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HEDGING EFFICIENCY: REGIME SHIFTS APPROACH

Estimating precise hedge ratio is the key to efficient hedging using futures contracts. In this paper Markov switching model is used to estimate hedge ratio and optimal number of contracts for every regime. Besides the differences between constant and time-varying methods, especially OLS, GARCH-M, State-Space models are discussed. Because Markov switching model is neither constant, nor time-varying, its advantages over other methods are shown. After that, a simple example of hedging situation is discussed, and optimal hedge ratio is estimated.

Key words: *hedge ratio, hedging efficiency, Markov switching model, time-varying hedge ratio, constant hedge ratio, futures contracts.*

JEL: G32, G39

1. Introduction

One of the widely used derivatives for hedging is futures contract or its over-the-counter twin forward contract. Efficient hedging requires a choice of optimal hedge ratio and optimal number of contracts. The delivery month of the underlying asset of futures is also crucial and can be very decisive during hedging process. The choice among futures contracts for hedging a position of an asset on which contracts are not traded, cannot be bypassed. For an airline company the position of jet fuel can be hedged only by taking positions on oil futures contracts, because futures on jet fuel do not exist. Choosing the right futures contract, underlying asset of which is highly correlated with the asset position, is the key to hedging efficiency (called cross-hedging).

In this paper, we will concentrate on hedge ratio, which is the critical constituent of hedging process. Hedge ratio, which is the ratio between the value of position in futures and the value of total exposure, is calculated using simple regression between spot price difference and futures price difference and as a proxy beta is taken[1]. Differences are taken between start and end times of hedge. It is usually more accurate to break time into many small intervals, so that there be enough observations for regression analysis. If we use simple regression, we will stand with only one static beta or hedge ratio. Many works have been done to prove that this is inefficient. But we will try to change this static simple beta to something, which is in essence time-varying beta, and it will make the task much more included, but will increase the accuracy of hedging process. However, let us not call it time-varying, because this method yields something that has only a few number of betas. By time-varying let us mean something that is changing at each point in time. For optimal hedging every hedger must have its own objective function, which must be optimized. For working out optimal hedge ratio it is usual to take the variance of hedged position or value of hedged portfolio. We've used measure of hedge efficiency offered by Bailleie and Myiers. The major part of this article will be concentrated on Markov switching models. This model uses Markov chains theory and regimes switching for doing regression analysis. It is assumed that there isn not just one static regime, but many regimes in futures and spot markets. Markov switching model will be used to calculate time-varying hedge ratio, which will give a different number of derivative contracts needed to hedge during that special regime or period. This will give more accurate and resilient results, which has many auspicious advantages over single beta methods. Static model gives only one coefficient, which is not efficient, because relationship between spot price and futures price is not constant. Time-varying methods give us continuously changing hedge ratios, number of which can exceed thousands. It may be efficient but applying it in reality is impossible, because nobody can change position in futures contracts at each point in time. And here Markov switching models comes, which gives us neither thousand nor one, but a few hedge ratios, which is more appropriate, because one does not have to spend a lot of money on commissions. Discovering other methods such as GARCH, OLS, State-space models is beyond the scope of this paper, but some patterns will be given, and they will be applied to make comparison with Markov switching model in terms of hedging efficiency.

2. Literature review

There is a vast majority of studies concerning hedge ratios and hedging effectiveness. Most of them try to show that OLS is not appropriate, and other

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[1] Another definition is also widely applicable: hedge ratio is the ratio between the value of spot instrument and hedging instrument that make the value of hedged portfolio unchangeable.

methods such as ECM, VAR, ARCH, and GARCH need to be applied. Ghosh has applied ECM for S&P 500 and Dow Jones futures (1993)[2]. With Clayton he has included other indexes too. This model is blamed to bypassing ARCH effects. Kroner, Sultan (1993), Park, Switzer (1995), Baillie and Myers (1991) have done some researches using ARCH, GARCH models along with VAR models.

Markov switching model was applied by Amir H. Alizadeh, Nikos K. Nomikos, Panos K. Pouliasis for energy commodities (2007). They have used Markov switching model with vector error correction model. They linked disequilibrium with uncertainty and regimes. They showed that this model helps to reduce risk of position.

3. Hedge ratio and hedging effectiveness

For optimal hedging it is crucial to estimate hedge ratio and choose the most optimal in terms of objective function optimization. In order to find optimal hedge ratio we need to choose quantities of spot and futures instruments in a way that will make the change of value of portfolio zero:

$$\Delta V_p = \Delta P_s * q_s - \Delta P_f * q_f = 0$$

Here V_p is the value of portfolio. P_s, q_s and P_f, q_f are price and quantity of spot and futures instruments respectively, and Δ is the difference. Setting it to zero, we will get two expressions for hedge ratio, which are identical. We can find optimal hedge ratio by minimizing variance of ΔV_p. If we use the first order condition of optimization and set it equal to zero, we'll get the optimal ratio[3]:

$$h = \frac{q_f}{q_s} = \frac{\Delta P_s}{\Delta P_f}, \qquad h^* = \rho * \frac{\sigma_s}{\sigma_f}$$

σ_s and σ_f are standard deviations of spot and futures instruments respectively, and ρ is the correlation between them. This is the hedge ratio that we are looking for. It is just a simple regression coefficient in the regression of ΔP_s on ΔP_f. So, after finding optimal hedge ratio next step is to find optimal number of contracts needed to hedge. There is a very short formula for that. Formulas are shown below:

$$\Delta P_s = h\Delta P_f + \varepsilon, \ \ N^* = h^* * \frac{S_A}{S_f}$$

N^* is the optimal number of contracts, S_A is the size of position being hedged, S_f is the size of one futures contract (quantity of asset in one contract). As we see, the higher the hedge ratio the higher the number of contracts needed.

When we use simple regression and estimate hedge ratio by OLS, R^2 is considered as a measure of effectiveness. It shows the percentage of variance, which is eliminated by hedging. For other methods we will use a method suggested by Baillie and Myers. They offered that in order to measure effectiveness of hedge we must construct unhedged portfolio based on spot prices and then hedge portfolio based on spot and futures prices. Formula for measuring hedging effectiveness is shown below:

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[2] **Ghosh A.**, Hedging with stock index futures: Estimation and forecasting with error correction model. Journal of Futures Markets, 13(7), 1993, p. 743-752.

[3] **John C. Hull.** Options, futures and other derivatives. Toronto, Canada. 2012, p. 56-76.

$$E = \frac{\sigma_{unh}^2 - \sigma_h^2}{\sigma_{unh}^2}$$

We have figured out that finding hedge ratio is nothing more than choosing accurate method for analyzing relationships between spot and futures prices. In terms of static or one beta hedge ratio it is not so cumbersome to estimate optimal hedge ratio. What we need is to estimate regression of the difference of spot price of hedged asset on the difference of futures contract price. Usually difference is taken between initial and end value of hedging period. However, this will not give us enough data. That is why it is more precise to break hedge time interval into small non-overlapping periods and compute difference for each time interval.

4. Estimating optimal hedge ratio using Markov switching model

In this research we will try to use Markov switching model[4] which in essence is neither static nor continuous time-varying. This model takes some structural equations instead of just one. This structure gives us different regression patterns. Model lets these structures be changed randomly with using transition matrix, which is the key component of switching model. These structural changes are controlled by latent variable, which follows Markov process.[5] Let us introduce switching model in a simple case. Assume that v_t is a state variable that follows Markov process and assumes values zero or one. We can construct Markov switching model with two different dynamic models with switching mechanism. This model is suitable only of stationary series. Of course this model is also applicable, when v_t follows Bernouli distribution. Random switching model is difficult to apply to time series, because state variables are independent. The nitty gritty is to construct model carefully. The simple model is:

$$\Delta P_{st} = \begin{cases} \alpha_0 + h_0 \Delta P_{ft} + \varepsilon_{t,} & v_t = 0 \\ \alpha_0 + \beta_0 + h_1 \Delta P_{ft} + \varepsilon_{t,} & v_t = 1 \end{cases}$$

Here we have just two regimes and switching to these regimes is determined by 4Ճ4 matrix, which is called transition matrix[6]. In order to clarify whether Markov switching model is appropriate or not, some hypotheses need to be tested. We need to test whether state variables are independent and switching intercepts are constant.

In order to be confident in model appropriateness we need to reject the first hypothesis. State variable are independent, if previous state has no effect on the current state or regime, that is $\mathrm{p}_{00} = \mathrm{p}_{10}$ and $\mathrm{p}_{01} = \mathrm{p}_{11}$. The model can also be presented in this way:

$$\Delta P_{st} = \alpha_0 + \beta_0 v_t + (1 - v_t) h_0 \Delta P_{ft} + v_t h_1 \Delta P_{ft} + \varepsilon_t$$

This model can be generalized to include many states or regimes. In that case transition matrix will involve many components. Upon finding transition probabilities, we can compute the average hedge ratio.

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[4] **Hsiang-Tai Lee.** Regime Switching Correlation Hedging. Taiwan. P. 2-28.

[5] It means that probability of variable to take some value in the next time conditional on previous values is equal to probability conditional only on previous time value. That is $\mathrm{P}(\mathrm{x}_{t+1} = \mathrm{i} | \mathrm{x}_{t-1} = \mathrm{j}, .., \mathrm{x}_{t-m} = \mathrm{m}) = \mathrm{P}(\mathrm{x}_{t+1} = \mathrm{i} | \mathrm{x}_{t-1} = \mathrm{j})$.

[6] $\mathrm{P} = \begin{pmatrix} \mathrm{p}_{00} & \mathrm{p}_{01} \\ \mathrm{p}_{10} & \mathrm{p}_{11} \end{pmatrix} = \begin{pmatrix} p(v_t=0|v_{t-1}=0) & p(v_t=1|v_{t-1}=0) \\ p(v_t=0|v_{t-1}=1) & p(v_t=1|v_{t-1}=1) \end{pmatrix}$

We know that $\sum_{i=0}^{n} p_{0i} = 1, \ldots, \sum_{i=0}^{n} p_{ni} = 1$. After that we can find average hedge ratio by taking average hedge ratio weighted by transition probabilties. Supposing that hedge ratios for different regimes are $h_{0,} h_1, \ldots h_n$ average hedge ratio can be computed as follows:[7]

$$\mathrm{h_{avg}} = \sum_{\mathrm{i=0}}^{\mathrm{n}} \sum_{\mathrm{j=0}}^{\mathrm{n}} \mathrm{p_{ji} h_i}$$

In this model, we have two regimes, which means we shall have two structures and, consequently, two hedge ratios. We must buy a number of futures contracts and after the regime switches, we must close our positions and buy futures contracts of other number. And this switching is determined by transition matrix which will give us signals when to change our position. In this case, we need to change our position for only two times. So two regime Markov model gives us cheap and convenient way to hedge our position. Dependent on regime, we must calculate optimal number of futures contracts.

Table 1

Optimal number of contracts

States	*Hedge ratio*	*Number of contracts*
Regime 1	h_1^*	$N_1^* = h_1^* * \frac{S_A}{S_f}$
Regime 2	h_2^*	$N_2^* = h_2^* * \frac{S_A}{S_f}$
...	...	...
Regime n	h_n^*	$N_n^* = h_n^* * \frac{S_A}{S_f}$

Of course, other methods that use structural breaks also exist. For example, we can use CHOW test to figure out whether we need two or more regression equations and, hence, hedge ratios. However, Markov switching model is more effective, because it uses Markov chains to work out the probabilities with which regression equations change, that is regimes are switching with some probabilities derived from data[8]. These probabilities will allow us to make prediction about future relationship between futures and spot prices making hedging procedure much more efficient. By applying this model, we shall get two types of probabilities: the above – mentioned transition probabilities and regime probabilities, which denote the probabilities that we are in some particular regime.

5. Application of regime shift hedge ratio for hedging

We are going to use Markov switching model for hedging procedure to find appropriate hedge ratios with letting switching between regimes with some probabilities. We will use other methods to compare all hedge ratios and their effectiveness with those derived by Markov switching model.

[7] One way to estimate this model is Quasi-maximum likelihood estimate. Common ML model gives efficient and consistent results, but procedure is difficult. QMLE estimates it with forming and maximizing function that is not equal to common log-likelihood function, but is related to it.

[8] **Amir H. Alizadeh, Nikos K. Nomikos, Panos K. Pouliasis.** A Markov regime switching approach for hedging energy commodities. London, UK. 2007. P. 2-10.

Let us assume that we have a company which is involved in transportation activities. The main resource for that company is gasoline, so the price of gasoline is a crucial part of financial management of our company. Let us assume also that in September, 2018 our company needs to buy 1,000,000 gallons of gasoline. So, hedging here is critical. Remember that futures or forwards on gasoline do not exist, but gasoline is created from oil, so there is an opportunity to hedge using oil futures because there is a high correlation between gasoline prices and oil prices[9].

As we have seen, regression requires monthly difference of spot prices and futures price. We have monthly data, so we have decided to subtract from each month number the previous date number but in a way that numbers do not overlap, that is we chose small time intervals that are non-overlapping. Ideally, we should take ΔS and ΔF as a difference during hedge time but as mentioned above this will lead to small observations. That is why we took small intervals. From available data we got the correlation coefficient of 0.64, and standard deviations of ΔS and ΔF respectively 0.18 and 7.2.

So firstly let us compute hedge ratio by simple formula:

$$h^* = \rho * \frac{\sigma_s}{\sigma_f} = 0.64 * \frac{0.18}{7.2} = 0.016,$$

which in essence is a very low number. Very low standard deviation of gasoline prices is the main reason for this, which gives us an opportunity to hedge with a few futures contracts. So, let us now compute the optimal number of futures contract needed. Assume that our company needs to buy 15,000,000 gallons of gasoline. Each futures contract, which is traded in CME or NYMEX is on 42,000 gallons per contract. Hence optimal number of contracts:

$$N^* = h^* * \frac{S_A}{S_f} = 0.016 * \frac{15000000}{42000} = 5.7 \approx 6$$

We can find the same hedge ratio by simple regression. First, we need to ensure that ΔS and ΔF are stationary[10]. We've found:

$$\widetilde{\Delta S} = 0.0156\widehat{\Delta F}$$

Here we have hedge ratio of 0.0156 (t = 6.4) which is near to 0.016: the same results. R-Squared is 0.38. It is measure of hedge effectiveness here and shows that 38% of variance of hedged position has been eliminated.

Now, let us use Markov switching model to estimate our hedge ratio. As we have seen, our time series are stationary, so, we can easily apply this method to our data. We take two as the number of regimes. The number of observations is 63.

Convergence has been achieved after four iteration. Two equations look like as follows:

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[9] We have used gasoline price monthly data from US energy information administration website for January, 2008 to July, 2018. For the vary time interval we have got data of West Texas intermediate oil futures prices from yahoo.com. We have taken futures contracts, which expire in September, 2018, so that contract expiration date and gasoline purchase match.

[10] We used Augmented Dickey Fuler test to work out this problem. For gasoline t-statistics are -2.9 and -3.5 for 5% and 1% levels respectively. That implies that change in gasoline prices is stationary. The same we got for oil futures. So, we have stationary series and can do a simple regression.

Table 2

Transition matrix

Regime 1: $\widetilde{\Delta S} = 0.04 - 0.0059\widehat{\Delta F}$
Regime 2: $\widetilde{\Delta S} = -0.035 + 0.0217\widehat{\Delta F}$

States	*1*	*2*
1	0.62	0.38
2	0.22	0.78

For the first regime hedge ratio is negative[11] which means that we must short futures contracts instead of taking long position on them. In our example, this is not significant, but it is a matter of empirical data. The second regime hedge ratio is significant. Therefore, we have two hedge ratios. We have also got constant transition probabilities.

As we see, probability going from regime 1 to 2 is 38%, this means that there is a low probability that regime will change and a higher probability that regime will persist. In addition, we have a lower probability to get back to initial regime, because the probability going form regime 2 to 1 is low, just 21% and remaining on the same regime is 78%. To make sure that Markov switching model is appropriate we need to verify whether $p_{11} = p_{21}$ and $p_{12} = p_{22}$. From transition matrix we see that the equalities do not hold, thus, we reject the first hypothesis that state variables are independent. Therefore, this model is appropriate here.

Now, let us look at Figure 1. As we see, we have smoothed probabilities that is every time we have some probabilities about whether we are in regime 1 or regime 2. It will give us an opportunity to think about changing our position in futures markets. Here, we have a difficult situation because probabilities are a little bit distorted.

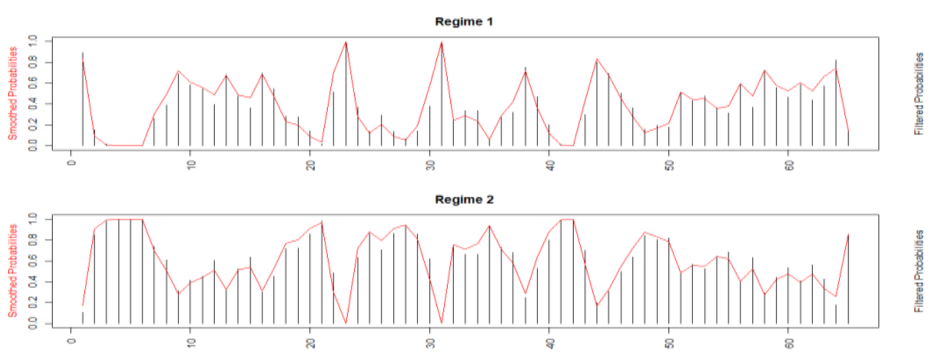

Figure 1: *Regime probabilities*[12]

However, we can do some tricks. We can take some threshold, for example 50%. For two regimes, we assume that if probabilities for observations are greater than 50%, we are in the first regime or state, otherwise, we are in the second regime. We want to approximate regime probabilities to see whether we are in state one or state two to make sure we can take reasonable positions in futures markets. So, now look at the next figure.

[11] Negative number seems not normal, but this is a problem of data.
[12] On the x axis we have months which are presented via discrete numbers.

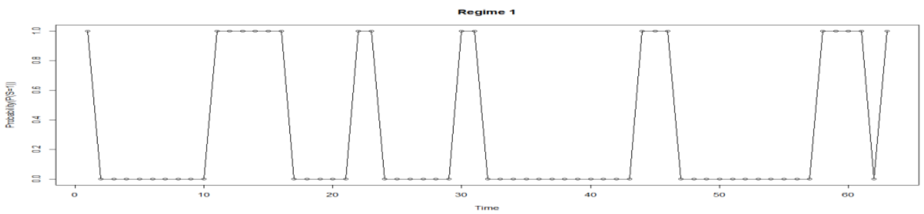

Figure 2: *Two regimes' probabilities*

Here we can see that we have been in regime two for seven times (past data) and we have been in regime two for six times. The change between these states is decided by Markov chains, and for that we have transition matrix. If we assume that future will look like past, we could imply that we must change our position in futures market 7 times with some probabilities. We have already found hedge ratios for two regimes (-0.0059 for regime 1 and 0.0217 for regime 2). Therefore, in the first month we must short futures, because hedge ratio is negative. After that we go to regime two, where we must take long position in futures market, but we need to close previous position. After some months pass, we close our position and take short position and so on. The optimal numbers of contracts are: $N^*_1 = 2, N^*_2 = 8$.

Therefore, we short two futures contracts after that with probability of 37% we close that position and buy eight futures contracts and so on.

This is the strategy that we imply using Markov switching models and applying it to our data. What it gives us is cost saving method to hedge. All procedure is based on probability, which is the drawback of this model, but advantageous over other methods[13], because we have two hedge ratios, and we can know for sure the optimal number of futures contracts that we must keep. However, the number of position changing is not known with 100%. We have just transition probabilities that will let us somehow decide whether it is time to change our position or not.

6. Hedge ratios derived by GARCH-M, State space model

We are going to use some models to find out hedge ratios for our Gasoline example.

GARCH-M

We have used the same data applying GARCH-M. Let us recall that this model includes variance as a regressor, which allows heteroscedasticity in data. Results of this model (GARCH (1, 1)) are:

$$\widehat{\Delta P_{st}} = 0.016\widehat{\Delta P_{ft}} - 1.5\widehat{\sigma_t^2}$$

Here our hedge ratio is 0.016 with z-statistic of 6.152, GARCH component is -1.5, which is non-significant. GARCH equation, which we don't need is:

$$\widehat{\sigma_t^2} = 0.0005 - 0.123\widehat{\varepsilon_{t-1}^2} + 1.15\widehat{\sigma_{t-1}^2}$$

Hedge effectiveness is 40.2%, which means that 40.2% of variance of hedged position was eliminated with taking hedge ratio equal to 0.016. Optimal number of futures contracts is:

[13] **Abdulnasser Hatemi-J.** Estimating Optimal Hedge Ratio with Unknown Structural Breaks. UAE. P. 2-7.

$$N^* = h^* * \frac{S_A}{S_f} = |0.016| * \frac{15000000}{42000} = 5.7 \approx 6$$

State Space model

Here we let regression coefficient vary over time that is we are dealing with time-varying hedge ratio. This model lets us estimate unobservable variable with observable variable. Let us recall:

$$\Delta P_{st} = \alpha_t + h_t \Delta P_{ft} + \varepsilon_t, \varepsilon_t \sim N(0, \sigma_{\varepsilon_t}^2)$$

$$h_t = h_{t-1} + v_t, v_t \sim N\left(0, \sigma_{v_t}^2\right), \; \alpha_t = \alpha_{t-1} + v_{t,} \; v_t \sim N(0, \sigma_{v_t}^2)$$

Here we let hedge ratio and constant be a random walk with v_t error term, that is they are time-varying. $s_t = (\alpha_t, h_t)^T$ is the state vector. R (language) has a function that allows to filter our data based on our model. After applying that we have got time varying hedge ratio, which looks like this:

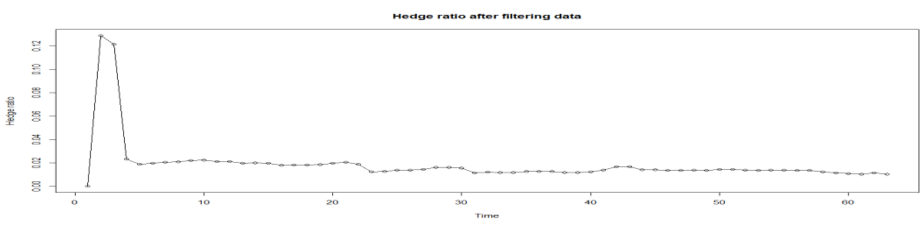

Figure 3: *Time-varying hedge ratio*

As we see hedge ratio during past time had the values close to ratios derived by other models. Here, hedge ratio takes values in interval 0 to 0.13. We have a different hedge ratio at each point in time. If we assume as before that future resemble past, then we can use this time pattern to hedge our position. Optimal number of futures contracts for our example (15,000,000 gallons of gasoline) is in interval 0 to 45.

Now when we have all hedge ratios derived from different methods, we can estimate effectiveness with method offered by Baillie and Myers.

As we saw for this formula we need hedge ratio. For some models (Markov SM, SSM) there are more than one hedge ratio. For convenience we have taken average of these hedge ratios to calculate the effectiveness. We noted that in some cases we can take R^2 as a hedge effectiveness measure, which shows the percentage of variance of portfolio, which is eliminated by hedging. However, for comparison we will calculate effectiveness via method suggested by Baillie and Myers. Of course, this formula does not give us the most precise results, but it somehow gives us intuition about model's effectiveness. So let us see the results of models in terms of effectiveness:

Table 3

hedge effectiveness

Models	*OLS*	*GARCH-M*	*SSM*	*Markov SM*
Effectiveness	61%	61%	48%	96.7%

Although the highest effectiveness is given by Markov switching model, we cannot take this measure as the most precise way and apply Markov switching model. This was given for just empirical diagnostics.

Here Markov switching model is considered as the most parsimonious and effective model in terms of few number of hedge ratios and cost saving. We showed that this model is the most appropriate for hedging procedure, because it gives resilience and makes the hedging close to reality. The only thing that needs to be done is constructing an optimization model, which will try to minimize costs of hedging and maximize hedging effectiveness, but all this is beyond the scope of this research.

7. Conclusion

As we have seen, OLS model is not appropriate method for computing hedge ratio, because it gives only one hedge ratio for hedging time interval, but it makes hedging much cheaper, because it requires taking position for only one time. When State space models are applied, they give time-variant hedge ratio, that is each point in time we get one hedge ratio. This is not easily achievable, because it requires much commission fees for changing positions. Instead, Markov switching model gives us a few hedge ratios, which is more possible to apply, and it is much more parsimonious model. Its effectiveness was shown to be the highest among other models, but it cannot be an efficient stone to stand up on it.

References

1. Ghosh A., Hedging with stock index futures: Estimation and forecasting with error correction model. Journal of Futures Markets, 13(7). 1993.
2. John C. Hull., Options, futures and other derivatives. Toronto, Canada. 2012.
3. Hsiang-Tai Lee. Regime Switching Correlation Hedging. Taiwan.
4. Amir H. Alizadeh, Nikos K. Nomikos, Panos K. Pouliasis. A Markov regime switching approach for hedging energy commodities. London, UK. 2007.
5. Abdulnasser Hatemi-J. Estimating Optimal Hedge Ratio with Unknown Structural Breaks. UAE.
6. Data. USA energy information administration. https://www.eia.gov/
7. Data. Yahoo finance. https://finance.yahoo.com/

ՏԻԳՐԱՆ ԴԱՎԹՅԱՆ
ՀՀ կենտրոնական բանկի ֆինանսական համակարգի կարգավորման վարչության աշխատակից,
ԵՊՀ տնտեսագիտության և կառավարման ֆակուլտետի մագիստրանտ

ԱՐԱՄ ԱՌԱՔԵԼՅԱՆ
ԵՊՀ տնտեսագիտության մեջ մաթեմատիկական մոդելավորման ամբիոնի վարիչ,
տեխնիկական գիտությունների դոկտոր, պրոֆեսոր

Հեջավորման արդյունավետությունը. Մարկովյան փոփոխման մոտեցումը.– Հեջավորման գործակցի ճշգրիտ գնահատումը ֆյուչերս պայմանագրերով հեջավորման արդյունավետության հիմքն է: Այս հոդվածում Մարկովյան փոփոխման մոդելն օգտագործվում է յուրաքանչյուր ռեժիմի հեջավորման գործակցի և պայմանագրերի օպտիմալ թվի հաշվարկի համար: Բացի դրանից, քննարկվում են հաստատուն և անընդհատ փոփոխվող մեթոդների տարբերությունները, հատկապես՝ OSI-ի, GARCH-M-ի, State-Space-ի: Քանի որ Մարկովյան փոփոխման մոդելը ո՛չ հաստատուն է, և ո՛չ էլ անընդհատ փոփոխվող, ցույց են տրվում նրա առավելությունները մյուս մեթոդների նկատմամբ: Այդ ամենից հետո բերվում է հեջավորման պարզ օրինակ և հաշվարկվում է հեջավորման օպտիմալ գործակիցը:

Հիմնաբառեր. *հեջավորման գործակից, հեջավորման արդյունավետություն, Մարկովյան փոփոխման մոդել, անընդհատ փոփոխվող հեջավորման գործակից, հաստատուն հեջավորման գործակից, ֆյուչերս պայմանագրեր*
JEL: G32, G39

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Эффективность хеджирования: подход переключения Маркова.– Вычисление точного коэффициента хеджирования является ключом к эффективному хеджированию с использованием фьючерсных контрактов. В этой статье используется модель переключения Маркова для вычислений коэффициента хеджирования и оптимального количества контрактов для каждого режима. Помимо этого обсуждаются различия между постоянными и изменяющимися во времени методами, особенно OLS, GARCH-M, модели State-Space. Поскольку модель переключения Маркова не является ни постоянной, ни изменяющейся во времени, показаны ее преимущества перед другими методами. После этого обсуждается простой пример ситуации хеджирования и вычисляется оптимальный коэффициент хеджирования.

Ключевые слова: *коэффициент хеджирования, эффективность хеджирования, модель переключения Маркова, изменяющийся во времени коэффициент хеджирования, постоянный коэффициент хеджирования, фьючерсные контракты.*
JEL: G32, G39