

STRATEGIC DECISION-MAKING USING THE BLACK-LITTERMAN MODEL ON THE SLOVAK STOCK MARKET

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Black-Litterman model

B-L model as combination of expected returns and subjective views of investor represent the following formula:

$$\mathbf{r}_{BL} = [(\tau\mathbf{C})^{-1} + \mathbf{P}^T\mathbf{\Omega}^{-1}\mathbf{P}]^{-1} \cdot [(\tau\mathbf{C})^{-1}\boldsymbol{\pi} + \mathbf{P}^T\mathbf{\Omega}^{-1}\mathbf{q}]$$

where

- \mathbf{r}_{BL} – new combined vector of expected returns ($n \times 1$),
- τ – calibrated or given parameter (scalar) determining the reliability of the estimate,
- \mathbf{C} – variance - covariance matrix containing variances of and covariances between all the assets handled by the model ($n \times n$),
- \mathbf{P} – matrix representing a part of the views with „ k “ views and „ n “ assets ($k \times n$)
Each row in the matrix contains the weights of assets of one view. The maximum number of rows, i.e. the maximum number of views is the number of assets in the portfolio,
- $\mathbf{\Omega}$ – diagonal matrix ($k \times k$) with the squared level of confidence assigned to view i , that represent the uncertainty of investment,
- $\boldsymbol{\pi}$ - the column vector ($n \times 1$) of equilibrium expected excess returns,
- \mathbf{q} – vector of estimated expected returns of investor ($k \times 1$).

Application of Black-Litterman model

The composition of the stock index SAX is as follows:

1. Biotika, a.s. – on the Czech and Slovak market, the corporation Biotika produces quality medicines for human and veterinary application and also feed additives for livestock,
2. OTP Bank Slovakia, a.s. - is a universal bank with total foreign exchange license. From 4.4.2002, the majority owner of OTP Bank Slovakia, a.s. is the largest Hungarian bank - OTP Bank Rt,
3. SES Tlmače, a.s. - supplier of boilers for power and heating plants and incinerators,
4. Slovnaft, a.s. - refinery and petrochemical company, which in addition to production, storage, distribution and wholesaling of petroleum products has the largest retail network in Slovakia that is aimed at selling motor fuels and lubricants and for providing a wide range of services for motorists,
5. VUB, a.s. - a universal bank with total foreign exchange license with more than 1.2 million customers and approximately 20% market share, currently the second largest bank in Slovakia.

Slovak Share Index (SAX) in the years 2005 - 2009



Characteristics of assets of SAX (5 years)

	Biotika	OTB banka	SES Tlmače	Slovnaft	VÚB
Average	11.15	13.10	22.07	109.83	112.84
MIN	6.64	6.30	7.63	60.00	62.21
MAX	14.94	21.91	49.79	141.24	141.74

Other input parameters necessary to calculate the B-L model

- Weights of the market share of companies (market capitalization vector w_{mkt}):

$$w_{mkt} = \begin{pmatrix} 3.56 \\ 24.39 \\ 10.39 \\ 28.77 \\ 27.47 \end{pmatrix}$$

- Variance-covariance matrix (**C**)

$$C = \begin{bmatrix} 0.010414357 & -0.001629825 & 0.001616839 & 0.001426225 & -0.000158552 \\ -0.001629825 & 0.023745154 & 0.006663913 & 0.003673279 & 0.003566998 \\ 0.001616839 & 0.006663913 & 0.017364862 & 0.004308502 & 0.002131215 \\ 0.001426225 & 0.003673279 & 0.004308502 & 0.00974341 & 0.00566651 \\ -0.000158552 & 0.003566998 & 0.002131215 & 0.00566651 & 0.008792607 \end{bmatrix}$$

Other input parameters necessary to calculate the B-L model

- *Vector of equilibrium expected returns (π), which was calculated on the basis of reverse optimization:*

$$\pi = \begin{bmatrix} 0.00044 \\ 0.00726 \\ 0.00455 \\ 0.00193 \\ 0.00440 \end{bmatrix}$$

The following investor views were respected in calculating:

1. view: Biotika, a.s. is going to achieve price of stock 10:35 ie. increase of 15% in the next period (one year) (reliability of view 75%) - absolute view,

2. view: VÚB, a.s. will receive about 8% higher increase in the price of stock compared to price of stock of OTB Bank, a.s. and SES Tlmače, a.s. in the next period (one year) (reliability of estimation 80%) - relative view,

3. view: The price of stock of Slovnaft, a.s. will increase of 20% in the next period (one year) (50% reliability of view) - absolute view.

The following investor views were respected in calculating:

- The before mentioned objectives are represented by matrix **P**, where they are respected three views on a package of five assets:

$$\mathbf{P} = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 \\ 0 & -0.64 & -0.36 & 0 & 1 \\ 0 & 0 & 0 & 1 & 0 \end{bmatrix}$$

- Another component is column vector of views (**q**):

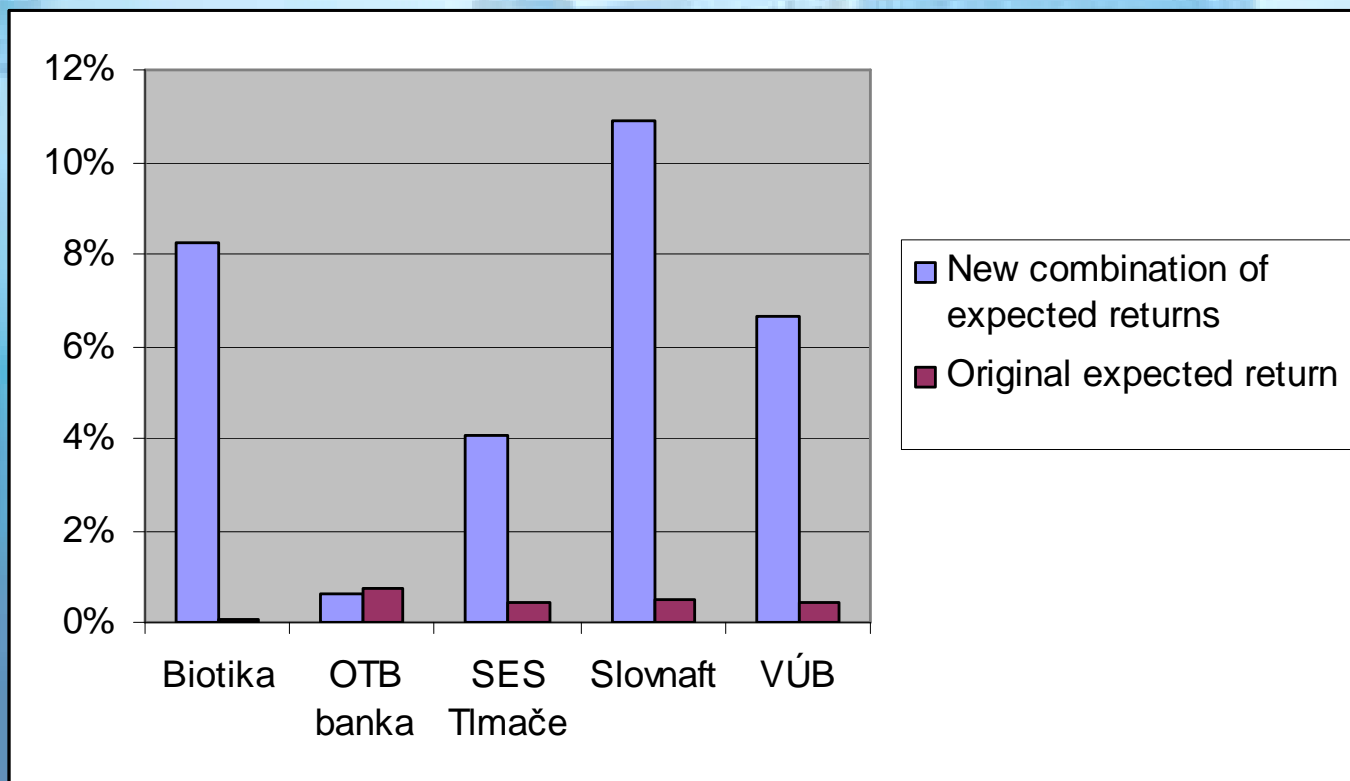
$$\mathbf{q} = \begin{pmatrix} 0.15 \\ 0.08 \\ 0.2 \end{pmatrix}$$

Results of application of Black-Litterman model

Expected returns were calculated are:

$$\pi_{new} = \begin{pmatrix} 0.07899 \\ 0.00195 \\ 0.02317 \\ 0.10971 \\ 0.05133 \end{pmatrix}$$

Original expected returns and the new combination of expected returns



Conclusion

- We presented the possibility of using Black-Litterman model to express the subjective view of the individual investor. The result is a compilation of new combinations of vectors of expected returns. As the data base, Slovak Share Index (SAX) was chosen.
- Application of Black-Litterman model offers an interesting option for investors with some investment experience and so proportionately utilize their past investment experience in this model. However, not every investor is able realistically evaluate the actual market situation and thereby correct their expectations, and therefore in such way the use of Black-Litterman model can significantly distort the estimation.