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APPLYING ARDL TO MEASURE THE EFFECT OF DEMAND-SIDE FACTORS ON VIETNAM'S EXPORTS IN THE CONTEXT OF COVID-19: A DATA MINING APPROACH

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Abstract
Demand-side factors and openness policies of import countries influence Vietnam's export significantly. In the context of Covide-19, the unforeseeable changes in these factors led to a sharp reduction in Vietnam's export. In this study, we utilize one of simple data mining technique, namely, the application of Autoregression Distributed Lag (ARDL), to investigate the effect of average economic growth of Vietnam's five most important trading partners (the US, the EU, Japan, South Korea, and China), their average tariff and Vietnam's market share in these markets on Vietnam's key exports. The empirical result shows that Vietnam's market share and the openness of five markets have a positive effect on Vietnam's export in both short term and long term at the 1% of significant level. However, Covid-19 has a reverse influence on Vietnam's export to the five markets in the long term, leading to decreased revenue of key exports in the important markets. Meanwhile, the economic growth rate of the five markets and tariffs have no effect on Vietnam's exports in the context of Covid-19.
Key words: export, VietNam, Covid – 19, ARDL, openness, GDP

1. Introduction

Vietnam witnessed a sharp change in its openness from 19% in 1988 up to 186% in 2021 (World Bank, 2022), which empirically has created a strong contribution to economic growth. For instance, the growth rates were 7.08% in 2018 and 7.4% in 2019 - the highest level in Asean countries (Asian Development Bank, 2023). However, Covid-19 has serious influence on global growth and international merchandise trade with deep contraction in 2020 by 4.4% and 20%, respectively (United Nations Conference on Trade and Development, 2021). In particular, Vietnam's important trading partners experienced a lot of economic difficulties such as the decline of the US and the EuroZone countries in GDP by 8.9% and over 12.4% in the second quarter of 2020, respectively (BEA, 2021; Eurostat, 2022). Consequently, their demand for Vietnam's exports also reduced, which led to a slowdown of Vietnam's export growth rate being 6.5% - the lowest growth level since the global crisis in 2008 (GSO, 2021). Especially, agricultural and aquatic products, garment and footwear exported to the main trading partners decreased sharply in 2020-2021, when Covid-19 spreaded widely. In 2020, garment export revenue downsized by 10% in comparison with that in 2019, for aquatic products, coffee and footwear exports were down by 9%, 2% and 8%, respectively (the authors' calculation based on Trademap statistics). However, Vietnam's steel exports grew significantly thanks to the change of the Chinese market with sudden increase of domestic demand, which released the global competitive tension (Global Times, 2021). The resilience of leading economies like the US, the EU, China since the end of 2021 with the exception of Japan (Organization for

Economic Co-operation and Development, 2023) in association with the new-generation FTAs with lower tariff rate for Vietnam commodities taken in effect are driving factors to help Vietnam's exports recover fast in the past two years. The study investigates whether the recovery of Vietnam's exports is sustainable in the new normal and finds out the effect mechanism among demand-side factors.

2. Theoretical framework and Hypothesis

Empirical studies pointed out that Covid-19 affected international trade with diversified degree among countries (Ugurlu & Jindřichovská (2022); Jindřichovská & Uğurlu (2021)). By applying ARDL, the results showed that China was rather flexible for policy adjustment to reduce the effect of pandemic by focusing on healthcare products during Covid-19. Meanwhile, Chinese farming exports reported a sharp reduction because of his trading partners' protective healthcare against the pandemic policy (Lin & Zhang, 2020; Zhao et al., 2021). Cengiz and Manga (2022) indicated that the EU and Turkey's policy on medical control against Covid-19 influenced their exports negatively. In particular, the increase in tough control measures, for example lockdown, by 1% reduced their export by 0.102%, and the number of infected cases grew by 1%, leading to the decline in their export turnover by 1.620%. The causality test on Dumitrescu–Hurlin control panel showed that Covid-19 infected cases and export turnover have dual causality.

If a country has a high openness degree (measured by the rate of international trade on GDP), the possibility of wide pandemic spread is very high, consequently, affecting his export stronger (Bontempi & Coccia, 2021). Actually, time-lag export, import and GDP are the most vulnerable elements during the pandemics (Resilience, 2011).

According to Krugman et al (2015), factors affecting exports can be considered from both demand and supply sides. On the demand side, the most important factor is the economic growth rate of the importing country. Similarly, the study of Labibah & Dawood (2021) showed that the lag in the US economic growth rate or in Japanese economic growth rate influenced Indonesian exports considerably at the significant level of 5%. Moreover, research of Gaware et al (2020) pointed out that Indian bird egg export was positively affected by export prices and its market share in the global market, but negatively affected by exchange rate. The analysis of Taj & Wani (2019) reported that the prospect of import market and Afghanistan's current export status were very important to improve its export competitiveness, and the role of structural factors required exporters to concentrate on some specific commodities and markets. Thus, Afghanistan's export achievements are the result of improvement in both competitiveness and selection of international spatial locations.

The explosion of Covid-19 has changed the effect degree of the above factors, leading to diversification in export possibilities. In particular, Tang et al. (2022) believed that exporters coped with dual threats such as pandemic spread and importers' constraints like import fees as measures for import reduction. Actually, tariff itself influences import in normal conditions, which decreases the import volume by price discrimination with higher price in import countries, thus, it declines the competitiveness of exporters. Accordingly, tariff reduction leads to an increase in exports (International Monetary Fund, 2019).

3. Data and methodology

3.1. Data mining approach and ARDL

Autoregression Distributed Lag (ARDL) is a powerful data mining technique that is widely used in time series analysis. This approach combines autoregressive (AR) and distributed lag (DL) models to capture the dynamic relationships within a time series dataset. ARDL is particularly valuable for examining how past values of a variable influence its current and future values, making it a robust tool for forecasting and trend analysis.

In ARDL, the autoregressive component deals with the lagged values of the variable itself, allowing the model to account for its own past behavior. The distributed lag component considers the impact of lagged values of other relevant variables, providing a more comprehensive understanding of the interdependencies within the dataset.

This technique is especially useful when dealing with time-dependent data, where historical patterns and dependencies play a crucial role. By leveraging ARDL, analysts can uncover hidden patterns, identify trends, and make informed predictions based on the temporal dynamics of the dataset. The flexibility of ARDL makes it applicable across various domains, including economics, finance, and environmental studies, enhancing the capacity to extract valuable insights from time series data.

The purpose of this research is to investigate the relationship among demand-side factors in Vietnam's export to major foreign markets such as GDP growth rates, openness, tariff for Vietnam's key exports (garment, footwear, aquatic products, coffee and steel), and Vietnam's market shares of the five products in these markets.

3.2. Data sources:

This research uses secondary monthly data extracted from international organizations' statistics with time series from January 2011 to March 2023. The value of Vietnam's monthly export Codes including HS03, HS09, HS61, HS62, HS63, HS64, HS72 to the US, the EU, Japan, Korea and China are extracted from https://www.trademap.org. Economic growth rates of the five markets calculated by their quarterly GDP growth rates are adapted from https://www.oecd-ilibrary.org, then they are processed by moving average method run on Eviews software.

Tariff is calculated by the average of lowest rates for Vietnam's five commodities exported to the five markets. Tariff rates are rectified by WTO and publicized on https://tao.wto.org, and assumed that they are unchanged throughout the study period.

Market share is determined by average market shares of the five commodities studied in the five markets named above. The monthly market share is calculated by:

$$\frac{\text{Vietnam's export value of commodity } i}{\text{Total commodity } i \text{ imported of the import country } k}$$

Monthly openness of Vietnam's five trading partners can be measured by their monthly export plus import value divided by their GDP.

$$\frac{\text{Export} + \text{Import}}{\text{GDP}}$$

The export and import value are extracted from https://www.trademap.org. Meanwhile, GDP is from https://www.oecd-ilibrary.org, which is transformed by moving average method. Because GDP is calculated by native currency, it is exchanged into USD with spot exchange rate extracted from https://fred.stlouisfed.org.

Covid-19 variable is taken from the statistics on monthly Covid infected cases in the period of January 2020 to March 2022 from https://ourworldindata.org/coronavirus .

3.3. Research Model:

ARDL model is a combination of Var model and common regression model applied for the analysis of multivariable time series (Halil, 2000). Variables themselves might have endogenous relationships, thus the application of VAR model is suitable for this research. The ARDL model for this research is detailed as below ($p_0, p_1, p_2, \dots, p_n$):

LnEx = β0 + β1*Growtht + β2 *Tarifft + β3*MSt + β4*Opt + β5*CV + ut

Of which:

LnEx: the total export value of the five commodities to the five markets mentioned in the research. This value is transformed into the price in 2010 and logarithmized in order to lessen high dispersion in the original data and facilitate data analysis. This variable is designated as a dependent variable.

Growth: average economic growth rate of the 5 mentioned markets

Tariff: Average tariff of the 5 markets levied on Vietnam's five commodities mentioned above.

MS: Vietnam's average market share in the five commodities in the five markets.

OP: Average openness of the five markets of the five markets.

CV: Covid variable

4. Research results

* ADF test

ADF test is applied to determine whether variables in the model get unit root. The result shows that the growth variable gets stable integration at 0 degree (I (0)) with 1% of significant level. Meanwhile, other variables including LnEx, Tariff, MS, OP are stable integration at 1 degree (I (1)) with 1% of significant level

Table 1. Augmented Dickey – Fuller test

Variables	ADF value	P - value	t- value		
			1%	5%	10%
1. Variable value (constant)					
LnEx	-2.023608	0.2765	-3.475819	-2.881400	-2.577439
Growth	-6.346914	0.0000	-3.476805	-2.881830	-2.577668
Tariff	-1.345763	0.6072	-3.475500	-2.881260	-2.577365
MS	-1.800092	0.3793	-3.476805	-2.881830	-2.577668
OP	-1.916548	0.3240	-3.477144	-2.881978	-2.577747
CV	-5.511014	0.0000	-3.475500	-2.881260	-2.577365
2. First order difference (Constant)					

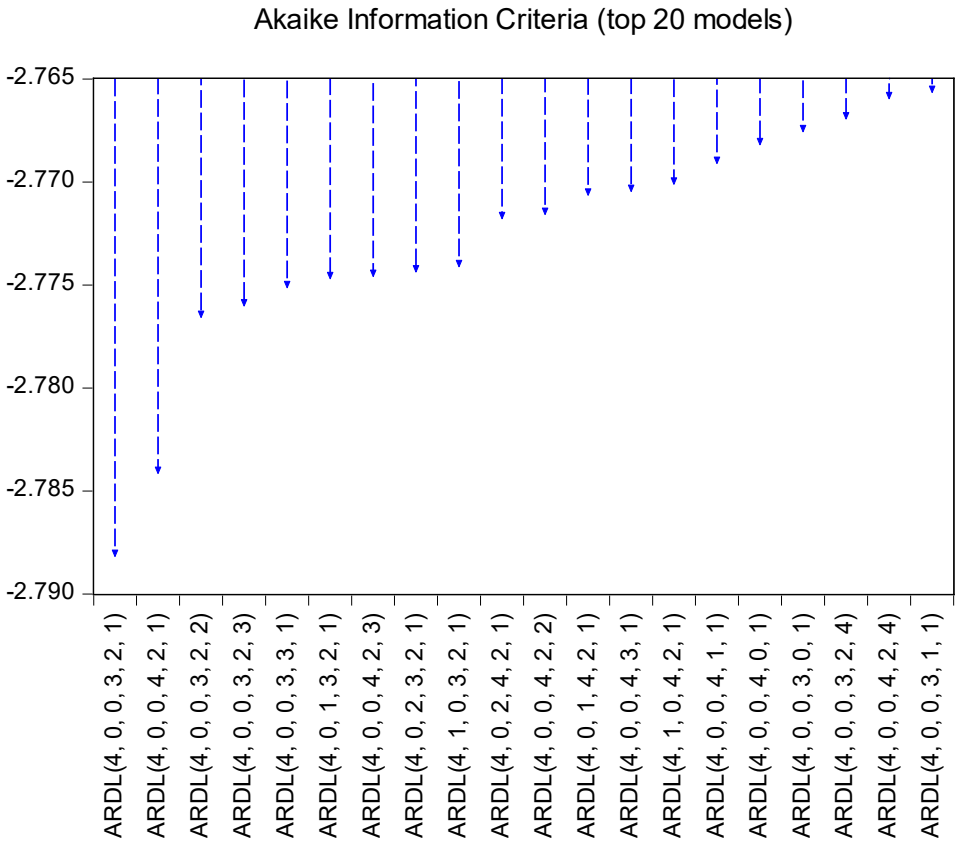
ΔLnEx	-19.09274	0.0000	-3.475819	-2.881400	-2.577439
ΔTariff	-11.96697	0.0000	-3.475819	-2.881400	-2.577439
ΔMS	-9.658139	0.0000	-3.476805	-2.881830	-2.577668
ΔOP	-4.222888	0.0009	-3.477487	-2.882127	-2.577827

Source: Authors' result from Eviews

* Lag selection:

The optimal lag selection helps choose the best model, guaranteeing the model is not affected by such factors as autocorrelation, variance changing or noise without normal distribution. To ensure an appropriate lag selection, the commonly used norm is AIC. The result shows that, for the model to be effective, optimal lag of variables such as lnEx, growth, dtariff, MS, OP, and CV are 4, 0, 0, 3, 2, 1 respectively.

Figure 1. Lag selections



Source: Authors' result from Eviews

*Bound test: When implementing Bound test, the calculated results show that the F-statistics is 15.25089, which is larger than the critical value of the limits I(0) equaling 3.06 and I(1) equaling 4.15 at 1% significance level. This proves that there exists a co-integration relationship between the variables in the tested model. It also implies that short-term equilibrium leads to long-term equilibrium.

In the long term, market share has the biggest impact on Vietnam's exports. This proves that, with just 1% increase in market share, Vietnam's exports will increase by 11.44%. This shows that Vietnam is quite dependent on export markets. The openness of the exporting country's economy also affects the export of some key commodities of Vietnam. If the economic openness of Vietnam's 5 main export markets increases by an average of 1%, the impact of Vietnam's exports will increase by an average of 2.234%. The Covid -19 pandemic has a negative impact on Vietnam's exports, according to which, for every 1% increase in the number of people infected with Covid, it will reduce exports by 7.48%.

Table 2. Results of estimating ARDL (4,0,0,3,2,1) in the long run

Dependent variable: DLnEx

Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
GROWTH	0.004841	0.008488	0.570376	0.5694
DTARIFF	0.019967	0.013791	1.447791	0.1502
DMS	11.44473***	2.036407	5.620060	0.0000
DOP	2.234415***	0.446884	4.999983	0.0000
CV	-7.48E-10***	2.56E-10	-2.922855	0.0041
C	0.006140	0.003852	1.594065	0.1134

Notes: *** means 1% of significance level

Source: *Source: Authors' result from Eviews*

Facts show that an increase in the number of people infected with Covid will reduce the amount of demand for some non-essential goods. Whether or not countries decide to allow the opening of their economies in the context of the domestic economy's difficulties will affect the increase in Vietnam's goods exports.

In the short term, Vietnam's exports of 5 main commodity sectors are affected by the export value of these sectors in the previous 3 months. Specifically, if exports last month, 2 months ago and 3 months ago increased by 1%, the total export value of 5 main commodity sectors would increase by 0.29%, 0.30%, 0.21% respectively. If the current market share of Vietnam in 5 main markets increases by 1%, the export value will increase by 8.92%. However, the export value of the market share of 1 month and 2 months later will decrease by 5.35% and 3.91% respectively. In the short term, foreign import taxes do not affect the value of Vietnam's exports. A 1% increase in the openness of the partner countries' economies at present will increase the export value of Vietnam, but a month later, due to the impact of many factors, including Covid in the recent 3 years has caused countries to issue blockade orders, making it difficult for imported goods to access the market. The impact of Covid-19 on exports is not statistically significant. Thus, in the short term, factors such as Vietnam's market share and the

openness of the partner countries' economies have a significant impact on the export value of 5 main commodity sectors at the 1% significance level. The CointEq index has a negative sign, with a coefficient value of -1.55 and has a significance level of 1%. This index means that when the factors change in the short term, skewing the export value of Vietnam's main commodities out of the long-term equilibrium curve, in the next period (next month), the value of these factors tend to return to the equilibrium position with the adjustment level of 155%.

Table 3. Estimation of short-term coefficients of ARDL model (4,0,0,3,2,1)

Dependent variable: DLnEx

Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(DLNEX(-1))	0.292458**	0.124011	2.358317	0.0199
D(DLNEX(-2))	0.308282***	0.095895	3.214775	0.0017
D(DLNEX(-3))	0.212034***	0.055224	3.839515	0.0002
D(DMS)	8.926747***	0.819932	10.88718	0.0000
D(DMS(-1))	-5.354892***	1.360057	-3.937257	0.0001
D(DMS(-2))	-3.915490***	0.939271	-4.168646	0.0001
D(DOP)	2.110584***	0.161915	13.03518	0.0000
D(DOP(-1))	-0.639753***	0.207627	-3.081255	0.0025
D(CV)	3.95E-11	4.11E-10	0.096229	0.9235
CointEq(-1)*	-1.552738***	0.146825	-10.57544	0.0000

Note: ***; ** means the significance levels of 1%, 5%

Source: *Source: Authors' result from Eviews*

After considering the effects of the variables in the short and long terms, the authors tested the accuracy of the model, using normal distribution tests, autocorrelation tests, and variable variance tests, tests of the model stability.

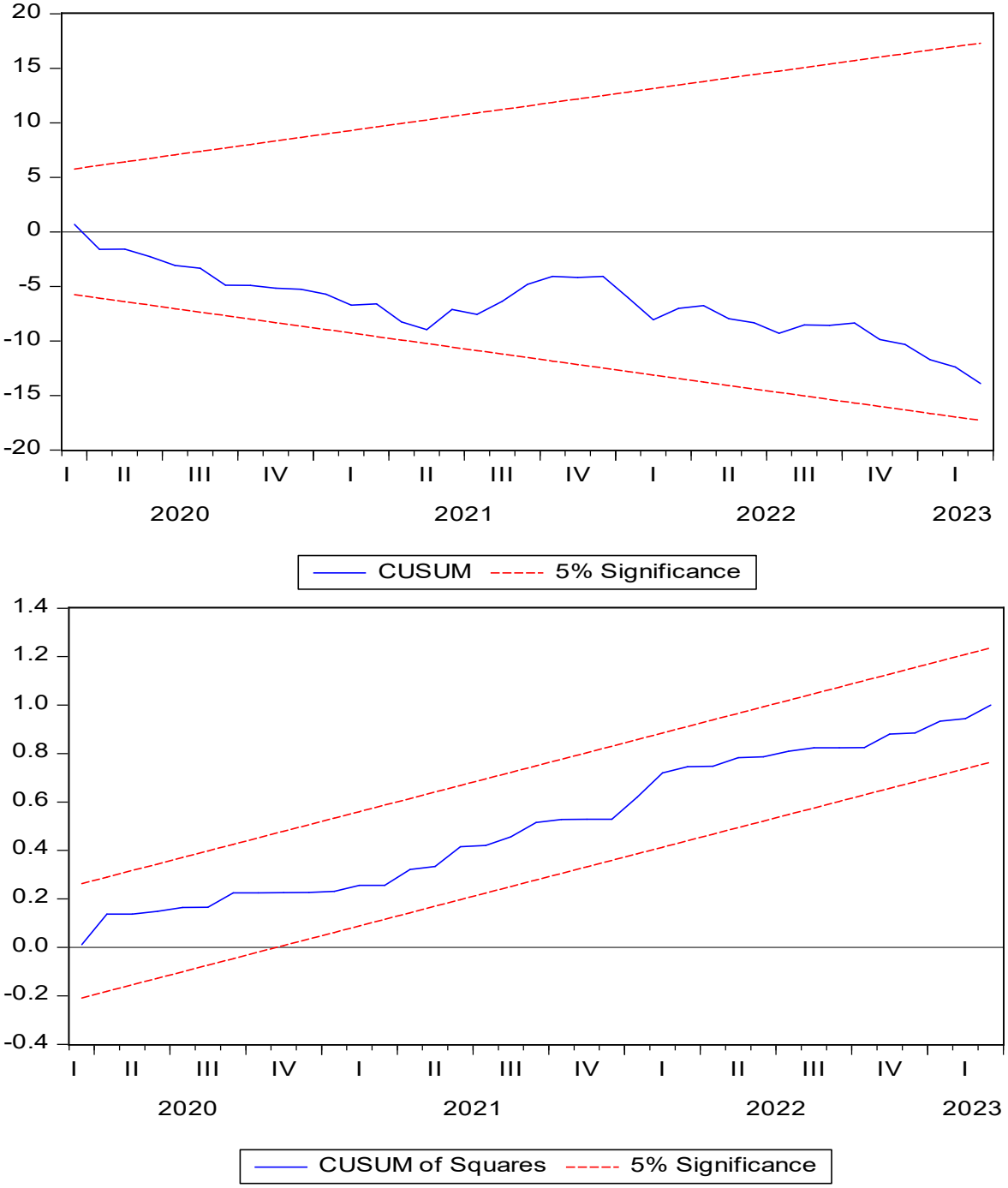
Table 4. Test results

Test	P-value	significant at 5%
Jarque-Bera	0,840819	The remainder is normally distributed
BreuschGodfreyLM Test	0.1800	The model has no autocorrelation
White	0.1018	The model has no variable variance
Ramsay RESET	0.8096	The specified model is correct

Source: *Source: Authors' result from Eviews*

The test results in Table 5 show that these tests give good results, and the model is appropriate and reliable. To confirm the stability of the model, CUSUM and CUSUMQ tests are performed to analyze whether the parameter to be estimated is stable or not.

Figure 2. The Cumulative Sum (CUSUM) of the remainder and the adjusted cumulative sum (CUSUMQ) of the remainder



The blue line is always within the red limit, showing that the model is stable at 5% of significance level.

5. Conclusion and implication:

This study uses ARDL model to study the impact of several demand factors from Vietnam's main export markets such as the US, EU, Japan, Korea, and China on the total exports of 5 commodity sectors from Vietnam, such as footwear, textiles, seafood, coffee, and steel. The research results show that in both short term and long term, Vietnam's exports depend slightly on Vietnam's market share in these markets, as well as on the openness of the economies of other countries, with a confidence level of 1%. In long term, the Covid - 19 factor has an impact on demand and thus reduces the value of Vietnam's exports. However, economic growth and import taxes have no impact on Vietnam's exports.

Based on the above research results, enterprises need to pay more attention to increasing production capacity to ensure the competitiveness of their products in the main export markets. The Vietnamese government also needs to support businesses to overcome challenges from Covid-19, and at the same time support trade promotion, helping businesses take advantage of opportunities from FTAs between Vietnam and other countries, as well as cooperation to increase their ability to export abroad.

However, the limitation of this study is that it has not been able to extract the demand-side factors from each individual market that affect the export value of each commodity.

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