

# A New Index of Belgian Shares<sup>1</sup>

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July 1997

## Abstract

A factor analysis of returns of shares traded on the Brussels Stock Exchange reveals that the first dominant factor is highly correlated with the popular Bel-20 index and that a distinctive alternative trend is represented by the market's second factor. We propose a new stock index consisting of 22 Belgian industrial and commercial shares which are particularly sensitive to this second market factor. The resulting index offers opportunities for diversification of a portfolio consisting of Bel-20 shares and could form the basis of derivative products which would be particularly sensitive to Belgian industrial performance. A fundamental analysis shows that shares within the new index are less sensitive to BEF/\$ exchange rate and the price of oil than are Bel-20 shares.

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<sup>1</sup> We have benefited from the financial and technical support from the Brussels Stock Exchange. Responsibility for errors and all views expressed is our own.

## **1. Introduction: Does Brussels Need a New Stock Index?**

In this study we explore the possibility of defining a new stock index for the Brussels Stock Exchange. Since it was introduced in the early 1990's the Belgian 20-Index has become the widely quoted benchmark for the Brussels Stock Exchange much in the same way that the Dow Jones Industrial Average operates for the New York Stock Exchange. Furthermore, it has served as the pricing basis for a number of Belgian equity derivative products such as the futures and options traded on the BELFOX. In light of this success, one may wonder why it might be interesting to introduce a new Belgian index?

We believe that a number of factors suggest that the future demand for equity products in Belgium may be strong. Belgian finance has been traditionally oriented toward interest rate products; however, the long-term bull equity market internationally has finally started to lead some Belgian savers to explore investment alternatives to bank deposits and bond mutual funds. In particular, in recent years there has been a strong growth in mutual funds giving investors a guaranteed rate of return plus a return enhancement based on the performance of the BEL20 index. While not sold as such, these funds implicitly give the investor a mix of Belgian government bonds plus call options on the BEL20. It seems quite likely that hedging of these funds has been at least part of the reason for the strong volumes recorded in recent years on the Brussels Stock Exchange. Given the strong returns registered by the BEL20, investors in these products have improved on the returns they would have obtained in an all-interest rate portfolio. This experience should encourage a continuation of the migration of the Belgian investor into equity products.

While the stocks included in the BEL20 certainly account for a large fraction of the volume on the Brussels Stock Exchange, there are reasons to believe that they represent a narrow basis for building the complex of equity products. In particular, the BEL20 has become increasingly weighted in financial companies, and this trend is likely to continue in the future. Furthermore, given the holdings of the Société Générale de Belgique in BEL20 shares, the degree of concentration on a small number of shares is even greater than it first appears. Thus the BEL20 is not a broad representation of Belgian industrial activity as a whole. Furthermore, given that the BEL20 is not widely diversified, it is possible that a period poor performance of a handful of companies could serve to depress the whole complex of Belgian equity products.

In light of this we have considered whether it is possible to use an alternative group of Belgian shares to define a new stock index which would be markedly different from the BEL20. If so, this index could be used to define a new line of equity products and, in combination with the BEL20, would allow for a greater diversification for Belgian investors.

It is clear that in going beyond the BEL20 shares, volumes tend to drop off rather sharply. In order to permit index arbitrage and hedging of index linked products, it is important that the shares to be considered for the new index be at least somewhat liquid. As a consequence, we have confined our attention to

shares treated on the Brussels forward market. However, we have not restricted our attention only to shares that are currently quite liquid. The reason is that we must recognize that inclusion in an index is often one of the factors that tends to make a share liquid. It is reasonable to expect that liquidity of some shares would increase should they included in a new index which is launched successfully.

Given the composition of the BEL20, our expectation from the beginning of the study was that the alternative index would have to be distinctly more industrial in character. However, we decided not to confine our attention to companies on the basis of industrial classifications (e.g., “chemicals”, “energy”, and so on). Given the diversification of many firms and the complex nature of their commercial relations, it is not easy to summarize the character of the firm under any single rubric. Furthermore, it seemed to us entirely possible that some Belgian holding companies could provide exposure to segments of Belgian industry currently little represented in the BEL20.

As a consequence of these considerations, it was decided from the outset that we would employ a statistical analysis of returns and volumes to serve as the basis for identifying a group of firms to be included in a new Belgian index. It was recognized that this historical study of past behavior potentially could lead us to the list of firms to be included in a new index at the time of its launch. However, to be operational the new index would need to be constituted on the basis of *criteria* for including and excluding shares. In this way the composition of the index could be adjusted as Belgian industry and the Brussels Stock Exchange evolve. Our study stops short of providing the detailed criteria for a new index. Instead, we provide an analysis of the fundamental economic determinants of the Belgian shares. This allows us to identify more clearly the ways that shares proposed for inclusion differ from other shares.

The remainder of the paper is organized as follows. In the next section we describe our data and methodology. In section 3 we study the liquidity of Belgian shares. In section 4 we study the main determinants of the returns of Belgian shares using the method of Factor Analysis. Using these results, in section 5 we propose a new stock index and discuss the relation of the new index and the current BEL20 index. In section 6 we study explore which economic variables account for the different performance of the new index. In section 7 we conclude.

## **2. Methodology and Data**

We carry out three distinct statistical studies: (1) an analysis of share liquidity based on historical volumes, (2) a factor analysis of the determinants of Belgian share returns, and (3) a regression analysis of the economic determinants of Belgian share returns. The first two studies were carried out using *daily* data from January 1992 through December 1996 provided to us by the Brussels Stock Exchange. These include volumes and closing prices for shares traded on the

forward market and quoted initially on CATS and more recently on NTS.<sup>2</sup> These were augmented by dividend and split information obtained from CRESUS<sup>3</sup> in order to calculate returns. Since economic activity variables (e.g. industrial production) are reported monthly, the third study has been carried out using *monthly* data since 1991. Economic variables came from the IRES Data Bank.

Microstructure studies of financial markets have taught us that market liquidity is a multi-dimensional concept. Ideally, in characterizing the liquidity of Belgian shares we would like to measure the *tightness*, *depth*, and *resiliency* of their markets. Something of this sort was done by Anderson and Tychon (1993) in their study of the hourly CATS quotes for the largest Belgian companies over a period of one month. Unfortunately, at this stage a machine-readable data set of NTS quotes is not available from the Brussels Stock Exchange, so we have not been able to carry out an analysis of this sort in the current study. Instead, we have been restricted to the more traditional measure of trading volume. We calculate a number of volume-based indicators of share liquidity detailed in section 3.

Factor analysis is a technique increasingly used in the study of stock returns data since it allows the identification of multiple sources of risk instead of the single factor (“the market”) employed in the Capital Asset Pricing model. By postulating unobservable factors, the analyst is not constrained to find the determinant of returns on the basis of reported data thus avoiding problems of measurement error or infrequent observations. The technique proceeds by a decomposition of the variance/covariance matrix of stock returns in order to infer the sensitivities (“the beta”) of the shares to the various sources of risk. Given the betas plus observations of prices, it is possible to infer estimates of the underlying factors. In this way we create time series of factors that have determined the evolution of the Belgian stock market. We can then see the degree to which movements of a given share or stock index are explained by factor 1, factor 2 and so on. Given the experience of applications in other stock markets we expect to find that the BEL20 will be predominantly determined by the movements of factor 1 and much less so by movements of factor 2. Thus we expect to look among the shares that are most sensitive to factor 2 to find candidates for forming a new stock index. After having selected shares on the basis of this criterion we define a capitalization weighted index in much the same way that the BEL20 is calculated. This new index can then be compared with the BEL20 as well as factor 1 and factor 2 to see to what extent the new index has attained our objective of providing an indicator sharply differentiated from the BEL20 index and representative of secondary tendencies present in Belgian shares.

The advantage of factor analysis is that by design the factors represent rather divergent movements in the underlying data; thus, we have a relatively high probability of identifying movements not reflected in the BEL20. The disadvantage of factor analysis is that is often difficult to give a clear interpretation to the various factors. However, ultimately the Brussels Stock Market is interested in specifying objective criteria that are readily understandable

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<sup>2</sup> The New Trading System (NTS) superseded the Computer Aided Trading System (CATS) on the Brussels Stock Exchange in 1996.

<sup>3</sup> A Belgian provider of financial data.

when elaborating a new stock index. As an aid to reflection in this directions we have sought to identify the characteristics of firms that have been selected for inclusion in the new index as distinguished from those which have not. In particular, we have noted that the firms do not fall into neat groupings by sector. For example, the new index includes some chemical firms but not others. In order to understand why, we undertake a regression analysis of fundamental determinants of returns of Belgian shares. Following the example of other studies along these lines<sup>4</sup> we consider industrial production, the price of oil, the dollar and short and long interest rates. The outcome of this analysis is that shares in the new index tend to be less sensitive to the dollar and the price of oil than are BEL20 shares. This suggests that the index is capturing influences more closely linked to the domestic Belgian economy than is the BEL20 index.

### 3. Liquidity of Belgian Shares

A stock index which is used as a support for derivative markets is subject to hedging and speculative operations. Its mode of construction should enable such operations without leaving open any kind of arbitrage opportunities. Hence, the portfolio it represents should be easily replicable and composed of relatively liquid stocks. The object of this section is to analyze the liquidity properties of the Brussels forward market.

The measures for liquidity used can be put into two groups analyzing two different issues. On the hand, we computed different descriptive statistics on the daily value of the traded volume. As an absolute measure we simply used the average value of the traded volume over a given period. Moreover, in order to obtain a better insight on the distribution of this statistic as a proportion of the entire market its cumulative distribution over the same period has been calculated. On the other hand, price-elasticities with respect to traded volume have been estimated for every stock  $i$  by using the following regression:

$$\left| \ln(P_{i,t}/P_{i,t-1}) \right| = b_i * \left| \ln(V_{i,t}/V_{i,t-1}) \right|$$

where  $P_{i,t}$  is the observed price of stock  $i$  at date  $t$ ,  $V_{i,t}$  its traded volume at date  $t$ , while  $b_i$  and  $\ln$  correspond respectively to the price-elasticity of stock  $i$  and the natural logarithm. The bars refer to the absolute value operator.  $b_i$  captures the relative impact on prices of a relative change in the volumes. Hence, one can say that the smaller the  $b_i$  the more liquid the stock. Indeed, in this case you would have to buy relatively more stocks if you wanted to influence prices.

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<sup>4</sup> For example, CHEN Nai-Fu, ROLL Richard and ROSS Stephen A. (1986): "Economic Determinants of Stock Market Returns," *Journal of Business*, Vol.59, No.3, pp.383-403.

The results for the statistics on the value of traded volume for the period beginning 24<sup>th</sup> June 1996 and ending 30<sup>th</sup> December 1996<sup>5</sup> can be found in chart 1. Not surprisingly, 18 out of the first 20 stocks are members of the existing BEL20. Furthermore, they account for about 85% of the total market volume. This is indeed true by construction since one criteria for the membership is based on this statistic. Conversely, one could also argue that the fact of being a member may even deepen the gap in that it increases its liquidity. The two stocks which do not belong to the BEL20 are Barco and Powerfin and the missing members are CMB and Cockerill Sambre.

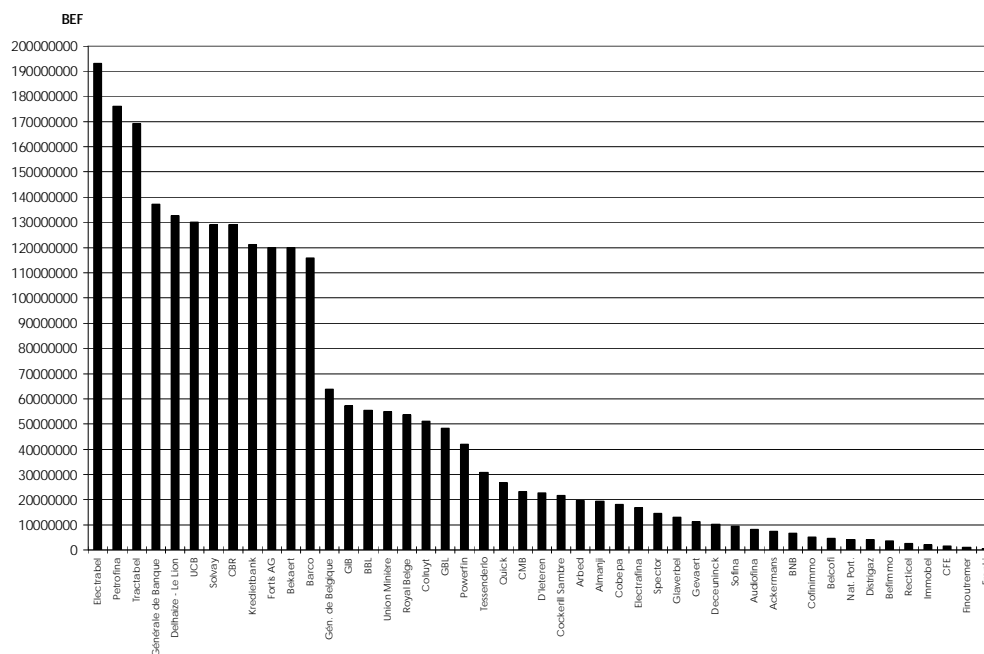


Chart 1: Value of traded volume 24<sup>th</sup> June 1996 to 30<sup>th</sup> December 1996

A somewhat different picture is given by the alternative measure. In the right column of table 1 the elasticities have been sorted in ascending order. Only 5 stocks from the BEL20 are among the 20 most liquid stocks according to this second measure. Interestingly, some of the stocks on the top of the list are found on the right tail of the distribution of the first measure. This may give some room for broadening the set of candidates for a new index. As a matter of fact, the inclusion of smaller volume stocks will not be too “harmful” if their weights in the index are not too important and their elasticities relatively small.

<sup>5</sup> This period corresponds to the one used for the factor analysis, as will be seen in the next section and coincides with the period for which the largest sample of stocks was available. 47 stocks are considered, excluding Dexia CC and Koramic which have been traded on the forward market only since November 1996. Note that if we included Dexia into the sample it would cover around 12% of the entire market, more than Electrabel!

Rank	Name of share	Elasticity	Rank	Name of share	Elasticity
1	Cofinimmo	0,001358	26	Tractebel	0,00774718
2	Befimmo	0,001966	27	Quick	0,007975197
3	BNB	0,003322	28	Barco	0,00828275
4	Nat. Port.	0,003485	29	Glaverbel	0,008323628
5	Ackermans	0,003925	30	Fortis AG	0,00890488
6	Immobel	0,004354	31	Gén. de Belgique	0,008971828
7	Spector	0,004442	32	Gevaert	0,009126004
8	Finoutremer	0,004786	33	Union Minière	0,009163981
9	Almanji	0,0048	34	Cobepa	0,009532297
10	BBL	0,005476	35	GBL	0,009693599
11	Sofina	0,005597	36	Solvay	0,009862997
12	CFE	0,005828	37	Franki	0,010031365
13	Tessengerlo	0,005871	38	Royal Belge	0,010354261
14	CBR	0,006018	39	UCB	0,011929571
15	Belcofi	0,006124	40	GIB	0,014655143
16	Electrabel	0,006162	41	D'leteren	0,014675975
17	Powerfin	0,006591	42	Deceuninck	0,01518319
18	Kredietbank	0,006775	43	Petrofina	0,016599978
19	Electrafina	0,007046	44	Bekaert	0,016775139
20	Colruyt	0,00706	45	Delhaize - Le Lion	0,017135876
21	Audiofina	0,007334	46	Cockerill Sambre	0,020160784
22	Arbed	0,007389	47	Distrigaz	0,035370392
23	CMB	0,007545	48	Dexia - CC	0,057418059
24	Recticel	0,007597	49	Koramic	0,197693762
25	Générale de Banque	0,007695			

Table 1: Price-elasticities in ascending order

#### 4. Factor Analysis of Belgian Shares

In this section we present the results obtained from a factor analysis of returns on Belgian shares. This technique is widely used in applications of the Arbitrage Pricing Theory (APT) which accounts for stock returns on the basis of sensitivities to a limited number of sources of systematic risk<sup>6</sup>.

Precisely, the procedures of factor analysis try to separate out that portion of the variance that is unique to the explained variable from the remaining variance. In other words, they try to account for the correlation matrix, ignoring the diagonal entries, or just letting them ride along. As a result, under the factor model each dependent variable, in our case the stock returns, will be represented as a *linear function* of an ideally small number of unobservable common factors and a factor which is specific to each dependent variable. Hence from such a method one can obtain a parsimonious representation of what underlies the evolution of stock returns. The respective sensitivities of the dependent variables to the factors are called factor loadings.

<sup>6</sup> See for instance ROLL Richard and ROSS Stephen A. (1980): "An Empirical Investigation of the Arbitrage Pricing Theory", *The Journal of Finance*, December, Vol. XXXV, pp.1073-1103.

Factor analysis is particularly well suited to our case, i.e., to explain the correlations between stock returns. The results of previous research in the same line have generally shown that the first factor, defined as the one explaining most of the common variance or, equivalently, the one associated with the highest eigenvalue of the correlation matrix, is the one capturing the trend of the market as a whole. Once this factor has been isolated, one can determine the second most important factor.

We will pursue the same type of analysis here: if we are able to find two factors explaining the correlation structure of the stock returns, we can separate stocks into different groups according to their sensitivities, i.e., their factor loadings. These results can be used to set up a list of candidates for a new index having a different behavior. Furthermore, once we have established the time series of the factors a portfolio can be created which replicates the factors accordingly as will be seen in Section 5.

To include as many stocks as possible into the analysis, namely 47, we used daily data from the forward market of the Brussels Stock Exchange beginning 24<sup>th</sup> June 1996 and ending 30<sup>th</sup> December 1996<sup>7</sup>. This corresponds to 131 days of observations. Stock returns are defined as the differences of the natural logarithms of daily prices (continuous compounding). Nevertheless, it should be noted that this method is static and that it should be interpreted mainly qualitatively rather than quantitatively<sup>8</sup>.

The correlation matrix of the stock returns has been computed as the input for the SAS factor analysis procedure. To achieve efficiency, maximum likelihood estimation with two factors have been used. The first factor seems to capture most of the market's variance since its eigenvalue is 12.8, and the second factor's eigenvalue drops drastically to 2.8 (the third to 1.7). The portion of the total variance is explained by the model's ratio of the sum of squares of the two first eigenvalues to the total sum of squares of the eigenvalues. In our case two factors explain 89.99% of total return variation. The values of the factor loadings can be observed in the tables 2 and 3 where they have been sorted in descending order respectively. Adding a third factor to the model would add only 1.5% of the total variance explained. Thus it is clear that the second factor is the most likely source of secondary trends in returns on the Brussels Stock Exchange.

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<sup>7</sup> Note that Dexia CC and Koramic have been excluded from the data base, because of insufficient numbers of observations.

<sup>8</sup> Good references for the interested reader are CLIFF Norman, *Analyzing Multivariate Data*, Harcourt Brace Javanovich, 1987, chapter 15, as well as MORRISON Donald F., *Multivariate Statistical Methods*, McGraw-Hill, Third Edition, 1990, chapter 9.



Rank	Name of Share	Factor 1	Factor 2 Sector
1	Fortis AG	0,7362	-0,0260 Insurance Div.
2	Gén. de Belgique	0,6306	-0,0894 Investment Comp.
3	Union Minière	0,6259	-0,3016 Metals & Mining
4	Delhaize - Le Lion	0,6164	-0,3144 Retail Stores
5	BBL	0,6103	-0,2483 Bank
6	Tessenderlo	0,6094	0,4102 Chemical Div.
7	CMB	0,5843	-0,1272 Maritime
8	Solvay	0,5734	-0,1667 Chemical Div.
9	UCB	0,5707	0,0756 Chemical Div.
10	Petrofina	0,5472	-0,0704 Petroleum Integra.
11	Electrabel	0,5449	-0,2743 Electric Utility
12	GIB	0,5412	0,1008 Retail Stores
13	Générale de Banque	0,5347	-0,2204 Bank
14	Colruyt	0,5276	-0,1551 Retail Stores
15	Kredietbank	0,5205	-0,2164 Bank
16	Powerfin	0,4872	0,1512 Electric Utility
17	Gevaert	0,4730	0,1873 Chemical Div.
18	Barco	0,4609	0,2307 Electronics
19	Royal Belge	0,4607	0,0970 Insurance Div.
20	GBL	0,4586	-0,1109 Holding
21	Cockerill Sambre	0,4373	-0,2661 Steel General
22	D'leteren	0,4008	0,4175 Auto & Truck
23	Sofina	0,3924	0,2883 Holding
24	CBR	0,3893	0,3308 Cement & Agg.
25	Deceuninck	0,3732	0,2853 Chemical Special
26	Recticel	0,3555	0,2207 Chemical Div.
27	Belcofi	0,3039	0,0092 Financial Services
28	Arbed	0,3014	-0,0839 Steel General
29	Ackermans	0,2975	0,2912 Holding
30	Tractebel	0,2932	-0,0009 Holding
31	Almanji	0,2904	0,1889 Holding
32	Glaverbel	0,2812	0,1348 Glass
33	Spector	0,2792	0,2376 Chemical Divers.
34	Quick	0,2593	0,2317 Restaurant
35	Bekaert	0,2363	-0,1622 Metal Fabrication
36	Electrafina	0,2325	0,2766 Holding
37	CFE	0,2292	0,2274 Building
38	BNB	0,2272	0,1505 Bank
39	Finoutremer	0,2105	0,0304 Holding
40	Cobepa	0,2054	-0,0320 Holding
41	Franki	0,1982	-0,1284 Building
42	Immobel	0,1783	0,0239 Real Estate
43	Cofinimmo	0,1751	0,0329 Real Estate
44	Distrigaz	0,1401	0,0547 Natural Gas Distr.
45	Nat. Port.	0,1138	0,1508 Holding
46	Audiofina	0,0563	0,0298 Investment Comp.
47	Befimmo	0,0084	0,2061 Investment Comp.

Table 2: Factor 1 loadings in descending order

Rank	Name of Share	Factor 1	Factor 2 Sector
1	D'leteren	0,40075	0,41751 Auto & Truck
2	Tessengerlo	0,60943	0,41022 Chemical Div.
3	CBR	0,38928	0,33080 Cement & Agg.
4	Ackermans	0,29746	0,29124 Holding
5	Sofina	0,39239	0,28831 Holding
6	Deceuninck	0,37317	0,28526 Chemical Special
7	Electrafina	0,23249	0,27656 Holding
8	Spector	0,27915	0,23757 Chemical Div.
9	Quick	0,25931	0,23173 Restaurant
10	Barco	0,46092	0,23067 Electronics
11	CFE	0,22921	0,22740 Building
12	Recticel	0,35547	0,22066 Chemical Div.
13	Befimmo	0,00839	0,20611 Investment Comp.
14	Almanji	0,29042	0,18885 Holding
15	Gevaert	0,47304	0,18726 Chemical Div.
16	Powerfin	0,48722	0,15118 Electric Utility
17	Nat. Port.	0,11377	0,15080 Holding
18	BNB	0,22718	0,15046 Bank
19	Glaverbel	0,28121	0,13482 Glass
20	GIB	0,54123	0,10078 Retail Stores
21	Royal Belge	0,46066	0,09701 Insurance Div.
22	UCB	0,57065	0,07564 Chemical Div.
23	Distrigaz	0,14010	0,05471 Natural Gas Distr.
24	Cofinimmo	0,17506	0,03288 Real Estate
25	Finoutremer	0,21053	0,03042 Holding
26	Audiofina	0,05630	0,02977 Investment Comp.
27	Immobel	0,17828	0,02392 Real Estate
28	Belcofi	0,30391	0,00915 Financial Services
29	Tractebel	0,29324	-0,00093 Holding
30	Fortis AG	0,73619	-0,02602 Insurance Div.
31	Cobepa	0,20541	-0,03201 Holding
32	Petrofina	0,54722	-0,07036 Petroleum Integra.
33	Arbed	0,30138	-0,08388 Steel General
34	Gén. de Belgique	0,63057	-0,08936 Investment Comp.
35	GBL	0,45861	-0,11094 Holding
36	CMB	0,58427	-0,12723 Maritime
37	Franki	0,19820	-0,12840 Building
38	Colruyt	0,52755	-0,15512 Retail Stores
39	Bekaert	0,23633	-0,16217 Metal Fabrication
40	Solvay	0,57342	-0,16667 Chemical Div.
41	Kredietbank	0,52051	-0,21643 Bank
42	Générale de Banque	0,53471	-0,22044 Bank
43	BBL	0,61028	-0,24825 Bank
44	Cockerill Sambre	0,43728	-0,26605 Steel General
45	Electrabel	0,54489	-0,27428 Electric Utility
46	Union Minière	0,62587	-0,30157 Metals & Mining
47	Delhaize - Le Lion	0,61642	-0,31442 Retail Stores

Table 3: Factor 2 loadings in descending order

Once the number of factors are determined (two in our case), we can reconstruct their evolution. Indeed, the factors can be computed by using the factor loadings. More specifically, an approximation of the daily growth rate of the underlying factors can be obtained by regressing the factor loadings on the stock returns cross-sectionally for every day of observation. More formally, for every date  $t$  one estimate the following regression across all the stocks  $i=1,2,\dots,47$

$$\begin{aligned} \ln(P_{i,t}/P_{i,t-1}) &= \alpha + \lambda_{i,1} * \beta_{1,t} + \lambda_{i,2} * \beta_{2,t} \\ &= \alpha + \lambda_{i,1} * \ln(f_{1,t}/f_{1,t-1}) + \lambda_{i,2} * \ln(f_{2,t}/f_{2,t-1}) \end{aligned}$$

where again  $P_{i,t}$  is the observed price of stock  $i$  at date  $t$ ,  $\lambda_{i,j}$  the factor loading  $j$  associated with stock  $i$  obtained through the factor analysis,  $f_{j,t}$  corresponds to factor  $j$  at date  $t$  and  $\ln$  to the natural logarithm. By using the exponential transformation of the estimated slopes  $\beta_{j,t}$  two scaled indexes can easily be computed. Chart 2 shows the obtained evolutions.

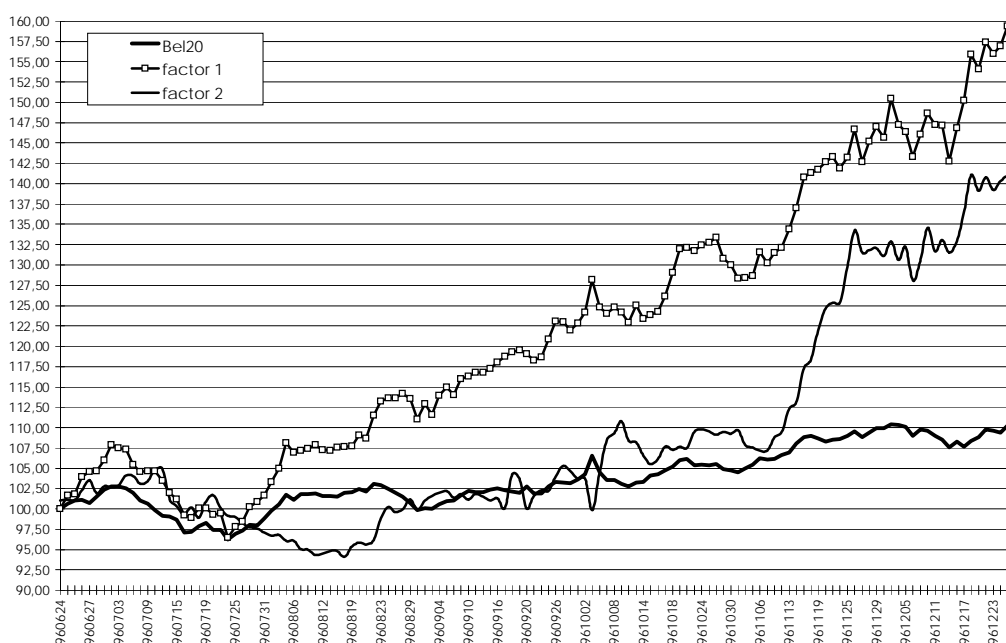


Chart 2: Evolutions of the estimated factors and the BEL20

One result becomes clear as soon as one analyses the factor loadings. If the loadings of factor 1 are sorted in descending order (Table 2) one can observe that 16 out of the first 20 stocks are members of the existing BEL20<sup>9</sup>. This coincides with the point noted above that the first factor often captures what is generally considered as the market movements. On the other hand, after sorting the loadings of factor 2 only two stocks from the BEL20 remain among the first 20, namely CBR and GIB. Nevertheless, four stocks with high factor 2 loadings

<sup>9</sup> The remaining four are Cockerill Sambre (21), CBR (24), Tractebel (30) and Bekaert (35).

also have high factor 1 loadings, namely Tessengerlo, Barco, Gevaert and Powerfin.

The correlations of returns between factor 1, factor 2 and the BEL20 are shown in table 4. The results confirm the fact that the first factor captures some trend close to the “market trend”: correlation with the BEL20 is 0.73, while the correlation with the second factor only amounts to 0.32. In addition, we see that the correlation between the BEL20 and the second factor is -0.138. Consequently, we should expect that an index oriented toward factor 2 will likely have a rather different behavior than the BEL20.

	<b>Factor 1</b>	<b>Factor 2</b>	<b>BEL20</b>
<b>Factor 1</b>	1.00000	0.32040	0.73805
<b>Factor 2</b>	0.32040	1.00000	-0.13808
<b>BEL20</b>	0.73805	-0.13808	1.00000

Table 4: Correlations of estimated factor returns and the BEL20

## 5. A New Stock Index

In this section we consider the characteristics of a new stock index chosen to include shares that are particularly sensitive to factor 2 identified in the previous section. Once we have selected the shares, the new index will be defined giving shares weights in proportion to the market valuations.

Inspecting table 3 which list shares in order of their sensitivity to factor 2, we see that the sensitivity of goes from 0.41 for share 1 (D’Ieteren) to 0.075 for share 22 (UCB). Beyond share 22 the sensitivities drop off sharply and the next shares in order are all low-volume shares. Therefore, we have focused on shares 1 through 22 on this list as members of the proposed new index.

In addition we have focused on somewhat narrower indices. First we note that the factor 2 sensitivity of share 19 (Glaverbel) is almost twice that of share 22. Thus we have examined an index based on shares 1 through 19 because the two indices are likely to be approximately equally sensitive to factor 2. Second, we note that by further restricting our focus to shares 1-15 we increase significantly the sensitivity to factor 2 and eliminate two problematic shares as well.<sup>10</sup> Thus we have focused our attention on our candidate index (BELIND22) as well as the two reduced indices (BELIND19 and BELIND15).

It should be noted that in constructing value weighted indices of firms sensitive to factor 2 we have included some firms that are also quite sensitive to factor 1 and therefore in all probability to the BEL20. As a consequence, the new indices will likely still follow the dominant market trends reflected in the BEL20. In the chart 3 one can see that the new index captures the overall bull market from June 1996 to December 1996 to much the same extent as the BEL20. However,

<sup>10</sup> The problematic shares are BNB which represents something of an anomaly of a central bank quoted on an exchange and National Portfolio which is a low volume share.

there are some notable differences in the behaviors of these indices. For example, the sharp rise of the BEL20 at the end of July followed by its subsequent fall in late August was not followed by BELIND22 and even less so by the narrower indices. The same is true of the sharp spike in the BEL20 in October.

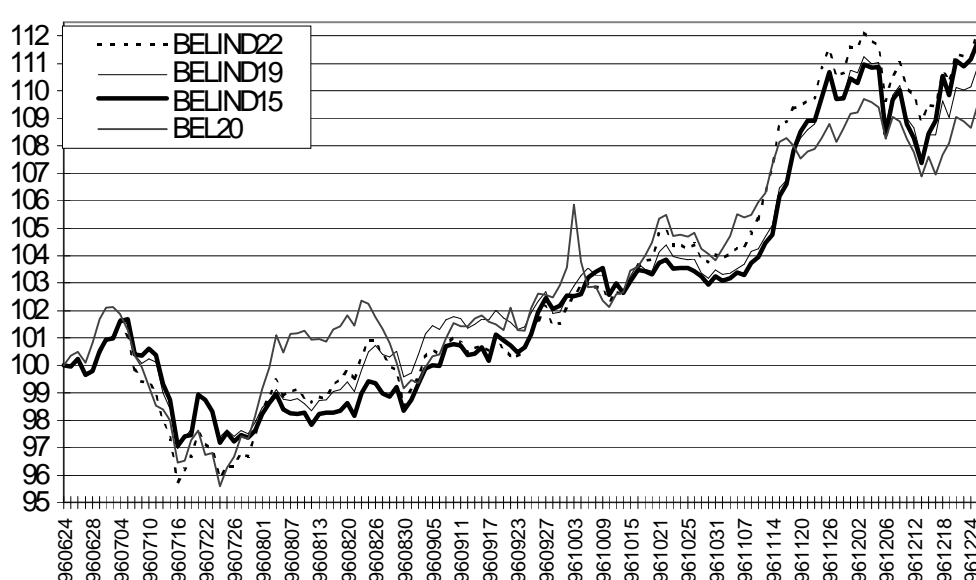


Chart 3: Comparisons of the computed indices

These patterns are reflected in the fact that the indices BELIND22, BELIND19 and BELIND15 are all mutually highly correlated as can be seen in table 5. Furthermore, the correlation between these indices and the BEL20 vary from 0.70 for the BELIND22 to only 0.53 for the BELIND15. Thus adding the stocks in one of these new indices to an initial BEL20-based portfolio would yield significant diversification gains.

	<b>BELIND22</b>	<b>BELIND19</b>	<b>BELIND15</b>	<b>BEL20</b>
<b>BELIND22</b>	1.00000	0.94112	0.89343	0.70117
<b>BELIND19</b>	0.94112	1.00000	0.95417	0.58299
<b>BELIND15</b>	0.89343	0.95417	1.00000	0.53451
<b>BEL20</b>	0.70117	0.58299	0.53451	1.00000

Table 5: Correlations of the indices

The new index allows for the elaboration of more sophisticated trading strategies in order to attained specific investment objectives. In particular, it is possible to combine the new index with the BEL20 index so as to capture what we have identified as factor 2. In particular we employ the reduced index BELIND15, weighting the two portfolios according to

$$Port(A)=A * BELIND15 + (1-A) * BEL20.$$

For example, setting A=0.5 equally weights the new portfolio and the BEL20. If we set A=2, it would imply going long 2 units of the new portfolio and going

short one unit of the BEL20. The resulting portfolio, Port(2), has a correlation of 0.84 with factor 2 (see table 6). In essence we have come close to replicating this factor that we have identified as representing the major secondary trend on the Belgian stock market (Chart 4).

A	Factor 1	Factor 2
-0.8	0.53387	-0.48655
-0.6	0.57819	-0.43040
-0.4	0.62830	-0.35724
-0.2	0.68255	-0.26159
0.2	0.77932	0.01508
0.4	0.79805	0.19033
0.6	0.78087	0.36779
0.8	0.72845	0.52310
1.2	0.57347	0.72370
1.4	0.49732	0.77692
1.6	0.43013	0.81036
1.8	0.37267	0.83098
2.0	0.32412	0.84347

Table 6: Correlations of the portfolios with the factors

To summarize, we have identified a new stock index of 22 Belgian shares which differs significantly from the BEL20. This new index can be closely approximated with using alternatively 19 or 15 shares. When added to a portfolio tied to the BEL20, the new index adds significant diversification benefits to the portfolio. Furthermore, when combined with short sales of the BEL20 it replicates well the major secondary trends in the Belgian market identified in Section 4. We now turn to the issue of the economic determinants of Belgian share returns which may suggest criteria for the implementation of this new index.

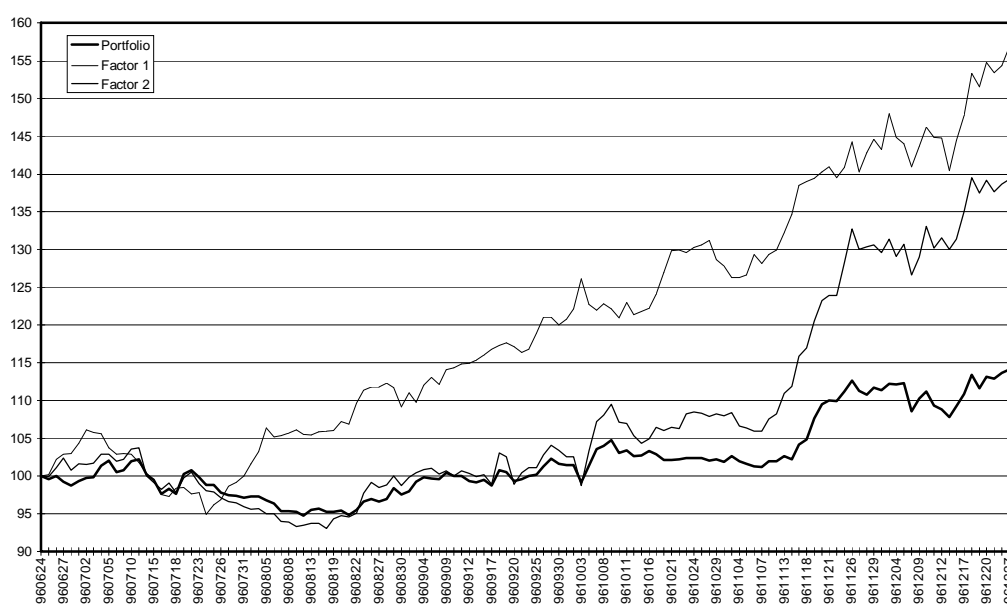


Chart 4: Evolutions of the estimated factor and simulated portfolio for A=2

## 6. Economic Characteristics of the BEL20 and the New Index

In what preceded this section we found via the statistical technique of factor analysis that the correlation structure of daily returns of Belgian shares was explained to a great extent by what is generally considered as the “market movements”. We then isolated the second most important factor and sorted the stocks according to their sensitivities to those factors. This enabled us to construct a couple of candidate indices with different behavior than the existing BEL20. Furthermore, using regression techniques the evolution of the factors over the tested period has been retraced and their correlations calculated. Nevertheless, so far nothing has been said about the fundamental variables underlying those factors.

In this section we attempt to isolate the economic characteristics of the BEL20 and the potential new index. This can be done by pooling stocks into different groups and regressing several industrial and financial indicators on those categories. The ideally significant differences on the coefficients may then give some insights on the factors underlying those groups of stocks. This is precisely the procedure used in the so called analysis of covariance.

In our analysis, two groups of stocks have been constructed. The first group consists of the 22 stocks which are most sensitive to factor 2 which we have included in the index proposed in previous section. The second covers the remaining 25 shares including most of those in the BEL20. The explained variable is the *monthly* difference of the natural logarithm of the stock prices. As explanatory variables the following candidates are used:

- log-variation of Belgian monthly corrected<sup>11</sup> industrial production as presented by the *Institut national de statistique* (dlprod)
- monthly log-variation of the prices for North Sea Brent (dlpet)
- monthly log-variation in the BEF/US dollar exchange rate (dldeb)
- monthly variation of the 3-month Euro-BEF (dct)
- monthly variation of the 10-year government bonds or *OLO* - yields (dlt)

Different regressions have been computed with monthly data beginning January 1992 and ending December 1996. The corresponding results are summarized in table 7. For simplicity we have not reported the coefficients of the variable *svm* associated with each stock in the equations which are aimed to capturing their specific variance.

These results show that in most cases the explanatory variables are significant for both the group of 22 firms included in the index and those which were not. However, we note that the levels of sensitivity to the explanatory variables differs from one group to the other. These differences are as follows:

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<sup>11</sup> Corrected with respect to opening days.

- The shares in our proposed index are less sensitive to variations in the price of oil than are BEL20 shares and other shares excluded from the new index.
- Similarly, the new index shares are relatively less sensitive to variations in the BEF/ US dollar exchange rate.
- The new index shares are relatively more sensitive to short-term interest rates.

Parameter	Group	Estimate	T for HO		Std Error of Estimate
			Parameter=0	Pr >  T	
DLPROD(G)	1	-0.030951960	-2.75	0.0059	0.01123721
	2	-0.042467730	-4.48	0.0001	0.00948231
DLPET(G)	1	0.001691814	0.05	0.9607	0.03430593
	2	0.083854258	2.87	0.0041	0.02918307
DLDB(G)	1	0.624917139	8.14	0.0001	0.07678369
	2	0.712237936	11.22	0.0001	0.06346577
DCT(G)	1	-0.636133969	-1.42	0.1558	0.44800873
	2	0.039635832	0.11	0.9116	0.35699355
DLT(G)	1	-2.727743018	-2.97	0.0030	0.91817755
	2	-2.343271257	-3.07	0.0021	0.76248852

Table 7: Estimated slopes of the general model

To reflect further on the differences between the BEL20 and our new index it is interesting to compare two shares within the same nominal sector when one is in the new index and other is in the BEL20 only. This is the case for the chemical firms Solvay (Chart 5) which is included in the BEL20 and not in the new index and Deceuninck (Chart 6) which is included in the new index but not in the BEL20. A comparison of their price charts shows very different patterns. In particular, Deceuninck made a big advance in late November 1996 and only a moderate advance in January 1997. In contrast, Solvay was relatively stable until January 1997 at which point it made a major advance. We note that this latter move corresponded very close to the major move in the dollar which went from DEM 1.54 to DEM 1.70 in the first two months of 1997<sup>12</sup>. In our view, this illustrates the fact that Solvay is a highly international firm whose sales and profits are largely in dollars.

Similarly, we have compared Générale de Belgique (Chart 7) and Ackermans (Chart 8) to holding companies. The former is in the BEL20 but not in the new index; whereas the opposite is true for Ackermans. Their charts clearly show the significant differences in price behavior of these two shares. We conjecture that the move of Ackermans in November 1996 which was not reflected in Générale de Belgique captures developments in industrial sectors not reflected in the BEL20.

<sup>12</sup>Or accordingly from 31.82 to 34.15 Belgian Francs.



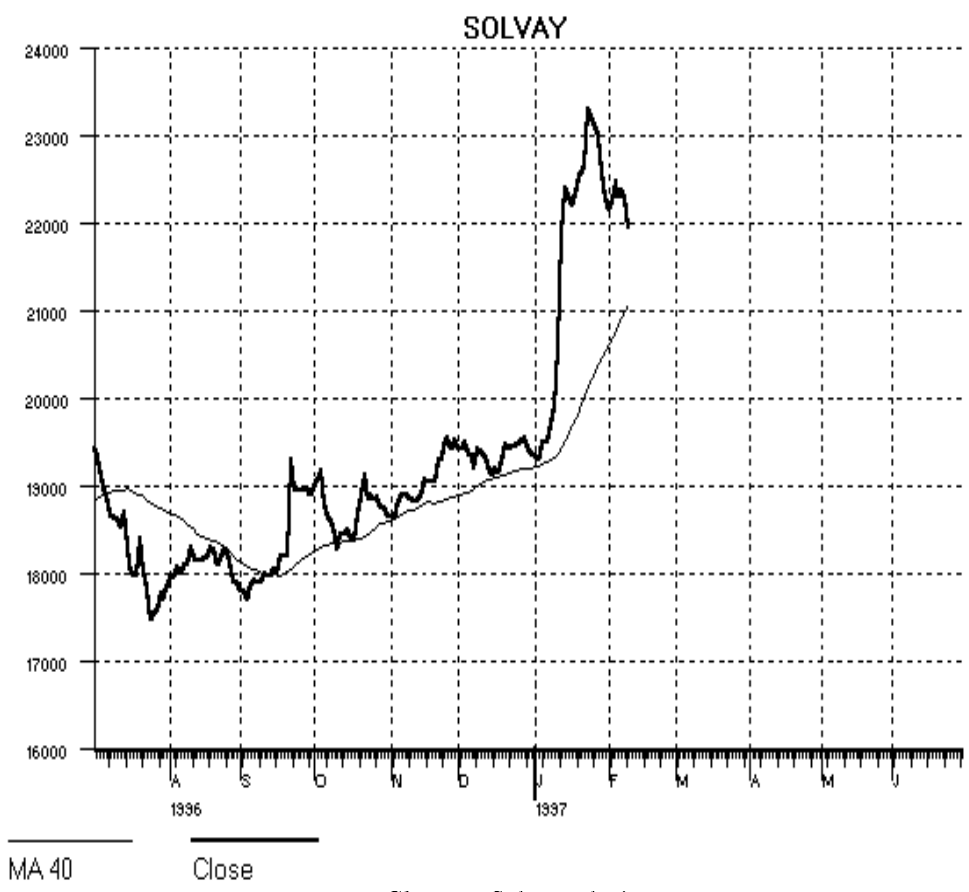


Chart 5: Solvay (closing)

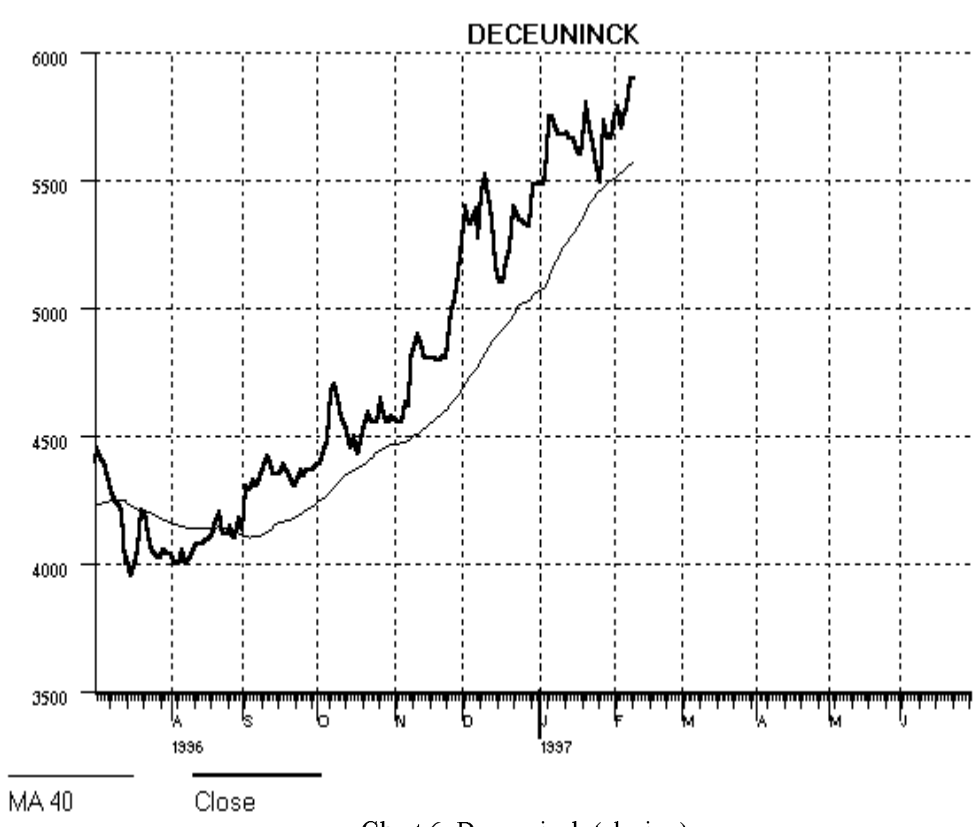


Chart 6: Deceuninck (closing)

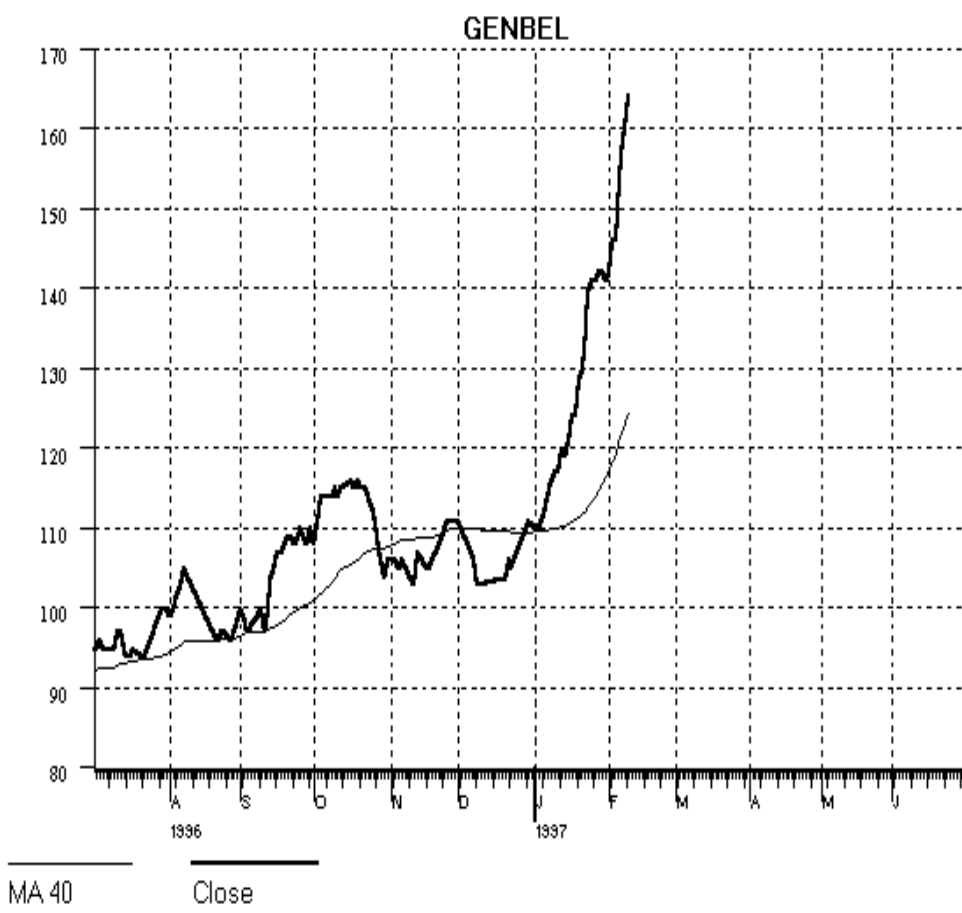


Chart 7: Générale de Belgique (closing)

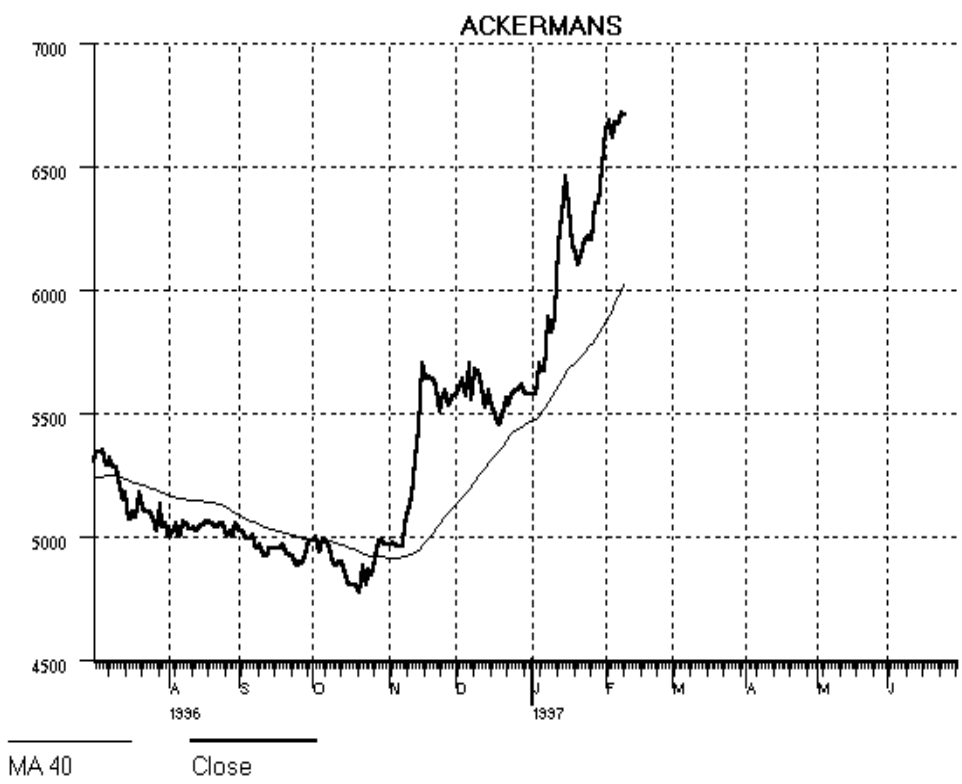


Chart 8: Ackermans (closing)

## 7. Conclusions

We have carried out statistical studies of the prices and volumes of shares traded on the forward market of the Brussels Stock Exchange with the objective of defining a new stock index which offers significant differences from the popular BEL20 index. Our major conclusion are:

- A factor analysis of Belgian returns finds that the most important trend in the market is closely associated with the BEL20 index. The second most important trend in the market departs significantly from the BEL20.
- A new index of 22 Belgian shares is proposed on the basis of sensitivity to the secondary market factor. Most banks heavily represented in the BEL20 are absent from this index. The new index is heavily weighted toward industrial shares.
- The new index of 22 Belgian shares would represent a significant opportunity for diversifying away from the BEL20 index.
- The new index in conjunction with short sales of the BEL20 comes close to replicating the secondary factor found in the Belgian market.
- The main characteristic distinguishing the new index from the BEL20 is that its shares are relatively less dependent on the Belgian franc/ US dollar exchange rate. The second characteristic is that its shares are less sensitive to the price of oil.

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