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E u r o E c o n o m i c a
Issue 2(33)/2014 *ISSN: 1582-8859*

Romanian intra-industry trade: A panel data approach

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Abstract. This research examines the determinants of intra-industry trade (IIT) in the automobile components sector in Romania. Following previous studies, our manuscript applies a gravity model equation with panel data. The dependent variable used is IIT in automobile components. The analysis of the determinants of IIT is undertaken using a panel approach. The panel data models were estimated with Pooled OLS, fixed effects (FE) and random effects (RE) estimators. The results are presented with country characteristics as explanatory variables, and the models have four statistically significant variables. This research adds significant contribution to the intra-industry trade topic. Little academic attention has been devoted to the Romanian experience. The trade in the automobile components sector between Romania and some European countries (Austria, Belgium, Bulgaria, Croatia, Czech Republic, France, Germany, Hungary, Italy, Netherlands, Poland and Turkey) was examined, between 1995 and 2008. Using a panel data approach, the results show a positive correlation between endowments and IIT. The results indicate that the Romanian IIT is explained by differentiated quality, i.e. vertical specialization. Our study also consider economic dimension, this proxy confirms the positive effect of IIT, and so the market size is important to differentiated product. The economic model also confirms the hypothesis that volume of trade increases if the transportation costs decreases.

Keywords: intra-industry trade, panel analysis, Romania.

1 Introduction

The last twenty years of transition profoundly marked the Romanian economy, and also its social and political environment, being transformed in a more mature and reliable economy of EU market, seen as a serious business and commercial partner by other European and world countries. The beginning of the transition period to market economy during the 1990s was marked by the liberalization of trade regime. The transition period created the possibility so that Romanian economy to be transformed in a mature, competitive one, brought new challenges and opportunities, vision' changes, new economic strategies, but also oscillations of the main macroeconomic indicators (i.e. GDP, export, import, industrial production, trade balance, unemployment rate). The main changes occurring in Romanian economic transition were also the result of profound rethinking of economic structures and new capitalist policies in various fields of the national economy hesitant at the beginning and more strongly applied in the last decade, especially in areas having a higher importance for a sustainable development (i.e. commercial relations, foreign investments). The profound transformations of many European economies, the emerging challenges are largely due to EU integration process, requiring

innovative strategies dealing with new approaches in creating a sustainable trade environment and improvements of the international commercial relations.

In the last twenty years, Romanian economy recorded various stages of decline and growth, especially the former ones affecting the commercial relations with other countries. Particularly in this context, the economic and commercial decisions were necessary for the business environment in the trade sector, and not only, to develop in a sustainable manner. Nevertheless, the insufficient economic restructuring transforms Romania in a net importer having a permanent negative trade balance, difficult to cover especially because of the insufficient foreign direct investments.

During the transition period, the policies aiming the adjustment of international trade have been oriented towards geographic diversification, especially through the reorientation to the West European countries and towards sectoral restructuring of traded goods and services. In 2001, according to the estimated Balassa index, Romania had a comparative advantage in fourteen product groups, and in four of them the indicator value was over 1, more precisely for wood products, basic manufactured products, leather products, garments (Zaman and Vasile, 2003).

Romania becomes EU member state in 2007 and the EU accession brought challenges on various fields, the status of member state offering a series of benefits, but also new obligations. European Union is the most important commercial partner of Romania, representing 69.8% of total external trade in 2008 (70.5% of export and 69.6% of imports). The FOB exports reached in 2008 a total amount of 33,725 million euro, while CIF imports were 57,240 million euro.

Joining the EU meant the consolidation of the position in the external commercial relations. Thus, in 2008 as compared with 2000, the Romanian exports with EU increased by +6.7 pp and imports by +13.0 pp. Still the balance of foreign trade transaction was negative for the entire analyzed period, from 1995 to 2008. The negative trade balance increased from one year to another, affecting the Romanian balance of payments.

Romanian economy has a competitive advantage in exporting machinery and mechanical appliances, electrical equipment, sound and image records and reproducers; base metals and articles of based metals; vehicles and associated transport equipments; textiles and textile articles; mineral products, these goods also having the most dynamic evolution in the last years. Nevertheless, these goods are the ones also having a high share in Romanian imports.

2 Literature review and empirical work

The pioneering models of intra-industry trade (IIT) exclude the idea that the traditional theories of trade (Ricardian trade theory and Heckscher-Ohlin trade theory) could explain *two-way-trade*. Falvey (1981), Falvey and Kierzkowski (1987), Flam and Helpman (1987) and Shaked and Sutton (1984) introduced new models of IIT explained with traditional theories. The models of horizontal intra-industry trade (HIIT) appear with Krugman (1979, 1980), Lancaster (1980) and Helpman (1981). These models were synthesized by Helpman and Krugman (1985). Later, the analysis was extended to oligopolistic structures. In the neo-Chamberlin models, consumers have identical tastes and preferences (Krugman, 1979).

In the neo-Hotelling models, consumers have asymmetric preferences, i.e., each individual has a map of preferences (Lancaster, 1980). These models consider that the IIT is associated with the economies

of scale and product differentiation (variety). In oligopolistic structures with homogeneous goods we can refer (Brander, 1981, Brander and Krugman, 1983) where the Cournot assumptions are applied to intra-industry trade. Eaton and Kierzkowski (1984) introduced the horizontal differentiation in oligopolistic markets. The authors refer to the models of Krugman (1979, 1980, 1981), Lancaster (1980) and Helpman (1981). Eaton and Kierzkoski (1984) also consider that each consumer has an ideal variety. The balance is achieved through a "game" where the entry decisions of new firms and the choice of variety are taken into account before the decision on the price and quality. Falvey (1981), Falvey and Kierzkowski (1987), Flam and Helpman (1987) and Shaked and Sutton (1984) introduced the vertical differentiation models.

The vertical product differentiation means that different varieties have different types of quality. The demand is made up of consumers with different types of choice, that is, a relationship that emerges from the quality- price. On the supply side is assumed that the products (varieties) are low or high quality. The low qualities products are labour intensive and high quality are capital intensive. The country labour abundant has comparative advantage in low-quality varieties, and capital-abundant countries have a comparative advantage in high-quality products. Falvey and Kierzkowski (1987) followed Linder (1961) theory. The authors consider that vertical differentiation could be explained by differences between per capita incomes. Falvey and Kierzkowski (1987) concluded that capital abundant countries have higher productivity and higher wages. Symmetrically, the labour abundant country (low-wage country) will have comparative advantages in low-quality varieties that are labour-intensive. Flam and Helpman (1987) contains the differences in technology (labour productivity) that explain VIIT. The country with most productivity has higher wages and exports the higher-quality products.

In the Shaked and Sutton's article (1984), trade is studied in the context of a natural oligopoly, vertical product differentiation. The IIT is explained by different varieties of quality products (differences in income distribution: lower income country specializing in lower quality products, higher income specializing of quality products).

Davis (1995) explains IIT with constant returns to scale and comparative advantages associated with perfect competition. Davis developed the model considering that Ricardian and Heckscher- Ohlin influence the IIT and inter-industry trade (based in comparative advantages).

Aturupane et al. (1997) analyse the determinants of IIT between Western European Union countries and Central and Eastern European countries (CEECs), during the 1990-95 period, and the levels of IIT between eight CEECs and the EU(9). The authors underline the high size of IIT in CEECs-EU trade, the high share of VIIT and the positive and significant FDI-product differentiation relationship for HIIT and VIIT.

Zaman and Vasile (2003) calculated IIT between candidate countries and EU(15) measured by Grubel-Lloyd index (1995–1999) and underline that IIT was more intense in the relationship between EU and Czech Republic, Slovenia and Hungary, the lowest recorded values were for relations between EU and Latvia, Lithuania and Romania and the indicator' evolution shows that in Romania the trade relations with EU are unbalanced, the country' exports are predominantly low competitive products and the imports are predominantly high value added products based on technology that effectively use labour and capital resources. Zaman and Vasile (2003) also calculated the Grubel-Lloyd index of IIT intensity by product groups for Romania, and a wide variability by product groups was observed, and high values, in 2002, for textiles, means of transport, etc.

Rault et al. (2007) focus on two Eastern European countries (Bulgaria and Romania) and OECD countries and estimate a gravity model using panel data techniques to characterize bilateral trade flows, for eighteen years. The authors' results underline the importance of the country size and geographical distance variables in the international trade flow explanation.

Kawecka-Wyrzykowska (2009) investigates the development of IIT, in an analysis focused on ten new member states that joined the EU in 2004 (EU-10) and also on Bulgaria and Romania (+2), for period 2000-2007. The author finds that since 2000, the share of IIT in trade of EU-10 and in trade with all partners has been declining and IIT of the EU-10+2 is largely low-quality VIIT.

Olteanu (2009) analyses the main European countries, USA, Japan and China, and the production and export by groups of activities and products, and also IIT (vertical specialisation) of European countries, estimating the difference in quality of their exported goods. The results show production and export specialisation differences between countries.

Caporale et al. (2009) analyses trade specialisation in Romania and Bulgaria and in EU15 countries in the period 1990-2006. The authors focus on the idea of a shift towards IIT, a beneficial aspect for economic convergence and technological catch-up. The results indicate an increase of IIT, actually VIIT, with production patterns of complementary type. The authors' analysis is based on estimation of a gravity model, over the period 1990-2006.

Recent studies found vertical IIT dominates HIIT in bilateral trade. Yoshida, Leitão and Faustino (2009) consider the vertical intra-industry trade (VIIT) between Japan and various European countries. The authors conclude that there is an increase of the IIT between European countries and Japan.

Zhang and Clark (2009) investigate HIIT and VIIT for the case of United States. This study uses both industry and country–specific characteristics as explanatory variables. The study of Zhang and Clark (2009) show that HIIT will have relatively low factor adjustment costs when compared with the VIIT. The results have support for new trade theories and traditional factor endowment-based (Heckscher - Ohlin model).

Chang (2009) examines the main factors of HIIT and VIIT including investment approaches of a firm in the industry of information technology for Asian, European and U.S. markets. The study uses time series data over the period of 1996-2005 for the mentioned variables in sample economies. The results indicate that VIIT is playing its significant role among Asian and European markets while HIIT is significant between Asian and US.

Leitão and Faustino (2008) analyses the determinants of IIT in the Portuguese food processing sector. The results of the authors underline that the difference in GDP per capita between Portugal and European trade partners, the geographical distance between trading partners, and industrial concentration are important variables.

The various studies are in agreement regarding the importance of HIIT and VIIT. As Zhang and Clark (2009) refer, the HIIT has low costs of adjustment taking into account that the products are differentiated by attributes.

3 Measure of intra-industry trade

The level of IIT is generally measured by the so-called Grubel and Lloyd (1975) index. They defined IIT as the difference between the trade balance of industry *i* and the total trade of this same industry. In order to make the comparison easier between industries or countries, the index is presented as a ratio in which the denominator is total trade.

$$IIT_i = 1 - \frac{|X_i - M_i|}{(X_i + M_i)} \Leftrightarrow IIT_i = \frac{(X_i + M_i) - |X_i - M_i|}{(X_i + M_i)} \qquad (1)$$

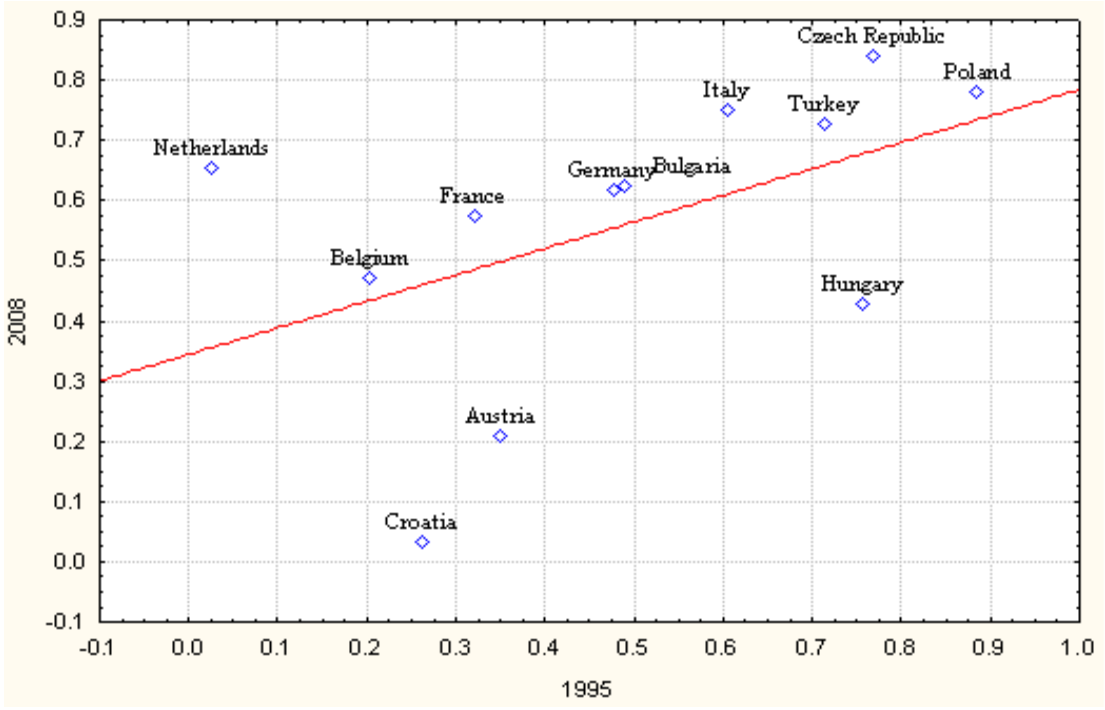
The index is equal to 1 if all trade is of the intra-industry trade type. If IIT is equal to 0, all trade is inter-industry trade.

The values of IIT index indicate more a changing in the pattern in the trade characteristics, from inter-industry trade to more intra-industry trade (Austria, Belgium, Czech Republic, Netherlands), Romania being more an importing country than an exporting one. Countries in Western and Central Europe had a comparative advantage in terms of factor (labour and capital) endowments and technology.

Romanian trade relations with its partners were marked by the difficult and long transition to the market economy, thus the IIT values oscillated from IIT to inter-industry trade at the beginning of 2000 back again to IIT in 2005-2008 as in the case of Poland.

The increase in IIT has been much steeper than before especially after 2003, reflecting technological progress and income convergence (Haar, 2010) and also integration of EU industrial patterns and hence convergence between the country and EU (Caporale et al., 2009). In the analysed period, the IIT was predominantly vertical, just in a reduce number of cases horizontal ones, especially with Italy (2002, 2005, 2006) and Poland (1995, 1996, 2005). Generally considering, the values of the Grubel-Lloyd (GL) index (1975) shows that VIIT is characterized by low quality products (sold at a lower average price), specific to developing countries, such as Romania, leading to specialisation in less capital-intensive production stages (Caporale et al., 2009).

The Grubel-Lloyd index for each European country with respect to Romania for 1995 and 2008 was plotted (see **Figure 1**). The countries placed at a further distance from the origin is associated with a higher IIT, also indicating the largest IIT countries consisting especially in those with similar development level (Hungary, Poland, Czech Republic, Turkey). Any country below the diagonal line experienced a decline in IIT with Romania (Hungary, Austria, and Croatia), while the countries above the diagonal line experienced an increase. In the analysed period the countries registering the highest increases in IIT were Netherlands (+0.63), Belgium (+0.27) and France (+0.26), namely developed Western European economies.



Source: authors' calculation and representation

Figure 1 Intra-Industry Trade between Romania and European Countries, 1995 and 2008

These increases in IIT are the most important feature of the recent development in EU trade also indicating that Romania's trade patterns are rapidly catching up with the rest of the European countries.

4 Econometric model

Following previous studies, our manuscript applies a gravity model equation with panel data. The dependent variable used is IIT in automobile components. It is calculated with the disaggregation of four digits of the automobile components. The data for explanatory variables is sourced from the World Bank, World Development Indicators (2010), except distance – source is CEPII database (Centre d'Etudes Prospectives et d'Informations Internationales). The source used for dependent variable is International Trade Yearbook of Romania (National Institute of Statistics) for the period 1995-2008.

Explanatory variables

Hypothesis 1: There is a negative correlation between differences in per-capita income and IIT.

LogDGDP is the logarithm of absolute difference in per-capita GDP (PPP, constant, 2005, international dollars) between Romania and trading partner. Regarding hypothesis 1, Helpman and Krugman (1985) suggest a negative relationship in the IIT model. Unemoto (2005) found a negative sign, when the author analysed the determinants of automobile parts between Korea and Japan.

Hypothesis 2: IIT occurs more frequently among countries that are similar in terms of factor endowments.

LogEP is a proxy for differences in physical endowments. It is the logarithm of the absolute difference in electric power consumption (Kwh per capita) between Romania and its partners. Considering hypothesis 2, the model of Helpman and Krugman (1985), Hummels and Levishon (1995) suggest a negative effect of physical endowment on IIT. Zhan et al. (2005) use the absolute difference in electric power consumption in examining IIT for China.

Hypothesis 3: The level of FDI in a particular industry is somewhat ambiguous since FDI may be a substitute for the IIT.

LogFDI is the Foreign Direct Investment net inflows (% of GDP). The dominant paradigm considers a positive sign (Greenaway et al. 1994). Gray (1988) considers an ambiguous relationship between FDI and IIT.

Hypothesis 4: The larger economic dimension (average size of two countries) increases IIT.

Regarding hypothesis 4, Jones and Kierzkowski (2004) and Grossman and Helpman (2005) suggest a positive correlation between economic size and IIT.

Hypothesis 5: Trade increases when partners are geographically close.

DISTxEP: This variable measures geographical distance multiplied by EP (between the Romania and each partner country).

According to Balassa and Bauwens (1987) and Krugman (1979, 1980) when IIT will be greater, the closer geographically are the trading partners.

Bergstrand and Egger (2006) provide a coherent insight into the relationship between the share of IIT and trade costs.

Model specification

The analysis of the determinants of IIT is undertaken using a panel approach. The panel data models were estimated with Pooled OLS, fixed effects (FE) and random effects (RE) estimators. The F statistics tests the null hypothesis of same specific effects for all countries. If we accept the null hypothesis, we could use the OLS estimator. The Hausman test can decide which model is better: random effects (RE) versus fixed effects (FE). A fixed effects model is employed. Consistent with the testable hypotheses discussed above, the model employed to explain the relative importance of IIT is specified as follows:

$$LogIIT_{it} = \beta_0 + \beta_1 LogDGDP_{it} + \beta_2 LogEP_{it} + \beta_3 LogFDI_{it} + \beta_4 LogDIM_{it} + \beta_5 LogDISTxEP_{it} + \delta t + \eta_i + \varepsilon_{it} \quad (2)$$

Where:

- $LogIIT_{it}$ is a measure of intra-industry trade in logs;

- $LogDGDP_{it}$ measures the economic differences between partners as the logarithm of the difference of income per capita between Romania and trading partner;

$$LogDGDP_{it} = Log\left|GDP^{Romania} - GDP^{Partners}\right| \quad (3)$$

- $LogEP_{it}$ is a variable for differences in physical capital endowments, in logs;

$$LogEP_{it} = Log\left|EP_{it}^{Romania} - EP^{Partners}\right| \quad (4)$$

- *LogFDI* is the logarithm of foreign direct investment inflows;

- $LogDIM_{it}$ is the logarithm of average of GDP of the two trading partners;

- *LogDISTxEP*: measures geographical distance multiplied by EP (between the Romania and each partner country), in logs;

- η_i is the unobserved time-invariant specific effects;

- δt captures a common deterministic trend;

- ε_{it} is a random disturbance assumed to be normal, and identical distributed (IID) with E (ε_{it})=0; Var (ε_{it}) = $\sigma^2 \succ 0$.

5 Empirical results

In this section we present the results with country characteristics as explanatory variables. We include in this estimation the main trade partner of Romania.

The Fixed effects are reported in Table 1. Our analysis pretends to evaluate the signs of the coefficients and their significances.

This equation was introduced as an explanatory for IIT in automobile parts and components.

Table 1 The determinants of intra-industry trade: Fixed Effects Model Estimates

Variables	Fixed Effects	*t-statistics*	Significance	Expected Sign
LogDGDP	-0.685	(-1.935)	*	(-)
LogEP	5.915	(5.533)	***	(-)
LogFDI	0.2658	(1.365)		(+)
LogDIM	4.2830	(4.697)	***	(+)
LogDISTxEP	-1.847	(-3.676)	***	(-)
Adj. R^2	0.28			
Observations	149			

T-statistics (heteroskedasticity corrected) are in round brackets.
****/** /* - Statistically significant, respectively at the 1%, 5%, and 10% levels.*

The model presents four statistically significant variables: (LogDGDP, at 10%), electric power (LogEP, at 1%), economic dimension (LogDIM, at 1%), and the variable LogDISTxEP (at 1%) validate the hypothesis formulated. The absolute difference in per capita incomes in logs (LogDGDP) presents a negative sign. This result is according to previous studies (Loertscher and Wolter, 1980, and Helpman and Krugman, 1985). Unemoto (2005) also found a negative correlation between this proxy and IIT, when the author analysed the automotive parts between Korea and Japan.

Following Hummels and Levinsoh (1995), Zhan et al. (2005), Leitão and Faustino (2009) and Leitão (2012) we incorporate the difference in electric power consumption per capita, to analyse the difference in endowments between Romania and its trade partners. According to previous studies we expected a negative sign, and we have a positive correlation between LogEP and IIT. As Romania IIT is mainly VIIT, this is consistent with the Heckscher -Ohlin trade theory.

The variable LogDIM (average of GDP), used also by Greenaway et al. (1994), has a significant and predicted positive effect on IIT. This result shows that economic dimension influences the volume of trade.

LogDISTxEP has been used as a typically gravity model variable. A negative effect of geographical distance on IIT was expected and the results are in conformity (Badinger and Breuss, 2008, Leitão, Faustino, and Yoshida, 2010). The variable is used as a proxy for transport costs.

In Table 2 we can observe the determinants of IIT using Probit model. All the variables are statistically significant: (LogDGDP at 10%, LogEP at 1%, LogDIM at 1%, and LogDISTxEP at 1%) with the exception of foreign direct investment (FDI).

Table 2 The determinants of intra-industry trade: Probit Estimator

Variables	Probit	*t-statistics*	Significance	Expected Sign
LogDGDP	-0.5725	(-1.950)	*	(-)
LogEP	4.294	(3.594)	***	(-)
LogFDI	0.133	(0.513)		(+)
LogDIM	1.285	(2.675)	***	(+)
LogDISTxEP	-1.100	(-3.608)	***	(-)
C	-20.430	(-3.241)	***	
LR		18.864	***	
Observations	149			

T-statistics (heteroskedasticity corrected) are in round brackets.
****/** /* - Statistically significant, respectively at the 1%, 5%, and 10% levels.*

The hypothesis for the logarithm of absolute difference in per-capita GDP presents a negative sign. The variable electric power consumption (LogEP) presents a positive sign. We can conclude that the probability of economic dimension (DIM) to influence positively total IIT is confirmed. For the proxy geographic distance (LogDISTxEP) we find a negative sign, and this result is according to the literature. Chemsriong et al. (2005) analyzed the determinants of IIT in Thailand, and also found a negative sign.

6 Conclusions

This research adds significant contribution to the intra-industry trade topic. Little academic attention has been devoted to the Romanian experience. The central objective of this study was to analyze some of the determinants of IIT in the automobile components sector. Econometric estimators are according

to the hypothesis formulated. Our results are robust with different estimators (Fixed effects, and Probit model).

The variable (LogDGDP) used to evaluate the economic differences between partners presents a negative correlation on IIT, when we used fixed effects, and Probit model. These results are according to the literature (Helpman and Krugman 1985). In relationship, the variable difference in physical endowments (LogEP) presents a positive sign. This result is contradictory with the literature (Helpman and Krugman, 1985, Hummels and Levishon, 1995, and Loertscher and Wolter, 1980). As automobile sector are mainly vertical specialization, this can explain the positive coefficient of this variable.

The proxy used to economic dimension (LogDIM) validates the hypothesis: the economic dimension influences the IIT. Jones and Kierzkowski (2004) and Grossman and Helpman (2005) show that market size is important to differentiated product.

It is usual that the literature attributes a negative sign to geographical distance, i.e., trade increases when partners are geographically close. The variable (LogDISTxEP) confirms this. In the future work, we need to consider research on VIIT. This sector is explained by different endowments and quality products. To calculate the HIIT and VIIT we need to apply the methodology of Abd-el-Rahaman (1991), or more recently the method of Kandogan (2003).

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