-0.2475	0.0283	0.1120	0.0330	-0.1295	*		*	*
Vivendi	-0.1484	*-0.4434*	-0.1287	*-0.3252*	-0.0084	*-0.2965*	0.0260	*-0.3383*	*	*	*	*

The estimates in *italics* character are non significant at the 5% level

Table 8: Estimate of the Rotated 4-State Model

Rotated 4-State Model (Arch)

	1st period				2d period				β stability			
	β_1	β_2	β_3	β_4	β_1	β_2	β_3	β_4	β_1	β_2	β_3	β_4
Accor	*0.0266*	-0.1113	-0.1273	-0.2164	*0.0199*	*-0.1713*	*0.1348*	*-0.1401*	*			*
AGF	0.5249	-0.5275	0.7268	-0.5129	*0.1271*	*-0.1961*	*0.0880*	*-0.4965*	*	*		*
Air liquide	0.1313	-0.1029	*0.0367*	-0.2115	*0.0420*	-0.1677	0.0692	-0.1653	*	*	*	*
Alcatel	*0.162*	-0.2556	*-0.0973*	-0.2796	*-0.0255*	-0.2881	*-0.0701*	-0.2997	*	*	*	*
Aventis	0.0797	-0.1010	*0.0813*	-0.2878	*-0.0287*	-0.1758	*0.0825*	-0.2830		*	*	*
Axa	-0.3975	-0.7384	*-0.1807*	-0.6440	*-0.0565*	-0.7493	*0.0374*	-0.6174	*	*	*	*
BNP	0.0661	-0.0729	*-0.0677*	-0.1713	-0.0915	-0.1864	*-0.0377*	-0.3098			*	
Bouygues	0.0672	-0.0614	*0.0344*	*-0.1064*	*0.0126*	-0.0986	*-0.0301*	-0.1358	*	*	*	*
Carrefour	*-0.0714*	-0.6879	*0.2573*	-0.5261	*-0.1481*	-0.3587	*-0.0483*	-0.5771	*		*	*
Casino	*0.1003*	*-0.0883*	*0.0536*	-0.2602	*0.0417*	-0.0978	*-0.0210*	-0.2372	*	*	*	*
Danone	0.0747	-0.1393	*0.0652*	-0.2548	0.1651	-0.1326	*0.0591*	-0.2738	*	*	*	*
Dassault	0.0663	*-0.0391*	0.0767	*-0.0828*	*0.0180*	-0.0715	0.0421	-0.1133	*	*	*	*
Dexia	*0.0523*	-0.1442	0.1423	-0.2827	*-0.0211*	-0.2019	0.0968	-0.2216	*	*	*	*
Cap Gemini	*-0.0348*	-0.2375	*-0.0240*	-0.2894	*0.1091*	-0.3364	*-0.0910*	-0.2559	*	*	*	*
Lafarge	0.0694	-0.0997	*0.0468*	-0.2272	*0.0450*	-0.1297	0.1326	*-0.1295*	*	*	*	*
Lagardere	*0.0565*	-0.0711	0.0604	-0.1266	0.0914	-0.0719	*0.0049*	*-0.0621*	*	*	*	*
L'Oréal	*0.0294*	-0.1681	*0.0554*	-.02368	*0.0208*	-0.1502	0.0577	-0.2536	*	*	*	*
LVMH	*-0.1156*	-0.6406	0.6832	-0.9688	*-0.0539*	-0.6974	*-0.1666*	-0.9754	*	*		*
Michelin	*-0.0762*	-0.3008	*0.0536*	-0.3411	-0.1408	-0.2888	*-0.0411*	-0.2446	*	*	*	*
Peugeot	*0.0128*	-0.1208	*-0.0867*	-0.2528	0.1274	-0.2206	*-.00319*	-0.2847			*	*
PPR	0.3382	*0.0065*	0.2173	*-0.0951*	*0.3037*	*0.0450*	*0.4150*	*0.1086*	*	*		
Renault	*0.0422*	-0.0886	*-0.0310*	-0.1403	*0.0668*	*-0.1202*	*0.1188*	*-0.1781*	*	*		*
Sanofi	*-0.0070*	-0.1121	0.1117	-0.2166	*-.00027*	-0.1093	*0.0671*	-0.2650	*	*	*	*
Schneider	*0.1332*	-0.6423	*-0.0146*	-0.7077	*0.0183*	-0.7925	0.3583	-0.8148	*	*	*	*
Soc. Générale	0.0962	-0.0779	0.0726	-0.1588	0.0544	-0.1841	*0.0333*	-0.1936	*		*	*
Sodhexo	0.1891	*-0.0301*	0.1982	*-0.1066*	0.2077	*-0.0346*	0.1742	*-0.0663*	*	*	*	*
Saint Gobain	0.0875	-0.0879	*0.0702*	-0.1244	0.1571	-0.1310	*0.0722*	-0.1465		*	*	*
St Microelec.	*-0.0382*	*-0.0394*	*-0.0276*	-0.1222	*-0.0134*	-0.0770	*0.0046*	-0.0958	*	*	*	*
Suez	0.0778	*-0.287*	0.0595	*-0.1089*	0.2141	*-0.0094*	*0.1018*	*0.0402*		*	*	
TF1	0.0869	*-0.0302*	*0.0046*	-0.0907	*0.0372*	-0.0604	*0.0483*	*-0.0444*	*	*	*	*
Thalès	0.0386	*-0.0185*	0.0967	-0.1223	0.0627	*-0.0587*	*0.0253*	-0.1103	*	*		*
Total	0.1204	-0.1041	*0.0056*	-0.1338	0.1320	-0.1981	*0.0717*	-0.2438	*	*	*	*
Vinci	*0.0269*	*-0.0254*	*0.0145*	-0.2234	*0.0270*	0.1145	*0.0565*	*-0.0948*	*		*	*
Vivendi	*-0.1816*	-0.4858	*-0.1167*	-0.3011	*-0.0355*	-0.3239	*0.0941*	-0.3228	*	*	*	*

The estimates in *italics* are non significant at the 5% level

Table 9: Estimate of the Rotated 4-State Model with an ARCH(1) process for the residuals