Cycle-Adjusted Capital Market Expectations under Black-Litterman Framework in Global Tactical Asset Allocation*

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Abstract. We propose an implementation of Black-Litterman allocation approach with views based on time-varying risk premiums during different phases of business cycle. To obtain views we define 5-phase business cycle taken from US economic history 1979–2012. Then we formulate stylized facts on assets classes' co-movement during different phases of business cycle and set simplistic rules for generating views based on mentioned facts. To predict phase of cycle we use methodology of 5-phase business cycle prediction based on key macroeconomic indicators analysis. We back-test both approaches and compare them to such classical asset allocation strategies performance, as market-equilibrium portfolio, equal-weighted "naive" diversification, 60/40 and other. We find that Black-Litterman allocation shows superior performance to almost all other allocation strategies during 1980–2011 years.

Аннотация. Вашему вниманию представлено внедрение модели Блэка-Литтермана с входящими данными в виде взглядов относительно доходностей различных классов активов в зависимости от фаз бизнес-цикла. Для формирования этих взглядов мы воспроизводим 5 фаз бизнес-цикла экономики США периода 1979–2012 гг. Далее мы выявляем закономерности динамики классов активов в разные периоды цикла и устанавливаем простые правила формирования взглядов, основанных на этих закономерностях. Для прогнозирования фазы цикла мы используем методологию 5-фазного бизнес-цикла, основанного на анализе ключевых макроэкономических показателей. Мы тестируем оба подхода модели и сравниваем ее с такими классическими стратегиями, как рыночный портфель, равно-взвешенная диверсификация, 60/40 и др. Мы считаем, что диверсификация активов методом Блэка-Литтермана превосходит практически все рассмотренные стратегии в период времени с 1980 по 2011 г.

Key words: Black-Litterman, Markowitz, MVO, MPT, Bayesian prior, posterior, asset allocation, business cycle, Fed recession indicator.

INTRODUCTION

The efficiency of asset allocation strategies is one of the core topics of modern financial science at least since seminal work of Brinson *et al.* (1995) and series of subsequent researches written since then. An evidence of evergreen relevance of this topic is well-known research by Faber (2007), Meucci (2005, 2010), Bekkers *et al.* (2009), which became one of the most-downloaded research papers on SSRN. Despite well-known flaws in Markowitz approach and theoretically better performance exhibited by Black-Litterman portfolios, no attempt has been made to test and compare historical performance of both approaches in Faber (2007) and Bekkers *et al.* (2009) style.

The mean-variance optimization (MVO) created by Markowitz became the most widely-used technique for making investment and asset allocation decisions. The essence of MVO is to create the efficient frontier — the set of most optimal portfolios at a given return or level of risk, using historical returns of an asset class. Unfortunately, when investors have tried to use this model, they faced some problems. The main problem of classical Markowitz and his MVO is that the results received are usually unreasonable. They occur when, having no constraints, the model chooses large short positions in many assets, and when constrained, it often prescribes "corner" solutions with zero weights in many assets and unreasonable large weights of assets with small capitalization. Thus, the portfolios formed by the MVO are unintuitive and highly concentrated.

Such nature of results is caused by two main problems. First, expected returns are very difficult to esti-

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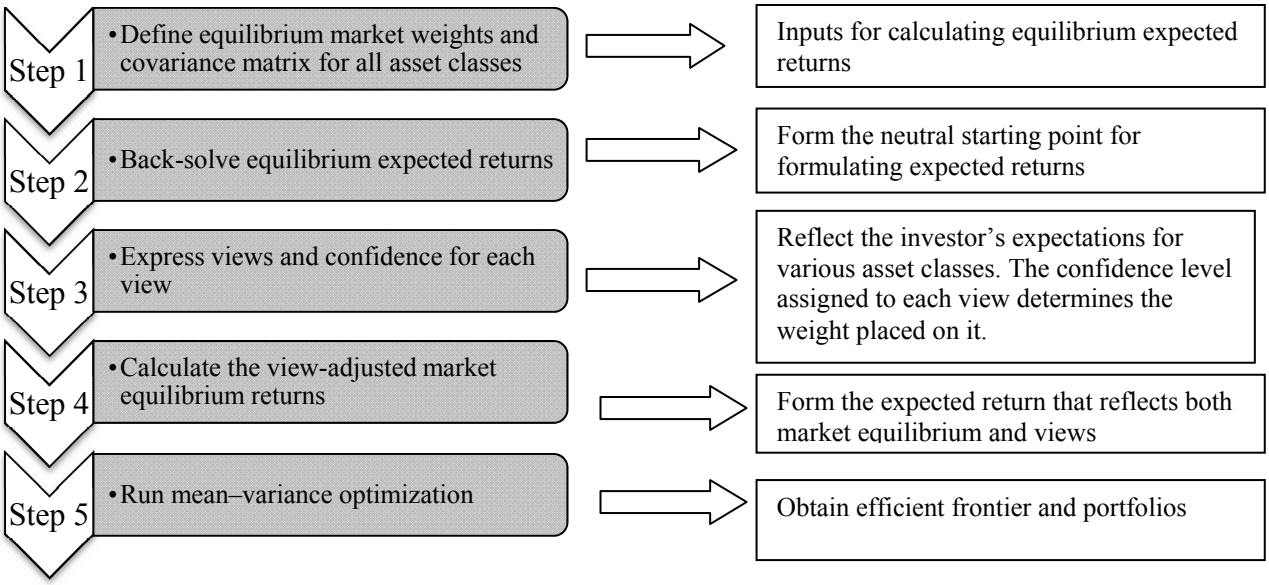

Figure 1. Steps of the Black-Litterman Model*.
Source: Maginn, J. L. (2007), "Managing investment portfolios: a dynamic process", Wiley and Sons.

* *See more detail and theoretical background of the Black-Litterman model in Idzorek, Thomas, "A Step-By-Step guide to the Black-Litterman Model, Incorporating User-Specified Confidence Levels.", Meucci, Attilio, "The Black-Litterman Approach: Original Model and Extensions."*

mate and the historical returns used by investors for this purpose provide poor guides to future returns. Second, the optimal portfolio asset weights and currency positions of MVO asset allocation are very sensitive to the return assumptions used. And these two problems compound each other. The model is not able to sort out confident and certain views from simple assumptions and the portfolio it generates has usually a little or even no relation to the views that investor wishes to express.

In order to avoid these problems, Fischer Black and Robert Litterman developed another quantitative approach, known as the Black-Litterman asset allocation model. The Black-Litterman model was first published by Fischer Black and Robert Litterman of Goldman Sachs in an internal Goldman Sachs Fixed Income document in 1990. Their paper was then published in the *Journal of Fixed Income* in 1991. A longer and richer paper was published in 1992 in the *Financial Analysts Journal* (FAJ). The model was then discussed in greater details in Bevan and Winkelmann (1998), He and Litterman (1999), Satchell and Scowcroft (2000), Litterman (2003), Idzorek (2004) and Walters (2008). Various applications and extensions of the model were discussed in Beach & Orlov (2007), José Luis Barros Fernandes (2011), Meucci (2010).

The Black-Litterman model combined the CAPM by Sharpe (1964), reverse optimization by Sharpe (1974), mixed estimation by Theil (1971, 1978), the universal hedge ratio/Black's global CAPM by Black (1989) and Litterman (2003), and mean-variance optimization of Markowitz (1952). The model is aimed to overcome the problems of unintuitive, highly-concentrated portfolios, input-sensitivity, and estimation error maximization. It provides both an intuitive portfolio and a clear way to specify investors' views and to blend the investors' views with prior information. The steps of the Black Litterman approach are shown in Figure 1.

But the quite obvious from the first sight conclusion of the Black-Litterman's superiority over the classical Markowitz is not such unambiguous and non-doubtful. It results in more intuitive, diversified portfolios, and most importantly has an opportunity of adding capital market expectations (CME).

First of all, it should be recognized that the process of generating the CME is rather subjective and it is not evident that adding such expectations improves the portfolio performance. The other problem is that no clear understanding exists regarding the validity and relevancy of the historical back-testing within the Black-Litterman or any other model as a tool of portfolio performance estimation. Some other questions and uncertainties are added up with the peculiarities and characteristics of modern financial markets where in addition to traditional debts and equities, a wide variety of alternative asset classes and financial instruments are represented. In other words, it is not unquestionable that the Black-Litterman with its all above-mentioned advantages is able to outperform other strategies in its risk and return characteristics.

METHOD

The main idea of this research is to assess the Black-Litterman model, its capability to fulfill the initial purposes incumbent on it and to create better performing portfolios in modern financial markets' conditions. The testing is to be implemented in several stages as follows:

1. Develop mechanical method of generating CME;
2. Find the source of "ideal post-hoc" CME, which supports us with such expectations as if we had a perfect knowledge about the existing and future market conditions. This source is needed because a high probability of mistakes exist when the expectations are developed by using the above-chosen mechanical method; using the "ideal" CME we will have an opportunity to assess the confidence of the mechanical method;
3. Test the classical Markowitz, the Black-Litterman without views, the Black-Litterman with "ad hoc" and "post hoc" views and other classical alternative strategies of asset allocation, based on the historical dataset. Among other strategies tested there are simple 60/40 stock/bond allocation, adapted 60/40 allocation, based on the market capitalizations weights allocation (market portfolio), equally-weighted allocation.

The main assumption of the research is that the fundamental macro-indicators, showing the stage of the business cycle in where the economy is at a point of time, are the main sources of CME. It is generally known that different asset classes act differently depending on the phase of the business cycle. Thus, to generate CME we should define the patterns of asset classes' behavior in different phases of business cycle.

The research is limited by the time horizon and the country analyzed. The testing will be done for the US national economy and financial markets, the time horizon is 33 years (since 1979). Asset classes and their proxies used in testing are as follows:

Domestic fixed income:

- Government bonds — 10-Year Treasury Constant Maturity Rate;
- Corporate bonds — Moody's Seasoned AAA Corporate Bond Yield;

Domestic equity:

- Large-caps — S&P 500 Total Return Index;
- Small-caps — Russell 2000 Total Return Index;

Commodities — S&P Goldman Sachs Commodity Total Return Index;

Real estate — NAREIT US Real Estate Return Index;

Gold — historical gold prices.

BUSINESS CYCLE

We analyzed the United States business cycle and connected its phases to the asset classes' returns and risks, trying to find the relation between the economy conditions, caused by the business cycle phase, and the asset classes' risks and returns during that phase. The time horizon analyzed was divided according to the phases of business cycle based on two main indicators: the NBER Recession Indicator and the Term Spread between long and short-term FED rates.

The NBER-based division has 5 phases — initial recovery, early upswing, late upswing, slowdown and recession. To find the beginning and ending points of these phases we took quarterly time series of US GDP growth rates, Output Gap, CPI, Sentiments, Initial Claims, Payrolls and NBER Recession Indicator. But this method of division is good only in historical testing, as its main indicators are lagging.

The second method, based on Term Spread, tries to predict the business cycle phases. This method is very hypothetical, because no single interpretation of the term spreads' values exists. Thus, we made our own assumptions of interpreting the probability values (which are the main concept of the method) in business cycle predicting. For each of these methods separate sets of views were developed (for more details see Appendix 1).

CREATING SPECIFIC INPUTS FOR BLACK-LITTERMAN MODEL

Views. As mentioned above, we have analyzed the business cycle of US to derive views about asset classes' behavior during its different phases. Using two methods (the NBER Recession Indicator-based and the Term Spread-based) we divided the US economy history into periods of different business phases. As a result, we have two types of business cycle divisions, so we will have two sets of views correspondingly.

Also, we made the assets classes' analysis over the same time horizon (1979–2012). In order to generate views for the Black-Litterman, we must combine that analysis with the business cycle divisions. It means that now we must analyze assets' quarterly returns and risks with respect to the phases of business cycle. In other words, we must find out the regularities in assets classes behavior over the cycle phases, formulate them and explore as a way of constructing more effective portfolio.

Table 2 contains mean quarterly returns and standard deviations for each NBER Recession Indicator–based business cycle phases.

We can now see that *in Recessions* Russell has the greatest return (5.57%), while the S&P GSCI has

Table 2. Asset Classes Mean Returns and Standard Deviations in Different Phases of the US Business Cycle.

Asset Class	rec		initial recovery		early upswing		late upswing		slow down	
	mean	stdev	mean	stdev	mean	stdev	mean	stdev	mean	stdev
10-Y Bonds	2.00%	1.07%	1.77%	0.82%	1.66%	0.81%	1.63%	0.44%	2.19%	0.87%
AAA	2.35%	0.90%	2.09%	0.70%	1.95%	0.70%	1.88%	0.41%	2.42%	0.71%
SP500	1.40%	11.53%	2.82%	8.77%	3.47%	5.89%	4.48%	6.60%	-2.95%	6.57%
Russell	5.57%	15.11%	6.72%	10.42%	4.14%	8.11%	3.29%	9.05%	-3.44%	9.50%
Gsachs	-3.11%	18.10%	2.07%	6.92%	2.68%	6.92%	3.26%	9.83%	5.28%	17.26%
Gold	0.39%	9.44%	0.38%	7.44%	1.20%	4.95%	1.71%	6.53%	5.16%	16.14%
NAREIT	2.00%	15.21%	6.36%	6.25%	3.91%	5.12%	2.70%	6.74%	-1.50%	5.75%

a maximum negative return and a highest standard deviation (18.10%). Rationally it can be explained by existence of risk-seeking investors, who are trying to get high returns and are ready to take risk even during recession, and are choosing Small-caps as the one having less of standard deviation and high rate of return.

In the Initial Recovery REITs are totally beating Gold as during last cycles the economy started its recovery with the growth of the real estate market.

As for *the Early Upswing* the Russell is outperforming S&P500, which is an evidence of growing confidence and a desire to switch to equities as more risky assets in order to have greater returns. *The Late Upswing* is characterized by the same sentiments but with the desire to switch to less risky equities, which is S&P 500. Thus, in Late Upswing Large-caps have higher returns than Small-caps. Summarizing all the above ideas, the following views are specified in Table 3.

The figure under each view is an absolute measure of the view. Thus the first view asserts that *in Recession* Russell's quarterly return is 8% greater than the one of S&P GSCI.

The same views will be used to the business cycle phases' breakup under the Term-Spread method. Nevertheless, the final views' vectors under different methods of business cycle breakup will differ from each other due to the differences in the breakups.

Market capitalizations. Using the market capitalization weights in asset allocation is one of the main distinctions of the Black-Litterman model from classic Markowitz. As we are analyzing the period since 1979, we must back-up each asset class' market-cap history for the same time horizon. The market capitalization history dataset is rather difficult to find. Mainly, the sources give annual data, which is not matching our criteria of quarterly time series. The mission is complicated not only by the long and quarterly frequency history needed, but also by the fact that such asset classes as bonds and gold do not have a clear measure of their market capitalizations. Taking all this into consideration, the quarterly time series of asset classes' market capitalizations since 1979 till 2012 has been derived by following ways:

- The market capitalization of S&P500, Russell 2000 and FTSE NAREIT are calculated having at least one market cap value of the index at any moment of time horizon since 1979;
- The market capitalization of 10-Year Treasuries and AAA Corporate Bonds is measured by the value of open market interest;

Table 3. The Views Regarding the Asset Classes' Returns

Asset Classes	Recession	Initial Recovery	Early Upswing	Late Upswing	Slowdown
10-Y Bonds					
AAA					
SP500			RUSS > SP 1.5%	SP > RUSS 1.5%	
Russell	RUS > GSachs 8%				
Gsachs					
Gold		REIT > GOLD 6%			GOLD > REIT 6%
NAREIT					

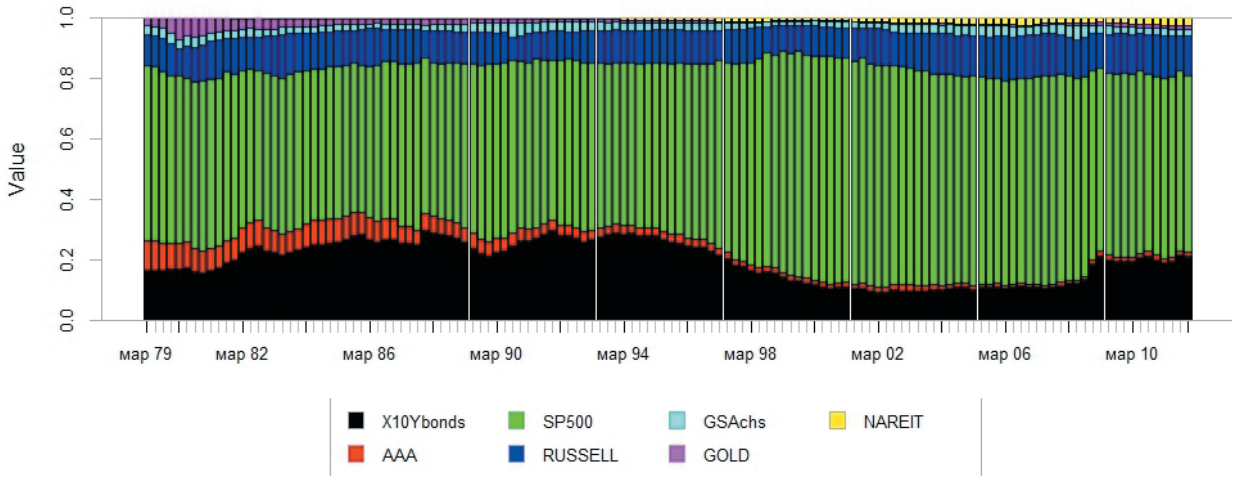

Figure 2. Historical Weights of Market Portfolio.

• As a measure of the gold's market capitalization the value of the total investable gold of US institutions is taken;

• The market capitalization of S&P GSCI is calculated by taking its structure at any moment of time. Having the weights of its constituents at a given moment, the value of open interests and the price of each futures contract, the market capitalization is estimated for that date. Then the same procedure is done with the S&P 500 and other simple price indexes.

Input assumptions and constraints. In addition to views specified, the Black-Litteman needs other input assumptions. For our Black-Litterman portfolios the following assumptions and constraints have been set:

• The value of parameter $\tau = 0{,}025$;

• Trading only long, no short positions allowed;

• The risk-free interest rate is zero;

• The starting point is the 27-th quarter of the period analyzed (1986 quarter 1). This assumption is made in order to supply the models with some history of returns as an input.

Having the historical returns, market capitalizations, views and assumptions, we can form all the Black-Litterman portfolios.

THE PORTFOLIOS PERFORMANCE ANALYSIS

In our testing we will compare the Black-Litterman portfolios with the ones of Markowitz, Market portfolio, Equally-weighted portfolio, simple 60/40 stock/bond portfolio, adapted 60/40 stock/bond portfolio.

The Black-Litterman model allows us to construct two types of portfolios: with views specified and without any views. At the same time the Black-Litterman portfolio without views differs from classical Markowitz as it takes into consideration the market capitalization weights of each asset class in the portfolio and uses equilibrium returns.

For our test we will use both these approaches and create two groups of ***Black-Litterman portfolios:***

• The Black-Litterman Equilibrium Returns portfolios without views;

• The Black-Litterman with views specified portfolios. As we have two series of views (NBER-based and FED rates spread-based) the Black-Litterman portfolio with views will be divided into two groups:

▪ The NBER-based views Black-Litterman;

▪ The Fed-based views Black-Litterman;

From the variety of portfolios on the efficient frontier for each type of Black-Litterman model we will take 5 portfolios:

▪ the minimum risk portfolio (minrisk);

▪ the maximum risk portfolio (maxrisk);

▪ the medium risk portfolio (midrisk);

▪ the middle between minimum and medium risk portfolio (minmidrisk);

▪ the middle between medium and maximum risk portfolio (midmaxrisk);

Such choice of portfolios will simplify further analysis of the models by comparing corresponding risk-level portfolios created by different asset allocation models and define which of them is better at different risk levels.

The same method is used in ***Markowitz' portfolios,*** which will also be subdivided by the risk interval.

The Market Portfolio is the portfolio which allocates asset classes basing on their market capitalizations. The weight of an asset class is determined by the ratio of its market capitalization to the total market capitalization. The reallocations are also done with respect to changes in market capitalizations.

A 60/40 stock/bond asset allocation is appropriate or at least is a starting point for an average inves-

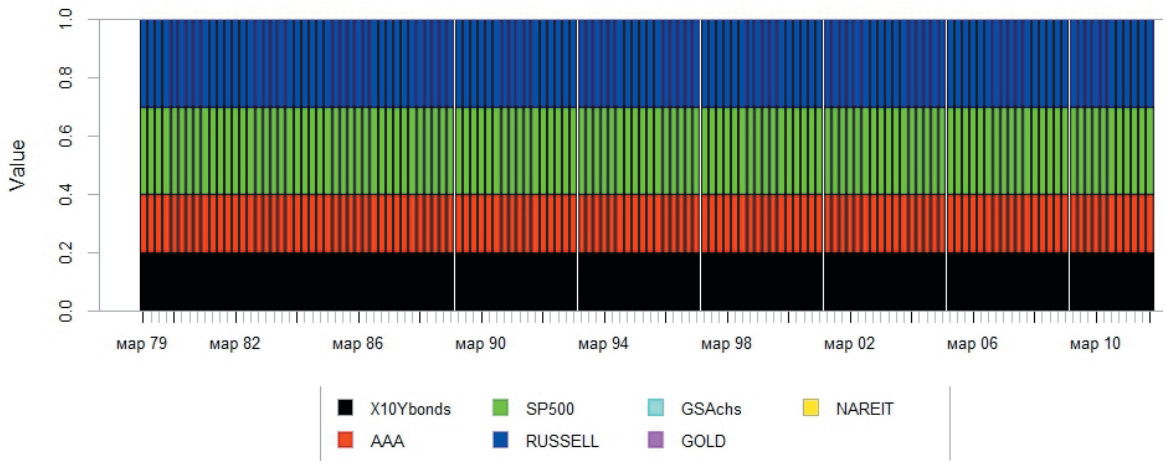

Figure 3. Historical Weights of Simple 60/40 Stock/Bond Portfolio.

tor's asset allocation. From periods predating modern portfolio theory to the present, this asset allocation has been suggested as a neutral (neither highly aggressive nor conservative) asset allocation. The equities allocation is viewed as supplying a long-term growth foundation, the fixed-income allocation as supplying risk-reduction benefits. If the stock and bond allocations are themselves diversified, an overall diversified portfolio should result.

Our 60/40 portfolio will consist of:

- S&P500 and Russell 2000 each with the weights of 30%, summing up to 60% of stocks;
- 10-Year Government and AAA Corporate Bonds each with the weight of 20%, giving 40% of bonds.

An adapted 60/40 stock/bond asset allocation differs from the simple 60/40 only by switching the regimes to 60/40 bond/stock asset allocation when being in recessions. Thus the portfolio is decreasing its risk due to dangerous economic conditions, choosing less risky assets.

Equally-weighted asset allocation gives equal weights to each other class and doesn't make any reallocations. As we have 7 asset classes, each of them will constitute a 14.3% part of portfolio.

The performance of the created portfolios is measured by the values of Sharpe, Sortino, Sterling ratios and by the Maximum drawdown. ***Sharpe ratio*** is defined as a portfolio's mean return in excess of the riskless return divided by the portfolio's standard deviation. In finance the Sharpe Ratio represents a measure of the portfolio's risk-adjusted (excess) return. ***Sterling ratio*** is defined as a portfolio's overall return divided by the portfolio's maximum drawdown statistic. In finance the Sterling Ratio represents a measure of the portfolio's risk-adjusted return.

Sortino ratio is s ratio developed by Frank A. Sortino to differentiate between good and bad volatility in the Sharpe ratio. This differentiation of upwards and downwards volatility allows the calculation to provide a risk-adjusted measure of a security or fund's performance without penalizing it for upward price changes. The values of all the listed indicators for each type of portfolio are represented in Appendix 1.

We can see that at a ***minimum risk level***, the

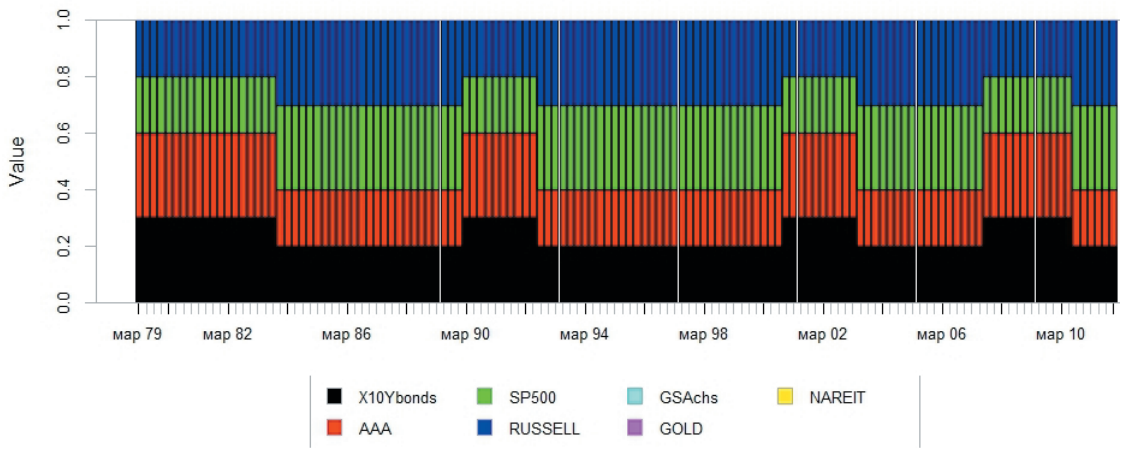

Figure 4. Historical Weights of Adapted 60/40 Portfolio.

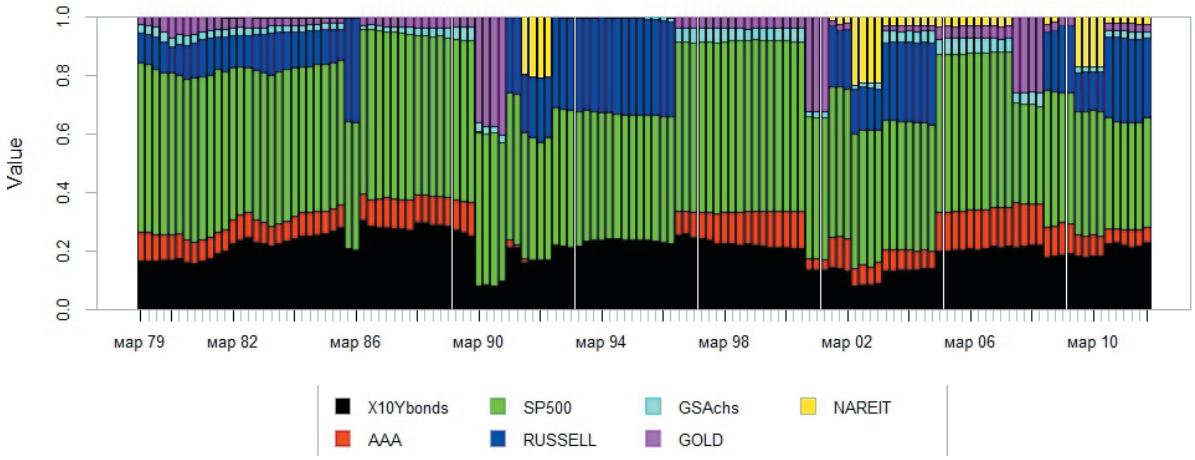

Figure 5. Historical Weights of the Minimum-Risk Black-Litterman with NBER-Based Views Portfolio.

Black-Litterman portfolios have much better results than any other in all the ratios. It is also evident that Black-Litterman portfolios do not differ between themselves in their performances, showing almost absolutely equal ratios for each of three portfolios. Figure 5 illustrates the minimum-risk Black-Litterman with NBER-based views.

At a ***min-mid risk level*** two portfolios are competing: the Markowitz and the Black-Litterman with Fed-views. The Markowitz has a greater Sharpe ratio and smaller Drawdown, the Black-Litterman has better Sortino and Sterling ratios. Figure 6 illustrates these portfolios:

The Markowitz portfolio is rather concentrated and almost totally invests into bonds as a low-risk asset. The Black-Litterman is much more diversified, which is an advantage. All else is equal.

At a ***mid-risk*** both of Black-Littermans with views show good results, just a little yielding the Markowitz in Sortino ratio. FED-based Black-Litterman has better Sortino and Sterling ratios and lower maximum drawback, while the NBER-based is succeeding in Sharpe ratio. As the Fed-based portfolio has better results in three out of four parameters, it is the best choice among the mid-risk portfolios. Figure 8 plots the returns of this portfolio over time horizon.

Moving to the ***mid-max risk*** the Black-Litterman with both types of views again are almost equally outperforming equilibrium Black-Litterman and Markowitz. But starting from this level of risk, the portfolios, which are not considering the market capitalizations (simple and adapted 60/40, equally-weighted portfolios) start to beat the Black-Litterman portfolios significantly. Markowitz' portfolios have been beaten by them since mid-risk level.

At the ***max-risk*** the tendency is strengthening and both of the Black-Litterman portfolios with views in their performance become to be equal to the simple market portfolio, again significantly beaten by both of 60/40 and Equally-weighted portfolios.

Figure 9 plots all portfolios and asset classes using their annualized values of risks and returns. The three lines on the plot correspond to the Sharpe ra-

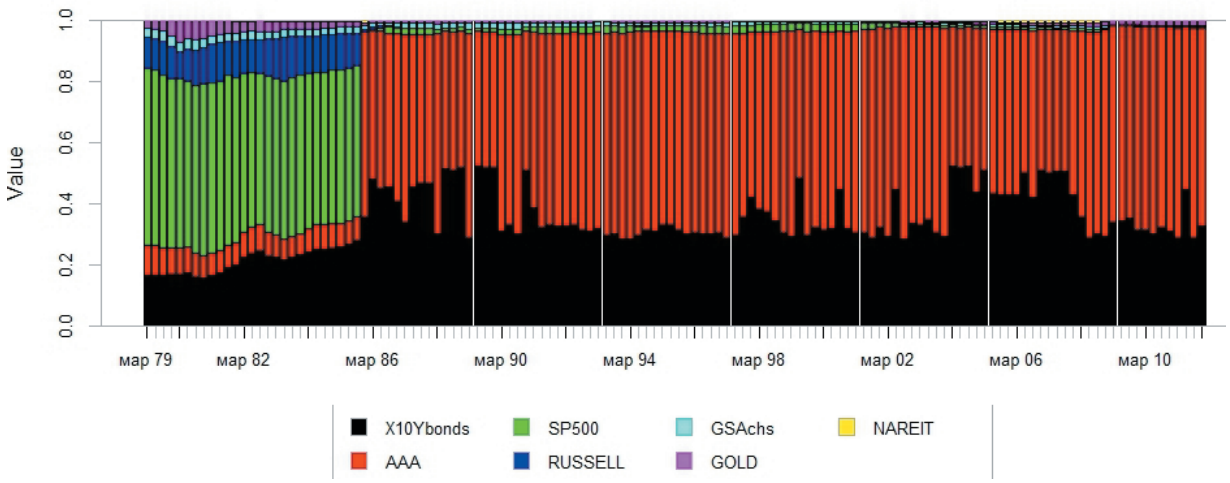

Figure 6. Min-Mid Risk Markowitz Portfolio.

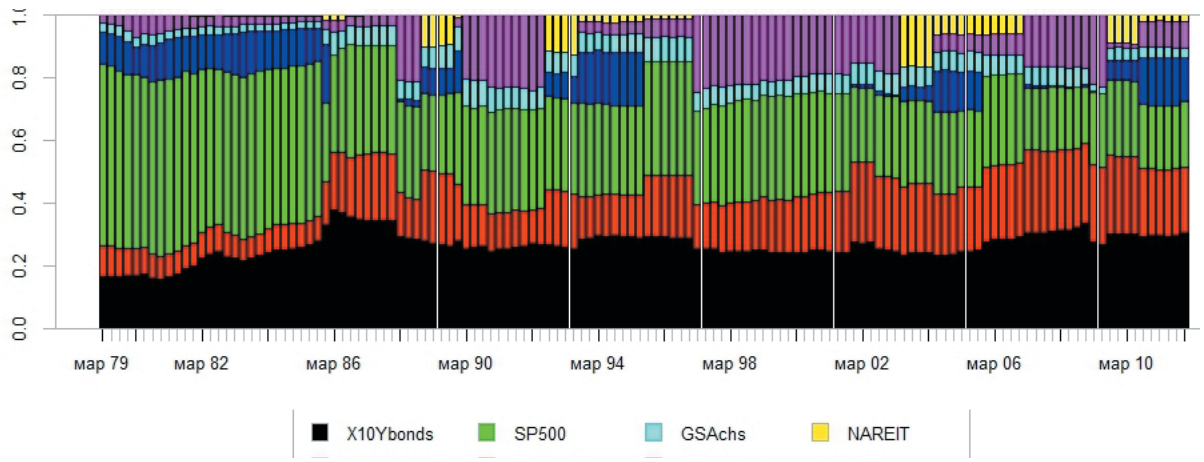

Figure 7. Min-Mid Risk Black-Litterman with FED-Based Views Portfolio.

tios. The left line is the line of Sharpe ratio = 3, the middle –2 and the Sharpe ratio of the right line is equal to 1.

From the Figure 9 we may conclude that the Black-Litterman portfolios of the min-mid risk have almost equal risk/return and thus the same attractiveness. The higher risk level portfolios of Black-Litterman and Markowitz show that the NBER-based Black-Litterman has the highest return level. The Markowitz with the same level of risk shows lower returns that an equilibrium Black-Litterman.

GENERAL CONCLUSIONS

1. *At the minimum risk level the views are not significant.* All of three Black-Litterman portfolios are beating other portfolios and are more effective and diversified. The values of all the ratios are almost equal for Black-Litterman models with views and without them, which means that views specified do not play a significant role at the minimum level of risk;

2. *With the increase of the risk level the significance of views increases too*. At the min-mid and mid-risk levels the Black-Litterman portfolios with views start to show much better results than the Black-Litterman without ones;

3. *At the middle risk levels the NBER-based Black-Litterman model is the most effective portfolio;*

4. *At the high risk levels the portfolios not based on market capitalization show better results.* Passing the mid-max point, the performance of the Black Litterman portfolios starts to decline. At this level of risk the portfolios, which do not take the market capitalization (adapted 60/40, equally-weighted and simple 60/40) start to beat the Black-Litterman portfolios;

5. *At the highest level of risk the Black-Litterman portfolios are similar by their performance to the simple market portfolio;*

6. *The Black-Litterman model beats Markowitz MVO at any level of risk;*

7. *The Fed term spread method is a precise tool for business cycle predicting.*

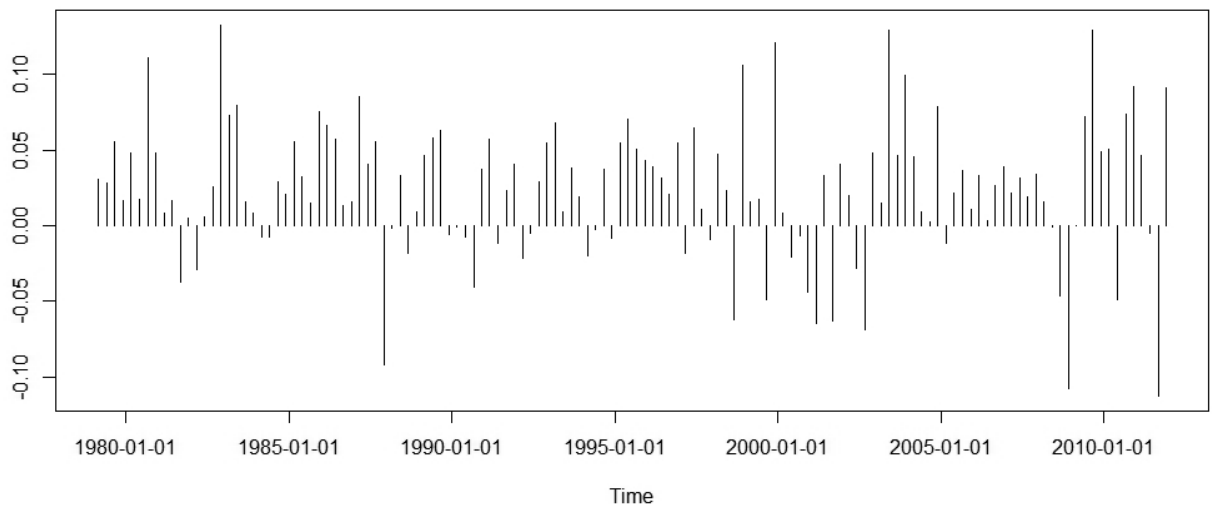

Figure 8. Mid-Risk FED-Based Black-Litterman Portfolio's Historical Returns.

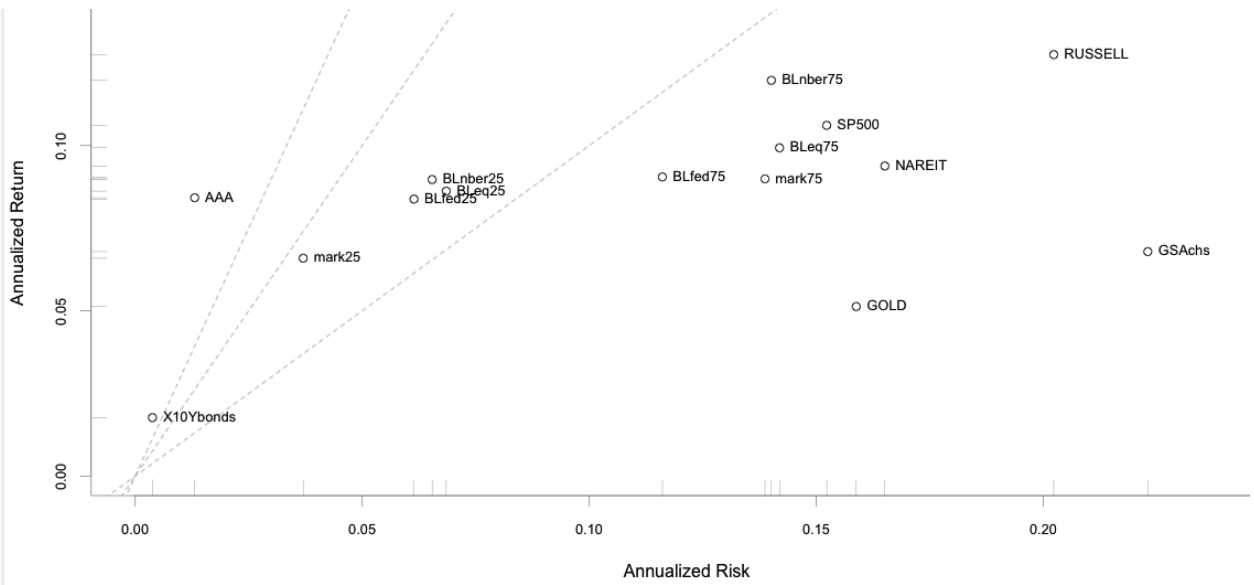

Figure 9. Annualized Assets' Risk/Ratio.

REFERENCES

Ammann, M. & Zimmerman, H. (2001), "Tracking Error and Tactical Asset Allocation", *Financial Analysts Journal* **57** (2).

Beach, S.L. & Orlov, A.G. (2007), "An application of the Black–Litterman model with EGARCH-M-derived views for international portfolio management", *Financial Markets and Portfolio Management* **21** (2), 147–166.

Bekkers, N., Doeswijk, R. & Lam, T. (2009), "Strategic asset allocation: Determining the optimal portfolio with ten asset classes", *Available at SSRN 1368689*, 1–33.

Bevan, A. & Winkelmann, K. (1998), "Using the Black-Litterman Global AssetAllocation Model: Three Years of Practical Experience." *Fixed Income Research*, Goldman, Sachs & Company, December 1998.

Black, F. & Litterman, R. (1992), "Global Portfolio Optimization, *Financial Analysts Journal* **48**, 28–43.

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

Black, F. (1972), "Capital Market Equilibrium with Restricted Borrowing", *Journal of Business* **45** (3), 444–455.

Black, F., Jensen M. C. & Scholes, M. (1972), *The Capital Asset Pricing Model: Some Empirical: Tests. Studies in the Theory of Capital Markets*, New York: Praeger Publishers.

Brinson, G.P., Hood, L.R. & Beebower, G.L. (1995), "Determinants of portfolio performance", *Financial Analysts Journal*, 133–138.

Campbell, J. & Shiller, R. (1991), "'Yield Spreads and Interest Rate Movements"", *Review of Economic Studies* **58** (3), 495–514.

Chatrath, A. & Liang, Y. (1998), "'REITs and Inflation: A Long-Run Perspective"", *Journal of Real Estate Research* **16** (3).

Chow, G., Jacquier, E., Kritzman, M. & Lowry, K. (1999), "Optimal Portfolios in Good Times and Bad", *Financial Analysts Journal* **55** (3), 65–73.

Christopherson, Jon, and Paul Greenwood, ""Equity Styles and Why They Matter."" *Journal ofInvestment Consulting*. Vol. 1, No. 1: 21–36, 2004.

Estrella, A., Mishkin, F. (1988), "Predicting U. S. Recessions: Financial Variables as Leading Indicators", *Review of Economics and Statistics* **80** (1), 45–61.

Faber, M.T. (2007), "A quantitative approach to tactical asset allocation", *Journal of Wealth Management*.

Fama, E. & French, K. (1988), "Business Cycles and the Behavior of Metals Prices", *Journal of Finance* **43** (5), 1075–1093.

Fama, E.& French, K. (1992), "The Cross-Section of Expected Stock Returns"", *Journal of Finance* **47** (2), 427–465.

Fama, E. & French K. (1996), "Multifactor Explanations of Asset Pricing Anomalies", *Journal of Finance* **51** (1), 55–84.

French, K. & Craig W. (2003), "The Treynor Capital Asset Pricing Model", *Journal of Investment Management* **1** (2), 60–72.

He, G. & Litterman, R. (1999), "The Intuition Behind Black-Litterman Model Portfolios", *Goldman Sachs Asset Management Working paper*.

Idzorek, T. (2005), "A Step-By-Step guide to the Black-Litterman Model, Incorporating User-Specified Confidence Levels", *Working paper*.

Grinold, R., & Kroner, K. (2002), "The Equity Risk Premium", *Investment Insights from Barclays Global Investors* 5 (3).

Grinold, R. & Kahn, R. (1995), *Active Portfolio Management*, Chicago, IL: Probus Publications.

Kitchin, J. (1923), "Cycles and Trends in Economic Factors", *Review of Economics*.

Markowitz, H. (1952), "'Portfolio Selection", *Journal of Finance* **7** (1), 77–91.

Markowitz, H. (1959), *Portfolio Selection: Efficient Diversification of Investments*, New Haven: Yale University Press.

Markowitz, H. (1984), "The Two Beta Trap", *Journal of Portfolio Management* **10** (1), 12–20.

Meucci, A. (2010), "The Black-Litterman Approach: Original Model and Extensions", *The Encyclopedia of Quantitative Finance*, Wiley.

Meucci, A. (2005), "Beyond Black-Litterman: views on non-normal markets", Working paper, available at SSRN 848407.

Merton, R. (1969), "Life Time Portfolio Selection Under Uncertainty: The Continuous Time Case", *Review of Economics and Statistics* **51**, 247–257.

Merton, R. (1973), "An Intertemporal Capital Asset Pricing Model", *Econometrica* **41** (5), 867–887.

Mitchell, W. (1954), "*Business Cycles, the Problem and Its Setting"* New York: National Bureau of Economic Research.

Moore, G. H. (1983), *Business Cycles, Inflation and Forecasting* (2nd edition), Cambridge: Ballinger Publishing.

Ross, S. (1976), "The arbitrage theory of capital asset pricing", *Journal of Economic Theory* **13** (3),341–360.

Satchell, S. & Scowcroft, A., "A Demystification of the Black-Litterman Model: Managing Quantitative and Traditional Portfolio Construction", *Journal of Asset Management* 1 (2), 138–150.

Sharpe, W., Gordon A. & Jeffery B. (1999), *Investments*, Upper Saddle River: Prentice Hall.

Sharpe, W. (1966), "Mutual Fund Performance", *Journal of Business* **39** (1), 119–138.

Sharpe, William. 1974. "'Imputing Expected Security Returns From Portfolio Composition"", *Journal of Financial and Quantitative Analysis*. Vol. 9, No. 3: 463–472.

Schumpeter, J. A. (1954), *History of Economic Analysis*, London: George Allen & Unwin.

Theil, H. (1971), *Principles of Econometrics*, Wiley and Sons.

Tobin, J. (1958), "Liquidity preference as behavior towards risk", *The Review of Economic Studies* **25** (2).

Tsay, R. S. (1998), "Outliers, level shifts, and variance changes in time series", *Journal of Forecasting* **7**, 1–20.

Walters, J. (2008), "The Black-Litterman Model in Detail", *Working paper*.

Yamarone, R. (2004), "The trader's guide to key economic indicators ", 2004.

Appendix 1

The NBER Recession based Phases of US Business Cycle (1979–2012)

Period (year/quarter)		The Phase of Business Cycle	Duration (months)	Business Cycle
Beginning	**End**			
–	1979/q3	Late upswing	N/A, 9 months of data analyzed	Partially completed business cycle with "double-dip recession", 47 months long
1979/q4	1980/q1	Slowdown	6	
1980/q2	1980/q3	Recession	6	
1980/q4	1981/q1	Initial recovery	6	
1981/q2	1981/q3	Slowdown	6	
1981/q4	1982/q2	Recession	15	
1983/q1	1983/q2	Initial recovery	6	Completed business cycle, 99 months long
1983/q3	1985/q4	Early upswing	30	
1986/q1	1989/q3	Late upswing	45	
1989/q4	1990/q3	Slowdown	12	
1990/q4	1991/q1	Recession	6	
1991/q2	1992/q1	Initial recovery	12	Completed business cycle, 126 months long
1992/q2	1996/q1	Early upswing	48	
1996/q2	2000/q2	Late upswing	48	
2000/q3	2001/q1	Slowdown	9	
2001/q2	2001/q4	Recession	9	
2002/q1	2002/q4	Initial recovery	12	Completed business cycle,80 months long
2003/q1	2004/q3	Early upswing	21	
2004/q4	2007/q4	Late upswing	39	
2008 q1	2008 q1	Slowdown	3	
2008 q2	2009 q2	Recession	15	
2009 q3	2010 q1	Initial recovery	9	Partially completed business cycle, 33 months long

Appendix 2

Portfolios Performance Ratios

Risk level	Portfolio Type	Performance Measure			
		Sharpe	Sortino	Drawdown	Sterling
MinRisk	Markowitz	0.91508	0.37984	0.06033	-0.20212
	BL without views	1.61104	0.74600	0.09712	-0.07951
	BL with Fedviews	1.61105	0.74601	0.09712	-0.07951
	BL with NBER views	1.61105	0.74601	0.09711	-0.07951
Min-Mid Risk	Markowitz	1.78132	0.67301	0.06033	-0.16128
	BL without views	1.25870	0.50258	0.17814	0.04281
	BL with Fed views	1.36454	0.68016	0.10687	0.09777
	BL with NBER views	1.37270	0.58016	0.15299	0.08664
Mid Risk	Markowitz	0.78269	0.55071	0.17408	0.07451
	BL without views	0.92402	0.37467	0.29495	0.12835
	BL withFedviews	1.03240	0.54599	0.19073	0.24387
	BL with NBER views	1.37300	0.43724	0.25921	0.19223
Mid-Max Risk	Markowitz	0.64770	0.28283	0.42647	0.16262
	BL without views	0.70015	0.30785	0.40261	0.16212
	BL with Fedviews	0.77926	0.43046	0.24847	0.29179
	BL with NBER views	0.85374	0.37561	0.37197	0.22880
Max-Risk	Markowitz	0.53607	0.25828	0.50351	0.23920
	BL without views	0.48386	0.23571	0.45803	0.25308
	BL withFedviews	0.80986	0.27794	0.43217	0.28791
	BL with NBER views	0.80265	0.36788	0.46054	0.23920
Market Portfolio		0.78950	0.32778	0.37746	0.17837
Simple 60/40		0.94971	0.42914	0.29340	0.17458
Adapted 60/40		1.14333	0.54928	0.18787	0.23243
Equally-weighted		1.10059	0.40897	0.31221	0.01307

TERMINOLOGY

NBER recession indicator is posted quarterly by Business Cycle Dating Committee of US National Bureau for Economic Research (NBER), an official arbiter of recessions for US economy. Committee uses no predefined rule but members' judgment based on macro data, to mark periods of recession with two-quarters lag. Indicator may be equal to 0 or 1, with 1 indicating recession period.

FED spread recession indicator is published monthly by New York FED and varies between 0 and 100, showing probability of US economy falling into recession during next month. This is leading index, calculated from spread between market price for short- and long-term US government debt. Method for calculation, as well as all accompanying materials, is in open access on the site of New York FED.

Black-Litterman and Meucci techniques are "add-ons" to famous Markowitz MVO approach to portfolio optimization. Black-Litterman approach allows to blend portfolio manager forecasts with prior returns distribution, based on assumptions of market returns normality, and uses blended returns as inputs for Markowitz optimisation procedure. Meucci's approach further extends that of Black-Litterman, by allowing returns to be non-normal.

Ensemble learning is class of decision making algorithms, combining forecasts of ensemble of "weak predictors" ensemble (i.e. any other decision making models with low predictive ability) to make one "strong predictor" with higher predictive performance than any of individual predictors, comprising it. Ensemble learning is believed to produce better results when applied to complex, non-stationary processes and high dimensional data.

Corporate sustainability reporting is optional non-financial reporting (often prepared as part of part of mandatory financial reporting), supplying organisation's stakeholders with additional information about social, environmental and governance performance of corporation. By preparing sustainability reports organisation shows to investors and mass media its awareness of bidirectional impacts of organisational activity and various aspects of sustainability, as well as internalizes its commitment to sustainable development and engaging stakeholders.

Real options is a valuation technique, which allows to consider simultaneously several paths or scenarios of development of some basic (for valued object) parameter and the flexibility of object's manager to react in real time to some particular path or scenario being realized. For example, applying real options approach to problem of finding fair rent price for gold mine allows to account for varying gold price and flexibility of mine's management to cease mine operation when gold price is low, and install new equipment when gold price is high. Real options approach have numerous applications in valuing endeavors in R&D, licensing, energy, mining, policymaking, etc. Real options are not traded derivatives; rather it is approach to valuation of objects, the fair value (of benefit from realization) of which could be conceptually tied to price of some underlying asset and depends heavily on decisions taken as reaction to the price change.