

## **Time-varying Predictors of Non-oil Export Volatility in Nigeria**

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### **Abstract**

The study of export volatility is important because it plays important roles in the growth of an economy. Most previous studies on export had concentrated on investigating its dynamics with classical econometric models which have static parameters that are incapable of capturing its associated time-varying dynamics and volatility. This paper proposed a Bayesian time-varying parameter dynamic linear model to investigate major non-oil export predictors in the economy of Nigerian. The Kalman filter and Markov chain Monte Carlo (MCMC) algorithms were used to perform posterior Bayesian inference on time-varying parameters which implicitly describes the fluctuating relationships between the key drivers of export in an economy. In particular, this study investigated the predictive performance of relevant macroeconomic variables on non-oil export, using a Bayesian time-varying parameter model. Empirical results show that gross

domestic product (GDP) and lending rate affected the level of fluctuation in the non-oil export in Nigeria for the period under consideration. Some policy implications and change point analyses of these results were also discussed.

**Keywords:** *Time-varying parameters, Economic growth, Bayesian inference, Non-oil export volatility, Nigeria*

**JEL Classification:** C5, C32

## 1. Introduction

The export activities of a nation play an important role in the macroeconomic performance of its economy and, *ceteris paribus*, have the tendency to improve the gross domestic product (GDP) and general welfare of the people. This assertion has been corroborated by Adenugba and Dipo (2013) as well as Sheridan (2014) who are of the view that export stimulates economic growth and promotes the economy. The gradual progression in export trade, as posited by Kandiero, Kamara and Ndikumana (2009), is a key factor influencing the performance of economic growth globally. Nigerian economic revenues have consistently come from two major sources: oil export and non-oil export. The former has historically been the most significant contributor to budget finance of the nation since inception (Alege, Oye, Adu, Amu, & Owolabi, 2017; Ogundipe, Adu, Ogundipe, & Asaleye, 2019). Nigeria is a country whose economy mostly depends on proceeds from crude oil export. With the recent dwindling in the price of crude oil as a result of the COVID-19 pandemic, the country needs to implement more policies that would diversify the economy and concentrate more on its non-oil revenues. It, therefore, becomes imperative to embark on non-oil export in the Nigerian economy given the variation in her resource endowments. This is in line with the Sustainable Development Goal 12 (SDG-12) which advocates sustainable, responsible consumption and production patterns in an economy.

Export fluctuations, on the average, act as a hindrance to the stability and growth of many African countries where the volumes of imports are mostly more than the exports (Awe, Akinlana, Yaya, & Aromolaran, 2018). Following the shortcomings of the economy, the Federal Government of Nigeria implemented an International Monetary Fund Policy called the Structural Adjustment Programme (SAP) in 1986 which was intended to

motivate a private sector-led economy. The key focus of the Structural Adjustment Programme (SAP) was to re-organise the Nigerian economy from an inward-looking import substitution approach to that of outward-looking export promotion approach with exchange rate as the policy variable (Williamson, 1995). A number of policies were pursued during the SAP regime to enhance the export of manufactured goods such as incentives and investment in research and development. However, the incentives and strategies adopted did not yield any significant appreciable effect on export. Weak manufacturing; for both export and domestic market, implies weak capacity utilisation for the economy with business closing down and widespread unemployment in the economy. The cost of investment activities within the economy and the poor availability of infrastructures, coupled with preference for foreign products by the citizens, further adversely affect manufacturing activities. Sadly, quite a number of manufacturing firms have to run on diesel due to unreliable electricity supply being generated in Nigeria. This is, invariably, a diversion of fund which could have been invested in manufacturing in order to improve the quality and competitiveness of Nigeria's non-oil export in the world market.

It is against this backdrop that this study considers a number of key macroeconomic variables which could have strong time-varying effects on non-oil export in Nigeria as a contribution to the body of knowledge and to provide policy directives to the government (Ogundipe, 2020). The factors considered include: movement in exchange rate; the consumer price index proxied by inflation rate; government capital expenditure on infrastructure; and lending rate. The export analysis was done with respect to the United States of America – the largest trade partner of Nigeria. The main objective of this paper is to investigate the time-varying pattern of fluctuation of export with respect to certain key economic indicators by using a proposed Bayesian dynamic modelling framework.

## **2. Literature Review**

### **2.1 Theoretical Review**

Most econometric studies often begin with a statement of a theoretical proposition (Greene, 2003). This section briefly reviews two neoclassical trade theories that are relevant to this study:

### **(a) The Theory of Absolute and Comparative Cost Advantage**

Absolute cost advantage and comparative cost advantage are widely known theories of international trade. Ruffin (2005: 714) describes the absolute advantage theory of trade *as being “necessary for a country to have a productivity advantage over other countries in order to profitably export”*. However, Smith (1776) opines that a country participates in international trade in commodities characterised by an absolute cost advantage. Conversely, Ricardo (Vol. 1, p.133) relays that “the same rule that controls the relative value of commodities in one country does not regulate the relative value of the commodities exchanged between two or more countries”. Comparative advantage, therefore, in the idea of Ricardo, requires that a country can embark on the importation of some units of a commodity despite that it could be produced domestically at lower real costs compared to the country that exports it.

Although several issues may surround this trade theory, it gives some level of insight as regards why the countries of the world should embark on international trade which has the prospect of stimulating an economy as well as promoting growth and development.

### **(b) Heckscher Ohlin Theory**

This theory states that a country should concentrate on the production and exportation of commodity that requires a higher factor intensity of the resources that are generously available and cheap while the ones that are relatively scarce and expensive should be imported. The Heckscher-Ohlin theory is premised on variation in relative factor prices and, therefore, attempts to investigate the underlying basis for countries to be characterised by different factor prices. The model assumes: (i) free mobility of commodities among countries (ii) that the technology employed in the production process is uniform (iii) there is no restriction to domestic mobility of factors of production (Subasat, 2003).

## **2.2 Empirical Review**

Several studies have investigated the factors that determine the volume of export. For instance, Funke and Holly (1992) opine that most of the previous studies on modelling export determinants have concentrated on

demand factors which make such models somehow inadequate in explaining long-run trends in export performance. Using quarterly data for the period 1961 to 1987, the study examined both the supply side and demand side factors. Funke and Holly's (1992) found that the supply side factors are much more significant in predicting and explaining export performance than the demand side factors.

Another study by Lipuma, Newbert, and Doh (2013) reveals the relevance of institutions in explaining export performance on the basis that there will be a superior export performance if there exists a high quality of institutions. Chen and Carlos (2016) investigated the synthesis and examination of recent research in respect of the determinants of export performance. They reviewed 124 papers published between the period 2006 and 2014 through the technique of vote-counting with the goal of examining export performance determinants. Chen and Carlos subsequently found the evidence of a significant progress during the period. The interaction and indirect relationships were also put into consideration. Nevertheless, the scholars held the view that the non-existence of synthetic theoretical basis, inconsistency in the results of empirical test and inadequacy in the research framework alongside statistical methodologies constrained the research of export performance.

Usman (2010) examined non-oil export determinants and their relationship with economic growth for the period 1988-2008. He found positive relationships between GDP and non-oil export volatility, and between exchange rate and consumer price index. He recommended an urgent need for the diversification of the economy in terms of export so as to stimulate and promote economic growth considering the fact that non-oil exports have a direct effect on GDP over the study period.

Ezike and Ogege (2012) analysed the empirical nexus between Nigerian foreign trade policy and its impact on non-oil export, using correlation and least squares techniques. They discovered an inverse effect between trade policies and non-oil export. The result further reveals that non-oil export and exchange rate exerts a direct and significant impact on the GDP of Nigeria. Diversification of the export base, according to them, has the prospect of the attainment of economic growth in Nigeria.

Aladejare and Saidi (2014) considered the determinants of non-oil export and economic growth in Nigeria, using the bound test approach to examine the long-run and short-run effects of the determinants on non-oil

export. The results show a significant effect of non-oil export on GDP in the short run and the long run.

Furthermore, Imoughelle and Ismaila (2015) examined the impact of exchange rate on non-oil export, using time series data obtained from the Central Bank of Nigeria for a 27-year period. They used Augmented Dickey-Fuller (ADF) test for the unit root test and Johansen's co-integration test to establish empirical relationships between non-oil exports and some related predictor variables. The result shows three co-integrating equations which established the existence of a long-run relationship non-oil export and the variables considered included the exchange rate.

Using annual data obtained from the Central Bank of Nigeria from 1980 to 2016, Vincent (2017) investigated whether Nigeria's non-oil export is effective in diversifying the Nigerian economy from crude oil as the major source of foreign exchange. The study adopted the Phillips-Perron (PP) and the Engel Granger Model (EGM) in conducting co-integration tests and found a strong evidence of co-integrating relationship of non-oil exports in influencing the rate of change in the level of economic growth of Nigeria. The results contained in this work are corroborated by the work of Alege, et al. (2017).

Similarly, Awe et al. (2018) examined the time series properties of co-integration and causality between oil (non-agricultural products) and non-oil (agricultural products) import and export in Nigeria, using Granger causality and Johansen and Juselius's co-integration methods to investigate causal relationships among various currency exchange rates, oil import, oil export, non-oil import and non-oil export (NE). The result reveals the existence of a long-run relationship between exchange rates, non-oil import, oil import and export.

Employing a disaggregated analysis approach, Uzonwanne (2020) examined the role of non-oil exports in boosting the economy of Nigeria, using selected independent variables (non-oil commodities) like hides and skins, rubber, vegetables, plastic and textiles exports by employing quarterly time series data from 2010 to 2017. The results of the study show that hides and skins, rubber, textile export and plastic have a positive and significant effect on the real GDP of the economy. The study also shows that there is bi-directional causality between real GDP and non-oil export.

It is essential to note that none of the earlier studies consider models that are capable of capturing the time-varying dynamics and fluctuations associated with export determinants over time. Therefore, this paper

examines the role of exchange rate, GDP, lending rate, consumer price index and capital expenditure in predicting non-oil export, using a time-varying parameter – Bayesian dynamic model – which implicitly describes the fluctuating relationships between the key drivers of non-oil export in the Nigerian economy over time.

### 3. Methodology

#### 3.1 Model Specification

We propose the Bayesian dynamic regression model of West and Harrison (1997) and Awe and Adepoju (2018) to assess the dynamic relationships between export and certain key economic predictors of the Nigerian economy over time. The model specification takes the following form:

$$y_t = X_t \theta_t + v_t \qquad v_t \sim N(0, V) \qquad (1)$$

$$\theta_t = G_t \theta_{t-1} + \omega_t \qquad \omega_t \sim N_\rho(0, W_t) \qquad (2)$$

Equation (1) is referred to as the observation equation and equation (2) is the evolution equation.  $G_t$  and  $X_t$  are known matrices of orders  $p \times p$  and  $k \times p$  respectively that determine how the observation and state equations evolve in time (Awe & Adepoju, 2018). We assume that all  $v_t$ 's are independent from the  $\omega_t$ 's.

In equation (1), the response  $y_t$  is the annual non-oil export of Nigeria from 1960 to 2009. The matrix  $X$  consists of economic indicators measured concurrently with export and includes a column of 1's representing a dynamic intercept term.  $\theta_t$  are time varying regression coefficients which describe the relationship between the regressors and the response at each time  $t$ . In the export model specification, we consider key macroeconomic variables that can potentially play meaningful roles in the determination of exports in African countries. It is assumed that the regression parameters in the model follow a Markov dependence structure, which permits the macroeconomic variables to evolve differently over time.

In the model estimation, the probability distribution of update is proportional to the product of the time series measurement likelihood and the predicted state:

$$\rho(\theta_t/y1:t) = \frac{\rho(y_t/\theta_t)\rho(\theta_t/y1:t-1)}{\rho(y_t/y1:t-1)} \quad (3)$$

$$\propto \rho(y_t/y1/\theta_t)\rho(\theta_t/y1:t-1)$$

Where the denominator  $\rho(y_t/y1:t-1)$  is constant relative to  $\theta_t$  and thereby ignored. The posterior was used to update the prior recursively until convergence is achieved.

The Gibbs sampler was run for  $M = 12,000$  iterations with a burn-in period of 2,000. Predictive performance of the variables in the various models estimated was assessed, using one-step-ahead Mean Squared Prediction Error (MSPE). The variable with the lowest MSPE indicates a stronger predictive power with respect to the response variable and is chosen as the best model. The Geweke convergence diagnostic (GCD) statistic was computed for each model.

## 4. Empirical Analysis

This section involves the data presentation and econometric analysis involving the predictors of Nigerian non-oil export data, using the proposed model and method outlined in section 3. Such analyses become relevant considering the need for the Nigerian government to diversify into non-oil exports.

### 4.1 Data

Data on Nigerian economic indicators sourced from the Central Bank of Nigeria ([www.cbn.org](http://www.cbn.org)) were used in this research. The data include 50-year annual time-series data on Nigerian non-oil export, GDP, capital expenditure, consumer price index, exchange rate and lending rate of the pre-global recession period (1960-2009). The GDP and non-oil export data were logged before analysis.



## 4.2 Empirical Results

The predictive effect of each macroeconomic variable on non-oil export was examined. It was discovered that the lending rate performed better than other variables in the study in terms of predictive performance as a result of the low value of MSPE. This indicates the predictive power of the variable. However, we find that GDP performed better in predicting oil export when combined with the lending rate. In the tables showing the various model results (Tables 1 and 2), lower values of MSPE indicate a better predictive performance, while higher values indicate a lower predictive performance of the variables.

**Table 1:** Dynamic linear regression of non-oil export on various economic variables

Model	Regressor	MSPE	GCD
1	GDP	0.003	0.996
2	CE	0.004	1.040
3	CPI	0.003	1.017
4	EXRT	0.009	0.916
5	LR	0.002	1.366

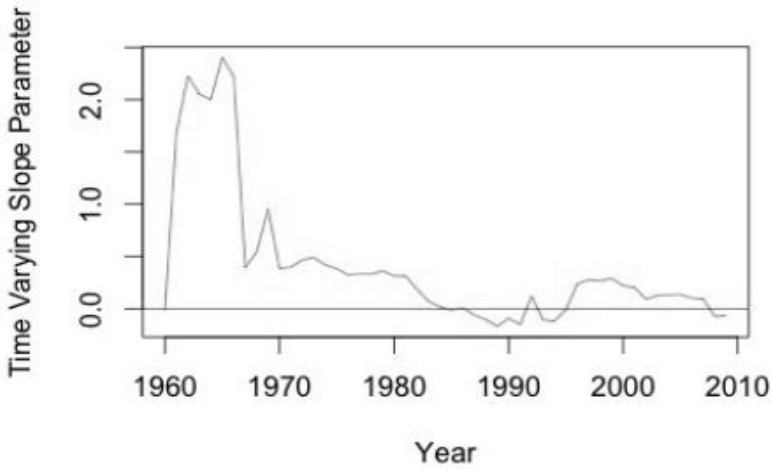
GDP – Gross Domestic Product

CE – Capital Expenditure

CPI – Consumer Price Index

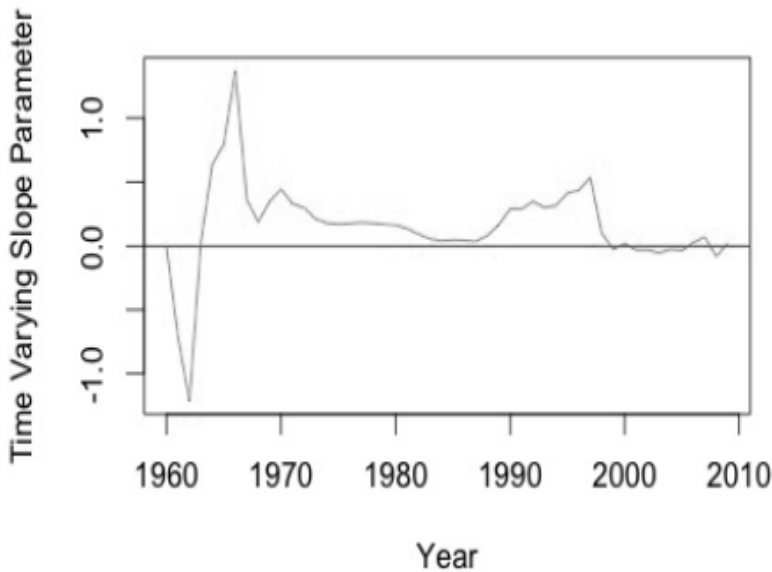
EXRT – Exchange Rate

LR – Lending Rate

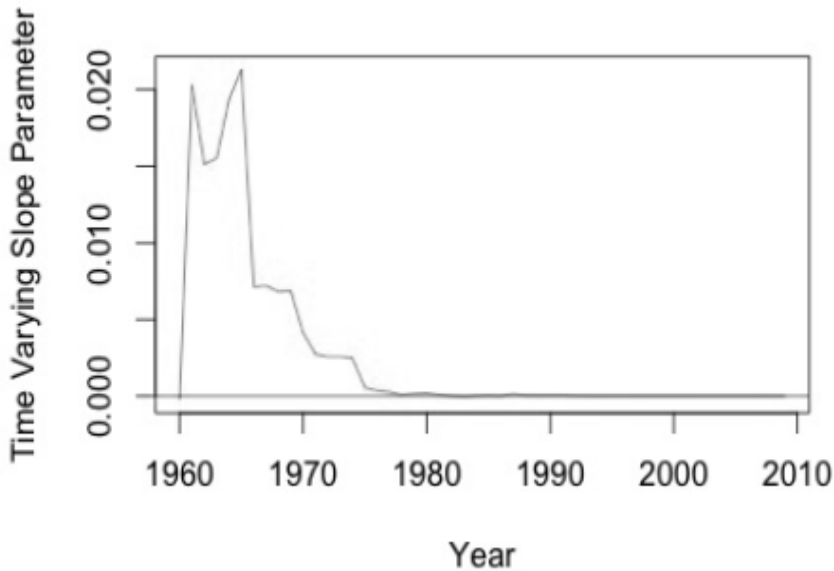


**Figure 1:** Dynamic regression of non-oil export vs GDP

Figure 1 depicts that non-oil export and GDP exhibit a strong relationship in the early 1960s but declined in the late 1960s.

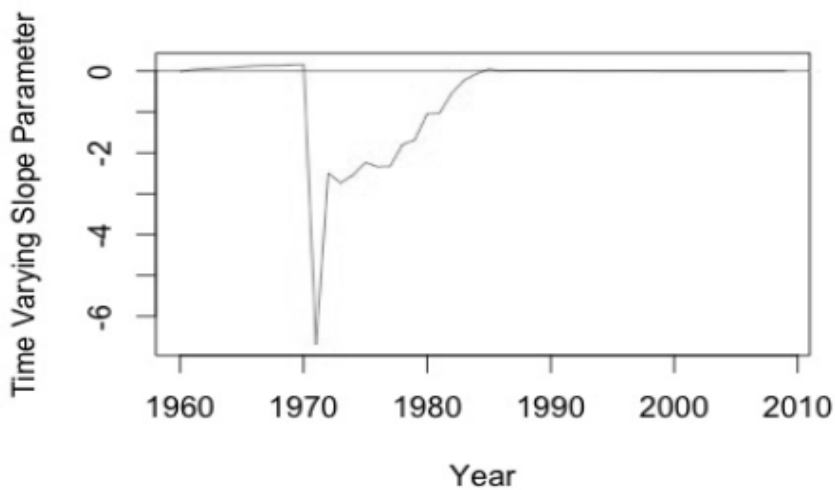


**Figure 2:** Dynamic regression of non-oil export vs capital expenditure  
Figure 2 depicts that Non-oil export and capital expenditure were strongly correlated around mid- 1960s. Thereafter, it followed a downward trend.



**Figure 3:** Dynamic regression of non-oil export vs consumer price index

Figure 3 shows that non-oil export and consumer price index were characterised by a swift upward relationship in the early 1960s and a swift downward trend in the late 1960s.



**Figure 4:** Dynamic regression of non-oil export vs exchange rate

Figure 4 shows that the relationship between non-oil export and exchange rate was mostly negative till around mid-1980s.

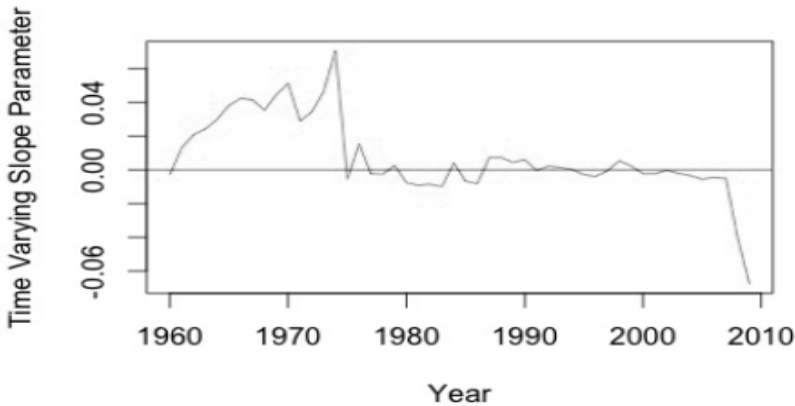
**Figure 5:** Dynamic regression of non-oil export vs lending rate

Figure 5 reveals that the relationship between non-oil export and lending rate was highly erratic over the study period.

**Table 2:** Dynamic linear model of non-oil export on various predictors

Model	Regressor	MSPE	GCD
1	LR +GDP	0.003	1.001
2	LR +CE	0.006	1.086
3	LR +CPI	0.004	0.058
4	LR + EXRT	0.007	0.966

### 4.3 Discussion of Results

There are quite a number of interesting results and lessons that can be gleaned from this study. Table 1 shows the dynamic regression of non-oil export on its various predictors. Lending rate exhibits the minimum MSPE of 0.002 on non-oil export. This result agrees with investment theory which requires that investment and interest rates are inversely related. The lending rate is the cost of capital; and as it reduces, it encourages more investment activities either for domestic or export. For instance, Bader and Malawi (2010) examined the impact the interest rate exerts on investment for

Jordan, using the co-integration technique for a period of 1990 to 2005 and established that the real interest rate exerts a negative influence on investment. It is, therefore, very pertinent for the monetary authority in Nigeria to effectively set its monetary policy rate towards ensuring stability of the lending rate in order to stimulate non-oil export business in Nigeria.

In Table 2, with non-oil export as the regressand, the lending rate and GDP predict non-oil export better than the other combinations of predictors. This agrees with the principle that a lower lending rate made accessible to aliens will stimulate foreign GDP, thus stimulating non-oil export.

Non-oil exports are mostly cash crops such as cocoa, timber, coffee, cotton, etc. Figure 1 shows that the relationship between non-oil export and GDP was very high in the 1960s when agriculture played a significant role in the economy of Nigeria. Sadly, the relationship consistently became poor thereafter, suggesting that a decline in foreign GDP reduces non-oil export. Capital expenditure and non-oil export did not fare well over the study period. This can be attributed to inadequate infrastructure in the supposed largest economy in Africa.

Figure 3 shows that, in 1960s, the consumer price index and non-oil export give a high positive time-varying correlation, suggesting that an increase in non-oil export will boost domestic income with its effect on aggregate demand and the price level (Ogundipe et al., 2019). Unfortunately, the relationship became poor and eventually neutralised beyond the mid-1960s. Figure 4 shows an unstable relationship between the time-varying parameter estimates of non-oil export and the exchange rate. In Figure 5, non-oil export and lending rate display an erratic pattern over the study period. This implies that the lending rate will influence the availability of capital for non-oil export activities, thus making its stability indispensable.

The proposed dynamic model also addresses reverse causality – as the lending rate affects exports, exports also affect the lending rate. All of the Geweke Z statistics are below the 1.96 threshold, indicating a failure to reject the null hypothesis of stationary means in each time series. In the results, if the null hypothesis of the convergence to the posterior distribution is not rejected for the parameters at the 5% significance level, it indicates an efficient sampling of the parameters.

## 5. Conclusion and Recommendations

The paper proposed and estimated a time-varying parameter dynamic model with application to econometric modelling of the predictors of non-oil export in Nigeria. The roles of exchange rate, GDP, lending rate, consumer price index and capital expenditure are considered in predicting non-oil export. The lending rate proves to be a better predictor when compared with other economic variables considered in the study. It is, therefore, pertinent for the monetary authorities in Nigeria to maintain the stability in the value of the lending rate. The lending rate combined with GDP gives a minimum mean square predictive error of 0.003. Investment in non-oil activities, most especially agriculture and manufacturing, should be encouraged. The economy will eventually improve as government's expenditure on social overhead capital expands, thus creating an enabling environment for investment activities with its resultant effects on employment generation and higher standard of living for Nigerians after the COVID-19 pandemic.

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