Advances in Business-Related Scientific Research Journal
ABSRJ
geacollege
Faculty of Entrepreneurship

REGIONAL ECONOMIC GROWTH IN THE EUROPEAN UNION: APPLYING THE QML ESTIMATOR

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Abstract

Regions have different characteristics and level of development starting from infrastructure, industry, tourism, services or taxations. This is why this investigation aims to find the most important determinants of regional economic growth in the European Union. The sample date was collected for 98 NUTS 1 and 271 NUTS 2 regions with a time frame of 14 years (2000-2013). To obtain the results for the two models used, the paper utilized the QML estimation. The results showed that labour productivity, employment, energy consumption, life expectancy are positively influencing growth, and that government debt and early leavers from education hinder growth.

Key Words

Regional economic growth; QML estimator; NUTS 1; NUTS 2.

INTRODUCTION

The empirical research in the field of regional economic growth has tried to determine what variables have an influence on growth and to come to a consensus on the relevant sign of the variation. There are a number of articles that determined a significant link between innovation (R&D expenditures, patent application, population employed in research), transportation (airport infrastructure, roads, highways), population growth, capital formation, energy consumption, public investments and economic growth at EU regional level (Parent & LeSage, 2012; Rodriguez-Pose et al., 2012, 2015).

Like in the case of economic growth at country level, there is still not a consensus on the effects of some variable. Contradictions in results may appear from studies made for different regions like South America, China, Indonesia, North America or Russia (Golubchikov, 2007; Spiezia & Weiler, 2007; Hartono et al., 2007).

The aim of this study is to contribute to the regional growth literature by testing and measuring the importance of several determinants (variables). The growth analysis will be employed for two different territorial levels in the EU 28. Firstly, the investigation will test an econometric model for the 98 NUTS 1 regions between 2000 and 2013. According to the Nomenclature of Territorial Units for Statistic (NUTS), a geocode standard made by Eurostat for reference the subdivisions of a country for statistical purposes, NUTS 1 areas represent the major socioeconomic regions in the European Union with administrative functions. After that, the study will go in depth and analyse a growth model for 273 NUTS 2 regions in the EU also between 2000 and 2013. NUTS 2 regions represent medium-sized regions for the application of regional policies, with a population that varies from 100 000 to 10 million inhabitants.

In order to achieve the results of the empirical investigation the rest of this paper is structured around six chapters. First, this short introduction is followed by the literature review on regional economic growth. Section 3 highlights the methodology used and the data sources. Section 4 presents the findings of the empirical methods applied in this case study. The study ends with the conclusion and references.

LITERATURE OVERVIEW

Economic growth analysis at territorial/regional level is starting to be more and more important for many researchers. This type of study can shed new light on what kind of influences can facilitate economic development at regional level. Different territories have certain characteristics and levels of development starting from infrastructure, industry, the spread of services, tourist facilities or regional taxes. Better understanding how certain regions are influenced by social, cultural and economic determinants will facilitate us in creating specific policies for fostering regional economic growth.

There are contradicting views regarding the impact of public investment at regional level. Some view public investment (especially infrastructure investment) as an important factor for growth and productivity (Aschauer, 1990; Munnell, 1992) and others are sceptic on the exact returns and the implications of public investment on economic growth (Crescenzi & Rodríguez-Pose, 2012; Rodriguez-Pose & Tselios, 2012).

Rodriguez-Pose, Psycharis and Tselios (2012) showed that public investment has a significant impact on the economy. This link is stronger in the long-run than in the short-run. Their results also indicate that growth is affected differently by different types of per capita public investment expenditure and that the spillovers of some types of public investment (especially investments in transport infrastructure) are essential for Greek regional economic growth.

Many authors demonstrated the importance of public investment spillovers in the diffusion of externalities across regions (Ottaviano, 2008). Their analysis of 51 regions (NUTS 3 level) in Greece also showed that both in the short-run and in the long-run, research and education, infrastructure investment and housing are the most important public investments that the Greek state has made.

There are many views in the literature that consider political factors to be very important in allocating public investment at regional level. Usually politicians can be biased and allocate resources to already developed regions, because they want to please their voters. Building roads, ports or bridges is also a very public and visible statement for politicians in showing that they are implicated in regional development.

Infrastructure investment can bring significant external benefits. It can generate an investment multiplier effect (job creation, increase in productivity) creating an increase in personal wealth and shaping the environment (Kessides, 1993). Investment in infrastructure can decrease transportation costs and lower the waiting time in production. These effects have a beneficiary outcome on trade and lower the prices of goods (Pol, 2003).

Crescenzi and Rodríguez-Pose (2012) also analysed the importance of public investment, particularly transport infrastructure (kilometres of motorways) in determining economic growth at European territorial level (NUTS regions) between 1990 and 2004. The correlation between infrastructure and economic growth was put in relation also with innovation, a social filter and migration. Contrary to the established thought that infrastructure is positively related to growth, their results showed that infrastructure endowment is poorly linked with economic growth. Also the regions that were surrounded by those with good infrastructure were not significantly influenced. Innovation and the social filter were more important for regional growth in the EU and also the regions that attracted migrants were influenced positively.

The positive link between innovation (investment in science and technology and R&D) and territorial growth has been demonstrated also by recent scientific works (Crescenzi et al., 2007; Usai, 2011; Rodríguez-Pose & Villarreal Peralta, 2015).

Population density can play an important role in regional economic development. High agglomeration in capital cities and large urban areas can have an influence on growth, increasing labour specialization and productivity (Puga, 2002). van Oort, de Geus and Dogaru (2015) showed that agglomeration plays an important role for 15 EU countries at regional level, specifically for 205 EU NUTS2 regions. Regional heterogeneity is influencing employment growth and that different levels of specialization are related to productivity growth.

At a country level, there are comprehensive and well established papers that investigated the role of tourism on economic growth, but not too many studies focused on analysing the regional component. Paci and Marrocu (2014) investigated the impact of tourism (domestic and international) on economic growth for 179 regions (Western European regions) between 1999 and 2009. Their results showed that regional economic growth is positively influenced by domestic and international growth and that domestic tourism plays a more important role than international tourism at regional level. The study will continue by presenting the methodology used and the data selected for this investigation.

METHODOLOGY

The primary objective of this study is to evaluate the most important determinants of regional economic growth for NUTS 1 and NUTS 2 regions in the European Union between 2000 and 2013. For each level of territorial division in the EU (NUTS 1 or NUTS 2) the investigation will employ a separate growth equation and it will use as dependent variable the regional real GDP per capita and regional real GDP in purchasing power standard per inhabitant.

The determinants that will be measured by the growth equations are population, fertility rate, population density (the agglomeration factor), life expectancy, employment, R&D expenditure, tertiary education, infrastructure, tourism, migration, employment rate among other. All the values are expressed at constant market prices and denominated in euros for the monetary variables. Nominal GDP is deflated using the Eurostat country deflator, with the base year being 2010. The models will be applied on dynamic panel data for a number of 98 NUTS 1 regions and 273 NUTS 2 regions..

All the variables that are used will be transformed using the neglog transformation. This is because there are also negative values for some variables. The neglog transformation behaves like $Ln(z)$, when z is positive and like $-Ln(z)$, when z is negative (Whittaker et al. 2005). Therefore the study will use a logarithm called $L = sign(z)ln(|z|)n(z) + 1|)$, where z is the value of the variable. Because the case study will want to investigate two different territorial levels, it will have to employ two separate growth equations.

The regional economic growth equation for the NUTS 1 level has the following formula:

$$LY_{it} = \beta_0 + \beta_1 Ly_{i,t-1} + \beta_2\, LPOP_{it} + \beta_3\, LFERT_{it} + \beta_4\, LLIFE_{it} + \beta_5\, LELET_{it} + \beta_6\, LTERT_{it} + \beta_7\, LWHOURm_{it} + \beta_8\, LWHOURf_{it} + \beta_9\, LEMPL_{it} + \beta_{10}\, LR\&Dexp_{it} + \beta_{11} LMOTORWAY_{it} + \beta_{12} LROADS_{it} + \beta_{13} LTOURISMint_{it} + \beta_{14} LTOURISMext_{it} + \beta_{15} LVEHICLES_{it} + \eta_i + \varepsilon_{it}.$$

The regional economic growth equation for the NUTS 2 level has the following formula:

$$LY_{it} = \beta_0 + \beta_1 Ly_{i,t-1} + \beta_2\, LPOP_{it} + \beta_3\, LFERT_{it} + \beta_4\, LLIFE_{it} + \beta_5\, LELET_{it} + \beta_6\, LTERT_{it} + \beta_7\, LWHOURm_{it} + \beta_8\, LWHOURf_{it} + \beta_9\, LEMPL_{it} + \beta_{10}\, LR\&Dexp_{it} + \beta_{11} LMOTORWAY_{it} + \beta_{12} LROADS_{it} + \beta_{13} LTOURISMint_{it} + \beta_{14} LTOURISMext_{it} + \beta_{15} LVEHICLES_{it} + \beta_{16} LDENSITY_{it} + \beta_{17} LMIGRATION_{it} + \eta_i + \varepsilon_{it},$$

where:
LY: the neglog of regional real GDP per capita (his variable will be expressed also as the regional real GDP in PPS standard per inhabitant to see it there are differences between the two indicators of growth);
Lyi,t-1: represents the neglog of one lag regional real GDP per capita or one lag regional real GDP in PPS standard per inhabitant;
LPOP: the neglog of regional population (inhabitants);
LFERT: the neglog of regional fertility rate (it is the average number of children that would be born to a woman over her lifetime);
LLIFE: the neglog of regional life expectancy measured in years (in the research literature, it is an important indicator and proxy for measuring the health of the inhabitants);
LELET: the neglog of early leavers from education and training. It is a proxy of the size of the group of individuals most at risk on the labour market;
LTERT: the neglog of regional persons with tertiary education (percentage of total, it is a measure for human capital and for skilled labour);
LWHOURf: the neglog of regional average number of usual weekly hours of work in main job for female;
LEMPL: the neglog of regional employment rate (this indicator will be also divided into male and female employment to investigate if there are differences between genders);
LR&Dexp: the neglog of regional total intramural research and expenditure for all sectors (% of GDP);
LMOTORWAY and LROADS: the neglog of regional motorway and roads (other roads besides highways) measured in kilometres;
LTOURISMint and LTOURISMext: the neglog of regional total nights spent by residents and non-residents in tourist accommodations (% of total);
LVEHICLES: the neglog of regional vehicles (except trailers and motorcycles). It is a proxy for stock of vehicles;
LDENSITY: the neglog of regional population density (persons per km2). It is a proxy for regional agglomeration;
LMIGRATION: the neglog of regional net migration (%);
η: the unobserved regional-specific effect;

ε: the disturbance term;
i: the individual regional dimension and t is the time period dimension.

The study will use the cross-section time-series dynamic panel data estimation by quasi-maximum likelihood, referred as the QML estimator, with a small time horizon and large number of cross-sectional units. The QML methodology has a higher efficiency compared with OLS or GLS estimator how yield biased results because of the possible correlation between the lagged dependent variable with the error term for short time samples. It has been developed by Kripfganz (2016). The ML (maximum likelihood) approach was pioneered by Bhargava and Sargan (1983), further developed by Hsiao, Pesaran and Tahmiscioglu (2002) and is suited also for panel data with missing values. Missingness can be solved by implementing a ML estimation or a multiple imputation technique.

RESULTS

Before implementing the QML estimation, the Hausman test has to be computed to see if fixed effects or random effects are needed. Almost all of the estimations will be with fixed effects and only one with random effects, namely that which has the Hausman probability higher that 5% (Prob>chi2 = 0.0124). A QML-RE estimation will be applied for the model with real GDP/capita with the employment rate split into male and female rates.

Table 1: Hausman test for the QML estimation

NUTS1		**NUTS 2**	
Real GDP/Capita	Real GDP in PPS/inhab	Real GDP/capita	Real GDP in PPS/inhab
Employment total (female+male)		Employment total (female+male)	
chi(15) = 48.87 Prob>chi2 = 0.00	chi(15) = 82.46 Prob>chi2 = 0.00	chi(17) = 37.13 Prob>chi2 = 0.0032	chi(17) = 78.40 Prob>chi2 = 0.00
Employment male and female		Employment male and female	
chi(16) = 55.55 Prob>chi2 = 0.00	chi(16) = 66.45 Prob>chi2 = 0.00	chi(18) = 34.04 Prob>chi2 = 0.0124	chi(18) = 54.59 Prob>chi2 = 0.00

Source: Own calculations.

To eliminate the most common sources of cross-sectional dependence, the panel estimation techniques will include time dummies. The Parm test was utilized to see if time fixed effects are needed and it confirmed the null hypothesis of the importance of time dummy inclusion. The next step is to compute the QML estimation for the NUTS 1 and NUTS 2, taking into consideration the results provided by the Hausman and Parm tests. Table 2 provides the results for the QML for the NUTS 1 regions. Column (1) and (2) is for the real GDP/capita estimations and columns (3) and (4) for the real GDP in PPS/inhabit.

Table 2: The results of the QML estimation for the NUTS 1 regions

	(1)	(2)	(3)	(4)
L.real GDP/capita	0.721***	0.710***		
	(10.64)	(10.85)		
L.real GDP PPS/inhab			0.830***	0.802***
			(17.74)	(21.25)
Population	0.00617	0.0163	-0.114	-0.107
	(0.03)	(0.08)	(-0.90)	(-0.98)
Fertility rates	0.232*	0.141	-0.0710	-0.0788
	(1.75)	(1.13)	(-0.88)	(-0.96)
Life expectancy	3.233**	3.258**	0.836**	0.743*
	(2.23)	(2.23)	(1.99)	(1.76)
Early leavers from edu.&tr.	-0.0726**	-0.0711**	-0.0489***	-0.0462***
	(-2.08)	(-2.13)	(-2.83)	(-2.80)
Persons with tertiary edu.	0.0721	0.0608	0.0471	0.0503
	(0.76)	(0.77)	(0.90)	(1.09)
Weekly hours of work-males	-1.500**	-1.511*	0.469	0.335
	(-1.96)	(-1.93)	(1.45)	(1.16)
Weekly hours of work-females	0.257	-0.0280	-0.174	-0.245
	(0.74)	(-0.07)	(-0.71)	(-0.97)
Employment rates - total	0.454***		0.220***	
	(4.85)		(3.23)	
Employment rates - male		0.552***		0.214***
		(4.80)		(3.48)
Employment rates - female		-0.0690		0.0122
		(-0.65)		(0.26)
R&D expenditure % GDP	-0.0290	-0.0393	-0.00555	-0.00217
	(-0.50)	(-0.62)	(-0.23)	(-0.09)
Motorways	0.00780	-0.0000137	-0.00570	-0.00443
	(1.15)	(-0.00)	(-0.96)	(-1.00)
Other roads	-0.0252**	-0.00385	-0.0154	-0.0223**
	(-2.47)	(-0.25)	(-1.45)	(-1.98)
Nights spent residents	0.0864	0.107	-0.00502	-0.0254
	(1.26)	(1.64)	(-0.19)	(-0.99)
Nights spent non-residents	0.0800*	0.122***	-0.0554**	-0.0596**
	(1.79)	(2.66)	(-2.11)	(-2.26)
Vehicles	0.0336	0.00547	0.0238	0.0187
	(0.42)	(0.06)	(0.60)	(0.51)
Constant	-9.816	-8.973	-2.115	-0.607
	(-1.47)	(-1.40)	(-0.62)	(-0.22)
Observations	424	424	424	424

Notes: *t* statistics in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. All regressions include time dummies. *Source:* Own calculations.

The lagged dependent variable is positive, confirming the presence of regional divergence in the EU. Only in column (1) fertility rate has a weak statistically positive effect on regional growth. Life expectancy has an

important outcome on growth. This means that healthier citizens contribute to a prosperous society.

From the results it appears that early leavers from education and training have a negative impact on regional economic growth. Furthermore, average weekly hours worked by male are an important negative determinant of regional growth in the EU.

From Table 2, total employment rate and male employment rate contribute to regional economic growth. Female employment rate was not statistically significant. In regards to infrastructure development, the conclusion is that motorways measured by km do not have a statistical significance on economic growth. Other road development appears to have a small but statistically significant coefficient. The impact of other roads is negatively related to economic growth.

Regarding the variables for tourism, total nights spent by residents do not have a significant coefficient. Total nights spent by non-residents are positively correlated with regional economic growth in the real GDP/capita equation and are negative in the real GDP in PPS/inhab estimation.

Population, tertiary education, average weekly hours worked by female and the stock of vehicles were not statistically significant in determining regional economic growth in any of the QML estimations. The same can be said for research and development expenditure, even if the coefficients are negative in every column.

The following table provides the outcomes of the QML test for the NUTS 2 regions. Columns (1) and (2) present the results for the real GDP/capita estimations and columns (3) and (4) for the real GDP in PPS/inhab. Column (2) is a random effect estimation and the rest of the columns being fixed effect methods.

Table 3: The results of the QML estimation for the NUTS 2 regions

	(1)	(2)	(3)	(4)
L.real GDP/capita	0.660***	0.737***		
	(34.43)	(24.55)		
L. real GDP PPS/inhab			0.780***	0.784***
			(38.81)	(36.93)
Population	0.757**	-0.000280	0.647***	0.445**
	(1.99)	(-0.03)	(2.88)	(2.09)
Fertility rates	0.167**	-0.0644	-0.210***	-0.219***
	(2.31)	(-1.11)	(-5.03)	(-5.11)
Life expectancy	0.860*	1.670***	-0.0903	-0.0472
	(1.77)	(4.03)	(-0.37)	(-0.19)
Early leavers from edu.&tr.	-0.0661***	-0.0406***	-0.0227***	-0.0222***
	(-5.93)	(-3.28)	(-3.73)	(-3.75)
Persons with tertiary edu.	-0.0326	0.0562*	0.0271	0.0313**
	(-1.08)	(1.73)	(1.54)	(2.02)
Weekly hours of	-0.0230	0.422***	-0.173*	-0.134

work-males				
	(-0.13)	(3.28)	(-1.80)	(-1.35)
Weekly hours of work-females	0.111	-0.486***	0.0741	-0.00982
	(0.72)	(-5.26)	(0.90)	(-0.12)
Employment rates - total	0.353***		0.231***	
	(6.03)		(6.25)	
Employment rates - male		0.455***		0.234***
		(7.56)		(7.37)
Employment rates - female		-0.0765*		-0.0280
		(-1.92)		(-0.99)
R&D expenditure % GDP	-0.0303*	0.0186	0.00539	0.00800
	(-1.84)	(1.13)	(0.57)	(0.90)
Motorways	0.000505	0.00208	-0.000561	-0.0000803
	(0.18)	(0.71)	(-0.38)	(-0.05)
Other roads	-0.0554	-0.00683	-0.00548	-0.0175
	(-1.36)	(-0.68)	(-0.23)	(-0.79)
Nights spent residents	0.0221	-0.0114	-0.0319	-0.0323
	(0.82)	(-0.42)	(-1.39)	(-1.37)
Nights spent non-residents	0.0110	0.0423***	-0.0152*	-0.0127
	(0.89)	(2.90)	(-1.70)	(-1.44)
Vehicles	0.167***	0.000542	0.0741***	0.0526*
	(4.42)	(0.07)	(2.78)	(1.90)
Population density	-0.960**	-0.00176	-0.985***	-0.724***
	(-2.39)	(-0.14)	(-4.20)	(-3.21)
Net migration	0.00422**	0.00812***	0.00120	-0.000491
	(2.07)	(3.17)	(0.81)	(-0.33)
Constant	-9.986***	-6.219***	-2.925	-0.954
	(-2.61)	(-3.40)	(-1.20)	(-0.41)
Observations	940	1034	940	940

Notes: *t* statistics in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. All regressions include time dummies. *Source:* Own calculations.

The Quasi-maximum likelihood estimation still provides conclusive results for the divergence hypothesis between EU regions. The coefficients are positive and statistically significant. Population appears to be influencing regional growth. Fertility rate increases economic growth when the dependent variable is real GDP/capita and has a negative influence when real GDP in PPS/inhab is used.

For this new estimation, life expectancy has a concrete outcome on regional growth. Life expectancy is used as a proxy for the health level of the population. It makes sense that a healthier and longer life positively impacts the economy.

Like it was stated before in the other regression, early leavers from education and training have a negative influence on growth. This social category is at risk economically and socially. Persons with tertiary education help in fostering regional economic growth, but the coefficients in Table 3 are small.

Average weekly hours worked by male appear to be negative in the QML estimations with fixed effects and positive in the QML estimation with random effects. In the same QML estimation average weekly hours worked by female is statistically significant and negative.

The analysis of employment rates offers the same conclusion as before: total employments and male employment are beneficiary for the economy and female employment decreases economic growth.

Research and development had a weak statistically significance on economic growth only in the QML-FE for real GDP/capita. This can mean that innovation is not contributing too much to EU regional growth as it was believed to do. Also infrastructure development appears to have small coefficients and none of them are statistically smaller than 10%.

Regarding total nights spent by residents and non-residents in tourist accommodations the results are not conclusive to say that these indicators have a major impact on regional growth. In Table 3 nights spend by residents were not significant to be validated and nights spent by non-residents contributed to growth in the QML-RE estimation and are negatively correlated with growth in the QML-FE estimation for real GDP in PPS/inhab (column 3).

The stock of vehicles at regional level is a variable that is useful for economic growth. From the results obtained for population density it seems that agglomeration is not an important factor at regional level. Finally, net migration is statistically significant in the estimation with real GDP/capita as dependent variable, but the coefficients were very small, implying that migration is not contributing very much to regional development.

CONCLUSIONS

The purpose of this study was to determine what factors influence economic growth at NUTS 1 and NUTS 2 level in the European Union between 2000 and 2013. To find the impact of each determinant on regional economic growth the study used two separate growth equations and as dependent variable the regional real GDP per capita and regional real GDP in purchasing power standard per inhabitant.

The models were applied on dynamic panel data for a number of 98 NUTS 1 regions and 273 NUTS 2 regions for all the EU country states (EU 28). The QML panel data estimation technique was utilised.

It was found that EU regions are not converging. From the results of the QML estimation for NUTS 2 regions, population appears to be influencing regional growth. The ones for NUTS 1 were not significant at 10%. The outcome for fertility rate offered mixed results. It increases economic growth

when the dependent variable is real GDP/capita and has a negative influence when real GDP in PPS/inhab is used.

The results confirm that life expectancy has a concrete impact on regional growth. Life expectancy is used as a proxy for the health level of the population. It makes sense that a healthier and longer life positively impacts the economy.

Early leavers from education and training are a negative influence on regional economic growth. This social category is at risk and policy makers have to adopt measures for the better integration of this group in the society and on the labour market.

Persons with tertiary education appear to contribute to regional economic growth, but the coefficients were small and not statistically significant in most of the results.

Regarding the average weekly hours worked by male this chapter comes to the conclusion that it hinders economic development. Also, the variable for average weekly hours worked by female is negative, but mostly not statistically significant.

The investigation into the effects of employment rates offers the following conclusion: total employments and male employment are beneficiary for the economy and female employment decreases economic growth.

Research and development had a negative impact on regional development in almost all of the regressions, even if some of the coefficients were not significant. Also infrastructure development appears to not have a defining role in shaping regional economic growth. Infrastructure endowment is poorly linked to economic growth and the exact returns and implications of this type of investment is not so clear (Crescenzi and Rodríguez-Pose, 2012; Rodriguez-Pose, Psycharis and Tselios, 2012).

Concerning total nights spent by residents and non-residents in tourist accommodations the results are not conclusive to say that these indicators have a major impact on regional growth.

In general, from this case study's regressions, the stock of vehicles at regional level is a variable that was positively correlated with growth. Furthermore the results obtained for population density contradict the agglomeration economies theory. It seems that regional agglomeration is not an important factor. This outcome can be attributed to Europe's high number of small and medium size cities and the negative externalities of living in a big city like congestion cost, labour competitiveness, pollution and high rental costs (Dijkstra et al., 2013).

Finally, net migration is statistically significant only for the model with real GDP/capita as the dependent variable. The coefficients were very small, implying that migration is not contributing very much to regional development.

Furthermore the claims of this chapter require further analysis to empirically test the assumptions made. As the QML estimation technique is being improved further analyses have to be conducted. This investigation has considerable policy implications for policymakers. Furthermore, certain economic and political shocks could have had significant implication for this empirical framework, like for example the 2008 economic crisis. Further

investigation of these inherent shocks could affect the estimated coefficients and might offer different results.

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