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Exchange Rate Volatility and Inflation in Nigeria: An Empirical Investigation (1970-2011)

Dr. Uduakobong S. Inam
Department of Economics, Faculty of Social Sciences, University of Uyo, P.M.B 1017, Uyo, Akwa Ibom State, Nigeria
udysammy@yahoo.com

Abstract
This paper empirically investigates the relationship between exchange rate and inflation in Nigeria using data for the period of 1970 to 2011. Specifically it sought to: analyse the influence of exchange rate volatility on inflation in Nigeria; and to determine the nature and direction of causality between exchange rate and inflation in Nigeria. Employing Ordinary Least Squares (OLS) techniques and Granger causality tests, the results indicate that Exchange rate (ER) has an insignificant negative influence on Inflation rate (INF). Furthermore, there is no causality between inflation rate(INF) and exchange rate(ER) in Nigeria. The study recommends that, policy makers and relevant monetary authorities should employ measures that will stabilize the exchange rate in order to ensure that the inflation rate is maintained at a reasonably low level.
Keywords: Exchange rate volatility, Inflation, Ordinary Least Square, Causality.

1.0 Introduction

Exchange rate stability remains an important issue that usually dominates the policy-making agendas of governments both in the developed and developing countries. This is so because it has broad implications not only for international trade and balance of payments, but also for the general price level, for the conduct of monetary policy and for macroeconomic stability. Exchange rate refers to the rate at which one currency is exchanged for another(Jhingan,2005). It is the price of a country's currency expressed in terms of another country's currency. In Nigeria and indeed many developing countries, the price of foreign exchange plays a critical role in the ability of the economy to attain optimal levels in production activities(Danmola,2013). Furthermore, governments in many developing countries use exchange rate as an instrument for stabilization purposes. This is particularly so for imported commodities and those produced within an economy whose intermediate inputs and raw materials depend heavily on imports (Adelowokan, 2012).

Inflation on the other hand, is also a topical macroeconomic problem that has been a priority over the years to all governments in the global economy. Inflation which refers to a sustained rise in the general level of prices- the price level (Blanchard, 2009), is one of the causes of economic retardation, and also it is a cause of both social and political unrest in many developing economies (Akinbobola, 2012). Inflation has beset the Nigerian economy over the years. Specifically, Nigeria's inflation rate has been volatile and mostly double digit (Umo,2007). Whereas economic literature views inflation as being a monetary phenomenon, a wide range of empirical studies have identified exchange rate volatility as one of the key factors that accounts for the variations in the general price level. Specifically, in Nigeria, most studies such as Adelowokan(2012), Egwaikhide, Chete and Falokun(1994), Nwosa and Oseni (2012), Oriovwote and Eshenake(2012), Imimole and Enoma(2011) have identified the fluctuations in exchange rate as one of the proximate causes of inflation in Nigeria.

Exchange rate volatility refers to the swings or fluctuations in the exchange rates over a period of time or the deviations from a benchmark or equilibrium exchange rate (Mordi, 2006). Also, it is seen as the risk associated with unexpected movements in the exchange rate. Economic fundamentals such as the inflation rate, interest rate and the balance of payments which have become more volatile in the 1980's and early 1990's, by themselves are sources of exchange rate volatility (Ozturk, 2006). Does the fluctuations in the exchange rate over the years have any implications for the general price level in Nigeria? Is there any linkage between inflation and exchange rate volatility in Nigeria? Does the

Movements or swings in the exchange rate cause variations in the price level in Nigeria? These and more are the underlying issues which this study seeks to tackle.

Therefore, this study seeks to empirically investigate the relationship between exchange rate and inflation in Nigeria using data for the period of 1970 to 2011. Specifically it seeks to: analyse the influence of exchange rate volatility on inflation in Nigeria; and to determine the nature and direction of causality between exchange rate and inflation in Nigeria.

This study is significant and relevant in that it will re-examine and also re-establish the already existing evidence that exchange rate fluctuations cause inflation in Nigeria. It will also re-awaken the need to strengthen and promote the exchange rate as an effective stabilization tool. Furthermore, it will offer reliable information that will assist the monetary authorities to embark on result-oriented actions that will forestall any incidence of general price instability.

This paper is organised into five sections beginning with the introduction in section 1, section 2 presents brief theoretical and empirical discourses while section 3 explains the methodology of research. The data and estimated results are discussed in section 4. Section 5 embodies the policy recommendations and conclusion.

2. Literature Review

2.1 Theoretical literature review

Exchange rate is the price of one country's currency expressed in terms of another country's currency. There are two concepts of exchange rate: the nominal exchange rate and the real exchange rate.

The nominal exchange rate is the rate at which the monies of different countries can be exchanged for one another. The real exchange rate is the rate at which the goods and services produced in different countries can be exchanged for one another(Delong, 2002). Similarly, there are two broad categories of exchange rate policies: the fixed exchange rate and the flexible exchange rate. In a fixed exchange rate system, foreign central banks stand ready to buy and sell their currencies at a fixed price in terms of dollars. In a flexible exchange rate system, by contrast, the Central Banks allow the exchange rate to adjust to equate the supply and demand for foreign currency (Dornbusch, Fischer and Startz, 1998).

Exchange rate language can be very confusing. In particular, the terms ''depreciation'', ''appreciation'', '' devaluation'' and '' revaluation'' recur in any discussion of international trade and finance (Dornbusch, et al, 1998). A devaluation takes place when the price of foreign currencies under a fixed rate regime is increased by official action. A devaluation thus means that foreigners pay less for the devalued currency and that residents of the devaluing country pay more for foreign currencies. The opposite of devaluation is a revaluation.

On the other hand, a change in the price of foreign exchange under flexible exchange rates is referred to as currency depreciation or appreciation. A currency depreciates when under floating rates it becomes less expensive in terms of foreign currencies. By contrast, a currency appreciates when it becomes more expensive in terms of foreign money (Dornbusch, et al, 1998). When the domestic currency is appreciated, its value in terms of other currencies is high. Foreign-produced goods are relatively cheap for domestic buyers, but domestic-made goods are relatively expensive for foreigners. In these circumstances, imports are likely to be high; exports are likely to be low. When the domestic currency is depreciated, the opposite is the case. Domestically-made goods are cheap for foreign buyers, thus, exports are likely to be high. But domestic consumers' and investors' power to purchase foreign-made goods is limited. Thus, imports are likely to be low (Delong, 2002).

The literature identifies a number of theories of inflation. These theories are: demand–pull, cost–push, structural, monetary and internationally transmitted inflation (i.e, imported inflation). However, for the purpose of this study, the relevant theories of the cause of inflation is a synchronization of the structural and imported inflation theories. The structuralists view inflation as resulting from the manifestation of basic structural factors which create supply shortages and inadequate government revenue to pay for imports to augment inadequate domestic supply. Structural inflation result from: supply shocks including relative inelasticity of the supply of food; foreign exchange constraints; import substitution industrialization strategy; protective measures; market imperfections; social and political instability, etc. (Kirkpatrick and Nixson, 1976; Thirwall, 1974; and Aghevei and Khan; 1978).

The internationally transmitted inflation (imported inflation) results from international trade. Under this theory, three effects are generally identified as channels of imported inflation, viz: price effect (transmitted by internationally traded goods and services), demand effect (by spill-over of excess demand across countries); Liquidity effect (by changes in foreign reserves occasioned by balance of payment adjustments).

2.2 Empirical literature review

Several studies have empirically investigated the relationship between exchange rate and inflation in most countries of the world. For instance, Noer, Arie and Piter (2010) analyzed the relationship between exchange rate and inflation. Using annual data from Asia (ASEAN +3), the EU and North America, they sought to compare the response or sensitivity of inflation to the changes in real exchange rates. Employing explorative statistics and Granger causality tests, the results, indicated that, for Asia, there is a significant one-way causal relationship where the nominal and real exchange rates have a significant impact on the rate of inflation. On the other hand, in the Non-Asian regions, the causal relationship is in the opposite direction. Furthermore, using panel data model with fixed effects, they found that the response or sensitivity of inflation to the changes in exchange rates in Asia is higher compared to these in EU and North America.

Ndungu (1997) studied the Price and Exchange rate dynamics in Kenya using data for the period 1970-1993. The results of the Granger Non- causality test showed that the level of inflation and changes in exchange rates affect each other. Similarly, Aliaa (2012) investigated the relationship between exchange rate changes and inflation using two indicators of inflation: Consumer Price Index (CPI) and Wholesale Price Index (WPI).

Employing the Granger causality test for monthly data in Egypt during the period of 1990-2008, the results showed a strong relationship between exchange rate changes and inflation. Both indicators of inflation succeeded in reflecting a clear Exchange Rate- Pass through (ERPT) Phenomenon, but WPI showed a faster response to exchange rate changes than CPI. This is due to the distortions of CPI.

Kamin and Khan (2003), examined the linkage between inflation and exchange rate in a multi-country comparison involving Asian and Latin American countries. Their study revealed that there exists a relationship between inflation rate and real exchange rate in most Asian and Latin American countries. Furthermore, they found that the influence of exchange rate changes on inflation rate is higher in Latin American countries than those in Asia and industrialized countries.

Chhiber and Shafik (1990) specified a macro-economic model to explain the inflationary process in Ghana. Using data covering the period of 1965-1988, the study revealed amongst other things, that official exchange rate did not exert any significant influence on inflation. However, the study showed that there existed a significant positive relationship between the parallel exchange rate and the general price level.

Similarly, Elbadawi (1990) in his study of the inflationary process, Stabilization and the Role of Public expenditure in Uganda found that rapid monetary expansion and the precipitous depreciation of the parallel exchange rate were the principal variables that determined inflation in Uganda. On the contrary, Rana (1983) investigated the impact of current exchange rate system on trade and inflation of selected developing member countries and found that exchange rate changes do not affect inflation rate.

LU and Zhang (2003) examined the Exchange rate reforms and its inflationary consequences in China and observed that in the short run, changes in the devaluation rate are positively correlated with the increase in the inflation rate. This signified a positive relationship between Exchange rate and inflation in China.

Within the Nigeria, context, Egwaikhide, Chete and Falokun (1994) examined the quantitative effects of exchange rate depreciation on inflation, government revenues and expenditures and money supply in Nigeria. Employing cointegration and error correction techniques, the results revealed that domestic money supply, real output, the shadow price of exchange rate, the parallel market exchange rate and the official exchange rate, cannot be ignored in evaluating the proximate causes of inflation in Nigeria.

Nwosa and Oseni (2012) examined the nexus between monetary policy, exchange rate and inflation rate in Nigeria. Using data for the period 1986 to 2010 and employing cointegration techniques and multi-variable Vector Error Correction Model the results revealed amongst other things, the existence of bi-directional causality between inflation rate and Exchange rate. Similarly, Oriovwote and Eshenake (2012) assessed the relationship between the real exchange rate and inflation in Nigeria. Using data covering the period between 1970 and 2010, the cointegration test result shows a long run relationship between inflation and the real exchange rate.

Imimole and Enoma (2011) examined the impact of exchange rate depreciation on inflation in Nigeria for the period 1986-2008 using Auto Regressive Distributed Lag (ARDL) cointegration Procedure. The research found amongst other things, that Naira depreciation has positive and significant long-run effect on inflation in Nigeria. This implies that exchange rate depreciation can bring about an increase in inflation rate.

Omotor (2008) examined the inflationary consequences of exchange rate reforms in Nigeria using data covering the period between 1970 to 2003. The results showed that exchange rate policy reforms is important in the determination of inflation in Nigeria. Similarly, Oyejide (1989) studied the stability of Nigeria's exchange rate and revealed that exchange rate depreciation often leads to increases in the domestic currency cost of imported inputs and final goods through the channel of cost-push inflation.

Ogundipe (2013) adopted a structural Vector autoregressive model to estimate the pass- through effect of exchange rate changes to consumer prices in Nigeria. Evidence from the analysis, covering the period of 1970 to 2008, revealed that exchange rate pass through to consumer prices is substantial in Nigeria. This further suggests that exchange rate is very important in explaining inflation in Nigeria.

The summary of literature reviewed reveals that there exists a long- run positive relationship between exchange rate and inflation with a uni-directional causality running from exchange rate to Inflation in most cases while a few cases recorded a bi-directional causality.

3. Methodology

3.1 Model Specification

This study employs the Ordinary Least Square regression technique to analyse the relationship between exchange rate and inflation in Nigeria. The study specifies an inflation model in which exchange rate is an explanatory variable as in equation (1):

INF = f (ER,)…….. (1)

However, from the literature, there are other factors that explain inflation in Nigeria. Thus, in order that the inflation model is not underspecified, these other factors are included in the inflation model as in equation (2). The primary model is thus specified:

$INF = f(MS_t, FD, ER, IR, PGDP_t, IMP_t)$ ..... (2)
(+) (+) (+) (+) (-) (+)

Where:

INF = Inflation rate (%)
MS_t = Growth rate of Real Broad Money Suppy (M_2) (%)
FD = Fiscal Deficit(as a % of GDP)
ER = Exchange Rate (%)
IR = Interest Rate (proxied by prime lending rate) (%)
$PGDP_t$ = Growth rate of Real GDP (%)
IMP_t = Changes in the value of Imports(%)

A Priori Expectations

The figures in parentheses represent a priori expectations about the signs of the coefficients.

The study also employs the Granger causality test to determine the nature and direction of causality between exchange rate and inflation in Nigeria. The Granger causality test is used to detect the nature and direction of influence or causality between two variables. In this study the Granger causality test was carried out based on the following equations:

$$LnInf_t = \sum_{i=1}^{n} r_i LnER_{t-i} + \sum_{i=1}^{n} r_j LnInf_{t-j} + U_{1t} \quad \text{... ....(3)}$$

$$LnER_t = \sum_{i=1}^{n} \theta_i LnER_{t-i} + \sum_{i=1}^{n} P_j LnInf_{t-j} + U_{2t} \quad \text{..... ... .(4)}$$

3.2 Data

The series employed are annual observations of Inflation Rate, Broad Money Supply (M2), Fiscal deficit (% of GDP), Exchange rate, Interest rate, real GDP and Imports for the period 1970 to 2011. They were sourced from various issues of the Central Bank of Nigeria Statistical Bulletin.

3.3 Diagnostic Tests

The statistical properties of the estimated inflation model as expressed in equation (2) were also examined. This is to ensure that the model is well specified. Thus, apart from the unit root test of stationarity of the variables employed, other diagnostic tests carried out include: the test of the goodness of fit R^2, the test of the overall significance of the multiple regression (F-Test), Durbin-Watson test of serial correlation, Normality test, heteroscedasticity test and Ramsey Reset test.

4. Analysis And Discussion of Results

4.1 Unit Root Tests

Tables 4.1a and 4.1b present the results of the Augmented Dickey Fuller (ADF) and Phillip Peron (PP) Unit root tests for the order of integration of the variables under investigation. The essence of the test is to determine whether the series: Inflation rate (INF); Growth rate of real Broad Money Supply (MS_t); Fiscal deficit (FD); Real Exchange Rate (ER); Interest Rate (IR); Growth rate of real Gross Domestic Product ($PGDP_t$); and Changes in value of Imports (IMP_t); are Stationary (i.e have unit roots) and their order of integration. Thus, the essence of the test is the null hypothesis of nonstationarity. To reject this, the ADF and PP statistics must be more positive or negative than the critical values and significant.

Table 4.1a Result of Unit Root Tests Based on Augmented Dickey-Fuller (Constant, time and trend included.

Variables	ADF Statistic	1% critical level	5% critical level	10% critical level	Order of Integration
INF	-3.414874	-3.600987	-2.935001	-2.605836	I (0)
MS_t	-4.466297	-3.600987	-2.935001	-2.605836	I (0)
FD	-3.853311	-3.600987	-2.935001	-2.605836	I (0)
ER	-5.869694	-3.605593	-2.936942	-2.606857	I (1)
IR	-9.993997	-3.605593	-2.936942	-2.606857	I (1)
$PGDP_t$	-6.713883	-3.600987	-2.935001	-2.605836	I (0)
IMP_t	-7.659700	-3. 600987	-2.935001	-2.605836	I (0)

Source: Computed Result (E-View 5)

Table 4.1b Result of Unit Root Tests Based on PHILLIP Perron (Constant, time and trend include)

Variables	PP Statistic	1% critical level	5% critical level	10% critical level	Order of Integration
INF	-3.283566	-3.600987	-2.935001	-2.605836	I (0)
MS_t	-4.350954	-3.600987	-2.935001	-2.605836	I (0)
FD	-4.016259	-3.600987	-2.935001	-2.605836	I (0)
ER	0.550916	-3.600987	-2.935001	-2.605836	I (1)
IR	-10.07826	-3.605593	-2.936942	-2.606857	I (1)
$PGDP_t$	-6.876119	-3.600987	-2.935001	-2.605836	I (0)
IMP_t	-7.660086	-3.600987	-2.935001	-2.605836	I (0)

Source: Computed Result (E- view 5)

After comparing the test statistic value against the Mackinnon critical value at 5% level of significance, it was noticed that most of the variables in the two tests employed, that is ADF and PP were stationary at levels. The results of both the ADF and PP test show that INF, MS_t, FD, $PGDP_t$ and IMP_t were stationary at levels while ER and IR are stationary at first difference.

Table 4.2: OLS Results of Macroeconomic variables Influencing Inflation
Dependent variable = Inflation rate

Variables	Double log function (Lead Model)	Exponential Function	Linear Function	Semi Log
C	-5.559(0.054) *	-114.258(0.022)**	2.839(0.776)	1.673(0.004)***
MSt	0.336 (0.177)	5.030(0.2279)	0.069(0.605)	0.002(0.760)
FD	-0.249 (0.603)	-7.792(0.340)	-0.139(0.789)	0.002(0.941)
ER	-0.227(0.176)	-7.158(0.018) **	-0.11(0.032)**	-0.004(0.174)
IR	2.286(0.008)***	44.359(0.003)***	-0.21(0.017)**	0.061(0.024)**
PGDPt	0.005(0.981)	-1.251(0.712)	0.066(0.277)	0.003(0.393)
AGDPt	0.159(0.473)	0.091(0.980)	-0.043(0.372)	-0.001(0.688)
IMPt	0.516(0.028) **	11.660(3.574)	0.069(0.077)*	0.002(0.382)
R^2	0.589	0.712	0.378	0.255
Adjusted R^2	0.397	0.577	0.249	0.101
F-Tests	3.066	5.294	2.946	1.659
Prob (Fstatistics)	(0.033)**	(0.003)***	(0.016) **	(0.153)
D.W	1.577	1.966	1.323	1.071
AIC	2.609	8.261	8.446	2.623
SIC	3.004	8.656	8.777	2.954

Diagnostic Tests	**Double log**	**Exponential**	**Linear**	**Semi-Log**
ARCH Test	0.244(0.631)	5.576(0.038)	6.790(0.013)	7.171(0.011)
LM test	0.026(0.975)	0.000(1.000)	4.484(0.019)	4.718(0.016)
RESET Test	4.225(0.059)	1.400(0.256)	0.557(0.461)	0.002(0.968)
Normality test	5.206(0.074)	0.211(0.900)	1.805(0.406)	0.848(0.655)

Notes:

1) Variables are as defined in Equation 2 in Section 3.1; **C** = Intercept; **R^2** = coefficient of determination; **DW** = Durbin Waston statistic; **AIC** = Akaike Information criterion; **SC** = Schwarz information criterion; **ARCH** = Autoregressive conditional Heteroscedasticity; **LM Test=** Lagrange Multiplier Test; **RESET Test** = Regression specification Error
2) Asterisks *, ** and *** denotes 10%, 5% and 1% significant levels respectively
3) Values in parenthesis are the P – values.

The lead model which forms the basis of our analysis is the Double Log function. This is because irrespective of having a high R^2 (although not higher than that of Exponential function), its AIC and SIC are lower than those of the other three forms. According to Gujarati and Porter (2009:494), the model with the lowest value of AIC and SIC are mostly preferable to other models with higher AIC and SIC. Furthermore, two

out of seven coefficients are significant at various levels of significance. Other diagnostic tests carried out indicated that the chosen functional form exhibited best fit in the presence of other functional forms.

The E-view Computed R^2 (R-Squared) value of 0.589 obtained simply implies that the specified explanatory time series explained about 58.9% of the total variations in the Inflation rate(INF). The F-Statistic of 3.066 is significant at 5% probability level, indicating that the R^2 is significant and this implies that the model (equation) has goodness of fit. However, the computed Durbin-Watson value of 1.577 indicates that there exists a minor serial correlation.

From the empirical results presented in Table 4.2, the coefficient of growth rate of real broad money supply (MSt) has a long-run positive but insignificant influence on Inflation rate (INF). The result satisfies a priori expectation. This implies that, an increase in the real broad money supply, increases the inflation rate. The slope coefficient of Fiscal deficits (FD) indicates a long-run negative but insignificant influence on inflation rate (INF). This result does not conform to the a priori expectation. This implies that any increase in Fiscal deficits leads to a decrease in the inflation rate and vice versa. Similarly, The result also shows that Exchange rate (ER) has an insignificant negative influence on Inflation rate (INF). This implies that when Exchange rate depreciates, inflation rate increases and vice versa. This result does not conform to a priori expectations and it departs greatly from the findings of other studies such as Imimole and Enoma (2011).

On the other hand, the slope coefficient of Interest rate (IR) indicates a significant and positive long-run relationship with Inflation rate. This conforms to a priori expectations. The result implies that a reduction in the prime lending rate (which is the measure of interest rate used here), leads to a decrease in the Inflation rate and vice versa. This relationship is such that for every one unit increase in Interest rate, Inflation rate will increase by 2.29 units and otherwise in terms of a decrease. Similarly, the coefficient of changes in the value of Imports (IMP) indicates a significant and positive long run relationship with inflation rate. This result conforms to a priori expectations. It implies that an increase in the value of imports leads to an increase in the inflation rate. The result also reveals that for every one unit increase in the value of imports, inflation rate will increase by 0.52 units.

Furthermore, the coefficient of the growth rate of real gross domestic product (PGDPt) indicates a long-run positive and insignificant relationship with inflation rate. This does not conform to a priori expectation and it implies that an increase in PGDPt leads to an increase in the inflation rate. Also, a reduction in the PGDPt, leads to a fall in inflation rate.

4.3 Granger Causality Results

Table 4.3 Pairwise Granger Causality Test Results

Null Hypothesis:	Obs	F-Statistic	Probability
ER does not Granger Cause INF	40	0.70005	0.50338
INF does not Granger Cause ER		0.51608	0.60132

From the Granger results, we accept the null hypothesis that exchange rate(ER) does not Granger cause inflation rate(INF). This is because computed F- statistic value is not significant. Similarly, we accept the null hypothesis that inflation rate(INF) does not granger cause exchange rate(ER). Thus, there is no causality between INF and ER. This finding differs greatly from the works of Nwosa and Oseni(2012) who revealed the existence of bi-directional causality between inflation rate and exchange rate using data for the period of 1986 to 2010.

5. Policy Recommendations and Conclusion

This study empirically investigated the relationship between exchange rate and inflation in Nigeria using data for the period of 1970 to 2011. Specifically it sought to: analyse the influence of exchange rate volatility on inflation in Nigeria; and to determine the nature and direction of causality between exchange rate and inflation in Nigeria. Employing Ordinary Least Squares (OLS) techniques and Granger causality tests, the results indicate that Exchange rate (ER) has an insignificant negative influence on Inflation rate (INF). This implies that when Exchange rate depreciates, inflation rate increases and vice versa. Furthermore, there is no causality between inflation rate(INF) and exchange rate(ER) in Nigeria.

From the findings of this study, the policy options can be easily discerned. Policy option requires that, efforts should be aimed at stabilizing the exchange rate to avoid depreciation of the naira given its adverse effect on the general price level. The depreciation of the nation's currency is likely to increase the cost of imported raw

materials as well as the cost of imported finished goods. Hence, a concerted effort of both the government and the private sector is required to: increase the productive capacity of the Nigerian economy to supply finished goods both for local consumption and for exports; as well as to harness the abundant natural resources for use as raw materials in relevant industries locally and internationally. Apart from enhancing the balance of payment position of the country, this will also serve as a safeguard against any inflation episode remotely triggered by exchange rate volatility. Specifically, policy makers and relevant monetary authorities should employ measures that will stabilize the exchange rate in order to ensure that the inflation rate is maintained at a reasonably low level.

In conclusion, given that exchange rate fluctuations have serious implications for the general price level in Nigeria, any effort geared towards exchange rate stability is a step in the right direction and a necessary action towards the achievement of general price stability. Moreover, exchange rate stability and general price stability are two macroeconomic goals that when achieved, can lead to the sustainable growth and development of any economy.

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