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A TIME-VARYING DYNAMIC ANALYSIS OF FACTORS AFFECTING THE LEVELS OF UNDERPRICING, AVERAGE PRICING, AND OVERPRICING OF THE US DOLLAR IN GLOBAL DERIVATIVES MARKETS

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ABSTRACT

Purpose- The aim of this study is to calculate the coefficient parameters of the factors affecting the pricing in the low, average, and overpricing intervals and points of the US Global dollar index and then to investigate the dynamic historical effects of these parameters.
Methodology in the study, "Quantile Regression" to calculate parameter differences in pricing intervals and "Kalman Filtering" methods to calculate their historical dynamic effects.
Findings- In the design of the study, The intervals are 0.5-0.95 incremental overpricing, 0.5 (Median) average, and 0.05-0.5 (Median) underpricing (low-pricing). The study's results show that model 0.4. quantile has respectively the highest value R2 and adjusted R2 values, approximately 53.2 percent and 49.1 percent. Additionally, the probability value of all 19 estimated models is statistically significant at the 0.05 level. While the coefficients of the Baltic Dry Index (at 5%), the Global gold prices (at 5%), and the US 10-year bond yields (10%) are negative, the coefficients of the Nasdaq (10%) and Vix (5% and 10%) have positive signs. These variables are significant in the underpricing quantiles that conducted interval of the US Dollar index (0.05-0.5) in the research design. The price point that represents the median value yields the same results. From that point of view, only the Vix index is significant and only at a 10% level. The Baltic Dry Index (5%), Bitcoin and Gold prices (5% and 10%), US 10-year interest rates-yields (5%), and CDS premium are among the factors that are relevant in the high-quantile overpricing range of the US Dollar index (0.05-0.5). (5 percent and 10 percent), Although the variables' coefficients are negative, the coefficients for inflation (at 5% and 10%), Nasdaq (at 5%), and the VIX index (10%) are positive. The dynamic coefficients determined historically and dynamically using the Kalman filtering technique in all quantiles have had the same values.
Conclusion- Since Kalman analysis and quantile regression analysis have different theoretical background, parameter differences in underpricing and overpricing periods may be eliminated when historical dynamics are examined. As a result, even though the findings of quantile regression and the results of Kalman analysis were roughly parallel, the predicted parameters for some variables did not closely match the effects of either technique. The literature has noted that research utilizing both methodologies might run into such statements that can be encountered in the study's findings under comparable circumstances (Bernardi v., 2016: 34). Additionally, as the geopolitical risk index conveys countercyclical hazards, the rising geopolitical risks in the historical coefficients raised the US dollar index, according to Kalman's study.

Keywords: Global US dollar ındex, derivatives markets, exchange rate shocks
JEL Codes: F30, F31, G13.

1. INTRODUCTION

Derivative instruments, in the simplest terms, refer to financial instruments whose financial value is directly dependent on the importance of another financial asset, commodity, or indicator. In this context, the indicators that are the basis of derivative instruments are commodities, securities, exchange rates, interest rates, statistics, indicators, indexes, etc. can be listed as The most basic usage purposes of derivative instruments are; It can be classified as hedging, speculation, and arbitrage.

Hedging; Derivative instruments protect the sides against possible price flux fluctuations to eliminate or manage potential risks in the spot market or by making purchases and sales today against future price changes.

Speculation; It expresses the gains provided by derivative instrument contracts as a result of changes in prices or rates of underlying commodities, financial indicators, etc.

Arbitrage; Investors who make arbitrage transactions aim to make risk-free profits from price imbalances between markets. In arbitrage transactions, if different contracts and transactions are made simultaneously, a certain profit is guaranteed under all conditions by taking advantage of the imbalances in prices or interest rates without taking any risk. In other words, arbitrage is the process of making risk-free profits.

In this context, although futures transactions are generally based on commodities, futures transactions can also be made on some financial indices. Theoretically, the US Dollar index is one of the most prominent of these indices and the one with the highest trading volume.

US Global dollar index calculated by the International Exchange Group, ICE Futures; It is a financial index calculated by weighting the exchange rates of various currencies against the dollar. Both the calculation method of the Global US dollar index and the theoretical interaction of exchange rates with many economic and financial variables indicate that many parameters may affect the US dollar index.

Changes in economic and financial variables can sometimes be relatively high, and in some cases, they can be, defined as close to stationary or static. Financial variables can have volatility effects due to their theoretical and practical structure. For this reason, the excessive growth of the US dollar index affects overpricing and its extreme decreasing effects on underpricing.

The interaction dynamics and coefficients of exchange rates with other economic and financial variables can be found out shocks and near-stationary changes. The model that is used to measure how the independent variables differ against the changes in the dependent variable's different growth points is the Quantile Regression method. For this reason, the Quantile Regression method examines the effect of the Global US dollar index traded in the Global futures markets with the factors affecting underpricing, average, and overpricing.

In the research; US Global dollar index (Dependent Variable); Baltic dry Index, bitcoin, Euro index, international gold prices, US CPI rate, US 10-year bond yields, US 10-year Euro CDS, Nasdaq index, Global geopolitical risk index, and Vix fear-risk appetite indices were chosen respectively as independent variables. Afterward, Kalman filtering analysis was performed to calculate the variable dynamic coefficients according to the historical time. For this reason, 0.05-0.5 quantile intervals for underpricing, 0.5 quantiles for average values, and 0.5-0.95 meanvely extremely overpricing. Nineteen regression equations were estimated for these selected quantiles, and then the historical dynamic parameters of the independent variables used in the study were determined.

Theoretical underpinnings for the Kalman and quantile regression approaches vary. Furthermore, the kalman analysis transforms the static coefficients of the independent variables of the equation derived from the quantile or any other regression method into dynamic coefficients in the observation range where the regression estimation is made. The quantile method measures the parameters at different growth points of the dependent variable. A systematic comparison of the two approaches is provided by the analysis and interpretation of the experimental evidence, which are presented in the study within the context of theoretical expectations about the global dollar index.

2. GLOBAL DOLLAR INDEX

The Global Dollar index refers to an index priced in the futures markets. The type of this futures market is the futures market. The International Exchange group, ICE Futures, calculates this Index, which is traded over the counter in 13 exchanges, including the USA, Europe, Canada, and Singapore. The Global dollar index is an index that is an indicator of US dollar pricing at the worldwide level. The components of the Index, which are traded 21 hours a day on platforms owned by ICE, consist of 6 different currencies. These currencies are expressed together with their weightings (See Table 1).

Table 1: Global US Dollar Index Components and Weights

Euro (EUR): 57.6% (Composed of 24 Different Currency Weights).
Japanese Yen (JPY): 13.6%
British Pound (GBP): 11.9
Canadian dollars (CAD): 9.1%
Swedish Krona (SEK): 4.2%
Swiss Franc (CHF): 3.6%

Source: https://finanswebde.com/dolar-endeksi/b/5fdf7d6d0f40270039fedcdc, Date of access, 10.01.2022

Three basic issues should be taken into account in the research design and interpretation of the results in the theoretical and experimental researches on the US global dollar index. While the first index is not a parity like the classical exchange rate; Second, the US dollar is the strongest global reserve currency. The third element is that this index is a financial indicator that can be traded in derivative markets.

In this context, while making comments on the Global dollar, index whose parameters will be estimated, examining the dependent variable as a parity and evaluating it as a local currency traded in the spot market will lead to theoretical and empirical wrong conclusions.

On the other hand, the fact that the US dollar is the strongest reserve currency indicates that the index is an important indicator in explaining commercial and financial flows at global and international level.

3. LITERATURE REVIEW

It has been observed that many studies have been carried out on Global dollar index pricing in recent years. In addition, it is seen that many of these studies were carried out, especially in the post-Covid pandemic period. While examining the subject, method, and findings of the studies selected from the literature, chronological order was followed.

Su (2016); analyzed the spillover effect of quantitative easing policies between metal markets and the US dollar index at a daily frequency (14 January 2002 - 15 November 2012) using GARCH and VAR methods. The findings show the negative correlation between the metal markets and the US dollar index after the quantitative easing has been observed much more clearly. In addition, while quantitative easing reduces the risk premium in the dollar index, the cointegration relationship with metal markets approaches the equilibrium point more rapidly.

Sun et al.(2017); investigated the horizontal correlations between US monetary policies, the dollar index, and crude oil prices. According to the study's results with the data observed at a daily frequency (4 February 1994-29 February 2016), US monetary policy operations have a relatively straightforward horizontal correlation behavior and multifractal effects on the time series of the study.

Fernando Eguren Martin et al., (2017); The panel examined the Global role of the US dollar and its consequences with the help of the VAR model. Contrary to the traditional trade channel hypothesis, the study's results show that the US dollar's rise leads growth outside of the US to decline below average (increasing import demand competition against the USA to boost growth in the rest of the world and reducing export competition demand).

Öner (2018); This research looked at how the three major worldwide financial indices, including the VIX, US dollar, and MOVE (Merrill Lynch Option Volatility Estimate) indices examined currency exchange rates between developed and developing nations. The research involves 1007 participants for this aim. daily observations are from May 1, 2013, to May 11, 2017, and include the VIX, the US dollar, and the MOVE index. are examined for causal relationships with the currency rates of the Euro, Brazil, Indonesia, India, South Africa, Turkey, Russia, Hungary, Poland, and Japan. Granger causality test results show that the VIX index affects the Euro. Japanese yen, the Brazilian real, the Indonesian rupee, and the Polish zloty are all affected by the US dollar index. Indian rupees and Russian rubles are driven by the yen and The MOVE index.

Boz et al. (2018); analyzed the relationship between Global trade and the US dollar at a monthly frequency (1989-2015) using the least-squares method. According to the results obtained from the three-country model, shocks in the monetary policy transmission channels of dollar pricing have an asymmetric effect on the USA and the rest of the world.

Stefan Avdjiev et al. (2018); examined the US dollar as a Global risk factor on investments with a quarterly frequency (2001 Q2-2016 Q4) panel data method. According to the results, the strength of the US dollar afts on low growth and actual investments in emerging market economies, and it seems to be an essential macroeconomic effect in contrast to the standard trade channel approach.

İlalan and Pirgaip (2019); investigated the effects of the US dollar index on stock markets in emerging markets a at daily frequency (22 May 2013-22 June 2017) with Granger causality and Rolling correlation analysis. Researchers have found reason and correlation between stock indices, the dollar index, bond purchase reduction, and investment horizon periods. In addition, the results obtained from both methods are consistent with each other.

Adolfo and Barajas et al. (2020); analyzed US dollar funding as a source of financial vulnerability of Global banks. According to the results, US dollar funding costs of non-US banks increase financial stress in emerging markets.

Kumar and Rabianto (2021); gold prices and the volatility effect on the US dollar index; It was researched on the Shanghai and Mumbai stock exchanges with the GARCH method at a daily frequency (16 June 2019- 17 June 2020). According to the results obtained, a positive effect, that is, the volatile effect, was observed in both markets on gold prices; This effect is more

substantial during periods such as the Covid pandemic. On the other hand, while the volatility effect was observed in emerging markets such as China and India for the US dollar index, this effect was not observed in some markets.

Chaudhryvd (2021); the impact of the contagion effect of covid 19 on gold, the US dollar on stock prices; analyzed with the GARCH method at a daily frequency (1 December 2019-31 May 2020). According to the results, the contagion effect between the dollar rate and stock returns was insignificant.

Georgiades et. al (2021); analyzed the relationship between Global risk pricing and the US dollar with the Bayesian VAR model by using monthly frequency (February 1990 - December 1999). According to the results obtained, decreasing in economic activities on a Global scale caused the appreciation of the US dollar. Moreover, It was observed that the appreciated US dollar also negatively affected economic activity through the financial channel.

On the other hand, a literature review was conducted regarding the variables selected in the research design. In this context;

Lee and Hogda (2010); researched the several factors affecting the US dollar index. To determine the relationship between the US dollar index and US economic strength, they chose the S&P 500 index as the US macroeconomic indicators and the industry index as the economic health of each US sector. They also developed models to consider the linkages between each sector index and the dollar index. As a primary indication, interest rates are also being studied. The crucial element, "capital flows," which significantly impacts the US dollar index, has been explained.

Black (2012); argued that alternatives, including commodity, currency, and credit default swaps, also result in more precise estimations of the coefficients, α and β.

Azar (2013); investigated the connections between the price of one particular commodity, oil, and US money supply, inflation, and the US currency. One empirical finding is that throughout the sample period, demand shocks from the US and the rest of the world instantly increased oil prices while delaying their impact on consumer prices. This oil price overshooting is anticipated to happen in the near term and to fade when consumer prices adjust entirely in the long term.

Azar (2015); studied US equities, gold, and oil related to the excess dollar Exchange rates; it was shown that US equities, gold, and oil are all subject to the rule of one price. According to this rule, a 1% increase in the value of the US dollar causes a 1% decline in the price of equities, gold, and oil. The intrinsic returns were determined in the next phase. Asset returns that regard the US currency the same as before are referred to as intrinsic returns. Although the US dollar and raw returns had a little negative correlation, intrinsic returns and the US currency were mainly unrelated.

Gurrib and Elshareif (2016); The Euro/US Dollar currency pair was examined in their study due to the increased correlation between the Euro Index and EUR/USD and the Dollar Index and EUR/USD over the past year compared to the previous 15 years. The study also examines the performance of an optimised fractal adaptive moving average strategy over various frequency intervals.

Curcuru et al.(2018); looked at how these two yield components' changes affected changes in exchange rates and foreign bond yields. They discovered that the dollar is more sensitive to anticipated short-term interest rates than to term premia. In addition, the rise in the dollar's sensitivity to monetary policy pronouncements since the GFC is mostly attributable to the currency's greater sensitivity to anticipated interest rates rather than to term premiums. They also found that changes in short rates and term premiums affect international yields in a manner that is comparable. All things considered, our results refute the widely held belief that conventional monetary policies have stronger global spillover effects than quantitative easing. In summary, their results oppose the widely held belief that traditional monetary policies have higher Global spillover effects than quantitative easing.

Yildirim (2019), in his article, found that over the long term, there was a positive correlation between the DAX Volatility Index (VDAX) and the Dollar Index (DXY) and the VIX Index.

Mokni and Noomen (2020); examined the relationship between crypto-currencies and the US Dollar index using the quantile Granger Causality method. The study aims to look into the causal relationship between the top five cryptocurrencies and the US dollar at various levels of the return distribution. We address this issue based on the Granger-causality in quantiles before and during the ongoing COVID-19 health crisis. The Granger causality test in mean reveals a significant causal association between the two markets, most notably during the COVID-19 epidemic.

Liyan et al.(2020); investigated the potential predictiopowerer of tpredpredictiveexchange rates of fourteen important currencies relative to the US dollar. Panel regression analysis shows that the BDI offers statistically substantial long-run currency return predictability.

Kumar and Rabianto (2021), a summary of the literature on this study, is explained in the first part of the literature review.

Long et al. (2022); researched the geopolitical risk that affected the cross-sectional price of cryptocurrencies. Coins with the lowest geopolitical beta beat those with the high geopolitical beta, according to their analysis of cryptocurrency exposure to changes in the geopolitical risk index. According to research, risk-averse investors need extra incentives to keep cryptocurrencies with low and negative geopolitical betas. Still, they are prepared to pay a premium for assets with high and positive geopolitical betas. The impact was resistant to various factors and could not be explained by an established return predictor.

4. METHOD AND DATASET

The quantile regression methodology and kalman filtering were chosen as the methods of the study. The quantile regression developed by Koenker and Bassett (1978) aims to expand the estimation of conditional quantile functions. This methodology has adopted a prototype that assigns Tukey's three averages as 0.25, 0.50, and 0.75 quantile values to the quartiles. (Koenker, 1984).

The quantile regression estimates are more reliable than the least-squares method against the presence of outliers in the data set.; The most crucial rationale for using quantile regression; is the ability to measure the relationship between a dependent and independent variable more fully and clearly (Ünvan and Demirel, 2020: 180, Conyon et al., 2017: 3-4).

Estimates made by the least squares method in the regression analysis do not constitute a practical estimation in cases where the assumptions cannot be met. In this case, we need alternative regression models. In parametric models, just as the most appropriate mathematical model is selected, alternative regression models should choose and use the most suitable model. One of the alternative regression models is quantile regression, and as in other regression models, this method aims to explain the relationship between variables. Unlike the least squares method, there is no requirement to provide any assumptions about the homogeneity of error variance and the distribution of errors (Yavuz and Işık: 2017).

The quantile method was developed for selected quantiles of the conditional distribution of the dependent variable. Unlike the classical regression model, it does not make any assumptions about the homogeneity of error variance and the distribution of errors. Because of these situations, it can be considered an flexible approach than linear regression. While classical regression searches for a model for the conditional expected value of the dependent variable,; quantile regression determines the model for the quantiles selected in the conditional distribution of the dependent variable. While classical regression is based on minimizing the conditional mean of the dependent variable and the sum of the residual squares, quantile regression functions are based on minimizing the weighted sum of the absolute residuals. If quantile regression model needs to be expressed (Yavuz and Işık, 2017: 140-141); (See equation 1,2,3,4).

$$y_i = x_i' \beta_\theta + u_{\theta_i} \tag{1}$$

It is expressed as. Here, xi is the (kx1) dimensional vector of independent variables and shows the linear regression between the independent variables with the θth quantile of the conditional distribution of the dependent variable yi. βθ is the vector of parameters related to the θ quantile regression. $u\theta i$ is the error vector. The θ, the conditional quantile of yi;

$$Q(y_i / x_i) = x_i' \beta_\theta \tag{2}$$

The objective function of quantile regression is weighted sums of absolute deviations. The objective function for θth quantile regression;

$$\min_{\beta} \frac{1}{n} \left\{ \sum_{y_i \geq x_i' \beta} \theta \left| y_i - x_i' \beta \right| + \sum_{y_i < x_i' \beta} (1-\theta) \left| y_i - x_i' \beta \right| \right\} \tag{3}$$

It is expressed as Expressed by the minimization function below; this function is a linear programming representation of quantile regression.

$$\hat{\beta}_\theta = \frac{1}{n} \sum_{i=1}^{n} \rho_\theta (y_i - x_i' \beta) = \sum_{i}^{n} \rho_\theta (u_{\theta_i}) \tag{4}$$

On the other hand, it is aimed to calculate and interpret the dynamic coefficients of the variables explaining the Global dollar index, which changes over time. For this reason, the Kalman-Filtering method was chosen methodologically in the study. In a linear state-space equation, there are two equations: observation and state. Equations (5) and (6) show the observation and state equations, respectively.

$$y_t = Z\alpha_t \quad + Dw_t + \varepsilon_t \tag{5}$$

$$\alpha_t = T\alpha_{t-1} \quad + Cw_t + v_t \tag{6}$$

αt in Equations A and B; At t time, mx1 dimensional unobservable state vector T: mxm dimensional matrix, which is accepted to be known, C: mxk dimensional coefficient matrix, wt: kx1 dimensional extrinsic variables vector at t time, tε and tv represent zero-mean Gaussian distribution vectors. ty: represents the Nx1-dimensional observation vector at time t, Z: the matrix that relates the Nxm-dimensional yt vector to the state vector, and D: the Nxk-dimensional coefficient matrix. Also, m and k represent the number of states and independent variables. (Harvey, 1990).

The variables used in the study were the US Global Dollar Index (Dependent Variable), Baltic Dry Index, Bitcoin, Euro index, international gold prices, US CPI rate, US 10-year bond yields, US 10-year Euro CDS, Nasdaq index, Global Geopolitical Risk Index, and Vix fear-risk appetite indices. The variables were chosen within the framework of the research design and the pertinent literature (See Table 2). Variables were observed at a monthly frequency, with estimation sample 2010.08-2021.12 and access date for all variables; It is 01.03.2022 (See Table2).

Table 2: Data Set

VARIABLE and ITS' REFERENCE	**CODE**	**SOURCE**
Bitcoin, (Mokni and Noomen, 2020)	Bitcoin	https://tr.investing.com/crypto/bitcoin
Global Dollar Index, (Lee and Hongda, 2010)	GLOBAL_DOLLAR_INDEX	https://tr.investing.com/currencies/us-dollar-index
Fear Index, (Yildirim, 2019)	VIX	https://tr.investing.com/indices/volatility-s-p-500
Baltic Dry Index, (liyan et al., 2020)	BDI	https://tr.investing.com/indices/baltic-dry
US 10-year bond yield, (Curcuru et al., 2018)	US_10YEAR_BOND	https://tr.investing.com/rates-bonds/u.s.-10-year-bond-yield
Gold, (Global Derived), (Kumar and Rabianto, 2021)	GOLD	https://tr.investing.com/commodities/gold
Euro index, (Gurrib, and Elshareif, 2016)	EURO_INDEX	https://tr.investing.com/indices/investing.com-eur-index
US CDS, (Black, 2012)	USA_CDS_10_YEAR_EURO	https://tr.investing.com/rates-bonds/united-states-cds-10-years-eur
Geopolitical Risk Index, (long vd,2022)	GPR	https://www.policyuncertainty.com/gpr.html
US CPI, İnflation (Azar, 2013)	CPI	https://tr.investing.com/economic-calendar/cpi-733
Nasdaq index, (Azari 2015)	NASDAQ	https://tr.investing.com/indices/nq-100

5. FINDINGS AND DISCUSSIONS

First, the Augmented Dickey-Fuller test was performed to determine whether there is a unit root in the time series of the variables. According to the test results, not all variables are stationary at the same level (See Table 3). However, since all variables in quantile regression analysis should be used in raw data format, level values of time series will be used in quantile regression analysis (Wu and Zhou, 2014).

Table 3: Results of Unit Root Tests

Null Hypothesis: Unit root (individual unit root process)
Series: GLOBAL_DOLLAR_INDEX, EURO_INDEX, GOLD, GPR, NASDAQ, CPI, US_10YEAR_BOND, USA_CDS_10_YEAR_EUR O, VIX, BDI, BITCOIN
Date: 05/31/22 Time: 15:16
Sample: 2010M08 2021M12
Exogenous variables: Individual effects, individual linear trends
Automatic selection of maximum lags
Automatic lag length selection based on SIC: 0 to 6
Total number of observations: 1452
Cross-sections included: 11

Method		Statistic	Prob.**
ADF - Fisher Chi-square		124.094	0.0000
ADF - Choi Z-stat		-5.52322	0.0000

** Probabilities for Fisher tests are computed using an asymptotic Chi -square distribution. All other tests assume asymptotic normality.
Intermediate ADF test results UNTITLED

Series	Prob.	Lag	Max Lag	Obs
GLOBAL_DOLLAR_INDEX	0.5869	0	12	136
EURO_INDEX	0.0000	1	6	108
GOLD	0.6920	0	12	136
GPR	0.0000	0	12	136
NASDAQ	0.0445	3	12	133
CPI	0.7795	1	12	135
US_10YEAR_BOND	0.0002	1	12	135
USA_CDS_10_YEAR_EURO	0.5444	3	12	133
VIX	0.0002	0	11	134
BDI	0.0328	0	12	136
BITCOIN	0.9681	6	12	130

Null Hypothesis: Unit root (individual unit root process)
Series: GLOBAL_DOLLAR_INDEX, EURO_INDEX, GOLD, GPR, NASDAQ, CPI, US_10YEAR_BOND, USA_CDS_10_YEAR_EUR O, VIX, BDI, BITCOIN
Date: 05/31/22 Time: 15:19
Sample: 2010M08 2021M12
Exogenous variables: Individual effects, individual linear trends
Automatic selection of maximum lags
Automatic lag length selection based on SIC: 0 to 6
Total number of observations: 1406
Cross-sections included: 11

Method		Statistic	Prob.**
ADF - Fisher Chi-square		598.740	0.0000
ADF - Choi Z-stat		-21.0261	0.0000

** Probabilities for Fisher tests are computed using an asymptotic Chi -square distribution. All other tests assume asymptotic normality.
Intermediate ADF test results D(UNTITLED)

Series	Prob.	Lag	Max Lag	Obs
D(GLOBAL_DOLLAR_INDEX)	0.0000	0	12	135
D(EURO_INDEX)	0.0000	6	6	72
D(GOLD)	0.0000	0	12	135
D(GPR)	0.0000	2	12	133
D(NASDAQ)	0.8963	2	12	133
D(CPI)	0.0000	1	12	134

D(US_10YEAR_BOND)	0.0000	1	12	134
D(USA_CDS_10_YEAR_EURO)	0.0000	2	12	133
D(VIX)	0.0000	0	11	132
D(BDI)	0.0000	0	12	135
D(BITCOIN)	0.0019	5	12	130

In the quantile regression analysis, models and coefficients were estimated for 19 quantile values in the range of 0.05-0.95 within the framework of 20 quantile processes. Pseudo R^2 and Adjusted R^2 values were plotted. In addition, at the eighth quantile value of 0.4, the significance level of the models is highest in quantile, and all models are significant at a 0.05 probability level at all quantile levels (See Table 4, Figure 1).

Figure 1: All Quantile Regressions' Values of R Squared and Adjusted R Squared

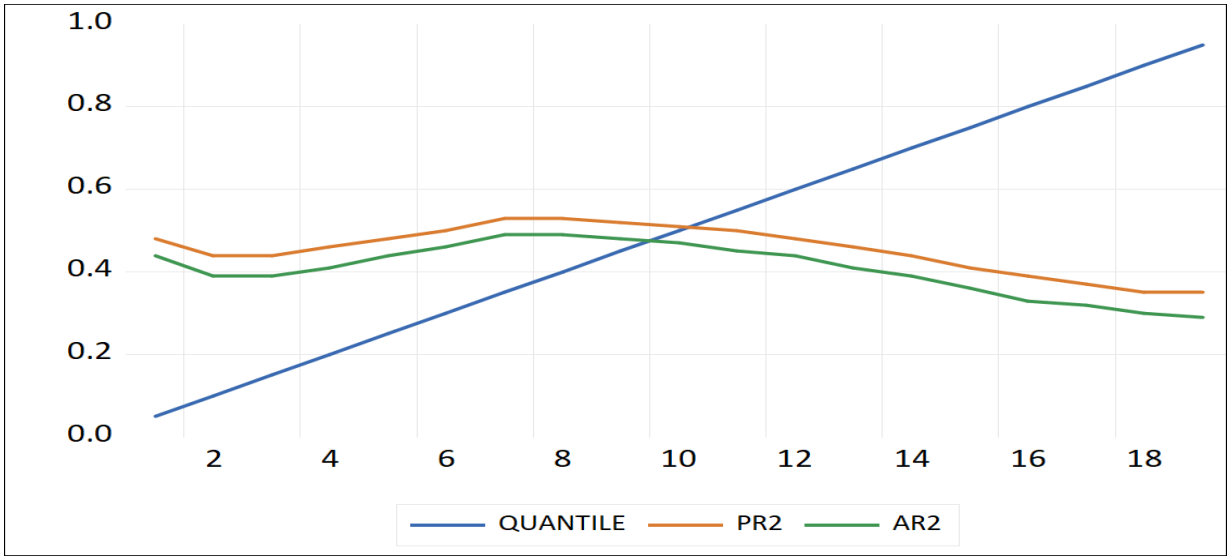
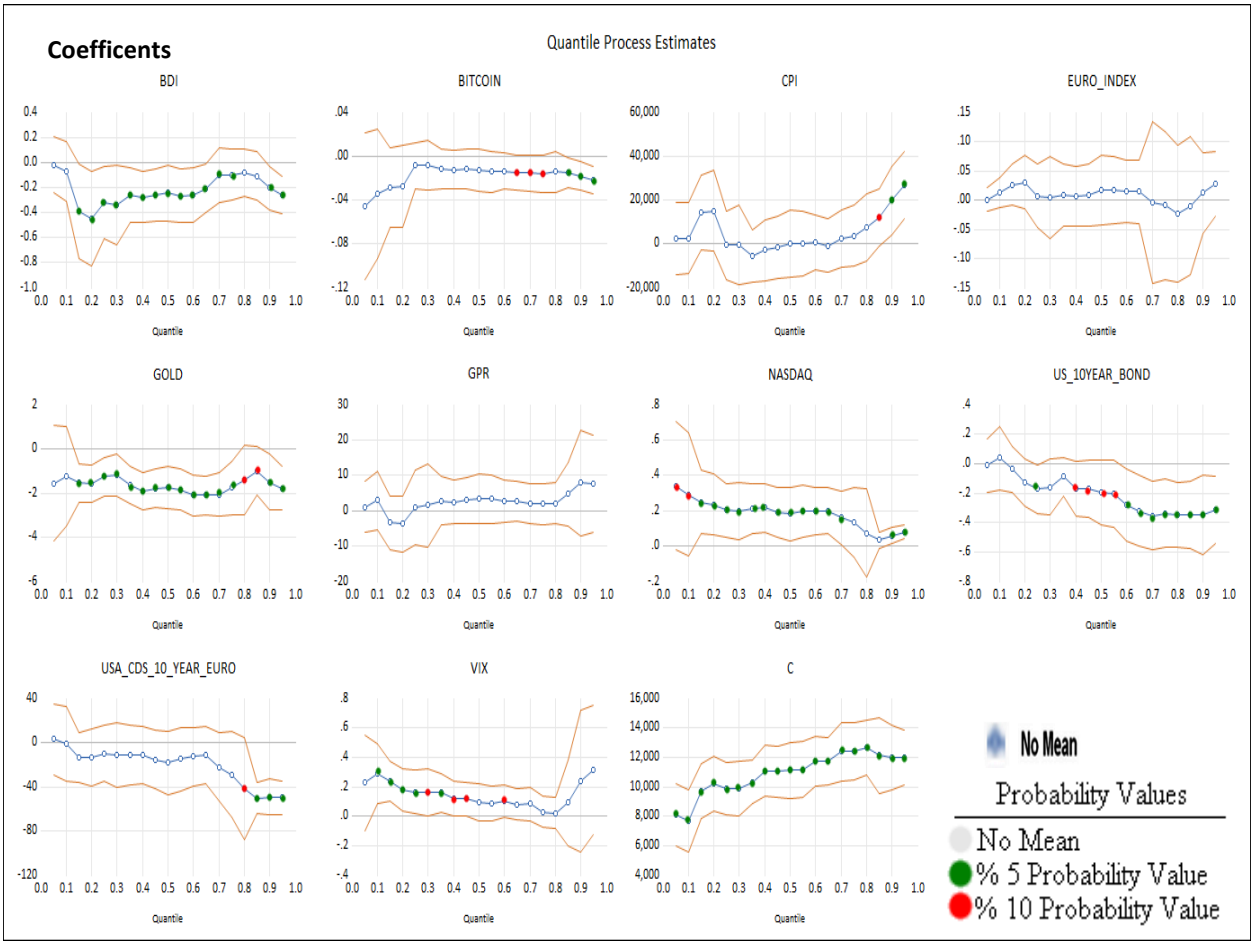


Table 4: Results of Quantile Regression Models

QUANTILE	Pseudo R-squared	Adjusted R-squared	Prob(Quasi-LR stat)
0,05	0.482387	0.437377	0.000000
0,1	0.443051	0.394620	0.000000
0,15	0.439105	0.390332	0.000000
0,2	0.456943	0.409721	0.000000
0,25	0.480758	0.435607	0.000000
0,3	0.503383	0.460199	0.000000
0,35	0.529952	0.489078	0.000000
0,4	0.532368	0.491705	0.000000
0,45	0.524551	0.483208	0.000000
0,5	0.511626	0.469159	0.000000
0,55	0.498418	0.454803	0.000000
0,6	0.481285	0.436179	0.000000
0,65	0.461257	0.414409	0.000000
0,7	0.437808	0.388921	0.000000
0,75	0.412464	0.361374	0.000000
0,8	0.386812	0.333492	0.000000
0,85	0.373308	0.318813	0.000000
0,9	0.352758	0.296476	0.000000
0,95	0.345550	0.288642	0.000000

After testing the significance of the models in 19 different quantiles, coefficient estimation was made. Accordingly, the coefficients of the variables according to 19 quantiles and their significance level at the 5% and 10% probability levels are shown (See Figure 2).

Figure 2: Quantile Regression Coefficient Estimates



- ✓ Coefficients of the BDI variable in all quantiles are negative and significant at the 5% level except for the first 2nd and 17th, and 16th quantiles. In general, the negative coefficients decreased as the quantile level increased. While increases by 0.2 quantiles in the Baltic dry index had the most negative effect on the Global dollar index, this negative effect decreased in the advancing quantiles. Still, it increased again in 0.9 and 0.95 quantiles.
- ✓ Bitcoin prices variable coefficients are negative near zero and 0.65, 0.7, and 0.75. at 10% level. In quantiles; 0.85,, 0.9 and 0.95, It is statistically significant at the 5% level. Excessive increases in Bitcoin prices negatively affected the Global dollar index.
- ✓ US CPI inflation is significant at 0.8 quantile, the at 10% level, at 0.9, and 0.95 quantile at the 5% level, and its coefficient is positive. High-level increases in the inflation variable increase the pricing of the Global dollar index.
- ✓ Although the coefficient of the Euro index variable is positive, it is not significant at any quantile level.
- ✓ The Global gold prices variable is significant in all other quantiles except the first two quantiles. While the significance is 10% at 0.8 and 0.85 quantiles, and it is 5% at other significant qauntiles. Since the coefficient is negative, the increase in gold prices decreases the Global dollar index.
- ✓ Geopolitical risk index coefficients are not significant in any quantile.

- ✓ Nasdaq index coefficients are significant in all quantiles except 0.75, 0.8, and 0.85. and the coefficients are positive. As the number of quantiles increases in the Nasdaq index, the effect of the Nasdaq Index on the Global dollar index decreases.
- ✓ While US 10-year bond yield variable coefficient has no mean between at 0.5-2.5 and 0.3 and 0.35 quantiles, İt has meaningfulness in all other quantiles. it is significant at the 10% level between 0.4 and 0.55 and the level of 5% for differ meaningfulfull quantiles. The coefficents'signs are negative. In addition, the negative coefficient increases as the number of quantiles increases. Excessive increases in US bond yields reduce the Global dollar index.
- ✓ Euro value of US CDS s' coefficients are negative at quantiles 0.85, 0.9, 0.95 at %10 level. At 0.8 quantile; it is significant at the 5% level, and the coefficients a negative. This negative effect is the most significant negative effect among all other variables.
- ✓ VIX fear index coefficients have meaningfulness between quantiles of 0.1-0.25 and at 0.35. quantile at 5% level. The coefficents have meaningfulness at 0.3, 0.4, 0.45 and 0.6 in quantiles at the 10% level. The coefficient is positive and decreases as the number of quantiles increases.

To summarize the results briefly according to the research design, the quantiles between 0.5-0.05 (Median) indicates underpricing, 0.5-average (Median), and 0.5-0.95 overpricing intervals. According to the study's findings, the model in the 0.4.quatile with the highest R^2 and adjusted R^2 values of approximately 53.2% and 49.1. In addition, all 19 predicted models are statistically significant at the 0.05 level regarding probability value. All the results of the research are summarized in Figure 3 (See Figure 3).

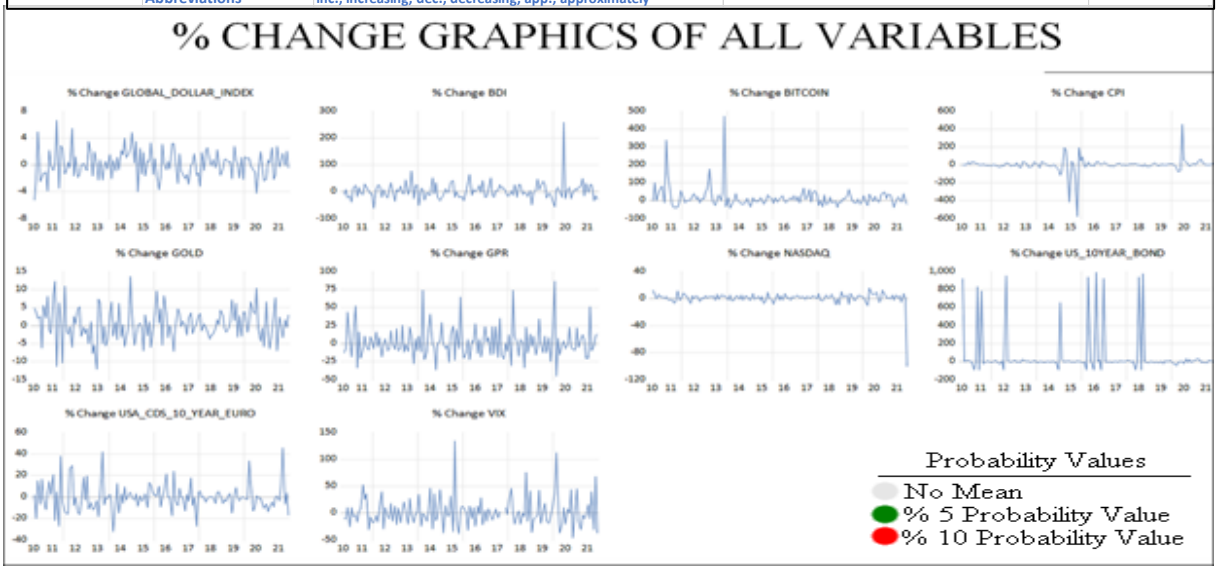
The Baltic dry index and gold prices in the forward markets have negative coefficients at the 5% significance level in the quantile intervals expressing the underpricing interval. The Nasdaq index was significant at the 10% , at the 5% level, and the VIX fear index at the 10% level and the coefficients of these variables were positive. The US 10-year government bond interest rate variable is significant at the 10% level, and its coefficient is negative (see Figure 3).

In the median quantile, which is the mean increase point (0.5), the Baltic dry Index, gold prices, and the Nasdaq index are significant at 5%, and the coefficient signs are respectively; negative, negative, and positive. US 10-year bond yields and VIX index are 10%; coefficients take negative and positive values, respectively (See Figure 3).

In the quantile ranges selected as the over-pricing intervals, Baltic dry index, Nasdaq index, and bond interest rates are significant at 5%, and the coefficients are respectively; negative, positive, and negative. The VIX fear index is significant at the 10% level, and its coefficient has a positive sign. On the other hand, the inflation variable is significant at both 10% and 5% levels in overpricing quantile intervals, and its coefficients are positive signs. Gold and CDS variables are significant at both 5% and 10% levels, and their coefficients are negative (See Figure 3).

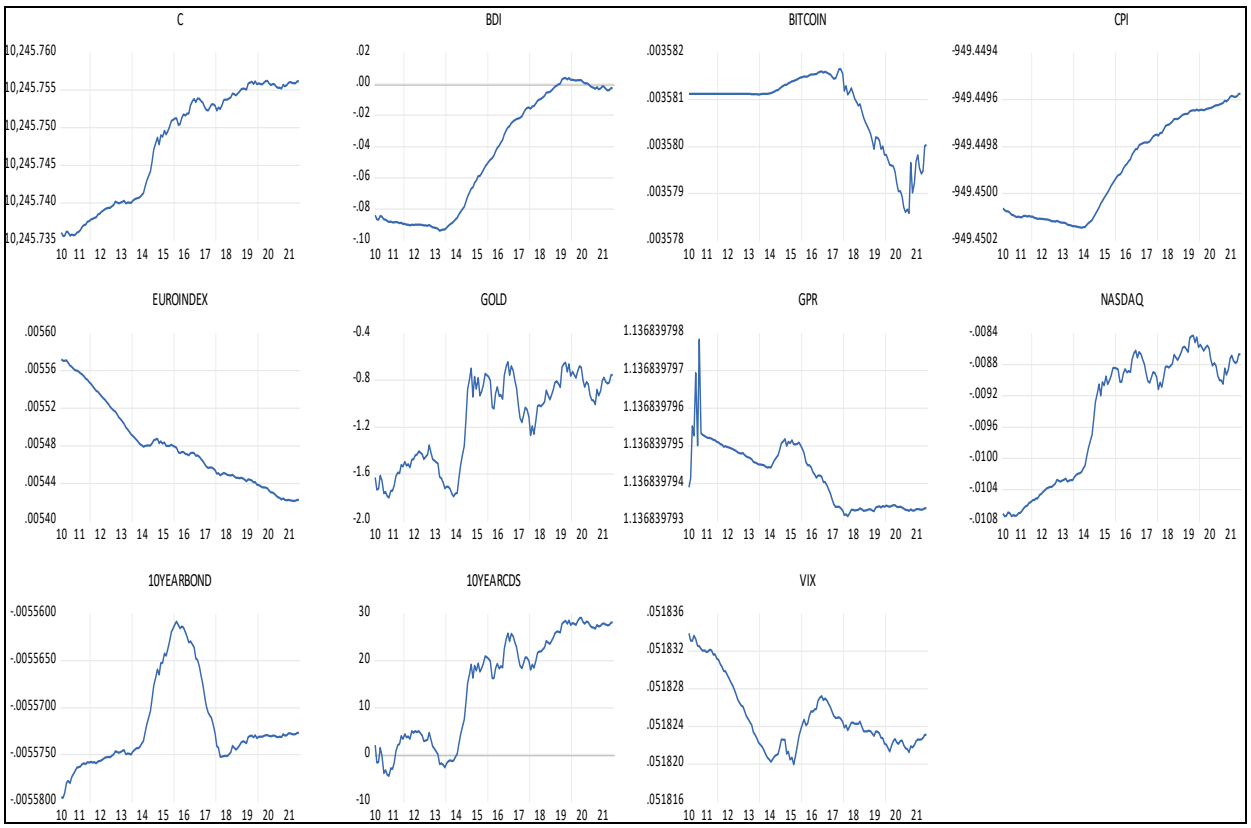
Figure 3: Quantile Regression and Kalman Filtering Combined Results and Data Graphs

		LOW PRICING	AVERAGE PRICING	OVERPRICING
	BDI	NEGATIVE VALUE	NEGATIVE VALUE	NEGATIVE VALUE
	BITCOIN	NO MEAN	NO MEAN	NEGATIVE VALUE
	CPI	NO MEAN	NO MEAN	POSITIVE VALUE
	EURO_INDEX	NO MEAN	NO MEAN	NO MEAN
QUANTILE PROCESS	GOLD	NEGATIVE VALUE	NEGATIVE VALUE	NEGATIVE VALUE
	GPR	NO MEAN	NO MEAN	NO MEAN
	NASDAQ	POSITIVE VALUE	POSITIVE VALUE	POSITIVE VALUE
	US_10YEAR_BOND	NEGATIVE VALUE	NEGATIVE VALUE	NEGATIVE VALUE
	USA_CDS_10_YEAR_EURO	NO MEAN	NO MEAN	NEGATIVE VALUE
	VIX	POSITIVE VALUE	POSITIVE VALUE	POSITIVE VALUE
		% 5 MEANING	%10 MEANING	
	BDI	NO MEAN, NEGATIVE INC. TREND	2012.08-2014.09,NEGATIVE INC. TREND	
	BITCOIN	NO MEAN, POSITIVE DEC. TREND	NO MEAN, POSITIVE DEC. TREND	
	CPI	ALMOST ALL TERMS, NEGATIVE INC. TREND	ALMOST ALL TERMS, NEGATIVE INC. TREND	
	EURO_INDEX	NO MEAN,POSITIVE DEC. TREND	NO MEAN,POSITIVE DEC. TREND	
KALMAN FILTERING	GOLD	ALL TERMS, NEGATIVE INC. TREND	ALL TERMS, NEGATIVE INC. TREND	
	GPR	ALL TERMS, POSITIVE DEC. TREND	ALL TERMS, POSITIVE DEC. TREND	
	NASDAQ	NO MEAN, NEGATIVE INC. TREND	NO MEAN, NEGATIVE INC. TREND	
	US_10YEAR_BOND	NO MEAN, NEGATIVE INC. TREND	NO MEAN, NEGATIVE INC. TREND	
	USA_CDS_10_YEAR_EURO	APP.ONE TO THREE OF ALL TERMS, POSITIVE INC. TREND	APP.ONE TO THREE OF ALL TERMS, POSITIVE INC. TREND	
	VIX	ALL TERMS, POSITIVE DEC. TREND	ALL TERMS, POSITIVE DEC. TREND	
	Abbreviations	inc.; increasing, dec.; decreasing, app.; approximately		



In the next step, the Kalman filter analysis was used to calculate the time-varying dynamic coefficients expressing historical dynamic effects of the variables on the Global dollar index (See Figure 4). For this, 0.5 quantile, which represents the median value and is a high percentage of model explanation, was used. It was also observed that the same coefficients were estimated for all quantiles by using kalman method.

Figure 4: Kalman Filter Results and Time-Varying Dynamic Coefficients



- ✓ The Baltic dry index coefficient was negative until 2018 and became positive after 2018. It started to decrease positively after 2020 and turned negative again.
- ✓ Bitcoin prices have increased positively until 2017. The coefficient shrank between 2018 and 2021, and the increasing effect of bitcoin prices on the dollar index became more vital in the post-2020 pandemic period.
- ✓ The inflation variable remained negative until 2014, and its negative impact on the dollar index continued to decrease during the post-2014 period of financial fragility risks in Global markets and inflationary pressure caused by the pandemic.
- ✓ The effect of the Euro index decreased, close to zero, in parallel with the quantile regression analysis.
- ✓ The dynamic effect of gold prices continued in a negative and increasing trend.
- ✓ The impact of geopolitical risks has been positively decreasing.
- ✓ The dynamic effect of the Nasdaq index; continued by converging to zero in the increasing trend in the negative.
- ✓ The effect of the US 10-year bond interest rates increased negatively until 2014 and converged to zero.
- ✓ The impact of the US 10-year CDSs turned negative between 2010 and 2011, then positive, but converged to zero in 2014. This effect continued to increase in the following years.
- ✓ The effect of the VIX fear index is positive, converging to zero. However, this effect has shown a decreasing trend over the years.

The coefficients obtained from the estimated dynamic equations were divided by the calculated standard errors, and the "T" statistics values were calculated. Since the degrees of freedom of the data set are 10, to estimate the statistical significance of the dynamic coefficients at the 5% and 10% levels, a comparison was made with the values of 1,372 and 1.833, which correspond to the 10th degree, respectively, in the T table (See Figure 5 and 6).

Figure 5: Kalman Filter Results and Time-Varying Dynamic Coefficients T Statistical Values

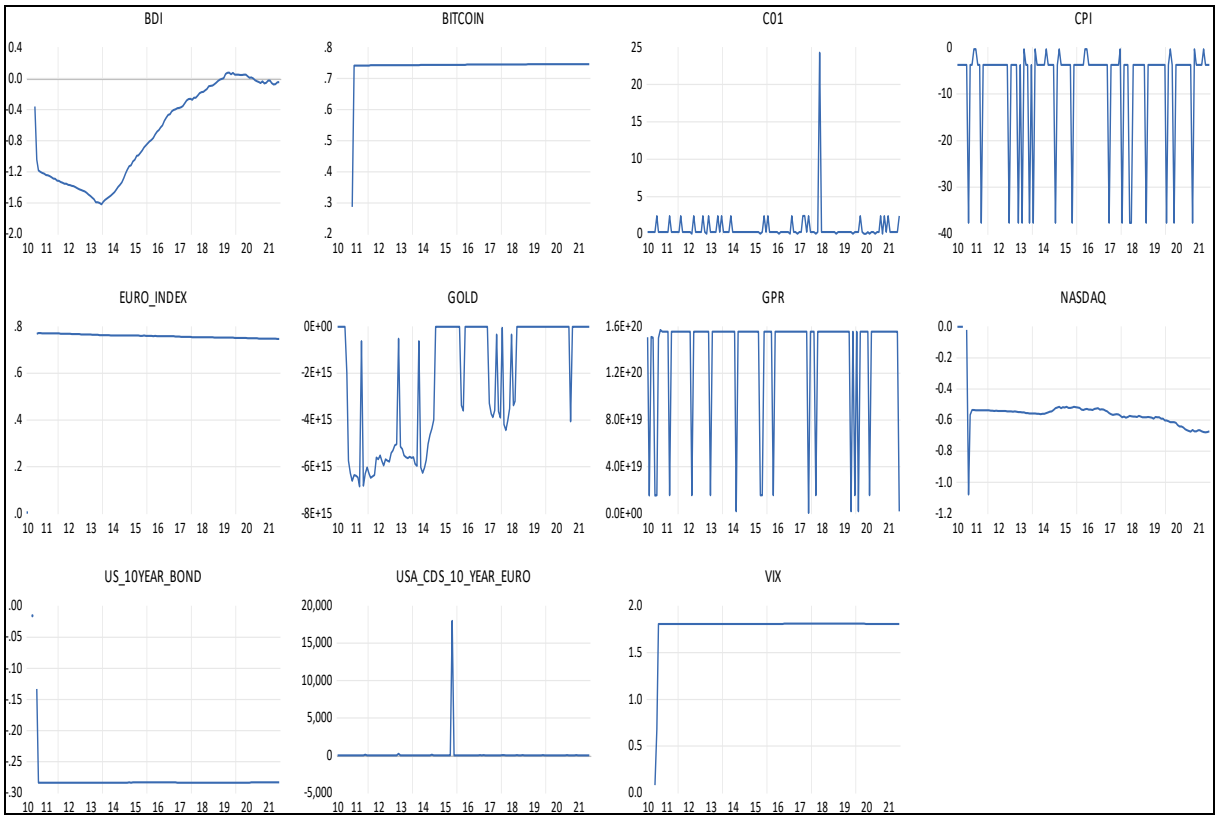
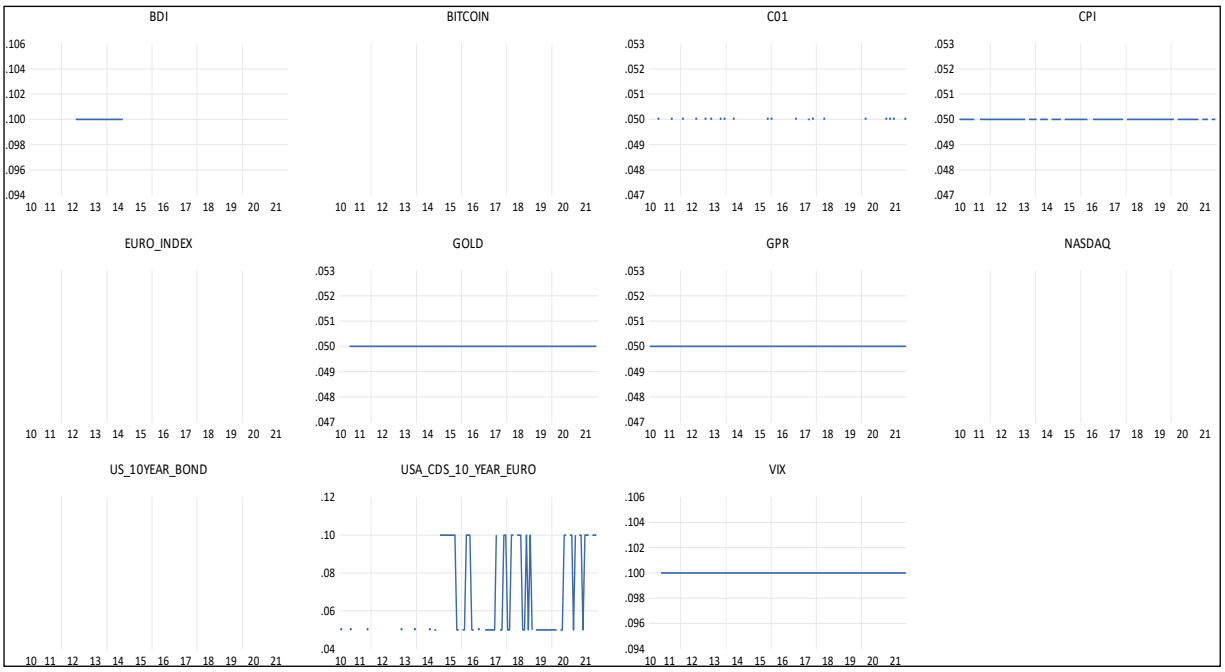


Figure 6: Kalman Filter Results and Time-Varying Dynamic Coefficients T Statistical Values and Significance at 0.05 and 0.1 Levels



6. CONCLUSION

Many economic and financial variables are influential in today's Global economic and financial order and the interaction dynamics of these international structures with local financial markets and systems. Among these variables, some have a secondary effect; some have a primary effect, that is, a determinant effect on all other variables.

In theory, these variables are exchange rates, interest rates, and inflation rates. Systemic, systematic, and non-systematic risks on a country basis are the main parameters that determine the value of the local currency against foreign currencies. Since it is generally acknowledged that the US dollar is the strongest currency in the global system and that it is the most widely used reserve currency of implementation in international commercial and financial flows, its value relative to other currencies is regarded in this context as the leading indicator of exchange rates for other countries. The value of the US dollar can be calculated as an exchange rate for each country's currency and as an index by international financial institutions. One of these indices is the "US Global Dollar Index" calculated by the International Exchange Group (ICE Futures).

Structural shocks or economic-financial recessions in Global and local economies may cause exchange rate pricing to be excessive or very low, Many economic and financial variables affect this pricing. In this context, "Quantile Regression," which provides parameter coefficient estimation in different quantiles. It refers to different growth-increase rates in the dependent variable. Because the method was chosen as one of the methods to be used in the study to estimate how the parameters are affecting the underpricing, average pricing and overpricing in the Global US dollar index, the study's dependent variable of the study.

Another method used in the study is the "Kalman Filtering" method, which is used to calculate time-varying dynamic coefficients historically in the observation-estimation interval of the study in any classical regression equation. In the research; US Global dollar index (Dependent Variable); Baltic dry Index, bitcoin, Euro index, international gold prices, US CPI rate, US 10-year bond yields, US 10-year Euro CDS, Nasdaq index, Global geopolitical risk index, and Vix fear-risk appetite indices were chosen as independent variables. . The time series were observed at a monthly frequency. The observation-estimation interval was determined as 2010.08-2021.12. In this context, regression equations and parameter coefficients were calculated for 19 quantile values in the interval of 0.05-0.95 qauntiles.

In the next step, to make more meaningfulness of the results obtained in the quantile regression models, the Kalman Filtering method, which is used to calculate the time-varying coefficients, was used. In this method, time-varying dynamic coefficients were calculated in the observation interval of the study from the regression equations calculated for both under, average and over pricing qauntiles intervals. However, these coefficients took the same values in all quantiles despite the change in quantile level. Accordingly, dynamic coefficients were calculated with the equations obtained at 0.05, 0.5, and 0.95 quantile levels. The coefficients obtained from the estimated dynamic equations were divided by the calculated standard errors, and the "T" statistics values were calculated. Since the degrees of freedom of the data set are 10, to estimate the statistical significance of the dynamic coefficients at the 5% and 10% levels, a comparison was made with the values of 1,372 and 1.833, which correspond to the 10th degree, respectively, in the T table.

To interpret the Kalman filtering results, which are used to calculate time-varying dynamic coefficients, integrated with quantile regression, combined results from expressing the effects of both methods were prepared (See Figure 6).

The study's data set performed the dynamic analysis at 0.05, 05, and 0.95 quantile levels. The technique was done with the Ewiews 12 Program. Dynamic coefficients were calculated precisely the same in all three quantiles. This indicates that it can be argued that the parameters that change according to the quantiles of the dollar index value, which are expressed as low or high growth rate, can be eliminated in the historical analysis. On the other hand, being able to more clearly observe the dynamic effects of the Kalman results and the growth rates of the dependent variable in the quantile analysis is essential in achieving the research objectives. Because; If we need to interpret the variables in order, within the framework of the figure whose results express the % changes in the raw data graphs of the variables; (See Figure 6).

The coefficient of the Baltic dry index remains negative, as in the pricing ranges; dynamic coefficients are significant only at the 10% level between 2012.08-2014.09). When we look at the % change graph, it is seen that the growth in the dollar index variable was high in this period.

While Bitcoin prices are not significant at the 5% and 10% levels in the time-varying analysis, the coefficient is increasing positively. In the quantile regression, the coefficient signs take negative values at 5% and 10% in the overpricing range.

The inflation variable coefficient is significant at 5% and 10% over time. In addition, almost all periods, it is in an increasingly negative trend; that is, it approaches zero. With this, in quantile regression, only the overpricing period was significant at both the 5% and 10% levels, and the coefficient took positive values. In other words, the inflation variable coefficient, which approaches zero in the observation interval and is negative, can bring positive values in the overpricing interval.

The Euro index variable was not significant for both analysis methods. With this, The coefficients varied with time, and most of the coefficients in the quantiles were positive.

The gold variable takes negative values in both methods and is significant at the 5% level. It was also significant at the 10% level in overpricing ranges. However, this negative effect increases by approaching zero in coefficients that change over time.

The geopolitical risk index variable is not significant in the selected quantile ranges; partially parallel with this result, it approaches zero in the positive and is significant at the 5% and 10% level in the coefficients varying according to time.

Nasdaq index historical values coefficients are not significant. However, it is statistically significant in the selected pricing ranges (10% in underpricing, 5% in others), and the coefficient has a negative sign in both methods.

The variable of US 10-year bond yields was not significant in kalman analyses. However, its coefficient has a negative sign. It was significant in the quantile intervals, but the coefficient took negative signs as the results of kalman analyses.

In terms of quantiles, US CDSs are significant only at the 5% and 10% levels in the overpricing ranges of the US dollar, with a negative coefficient. With this, in the kalman method, the coefficients at the 5% and 10% are significant in some periods, and it has been observed to increase in the positive.

Although the VIX fear index has positive values in all quantile ranges and is significant at the 5% and 10% levels, this positive effect is the quantiles expressing the pricing intervals. It has been observed to decrease with time-varying coefficients.

Using two methods whose research assumptions differ may reveal the problem of partially one-to-one matching in terms of both approaches' results and theoretical expectations. With this, the study shows that the results of the two methods are similar. Statistical significance tests were conducted to examine the different variables' results better. In this context, the variables whose results are not compatible with each other in terms of both methods; are inflation (partially), geopolitical risk index, Nasdaq index, and US 10-year bond rates. Therefore, clarification of these points theoretically is essential in achieving the research aims. In addition, deepening the analysis of the baltic dry Index will contribute to the purpose of the research.

In this respect, as can be interpreted from the results of the inflation variable, it can be stated that takes positive values in ranges the US dollar index where it is overpriced and negative values in other pricing ranges.

Although the geopolitical risk index is not significant in the selected pricing ranges being substantial and positive in time-varying coefficients, It can be argued that geopolitical risks are because they are countercyclical. As a theoretical expectation, increased risks increase exchange rates. In this context, the time-varying coefficients of geopolitical risks are also positive in parallel.

While the Nasdaq index variable had positive values in quantile intervals, it had negative values in the Kalman analysis; but it is not statistically significant. In this context, by the theory, increasing US stock returns will increase the US dollar index, as it will increase the US dollar's return. In this context, while making theoretical interpretations, the variable used in the study is not parity but an index. In this context, in a two-country model and the other country's currency/US dollar parity, the decrease in the risks of the USA will strengthen the value of the US dollar against the other currency.

Theoretically, increasing interest rates in the US 10-year indicators can increase the value of the US dollar against other countries in terms of parity. With this, As we can define again, the critical point is that since the selected variable is an index value, the degree of divergence of the bond rates of the countries in the Index in terms of US interest rates will determine the direction of the Index. In this context, benchmark interest rates in other countries included in the dollar index were generally above the US indicators. Therefore, the negative coefficient of the variable is in line with the theoretical expectations. In this context, if we need to interpret the results of other variables with academic expectations;

increase in the Baltic dry index; As a result, it shows that volume of international trade and finance flows are higher. Accordingly, the realization of an increase in the Index will reveal more commercial and financial flows and Global movement of the US dollar as a reserve currency outside the USA. In this context, it can be argued that since the currencies constituting the calculation of the US dollar index will gain value against the US dollar, decreases may be observed in the US dollar index. In this direction, if we need to rank the results obtained in the research;

While the Baltic dry index (at 5%), global gold prices (at 5%), and US 10-year bond rates (at 10%) have negative coefficients, the Nasdaq (10%) and Vix (at 5% and 10%) indices have positive coefficients. These variables are significant in the low quantile pricing range of the US Dollar index (0.05-0.5).

The same results are valid for the pricing interval that expresses the median value. Only the Vix index is significant only at the 10% level.

In the high-quantile overpricing interval of the US Dollar index, the Baltic Dry Index (5%), Bitcoin prices (5% and 10%), Gold prices (5% and 10%), US 10-year interest rates (5%), and CDS premium (5% and 10%) are the variables that are significant (0.05-0.5).While these variables' coefficients are negative, the inflation (at 5% and 10%), Nasdaq (at 5%), and Vix index (10%) variables' coefficients are positive.

The dynamic coefficients calculated retrospectively according to the Kalman filtering analysis have historically taken the same values in all quantiles.

For this reason, parameter differences in underpricing and overpricing intervals can be eliminated when retrospectively analyzed. The reason for this can be explained as follows;

The theoretical basis of Kalman analysis and quantile regression analysis is different. Therefore, although the Kalman results broadly estimated parameters parallel to the quantile regression results, the estimated parameters for some variables did not match the effects of both methods to the same extent. In other studies in the literature in which both methods are used, it is observed that situations related to this incompatibility are encountered (Bernardi et al., 2016: 34).

In addition, since the geopolitical risk index expresses countercyclical risks, the increasing geopolitical risks in the dynamic coefficients increased the US dollar index.

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