# NEW EVIDENCE ON BETA STATIONARITY AND FORECAST FOR BELGIAN COMMON STOCKS

by
Gabriel A. HAWAWINI
and
Pierre A. MICHEL

N° 81/07

Directeur de la Publication :

Jean-Claude THOENIG
Associate Dean: Research and Development
INSEAD

Dépôt légal : 1er Trimestre 1981

Imprimé par l'INSEAD, Fontainebleau
France.

# NEW EVIDENCE ON BETA STATIONARITY AND FORECAST FOR BELGIAN COMMON STOCKS

*Gabriel A. HAWAWINI*

European Institute of Business Administration (INSEAD)
and the City University of New York

*Pierre A. MICHEL*

University of Liège

February 1981

Do not quote or reproduce
without the permission of
the authors

Mailing address:

INSEAD
Boulevard de Constance
77305 FONTAINEBLEAU
France

# NEW EVIDENCE ON BETA STATIONARITY AND FORECAST FOR BELGIAN COMMON STOCKS

## ABSTRACT

Based on a comprehensive sample of 210 securities traded continuously on the Brussels Stock Exchange this paper presents evidence which indicates that the stationarity of beta-coefficients is not as strong as reported in previous studies which were based on small samples. It is shown, however, that beta forecast can be generally improved using an adjustment method and that the improvement is largest for portfolios of increasing size.

# NEW EVIDENCE ON BETA STATIONARITY AND FORECAST FOR BELGIAN COMMON STOCKS

## 1. Introduction

The systematic risk of a security known as its beta-coefficient is a central concept in capital market theory. Practical applications of this theory require that historical betas be estimated with the least amount of measurement errors and that their future values be predicted as accurately as possible. It is the stationarity and forecast aspects of beta-coefficient that are the concern of this paper.

The simplest forecast of next period beta is the most recent historical estimate of beta. The purpose of this paper is to find out if the accuracy of the forecast of next period beta, for a comprehensive sample of Belgian common stocks, can be improved by adjusting the historical estimates of beta according to three alternative adjustment techniques: the Bayesian method developed by Vasicek (1973), the method developed by Blume (1971, 1975) and that used by the brokerage firm of Merrill Lynch Pierce Fenner and Smith (MLPFS). These adjustment techniques are described in the third section.

The next section combines a brief summary of previous work and a presentation of the properties of the sample used in this study. Methodological issues are discussed in Section 3. Section 4 presents the empirical findings. Our major result is that the stationarity of beta-coefficients for Belgian common stocks is not as strong as previous studies have shown.

Their forecast, however, can be generally improved using an adjustment method and the improvement is largest for portfolios of increasing size. The last section contains concluding remarks.

## 2. Previous Work and Sample Properties

Klemkosky and Martin (1975) have examined the question of adjusting beta forecasts for a sample of U.S. common stocks and concluded that "the accuracy of a simple no-change extrapolative beta forecast can be improved. A combination of the Bayesian (Vasicek) predictor and a reasonable portfolio size would appear to make the beta coefficient a highly predictable risk surrogate."

Recently, Eubank and Zumwalt (1979) confirmed Klemkosky and Martin's results over estimation periods of 12 to 120 months.

To our knowledge, there has been no published account of an evaluation of the adjustment beta forecasts for European common stocks.[1] This study will focus on stocks traded on the Brussels Stock Exchange (BSE). The stationarity of Belgian betas was investigated by Hawawini and Michel (1978, 1979) and by Fabry and Van Grembergen (1978). The former have concluded that Belgian betas are generally more stationary than French or U.S. betas but they did not examine if a simple no-change extrapolative beta forecast can be improved. The latter concluded that the true betas of small portfolios - as opposed to the estimated betas - are generally stationary. Single security betas, however, were not found to be stationary. Again, no attempt is made to see if adjusting the estimated betas will improve their accuracy in predicting the next period betas.

Another important aspect of this paper which differentiates it from previous work on Belgian stocks is the property of the sample used. Hawawini and Michel (1978, 1979) had a sample of only 30 common stocks and Fabry and Van Grambergen (1978) had a sample of 46 stocks. These were small samples that suffered from a considerable bias toward frequently traded securities which are not closely owned and which have the largest market values of shares outstanding. The sample used in this study contains 210 securities. It consists of <u>all</u> the securities which were listed continuously on the BSE over the 12-year period starting in November 1966 and ending in November 1978. Empirical results drawn from this comprehensive sample show that beta-stationarity is not as strong as reported by either Hawawini and Michel or Fabry and Van Grembergen. It is possible that the relatively stronger stationarity observed by these authors was due to the fact that they restricted their investigations to a sample of securities which was frequently traded and had large market values.

## 3. Methodology

### 3.1 Adjustment methods

A security's beta-coefficient can be estimated from historical price data using the well-known Market Model[2]:

$$\tilde{R}_{i,t} = \alpha_i + \beta_i \tilde{R}_{m,t} + \tilde{\varepsilon}_{i,t} \qquad (1)$$

where $\tilde{R}_{i,t}$ us the monthly total return of security i, $\tilde{R}_{m,t}$ is the corresponding rate of return of a market index which we take as the arithmetic average of the 210 securities in our sample and $\tilde{\varepsilon}_{i,t}$ is a random variable assumed to be serially uncorrelated with zero expected value and constant variance.

Consider the following notations:

$b_e = \dfrac{\hat{cov}(\tilde{R}_{i,t},\tilde{R}_{m,t})}{\hat{var}(\tilde{R}_{m,t})}$ = beta estimated using equation (1)

$b_p$ = predicted beta

$s_t$ = standard error of estimation of beta from the time-series analysis based on equation (1)

$\bar{b}_e$ = cross-sectional average of the estimated betas

$s_c$ = cross-sectional standard deviation of the estimated betas

1,2,3, = three consecutive estimation periods.

If the beta forecasts are not adjusted, then next period betas are predicted by betas estimated over the preceding period. We have:

$$b_{2p} = b_{1e}$$

That is, our forecast of period-two beta ($b_{2p}$) is beta estimated over period one ($b_{1p}$). This is the simple no-change extrapolative beta forecast.

Alternative forecast of period-two beta, however, can be obtained by adjusting the simple no-change extrapolative forecast ($b_{1e}$) by one of three methods. The first is the Bayes-Vasicek adjustment which is given by:

$$b'_{1p} \quad = \quad \frac{(b_{1e}/s^2_{1t}) + (\bar{b}_{1e}/s^2_{1c})}{(1/s^2_{1t}) + (1/s^2_{1c})} \tag{3}$$

This estimator uses information on the standard error of estimation of beta ($s_{1t}$), the cross-sectional average of the estimated betas ($\bar{b}_{1e}$) and the cross-sectional standard deviation of the estimated betas ($s_{1c}$) to adjust the no-change extrapolative forecast ($b_{1e}$) according to (1).

The second estimator is given by the Blume adjustment method. We have:

$$b''_{3p} \quad = \quad \hat{\partial} + \hat{\gamma} \; b_{2e} \tag{4}$$

where $\hat{\partial}$ and $\hat{\gamma}$ are derived from the regression $b_{2e} = \partial + \gamma \; b_{1e}$ + error. Note that the derivation of the Blume estimator requires two consecutive periods (period one and two) preceding the forecast period (period three) in order to estimate the coefficients $\partial$ and $\gamma$.

The third and last alternative estimator is the MLPFS estimator given by:

$$b'''_{3p} \quad = \quad 1 + \rho(b_{2e} - 1) \tag{5}$$

where $\rho$ is the product moment correlation between $b_{1e}$ and $b_{2e}$. Again, as in the case of the Blume estimator, two consecutive periods preceding the forecast period are required in order to estimate $\rho$.

## 3.2 Evaluation techniques

We wish to evaluate the predictive ability of the four alternative beta-forecast ($b_p$, $b'_p$, $b''_p$, and $b'''_p$) of next period beta. To do so, we can first estimate the value of beta which has actually occurred over the next period and then compare this realized value of beta ($b_r$) with each one of the four alternative forecasts.

The predictive ability of each one of the four alternative beta forecasts can be measured by the product moment correlation coefficient between each predicted value and the realized value of beta ($b_r$). The higher the correlation the more accurate is the forecast. This method suffers from known deficiencies.

An alternative and more general method of evaluating the predictive ability of beta forecasts is to compute the mean square error (MSE) between predicted ($b_p$) and realized ($b_r$) beta-coefficient and to examine its components.[3] We have:

$$\text{MSE} = \frac{1}{N} \Sigma_{i=1}^{n} (b_r - b_p)^2$$

$$\text{MSE} = (\bar{b}_r - \bar{b}_p)^2 + (1 - s_{rp})(s_c^2)_p + (1 - k_{rp}^2)(s_c^2)_r \qquad (6)$$

where $s_{rp}$ is the slope coefficient of the regression of $b_r$ on $b_p$, $(s_c^2)_p$ and $(s_c^2)_r$ are the cross-sectional sample variances of $b_p$ and $b_r$, respectively; and $k_{rp}$ is the correlation coefficient between $b_r$ and $b_p$.

The first term in (6) is the bias component which indicates the portion of the MSE due to over- and underestimation of the mean of the realized betas ($\bar{b}_r$) over the mean of the predicted betas ($\bar{b}_p$). The second term is the inefficiency component which captures the tendency of the forecast errors to be positive for low values of $b_p$ and negative for high values of $b_p$. The last term represents the random component of the MSE. Note that a perfect correlation between $b_r$ and $b_p$ ($k_{rp} = 1$) will reduce the random component to zero but will not produce a zero MSE. The MSE will be zero only if the predicted values of betas ($b_p$) are identical to their realized values ($b_r$).

## 4. Empirical Findings

### 4.1 Securities

The sample consists of all the securities which traded continuously from November 1966 to November 1978 on the Brussels Stock Exchange. There were 210 securities meeting this criterion. For each security, we computed 144 monthly total excess returns where the risk free rate is the monthly rate of return on short-term Belgian Government bonds. The monthly total excess returns on the market index were generated by assuming an equal investment in each one of the 210 securities in the sample. Using the Market Model expressed in (1) we first obtained estimates of each security's beta-coefficient over two consecutive subperiods of equal length. Betas estimated over the first subperiod were either unadjusted (these betas are referred to as "classical" estimators) or adjusted according to the Bayes-Vasicek method. Correlation coefficients and MSEs for predicted vs. realized betas are summarized in the upper part of Table 1.

The total 12-year estimation period was also broken down into three consecutive subperiods of equal length. Classical and Bayes estimators were computed over the first and second subperiods and compared to realized betas over the subsequent subperiods. We also compared the classical and the Bayes estimators obtained over the first subperiod to the realized betas over the third subperiod. Finally, using the first two subperiods we calculated the MLPFS and the Blume estimators which we compared to realized betas over the third subperiod. All the results are summarized in Table 1. The following observations can be made:

(1) The correlation coefficients are weaker than those reported by either Hawawini and Michel (1978, 1979) or Fabry and Grembergen (1978).[4] Thus, earlier evidence of stronger stationarity may be due to the small and biased sample used by these authors.

(2) The value of the correlation coefficient for the Bayes-adjusted forecasts is higher than that of the unadjusted (classical) forecast. The Blume-adjusted betas and the MLPFS-adjusted betas do not yield higher correlations than unadjusted betas.

(3) There is no statistically significant correlation between realized and predicted betas when the subperiods are not consecutive (12.66/11.70 and 12.74/11.78).

(4) MSEs can be significantly reduced by adjusting beta forecasts. The reduction in the MSEs comes primarily from the inefficiency component of total MSE. Referring to the lower part of Table 1, we can see that no particular adjustment technique provides a better reduction of MSE. The total MSE of adjusted betas is, for all three techniques, about 20% smaller than that of the unadjusted (classical) beta.

### 4.2 Portfolios

Correlation coefficients and MSEs were also obtained for portfolios of varying size. These portfolios were constructed by ranking individual securities' betas in decreasing order of value and assigning the first n-securities to the first portfolio of size n and so on until every security in the sample had been assigned to a portfolio. Empirical results are summarized in Table 2. We observe the following:

(1) As portfolio size increases, the correlation coefficients rise and total MSEs fall. This is consistent with what has been observed on the New York Stock Exchange.

(2) Most of the reduction in the MSEs comes from the random error component of total MSEs.

(3) MLPFS-adjusted betas provide the best forecast. With a portfolio-size of 21 securities, the total MSE of the MLPFS-adjusted beta is reduced to a third of the value of the total MSE of unadjusted betas.

## 5. Conclusion

In this paper, we presented evidence that the stationarity of beta-coefficients for Belgian common stocks is not as strong as previous studies have shown. Their forecast, however, can be generally improved using an adjustment method. We have shown that over our 12-year sample period the forecast error of adjusted betas is about 20% smaller than the forecast error of a simple no-change extrapolative beta forecast for individual securities. The forecast error can be further reduced if one uses portfolios of securities. With about 20 securities the forecast error of adjusted betas can be reduced to a third of the forecast error of unadjusted portfolio betas.

## Table 1

## Correlation Coefficients and Mean Square Errors for Securities

| Forecasting Method | Correlation Coefficient | Bias | Inefficiency | Random Error | Total MSE | [Total MSE]$^{\frac{1}{2}}$ |
|---|---|---|---|---|---|---|
| 2 periods | | | | | | |
| (12-66/11-72) and (12-72/11-78) | | | | | | |
| Classical | .16402* | .00159 | .22157 | .16111 | .38428 | .61990 |
| Bayes | .25169* | .00579 | .06840 | .16010 | .23429 | .48404 |
| 3 periods | | | | | | |
| (12-66/11-70) and (12-70/11-74) | | | | | | |
| Classical | .26259* | .00257 | .30614 | .14601 | .45471 | .67432 |
| Bayes | .34139* | .01127 | .10853 | .14440 | .26421 | .51401 |
| (12-66/11-70) and (12-74/11-78) | | | | | | |
| Classical | .07317 | .00663 | .34623 | .26857 | .61543 | .78449 |
| Bayes | .09318 | .00650 | .15491 | .26767 | .42908 | .65504 |
| (12-70/11-74) and (12-74/11-78) | | | | | | |
| Classical | .15788* | .00065 | .12433 | .26329 | .38828 | .62312 |
| Bayes | .23805* | .00000 | .01312 | .25942 | .27254 | .52205 |
| MLPFS | .15788* | .00363 | .00215 | .26329 | .26907 | .51872 |
| Blume | .15788* | .00119 | .00099 | .26329 | .26547 | .51523 |

* Asterisk indicates significant correlation at the 5% level.

## Table 2

### Correlation Coefficients and Mean Square Errors for Portfolio

(12-70/11-74) and (12-74/11-78)

| Portfolio Size | Forecasting Method | Correlation Coefficient | Bias | Inefficiency | Random Error | Total MSE | $\left[\text{Total MSE}\right]^{\frac{1}{2}}$ |
|---|---|---|---|---|---|---|---|
| 2 | Classical | .23223* | .00061 | .12470 | .11552 | .24083 | .49074 |
| | Bayes | .28982* | .00012 | .05291 | .11320 | .16623 | .40771 |
| | MLPFS | .24551* | .00120 | .00021 | .12301 | .12442 | .35273 |
| | Blume | .24551* | .00301 | .00562 | .12300 | .13163 | .36281 |
| 5 | Classical | .34462* | .00071 | .12771 | .04521 | .17363 | .41669 |
| | Bayes | .38741* | .00040 | .07862 | .04520 | .12422 | .35245 |
| | MLPFS | .33273* | .00110 | .00080 | .05951 | .05981 | .24456 |
| | Blume | .33273* | .00201 | .00510 | .05950 | .06661 | .25809 |
| 10 | Classical | .50920* | .00061 | .11570 | .01922 | .15553 | .39437 |
| | Bayes | .67041* | .00080 | .08321 | .01851 | .10252 | .32019 |
| | MLPFS | .46331* | .00110 | -.00070 | .03650 | .03690 | .19209 |
| | Blume | .46331* | .00171 | .00501 | .03651 | .04323 | .20792 |
| 21 | Classical | .81583* | .00062 | .11240 | .00681 | .11983 | .34615 |
| | Bayes | .81154* | .00070 | .08700 | .00691 | .09461 | .30759 |
| | MLPFS | .77402* | .00120 | -.00131 | .01250 | .01241 | .11136 |
| | Blume | .77402* | .00110 | .00331 | .01250 | .01691 | .13004 |

---

* Asterisk indicates significant correlation at the 5% level.

Footnotes

1. For Canadian stocks, see the work of Mantripradaga (1980).

2. See Sharpe (1963) and Fama (1973).

3. For details see Mincer and Zarnowitz (1969).

4. We should point out that our estimation periods do not exactly correspond to those used by Hawawini and Michel (1978, 1979) or Fabry and Van Grembergen (1978). The former report a correlation coefficient of .699 based on monthly returns for individual securities over a total estimation period starting in 1963 and ending in 1976. The total period was broken down into 2 subperiods of equal length (see their Table 1). The latter report a correlation coefficient of .402 based on monthly returns for individual securities over a total estimation period starting in 1964 and ending in 1975. This total period was broken down into 2 subperiods of equal length (see their Table 1).

## References

BLUME, M. E., 1971, On the assessment of risk, *Journal of Finance,* (March).

BLUME, M. E., 1975, Betas and their regression tendencies, *Journal of Finance,* (June).

EUBANK, A. A. and J. K. ZUMWALT, 1979, On analysis of the forecast error impact of alternative beta adjusting techniques and risk classes, *Journal of Finance,* (June).

FABRY, J. and W. Van GREMBERGEN, 1978, Further evidence on the stationarity of betas and errors in their estimates, *Journal of Banking and Finance,* (October).

FAMA, E. F., 1973, A note on the market model and the two-parameter model, *Journal of Finance,* (December).

HAWAWINI, G. A. and P. A. MICHEL, 1979, An assessment of risk in thinner markets: the Belgian case, *Journal of Economics and Business,* (Spring).

HAWAWINI, G. A. and P. A. MICHEL, 1978, Modèle du marché et évaluation du risque sur la Bourse de Bruxelles, *Analyse Financière,* (March).

KLEMKOSKY, R. C. and J. D. MARTIN, 1975, The adjustment of beta forecasts, *Journal of Finance,* (September).

MANTRIPRADAGA, K. G., 1980, Beta adjustment methods, *Journal of Business Research,* (September).

MINCER, J. and V. ZARNOWITZ, 1969, The evaluation of economic forecasts, Economic Forecasts and Expectations, by J. Mincer (ed.), Columbia University Press, New York.

SHARPE, W. F., 1963, A simplified model for portfolio analysis, *Managerial Science,* (January).

VASICEK, O. A., 1973, A note on using cross-sectional information in Bayesian estimation of security betas, *Journal of Finance,* (December).

# LIST OF INSEAD RESEARCH WORKING PAPERS

80/01 "Identifying cognitive style determinants of retail patronage, by Christian PINSON, Arun K. JAIN and Naresh K. MALHOTRA, January 1980.

80/02 "Dimensions culturelles des conceptions de management - une analyse comparative internationale", par André LAURENT Février 1980.

80/03 "Cognitive style and effective communication", by Arun K. JAIN, Naresh K. MALHOTRA and Christian PINSON, Dec. 1979.

80/04 "Accomodative cognitive style differences in consumer reduction of alternatives", by Naresh K. MALHOTRA, Christian PINSON and Arun K. JAIN, October 1979.

80/05 "Stability and reliability of Part-Worth utility in conjoint analysis : a longitudinal investigation", by Arun K. JAIN, Naresh K. MALHOTRA and Christian PINSON, September 1979.

80/06 "The expected future spot exchange rate, the forward rate, and the trade balance", by Charles A. WYPLOSZ, March 1980.

80/07 "Decline and adjustment: Public intervention strategies in the European clothing industries", by José de la TORRE, July 1980.

80/08 "The uncommon market: European policies towards a crisis industry - clothing in the 1970's", by José de la TORRE and Michel BACCHETTA, May 1980.

80/09 "Stratport: a decision support system for strategic planning", by Jean-Claude LARRECHE and V. SRINIVASAN, April 1980, Revised October 1980.

80/10 "A new approach to market segmentation strategy: a banking application", by Arun K. JAIN, Christian PINSON and Naresh K. MALHOTRA, March 1980.

80/11 "The exchange and interest rate term structure under risk aversion and rational expectations", by Charles A. WYPLOSZ, Revised Version, September 1980.

80/12 "Individual cognitive differences in MDS analysis of perceptions", by Arun K. JAIN, Naresh K. MALHOTRA and Christian PINSON, July 6-12, 1980.

80/13 "STRATPORT: A Model for the evaluation and formulation of Business Portfolio Strategies", by Jean-Claude LARRECHE and V. SRINIVASAN, April 1980, Revised November 1980.

80/14 "Les styles cognitifs : une nouvelle approche de la segmentation des marchés, by Christian PINSON, Naresh K. MALHOTRA and Arun K. JAIN, Septembre 1980.

80/15 "Cognitive styles: A new approach to market segmentation", by Christian PINSON, Naresh K. MALHOTRA and Arun K. JAIN, March 1980.

81/01 "Eurobanking, open market operations and the monetary base" by Herwig LANGOHR, August 1980.

81/02 "Alternative approaches to the theory of the banking firm: a note" by Herwig LANGOHR, September 1980.

81/03 "Why does beta shift when the length of securities returns varies?" by Gabriel HAWAWINI, December 1980.

81/04 "Forward market and the cooperative firm" by Gabriel HAWAWINI, January 1981.

81/05 "On some propositions regarding the behavior of the labor-managed firm under uncertainty" by Gabriel HAWAWINI, Jan. 1981.

81/06 "Impact of the investment horizon on the association between securities' risk and return: theory and tests" by Gabriel HAWAWINI and Ashok VORA, February 1981.