

Application of Composite Frequency Data Analysis Model to Forecast the Growth of Vietnam's Coffee Exports



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ABSTRACT: In recent years, mixed-frequency data analysis models have received much attention and application in the fields of economics and finance, especially in forecasting national macroeconomic indicators. However, in Vietnam, there are almost no studies applying these models. Vietnam is a country with a long-standing agricultural production background and the workforce mainly makes a living from farming. There are many types of Vietnamese agricultural products with high export value, bringing a significant source of foreign currency to the country. Coffee is Vietnam's main export product, a product that earns a lot of foreign currency, contributing to the country's socio-economic development. Therefore, applying models with mixed frequency data such as MIDAS to forecast coffee export growth is a promising new research direction.

KEYWORDS: forecast, export growth, coffee

1. INTRODUCTION

In the context of the world economy in general and the Vietnamese economy in particular appearing more and more frequently unstable factors, accurately analyzing and forecasting the movements of economic indicators is essential. Macroeconomics is extremely important in policy management and macroeconomic stability. A good analysis and forecast result will help the economy avoid disruptions, limit risks, and take advantage of development opportunities. Analyzing and forecasting macroeconomic indicators in general and forecasting export turnover in particular is always an urgent requirement, especially for a developing country like Vietnam, an open economy. Due to its small scale, it is vulnerable to adverse external fluctuations. Therefore, researching and finding appropriate forecasting methods for Vietnam's export turnover is important.

Over the past several decades, Vietnamese coffee production has developed as an export-oriented industry. Although coffee has gone through many ups and downs, fluctuations in output, turnover and export prices, it is always a key industrial crop, strategically linked to the lives of tens of thousands of producers, contributing to improve living standards and income for thousands of workers.

As the world's second largest coffee producer and exporter, our country's coffee products have been exported to more than 80 countries and territories, especially markets such as the United States and the EU. , Japan, Korea, with the signing of free trade agreements, Vietnam's coffee export industry in recent years has increasingly improved in quality and output, enhancing competitiveness. Compete with other countries.

However, deep international integration will cause Vietnam's economy to suffer strong fluctuations due to shocks in the international market, typically the Covid-19 pandemic. When global supply chains break down, it will significantly affect the connection points of the chain (including Vietnam), thereby, there will be certain impacts and risks on export activities in general. General and coffee export activities in particular. Therefore, forecasting coffee export growth in the coming period is a concern not only for researchers but also for policymakers in each country in the world.

This reality creates an urgent need to build new layers of models to better forecast unusual fluctuations in the short term, promptly meeting the requirements of macroeconomic management. The mixed-frequency data analysis model has the great advantage of making the most of high-frequency data collected (day, week, month) to make predictions for the dependent variable with low-frequency data. (Year quarter). According to Kuzin's (2011) research, the mixed frequency data analysis method shows effectiveness in short-term forecasting of macroeconomic indicators; According to Yu Jiang and research team (2017), forecasting methods using mixed frequency data have better accuracy than traditional forecasting methods. Therefore, in this study, the mixed-frequency data analysis model is applied to best exploit data collected with different frequencies (daily, monthly, and

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quarterly) and from many activities. Different economic sectors/regions to instantly forecast the growth rate of Vietnam's coffee exports. The experimental results are expected to create a premise to further promote the application of mixed-frequency data analysis models for forecasting other important macroeconomic indicators that government agencies need. The government needs to monitor for policy planning, and at the same time serve as a basis for integrating mixed-frequency data regression techniques into the quantitative analysis model system of policy-making agencies to meet the needs of the government. The goal of manage macroeconomic policies in general and coffee export policies in particular in the new period of Vietnam.

2. OVERVIEW OF MIXED FREQUENCY DATA ANALYSIS MODELS

The mixed frequency data analysis model (MIDAS) was proposed by the author group Eric Ghysels, Arthur Sinko & Rossen Valkanov in 2002. The mixed frequency data analysis model is the regressions. The reduced-form parameterization involves sampling processes at different frequencies. In which, the explanatory variables have different frequencies, equal to or higher than the frequency of the dependent variable, and for explanatory variables with higher frequencies, lagged distribution polynomials are used to prevent the increase in frequency. Increase in the number of parameters as well as problems related to the choice of delay order.

Basic mixed frequency data analysis model for one explanatory variable and the next step with $h_q = h_m/m$ is defined as follows:

$$y_{t_q + mh_q} = y_{t_m + h_m} = \beta_0 + \beta_1 b(L_m; \theta) x_{t_m + w}^{(m)} + \varepsilon_{t_m + h_m}$$

In there:

- y is the dependent variable with low frequency; x is an explanatory variable with high frequency.
- t_q is the time at which low-frequency data is available, t_m is the time when y has high frequency data available and h_q is the low frequency forecast time; h_m is the time of high frequency forecasting.
- m is an index that determines the higher frequency of the independent variable compared to the dependent variable. For example, if y has a quarterly frequency and x has a monthly frequency, then $m = 3$, and if y has a quarterly frequency and x has a weekly frequency, then $m = 12$.

- $b(L_m; \theta) = \sum_{k=0}^K c(k; \theta) L_m^k$ is the lag polynomial with L_m is the delay operator defined by:

$$L_m^k x_{t_m}^{(m)} = x_{t_m - k}^{(m)} \cdot x_{t_m + w}^{(m)} \text{ sampled from high-frequency variables } x_{t_m}$$

- $c(k; \theta)$ are the parameters of the model's lag coefficients that need to be estimated.

One of the main problems of the MIDAS method is to find a suitable parameterization for the lag coefficients $c(k; \theta)$. Because x_{t_m} has a higher frequency y_{t_q} , full modeling often requires multiple lags in the regression equation, which can lead to over-parameterization. Some popular weighting schemes for parameterization such as Almon are also called "Exponential Almon Delay" corresponding to the Almon delay function. Specifically, the Almon diagram is represented as follows:

$$c(k; \theta) = \frac{\exp(\theta_1 k + \dots + \theta_Q k^Q)}{\sum_{k=1}^K \exp(\theta_1 k + \dots + \theta_Q k^Q)}$$

Where Q is the number of parameters of θ , or $\theta = (\theta_1, \theta_2, \dots, \theta_Q)$ are the parameters that need to be estimated. This function is quite flexible and can take many different shapes with just a few parameters. They can be ascending, descending or concave patterns. Ghysel, Santa-Clara, and Valkanov (2005) used this functional form with two parameters, which allows great flexibility and determines how many lags are included in the regression. Because the Almon lag scheme is the most commonly used and highly flexible, in this study the authors used the Almon lag scheme to determine appropriate parameterizations for the lag coefficients of the model.

Mixed frequency data analysis models are widely used in the financial sector; macroeconomics and was developed by Ghysels and a number of authors to produce extended models of unrestricted mixed frequency data analysis or U-MIDAS (a model for analyzing data with mixed frequency The mixture is supplemented with various restrictions on the influence of high-frequency variables by having each higher-frequency factor identified as an explanatory variable in a low-frequency regression, analyzing high-frequency data. STEP weighted mixed probability or STEP-MIDAS (which is a U-MIDAS model where the coefficients for high-frequency data are constrained using the STEP function, augmented polynomial lag MIDAS model or ADL-MIDAS (where, for each high frequency up to k , the regression coefficients of the high-frequency components are modeled as a p -dimensional lag polynomial), the exponential Almon weighted MIDAS model or EAW-MIDAS (which is a MIDAS model using exponential weights

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and second-order lag polynomials), β -weighted MIDAS model or BW-MIDAS (which is a MIDAS model using β -weighting function) (Andreou, Ghysels, and Kourtellis 2010; Ghysels, Kvedaras, and Zemlys 2016; Kvedaras et al. 2021). In particular, the U-MIDAS, STEP-MIDAS, and ADL-MIDAS models are estimated using the least squares (OLS) linear regression method, while the EAW-MIDAS and BW-MIDAS models are estimated using the least squares nonlinear regression method. The advantage of the mixed frequency data analysis (MIDAS) model is that, in addition to overcoming the problem of mixed frequency data, it also reduces the number of estimated parameters and simplifies the regression model. The weighting function is used to reduce the number of parameters in MIDAS regression. According to published research results, mixed-frequency data analysis models are often effective for immediate forecasting and short-term forecasting.

3. RESEARCH DATA

3.1. Data source

The research was conducted on a data set of macroeconomic indicators, collected with different frequencies (quarterly, monthly, weekly) from websites such as the General Statistics Office, the General Department of Customs, and the IMF. , WB,... in the period from 2019 to 2023. The reason for the authors to choose the period 2019 - 2023 is because the COVID-19 pandemic broke out strongly in 2020, the entire economy, economic indicators The macroeconomic economy has strong fluctuations, which contributes to increasing the testability of the model.

In this study, the authors forecast Vietnam's coffee export growth rate quarterly using the basic MIDAS model in which independent variables are selected at different frequencies. Analyzes were performed on Excel and Eviews 12 software.

3.2. Variables included in the model

To forecast export growth rate by quarter, the research team based on a data set of 22 variables corresponding to 19 economic indicators (of which: 5 quarterly frequency variables, 14 monthly frequency variables) and 3 inverters. weekly rate, described in detail in Table 1, Table 2, Table 3.

Table 1: Quarterly frequency economic indicators

Variable	Unit	Economic Index
TTXK_Q	(%)	Export growth
TTGDP	(%)	GDP growth
CCTT	(%)	Balance of payments
DTTR	(%)	Net direct investment
TKV	(%)	Capital account

Table 2: Monthly frequency indicators

Variable	Unit	Economic Index	Variable	Unit	Economic Index
TTDSBL	(%)	Retail sales growth	TDTQT	(%)	Total international reserves (excluding gold)
TTSXCN	(%)	Industrial production growth rate	TTNK	(%)	Growth of goods imports
TTCT_M	(%)	Money supply growth	CCTM	(%)	Balance of trade
TLDT_M	(%)	Reserve ratio	LP	(%)	Inflation rate
CSGCP	Index	Composite stock price index	USD_M	USD/VND	USD/VND exchange rate (1 month average)
LS	(%)	Interest rate	V_M	USD/OUNCE	Gold futures contract
CSTGHD	Index	Exchange rate index	DT_M	USD/barrel	Crude oil futures contracts

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Table 3: Weekly frequency economic indicators

Variable	Unit	Economic Index
USD_W	USD/VND	USD/VND exchange rate (1 week average)
V_W	USD/OUNCE	Gold futures contract
DT_W	USD/barrel	Crude oil futures contracts

4. FORECAST RESULTS OF VIETNAM'S QUARTERLY COFFEE EXPORT GROWTH

4.1. Vietnam's coffee export growth situation in the period from 2019 - 2023

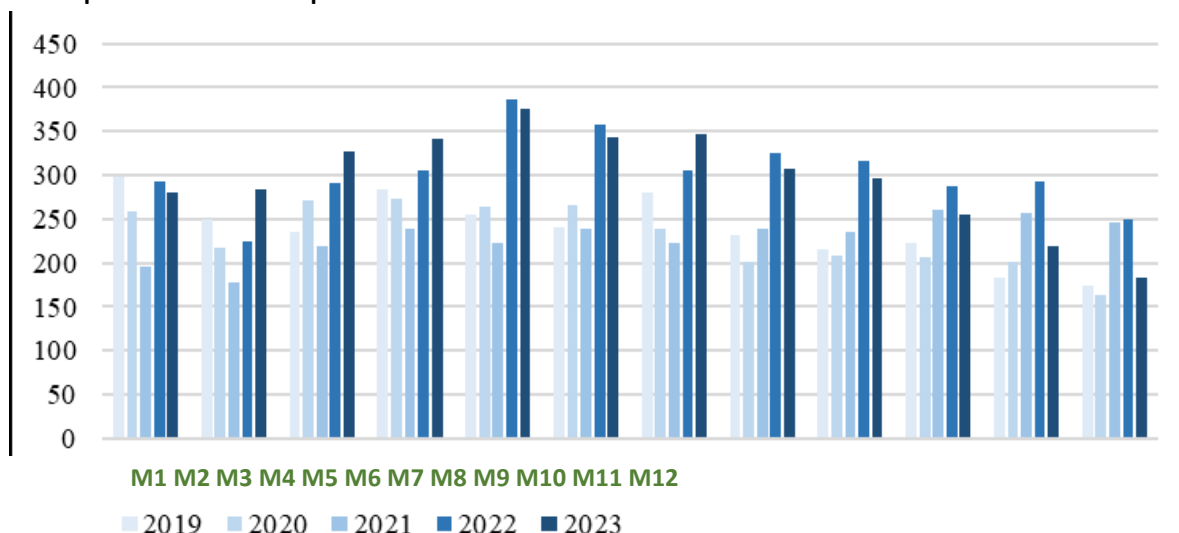
For many years, Vietnam has always been the second-largest coffee exporting country in the world, and the world leader in robusta coffee exports, present in more than 80 countries and territories, accounting for 14.2%. Global green coffee export market share (ranked 2nd, after Brazil). In particular, exported roasted, ground, and instant coffee has accounted for 9.1% of the market share (ranked 5th, after Brazil, Indonesia, Malaysia, and India). The EU is the largest consumer market for Vietnamese coffee, accounting for 40% of the total volume and 38% of the country's total export turnover; followed by Southeast Asia, accounting for 13% of total volume and total turnover. Coffee exports have grown strongly in the period 2019-2023, a period of crisis due to the Covid-19 pandemic and geopolitical conflicts.

Figure 1: Vietnam coffee export turnover in the period 2019 - 2023

Unit: US Dollar Billion

	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12
2019	297,862	249,898	234,626	283,049	254,661	240,809	280,683	231,527	215,145	223,529	183,889	174,635
2020	259,475	218,093	270,987	273,654	263,786	265,115	239,113	200,381	208,31	206,434	200,73	163,657
2021	196,179	177,244	218,526	238,32	223,475	238,337	222,952	239,488	234,51	260,131	256,381	245,78
2022	292,218	223,995	291,186	304,85	386,551	358,278	305,363	324,622	315,934	286,767	293,533	249,087
2023	280,922	283,512	327,047	341,916	375,704	342,937	346,652	307,76	296,164	255,804	218,293	182,219

Vietnam coffee export turnover in the period 2019 - 2023



Source: Results of the data analysis by the Author

For the whole year 2019, coffee exports reached a total of 1,653,265 tons (about 27.55 million bags), a decrease of 223,702 tons, or a decrease of 11.92% compared to the export volume of 2018, accounting mainly for Robusta coffee. Germany and the US continue to be Vietnam's two largest coffee consumption markets. Vietnamese coffee products are exported to more than 80 countries and territories, accounting for 14.2% of the global coffee export market, ranking second after Brazil. In general, coffee export turnover tends to decrease quite significantly in 2019, the reason is said to be reduced coffee output due to bad weather and reduced cultivation area.

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In 2020, the volume and value of coffee exports for the whole year 2020 reached 1.51 million tons and 2.66 billion USD, down 8.8% in volume and 7.2% in value compared to 2019. Germany, the US, and Italy continue to be Vietnam's three largest coffee consumption markets in the first 11 months of 2020 with market shares of 12.8%, 9.3%, and 8.4% respectively. In particular, robusta coffee exports to many main markets decreased, such as Germany, the US, Spain, Russia, Belgium, and Thailand. On the contrary, robusta coffee exports to other main markets increased, such as Italy, Japan, Algeria, and the Philippines. The reason is that large markets such as the EU, the US, and Russia increasingly prefer Arabica coffee varieties with a more delicious and delicate flavor.

According to the Import-Export Department (Ministry of Industry and Trade), for the whole year 2021, Vietnam's coffee exports reached 1.52 million tons, worth approximately 3 billion USD, down 2.7% in volume, but increased 9.4% in value compared to 2020. Notably, in December 2021, export coffee prices reached their highest level since June 2017. According to the Import-Export Department (Ministry of Industry and Trade), easing social distancing, more favorable customs clearance activities, and increased world demand are factors helping Vietnam's coffee exports recover at the end of 2021. According to estimates, Vietnam's coffee exports in December 2021 reached 130 thousand tons, worth 305 million USD, an increase of 21% in volume and an increase of 26.2% in value compared to November 2021, compared to January 2021. December 2020 decreased by 6.5% in volume but increased by 20.3% in value. By 2022, the global coffee market will face many difficulties when global inflation increases rapidly and consumers tend to "tighten their belts", causing demand for coffee to decrease. Despite this, Vietnam's coffee industry still achieved remarkable results when exports grew at double digits compared to 2021. In 2022, Vietnam's coffee exports reached 1.72 million tons, reached 3.94 billion USD, an increase of 10.1% in volume and an increase of 28.3% in value compared to 2021. In the first months of 2022, Vietnam's coffee exports grew strongly thanks to recovering demand. returned after the COVID-19 pandemic and rising coffee prices in the context of tight global supply due to crop failures and supply chain congestion in some major producing countries. In addition, the increase in exports was also supported by improved container and ship supply.

According to the Report at the conference "Summary of the 2022-2023 coffee crop year, and mission directions for 2023-2024", at the end of the 2022-2023 crop year (from October 2022 to September 2023), coffee exports coffee reached 1.66 million tons, down 4.5% compared to the 2021-2022 crop year, but turnover reached 4.08 billion USD, up 3.4% thanks to high selling prices. This is the highest turnover level in any crop year to date. The average coffee export price reached 2,451 USD/ton, an increase of 5.5% compared to the previous crop year.

Although coffee exports decreased in the first half of 2023, over the past several months, world Robusta coffee prices have recorded a continuous upward trend, contributing to Vietnam's coffee export turnover still growing positively. In particular, in June 2023 alone, Vietnam exported 150,00 tons of coffee with a value of 342.94 million USD, an increase of 9.1% in volume and 24.3% in value compared to the same period in 2022.

Accumulated in the first 9 months of 2023, Vietnam's coffee exports reached 1.27 million tons, down 7.3% over the same period last year; Turnover reached 3.16 billion USD, up 1.9%. Citing data from the General Department of Customs, in October 2023, the whole country exported over 43,000 tons, down 14.2% over the previous month and down 48.8% over the same period last year. This is the lowest export volume every month in the past 12 years. Coffee export turnover in October 2023 reached 157.55 million USD, down 6.6% compared to September 2023 and down 28.0% compared to January 2022. Specify the reason why the amount of coffee exported decreased sharply, accordingly, there were no more goods left for export in the country. Overall, in 2023, Vietnam's coffee exports will reach 1.62 million tons, down 8.7% compared to 2022; but turnover reached a record high of more than 4.24 billion USD, an increase of 4.6% compared to 2022. Output decreased but turnover increased because export prices in 12 consecutive months increased sharply, on average reaching 2,613, 8 USD/ton, up to 14.5% over the same period in 2022.

4.2. Results of forecasting growth of Vietnamese coffee exports using the MIDAS model

In the forecast study on Vietnam's coffee export growth, the team applied the basic MIDAS model with the parameters in the model selected as presented. The team reviewed and selected a model with 17 variables, including 16 independent variables.

MIDAS model: The 16 independent variables include 8 quarterly frequency variables and 8 monthly frequency variables

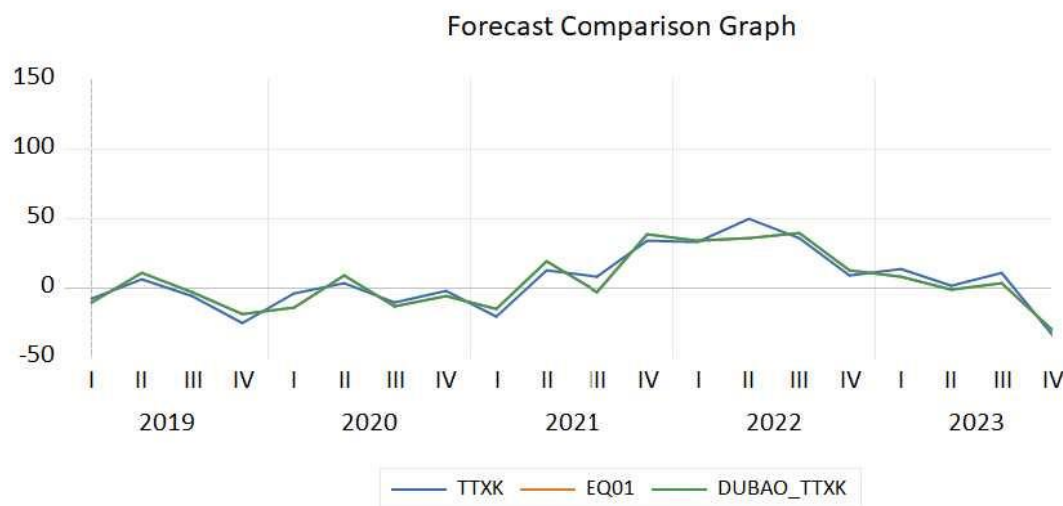
The peculiarity of the MIDAS model is to quickly forecast export growth in the period when the data has not been published based on the information collected up to the most recent time. Therefore, the research team applied to forecast Vietnam's coffee export growth in the first quarter of 2024 and the second quarter of 2024 with high-frequency data collected until December 2023. The way the forecast is conducted is as follows: The authors will forecast the next quarter based on the previous quarter's data and compare it with the actual data value of that quarter when announced.

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For example, the results of the fourth quarter of 2020 will be used to forecast the results of the first quarter of 2021 and compare the results with the actual published data of the first quarter of 2021; Then continue to use the announced results of the first quarter of 2021 to forecast the second quarter of 2021 and compare the results with the actual published data of the second quarter of 2021, the forecasting process continues similarly. same for the following quarters.

*Regression results:

Figure 2: Results of quarterly coffee export growth forecast of the MIDAS model



Source: Results of the research team

Through the process of building a model on Eviews, 12 groups have produced a model to test the quarterly growth forecast of Vietnamese coffee exports. With test data for the period 2019-2023, the chart is represented by two growth lines including the forecast growth line for Vietnamese coffee exports through the MIDAS model (DUBAO_TTXK) and the growth line for Vietnamese coffee exports South reality (TTXK). The team provided a comparison chart between the two growth paths to test the reliability and accuracy of the model compared to reality.

The results in the chart show that the two growth lines have almost the same development trends at each stage and are almost asymptotic to each other. Thereby, it partly shows that the model has relative accuracy, reflecting the actual situation of Vietnam's coffee export growth in the period 2019-2023 despite many objective fluctuations in the economy. To test in more detail the reliability and accuracy of the forecast model, the research team continues to evaluate the indicators of the forecast model.

Evaluate forecast error

Evaluate the forecast error of the MIDAS model

Time	TTXK (Actual)	MIDAS (Forecast)	and
2019Q1	-8,2900	-10,5229	2,2329
2019Q2	6,3800	10,8310	4,4510
2019Q3	-6,1800	-3,5095	2,6705
2019Q4	-25,0700	-18,9890	6,0810
2020Q1	-4,3200	-14,4955	10,1755
2020Q2	3,0900	8,6381	5,5481
2020Q3	-10,9400	-13,3115	2,3715

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2020Q4	-1,9300	-6,3790	4,4490
2021Q1	-20,9000	-14,8937	6,0063
2021Q2	13,0000	19,3000	6,3000
2021Q3	7,5900	-2,0040	9,5940
2021Q4	33,5400	38,2200	4,6800
2022Q1	33,2100	34,1846	0,9746
2022Q2	49,8800	35,3966	14,4834
2022Q3	35,7200	38,9932	3,2732
2022Q4	8,7400	12,5101	3,7701
2023Q1	13,0100	7,9505	5,0595
2023Q2	1,0200	-1,5871	2,6071
2023Q3	0,3600	3,68	3,3200
2023Q4	-34,8800	-31,14	3,7400
R2	0,915228		
RMSE	1,349254688		
THERE IS	0,3373136719		

Graph of the forecast line obtained from the MIDAS model in the chart and measurement indicators such as R-squared index, average error measurement index (RMSE), average absolute value measurement index of error (MAE) of the regression model in the table shows that in general, the basic MIDAS model gives quite good forecasting results for Vietnam's quarterly coffee export growth with high indexes close to 1 (The closer the value is to 1, the better the model). The authors chose a large sample size from the first quarter of 2019 to the fourth quarter of 2023 to provide the smallest standard error. The smaller the standard error, the more accurately the model shows the ability to predict and explain secondary variables. belongs well.

The chart shows that the model can almost predict periods of major changes in Vietnam's coffee export growth rate, specifically in the period 2020-2021 when the COVID-19 pandemic caused export growth to increase. Vietnam's coffee exports fluctuate abnormally or in 2023 export growth will decrease sharply, mainly due to the decline in aggregate demand, supply chain disruption, and tightening monetary policy. This method proves to be superior to traditional models that are limited by using balanced data (for example, models that only use monthly data or models that only use quarterly data). The flexibility will not be as high as the MIDAS model.

This result proves that the development of these forecasting models is on the right track and the input data are selected appropriately. Furthermore, adding high-frequency financial data to the MIDAS regression model also improves prediction accuracy, demonstrating that financial data plays an important role in predicting commodity export growth. chemistry. This finding implies that to fully utilize the predictive power of financial indicators, they must be combined with macroeconomic data.

5. CONCLUSION

The study uses the MIDAS model to predict Vietnam's coffee export growth based on a data set of macroeconomic indicators collected in the period 2019 - 2023. Analysis results show that, with the same independent variables, and data taken at

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a higher frequency, the MIDAS model will give better forecasting results. Like some previously published research results, the forecast results show that the MIDAS model is effective for short-term forecasting. The research results also show that high-frequency financial variables can be used to forecast Vietnam's coffee export growth. This may be related to the recent development of Vietnam's financial market.

From a policy perspective, our findings imply that financial variables need to be closely monitored to predict fluctuations in the commodity export cycle. On the model side, the results point to the importance of linking financial sectors and economic reality in macroeconomic models. The role of financial variables in predicting export growth is due not only to their forward-looking nature but also to the close linkage between financial markets and a country's import and export activities. .

Short-term forecasts of macroeconomic indicators will have important implications in policy planning and devising each country's economic development strategy. Therefore, with the goal of providing timely and appropriate forecasts in the future, the research team will continue to build and deploy models with different frequency data to forecast economic indicators. Macroeconomics of Vietnam.

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