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Reconsidering the Demand for Municipal Public Goods Specification : Evidence from French Municipalities

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**RECONSIDERING THE DEMAND FOR MUNICIPAL PUBLIC GOODS
SPECIFICATION: EVIDENCE FROM FRENCH MUNICIPALITIES**

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Abstract: Following Bergtrom and Goodman (1973), this paper can be integrated in the set of studies that have estimated the demand for municipal public services. The main innovation in this paper is methodological as we use a Stone Geary utility function to describe the median voter preferences. Unlike previous studies, we are able to derive the local public expenditure function in a (simplified) linear expenditure system, directly from the theoretical framework. The linear expenditure system provides an estimate of the portion of the incompressible public expenditure in each municipality. Using cross sectional municipal data from France, it is found to be 30% of the total per capita expenditure. Compared to the specification generally used in the literature, linear expenditure system shows a greater sensitivity to price and income variations and reveal a greater number of significant variables.

Key-words: Demand for local public services, Median voter, Linear expenditure system, Nonlinear least squares.

JEL codes: H72, R51, C51.

Introduction

The estimation of household demand for public goods has long been a concern of public finance economists. Indeed, estimates to explain local (per capita) expenditures are usually derived from the well-known median voter model as the local fiscal behavior is “as if” it satisfies the median voter’s demand for public goods, see the seminal works of Borcharding and Deacon (1972) and Bergstrom and Goodman (1973). In the literature, as the functional form of the median voter’s utility function is not specified, empirical studies estimate a linear relation (or a log-log transformation) to explain local public spending (per capita) by the median income and tax share, in addition to other explanatory variables describing the municipal population or approximating cost differentials in supplying public goods. See the papers of Colburn and Horowitz (2003) or Turnbull and Djoundourian (1994) following this approach. But this methodological approach is subject to methodological issues as mentioned by Reiter and Weichenrieder (1997) in their critical survey of the empirical literature.

Particularly, Atkinson and Stiglitz (1980) focus on one issue: *‘The results of estimating median voter models provide insight into a number of aspects, but are open to a number of criticism... for example the specification of the functional form’*. In this article, we focus on the question of the functional form of the demand function for public services and thus provide one methodological innovation. More precisely, using a Stone-Geary utility function to describe the median voter preferences, we are able to derive the public spending function in a simplified linear expenditure system (with only two goods, private consumption and local public services). Therefore, the functional form of the public spending function is directly derived from the median voter model. The linear expenditure system (LES) is a system of demand functions proposed by Stone (1954) by imposing theoretical restrictions (additivity,

homogeneity and symmetry) on a general linear formulation of demand. Then, our specification is consistent with utility maximization. And, the translating method, inspired by Pollack and Wales (1981), allows the introduction of variables to capture production costs and tax shares differences across municipalities.

Another attractive feature is that parameters have economic meaning. Thus, LES allows to break down total public expenditure into two constituent parts: the incompressible part which may be interpreted as a minimum required local public service standard depending on the median voter preferences, and the variable part which depends on income and tax price levels. To demonstrate that the linear expenditure system has something useful to contribute to the existing empirical literature, our specification is tested against the specification generally used.

This article is then an original contribution to the empirical public finance literature as only two other articles have recently used a linear expenditure system on a similar topic, Aaberge and Langorgen (2003) and Allers and Elhorst (2011). But, their modeling approach is very different as it is not based on the median voter model. And they do not observe prices on local public services. Furthermore, they consider a system of municipal public services supposed to be substitutes.

To deal with heterogeneity in terms of population size, we concentrate on the 109 French municipalities of more than 50,000 inhabitants in 2005 (except Paris). In France more than 36,000 municipalities form the first local level as they provide 57% of total local public expenditure (45 % by municipalities and 12% by their intercommunity groups). Estimating the linear expenditure system with non linear least squares (due to non linearity in coefficients) allows us to obtain original results.

Firstly, we are able to estimate the incompressible local spending value which corresponds to, in average, 30% of total municipal per capita spending level. Therefore, we conclude that a dominant part of municipal public spending (the variable part which depends on price and income variations) can be reduced without threatening implications for the reelection of the local incumbent.

According to the translating method, two opposite forces contribute to explain the incompressible value. On the one side, an increase in the size of the population contributes to reduce per capita expenditure because of economies of scale in consumption. On the other side, the operating and capital expenditures targeted on restricted categories of users (recipients of social benefits, expenditure in favor of tourism or transport essentially) increase the incompressible expenditure level. Finally, values of elasticity obtained are consistent (as they respect the restrictions of the specification) and reveal a greater sensitivity to the price and income than values obtained with the traditional method.

This article is organized as follows: the next section highlights the alternative demand specifications. Section 3 contains a description of the data and presents the determinants of the incompressible spending value. In section 4, the two applications to a model explaining per capita municipal public spending for the French municipalities of more than 50,000 inhabitants are provided and compared. Section 5 concludes.

2. Demand estimates for local public goods: two alternative functional forms

The first step is the description of the standard method used in the literature. The second step consists of presenting the linear expenditure system.

2.1 Traditional approach

One traditional specification for estimating demand functions of individuals for municipal public services is the one proposed by Bergstrom and Goodman (1973). It is based on the median voter model. Therefore, the demand for local public goods can be derived from the following simple model.

To check the single dimension hypothesis, we can consider the total public spending $C_G G$, where C_G is the unit cost of providing public services and G denotes the total public output.

The economy is composed of different citizens who derive utility from public services and from a private consumption good x . Given the median voter's utility function $U_m(x, g)$, the supplied municipal commodity matches with the quantity demanded by the median voter if:

$$\text{Max } U_m(x, g) \text{ u.c.} \left\{ \begin{array}{l} (1) y_m = tb_m + x \\ (2) C_g G = tB \\ (3) g = \frac{G}{N^\gamma} \end{array} \right.$$

The first equation is the budget constraint of the median voter where y_m is the median income within the local jurisdiction and b_m is the median voter's tax base. B gathers all the local tax bases, N is the population size and b is the average tax base. The second equation describes the budget constraint of the jurisdiction where t is the uniform municipal tax rate.

The private consumption, measured in quantities x , serves as numeraire while g is the volume of local public services available for each citizen. g differs from the aggregated level G of local public services only when there is congestion, see (3) where λ denotes the congestion parameter.

To check the single dimension hypothesis, we substitute (3) in (2) to obtain an expression of the tax rate t to be substituted in (1). Differentiating by g and x , we obtain the marginal rate of substitution between the private consumption and the local public services:

$$(4) \quad MRS_{x,g} = \frac{\partial U_m / \partial g}{\partial U_m / \partial x} = \frac{b_m}{b} N^{\lambda-1} C_G = p_g$$

In the literature, as the functional form of the decisive voter's utility function is not generally specified, the estimable function of local public expenditures is supposed to be a linear function of the tax price p_g and the median income, with additional socioeconomic variables.

In the median voter model, tax price measures the price that the median voter considers to formulate her demand for public services. Tax price includes tax share $\frac{b_m}{b}$, defined as the proportion of the tax burden associated with residential property, unit costs of public services C_G , and the size of the population to deal with congestion effects. As tax price measurement presents some difficulties, existing studies generally retain a simplified specification. Thus, Bergstrom and Goodman (1973) assume that tax price is proportional to the median voter's tax share. On the contrary, Borchering and Deacon (1972) suppose that tax shares are identical across US States and use public wages as price variable.

Therefore, in the spirit of Bergstrom and Goodman (1973), the level of public expenditure can be expressed as a linear regression of the form:

$$(5) \quad Exp = c + \alpha N + \delta \frac{b_m}{b} + \gamma y_m + \sum_{i=1}^k \beta_i X_i + \varepsilon$$

Where Exp measures total municipal expenditure (or expenditure per capita). The X_i 's include the demographic characteristics of the population and variables describing cost differentials in supplying local public services. ε is the error term.

Then, we are able to obtain price and income elasticities of demand using parameters δ and γ respectively and mean values of median income and tax share. Or, if we apply a log transformation of all the variables, we obtain constant price and income elasticities. In the literature, typical estimates of price elasticity are negative whereas income elasticity is generally positive and smaller than unity.

2.2 Linear expenditure system

The originality of this paper is to specify the median voter's utility function in the following

Stone-Geary form: $U_m = \beta \log (g - m_g) + (1 - \beta) \log (x - m_x)$.

m_x is often considered as a subsistence level of private consumption. m_g can be regarded as a minimum required for local public services which depends here on the median voter preferences. Fiscal need, defined as a common level of services for which each government is responsible, is a similar concept developed by the U.S Advisory Commission on Intergovernmental Relations (1990).

Then, in our study, the local public expenditure function is derived from the following program $MAX U_m(x, g)$ subject to $y_m = p_g g + p_x x$:

$$(6) \quad p_g g = p_g m_g + \beta(y_m - p_g m_g - p_x m_x)$$

$p_g g$ denotes per capita expenditure in each municipality and p_x is the price of the private consumption. p_g is supposed here to be measured by the tax share as in Bergstrom and Goodman (1973).

This specification is a (simplified) linear expenditure system (LES) if we consider only two goods (local public services and aggregate private consumption). In this framework, some minimum level of each good has to be consumed, irrespective of its price or the consumer's income. So, the median voter first purchases the minimum level of each good, and the left-over income is then allocated in fixed proportion β to the demand for local public services. Since public spending is usually characterized by inertia, this specification is then particularly well suited to account for these features of the fiscal process.

The linear expenditure system was estimated for the first time by Stone (1954) and checks properties usually considered desirable from the standpoint of consumer theory (additivity, symmetry and homogeneity). In the general case (with n substitutes goods), LES is a system in which expenditures on individual commodities are expressed as n linear functions of total expenditures (or income) and prices. But at the empirical level, we estimate a system of $n-1$ equations. Then, as we only consider two goods here, we just have to estimate the public expenditure function. And, as we are only interested in the demand for municipal public services, we suppose that the minimal private consumption value can be incorporated in parameter γ :

$$(7) \quad p_g g = \frac{b_m}{b} m_g + \beta (y_m - \frac{b_m}{b} m_g - \gamma)$$

The income elasticity may be written as: $E(g/y_m) = \frac{\beta}{\omega}$ with $\omega = \frac{p_g g}{y_m}$.

In addition, price elasticity is not constrained to increase with price:

$$E(g / p_g) = -1 + (1 - \beta) \frac{m_g}{g}$$

Thus, the income elasticity is always positive and the municipal public goods are always normal goods since the marginal budget share β is positive. Furthermore, as $0 < \beta < 1$, price elasticity is greater than -1 and the demand is inelastic.

3. Application to the municipal public expenditure

Following the translating method developed by Pollack and Wales (1981), one way to propose a better empirical specification and to reduce unexplained variation in expenditure behavior is to postulate that the parameter measuring the minimal required local public services is a function of the characteristics of the municipality. So, after explaining the decomposition of the incompressible value in the first subsection, we propose the description of the data in the second subsection.

3.1 Determinants of the incompressible public consumption

Pollack and Wales (1981) have used the translating method to allow subsistence parameters to depend on demographic variables. Then, the explanatory power of the econometric model is increased and biases in estimators are reduced. In recent cross-section analysis, Gaudin et al (2001), Aaberge and Langorgen (2003) and Allers and Elhorst (2011) have also implemented translating methods to estimate the demand function for public services. In this article, translating the parameter representing the minimum required local public services allows to include in the specification additional variables.

In the linear expenditure system, the incompressible public consumption is by definition independent of price and income. So, according to our specification, it depends here on the unit cost of the public services and on the number of public users (as the price variable is measured here by the tax share).

So, if we consider the general missions intended for the whole of the population in French municipalities (general administration), we expect that the per capita public expenditure will decrease with population size (economies of scale in consumption). But for more specific competences, an increase in each category of users is likely to have an opposite positive effect on the total expenditure per capita. Therefore, the municipal population is differentiated by distinguishing the main categories of users of the municipal public services in France. Then, we differentiate the number of school pupils (variable *pupils*) and the number of recipients of social benefits (variable *social beneficiaries*) from the rest of the municipal population (variable *pop*).

Furthermore, the cost of providing public services is supposed to depend on the size of the public capital stock. According to the data availability, several variables such as the road network length, the number of secondary residences or the number of municipal social housing units may be used. The introduction of the number of secondary residences is a proxy used to capture costs of public investment in terms of leisure or tourism.

Therefore, m_g can be defined by the following system of equations (8-12):

$$(8) \quad m_g = \alpha_1 N_c + \alpha_2 Y_1 + \alpha_3 Y_2 + \alpha_4 Y_3$$

Where Y_1 measures the social housing units, Y_2 is the number of secondary residences, Y_3 is the road network length. N_c measures the size of the population using the municipal public services, according to:

$$(9) \quad N_c = pop + \delta_1 \text{ pupils} + \delta_2 \text{ social beneficiaries}$$

Equation (9) decomposes public users according to the different categories of municipal beneficiaries.

Equations (10-12) enable us to include the effect of the intercommunity group on the public investment level since the membership of an intercommunity group is supposed to create economies of scale in production. $D(Intercommunity)$ denotes a dummy variable that takes the value of one if the municipality does not belong to a group of cooperating municipalities, zero otherwise. We also try to identify partisan effects with the introduction of another dummy variable $D(LEFT)$, which takes the value of one when the municipal incumbent is left-wing, zero otherwise:

$$(10) \quad \alpha_2 = \alpha_{20} + \alpha_{21}D(Intercommunity) + \alpha_{22}D(Left)$$

$$(11) \quad \alpha_3 = \alpha_{30} + \alpha_{31}D(Intercommunity) + \alpha_{32}D(Left)$$

$$(12) \quad \alpha_4 = \alpha_{40} + \alpha_{41}D(Intercommunity) + \alpha_{42}D(Left)$$

$\alpha_1, \alpha_{20}, \alpha_{21}, \alpha_{22}, \alpha_{30}, \alpha_{31}, \alpha_{32}, \alpha_{40}, \alpha_{41}, \alpha_{42}, \delta_1$ and δ_2 are the parameters to be estimated.

Equations (8-12) are substituted in the municipal expenditure function to obtain one equation with non linearity in parameters.

3.2 Data description

As the median voter model has been found to apply to the lowest tier of localities and is appropriate for explaining the aggregate behavior of governments, we decide to explain the total expenditure per capita at the municipal level, see Turnbull and Djoundourian (1994) for a discussion. To deal with heterogeneity in terms of population size, we concentrate here on the 109 French municipalities of more than 50,000 inhabitants in 2005 (except Paris). The year 2005 is representative of the current situation of the French municipalities, posterior to the latest decentralization laws in 2003. Data are provided by the Economy and Interior ministries.

The dependent variable is total municipal expenditure per capita and is measured by the operating expenditures increased by gross saving which covers the repayment of loans coming from past investments. Such an approach seems desirable with cross-section data because investment expenditures are discontinued in the time dimension. In France, total municipal spending includes a wide range of services. Each year, municipalities must finance their compulsory charges corresponding to the payment of wages, loan repayment, municipal road maintenance costs, and traditional public services decentralized at the municipal level (primary school, general administration, street lighting, police protection, town planning management,...). Since 2000, municipalities of more than 3,500 inhabitants must build 20% of social housing units, but this objective is rarely reached. Lastly, French municipalities must fulfill a specific social mission through the municipal center for social action.

Furthermore, we consider the median income increased by the per capita national grants received by the municipality. The median income is computed with the distribution of the

taxable income of households in the municipality. Note that social allowances are non-taxable income in France.

Tax share is the tax base of the median voter divided by the total tax base (including the local business tax) per inhabitant. The median voter tax base is measured by the sum of the occupancy tax base and the property tax base (paid by households) divided by the municipal population. This variable gives account for the direct influence of taxation on the choice of the decisive voter. It denotes the share of taxes between firms and households. The ratio is near 1 in residential areas, while it tends towards 0 in industrial areas. The set of available variables, measured in 2005, and summary statistics for all variables are given in table 1:

Table 1. Data set description, 109 French municipalities of more than 50,000 inhabitants in 2005 (Euros)

Description of variables	Mean	Min	Max
Total municipal expenditures per capita	1141	731	3137
Yearly median municipal income	9314	5184	36286
Tax share	0.24	0.12	0.41
Municipal population	106,107	50,070	807,070
Number of social benefit beneficiaries (for 1000 habitants)	1670 (14)	72	19,679
Number of secondary residences	1798	90	23,560
Number of secondary school pupils	16,874	7010	132,000
Number of social houses (for 1000 inhabitants)	12,005 (120)	600	69,200
Road length (meters)	224,357	27,000	1,250,000

Among the 109 municipalities of more than 50,000 inhabitants, 86 belong to a group of cooperating municipalities (80%) and 50 (46%) have a left-wing government.

4. Empirical results

In section 4, estimation results for the linear expenditure system are reported (4.1) and compared to the results obtained with the traditional method generally used in the literature (4.2).

4.1 Linear Expenditure system

We provide the regression results of estimating the linear expenditure system. Insignificant values of parameters obtained in preliminary estimations have finally been set equal to 0. In the same way, the value of the subsistence private consumption is fixed to be 0 to obtain consistent estimates¹. As the Breush-Pagan test reveals the presence of heteroscedasticity, robust standard errors are computed in a heteroscedastic-consistent matrix. Empirical results obtained using a nonlinear least squares estimate to deal with the non-linear coefficients are listed in table 2:

Table 2. Estimation results of the linear expenditure system

<i>Coefficient estimates</i>	<i>Value</i> <i>(probability)</i>
β_1 (marginal budget share)	0.081 (0.000)***
β_2 (marginal budget share, quadratic form)	

¹ We have considered values between 0 and 3,000 Euros a year and we have finally selected $\gamma = 0$ according to the SBIC criteria.

α_1 (population)	-0.024 (0.000)***
α_{20} (social housing, common effect)	0.198 (0.00)***
α_{21} (social housing, intercommunity effect)	0.246 (0.00)***
α_{22} (social housing, left-wing effect)	0
α_{30} (secondary residences, common effect)	0.198 (0.00)***
α_{31} (secondary residences, intercommunity effect)	0
α_{32} (secondary residences, left-wing effect)	0
α_{40} (road length, common effect)	0.0039 (0.005)**
α_{41} (road length, intercommunity effect)	0
α_{42} (road length, left-wing effect)	0
δ_2 (social beneficiaries)	0
δ_1 (pupils)	0
Lm het p-value	0.00 ***

Schwarz B.I.C	799
MAPE	19.22 %
Number of observations	109
Mean value of the estimated incompressible per capita public spending	361 (31%)

*Significance level: *** for 1%, ** for 5 % and * for 10 %.*

For each municipality, the incompressible spending value can be computed by multiplying \hat{m}_g by the corresponding tax share. Finally, estimates show that per capita incompressible municipal spending is around one third, in average. Then, to go further into the interpretation of the “incompressible” per capita municipal public consumption, we can derive marginal effects with:

$$(13) \quad \hat{m}_g = -0.024 \text{ pop} + (0.198 + 0.246 \text{ D(Intercommunity)}) \text{ Social houses} + 0.198 \text{ Secondary residences} + 0.0039 \text{ road length}$$

So, results reveal a negative and significant impact of population size on total per capita local public expenditure². An increase of 1,000 inhabitants will result in a decrease of -5 euros in per capita local expenditure.

Conversely, a greater number of social housing, secondary residences, and road length significantly increases the incompressible per capita expenditure. Estimates show that an increase of 100 social housing units will generate an increase of around 4 euros in per capita

² $\frac{\partial EXP}{\partial N} = \frac{\partial EXP}{\partial m_g} \frac{\partial m_g}{\partial N}$

total municipal spending. Furthermore, this positive effect is larger when the municipality does not belong to an intercommunity group (+ 9.7 euros).

The number of secondary residences has also a positive impact on per capita municipal spending: 100 additional secondary residences will generate an increase of around 4 euros in per capita spending. Next, an increase of the road length has a small positive impact upon municipal spending as 1,000 additional kilometers will generate an increase of less than one euro per capita.

Finally, the number of social beneficiaries and of pupils have no significant impact on the per capita public spending level ($\delta_1 = \delta_2 = 0$), nor does the partisan effect ($\alpha_{22} = \alpha_{32} = \alpha_{42} = 0$).

We now develop the results obtained with the standard method in the second subsection. Then, price and income elasticities derived from the two specifications will be presented and compared.

4.2 Traditional method and comparison of alternative specifications

We have initially used the same explanatory variables as in the linear expenditure system, including specific effects (multiplying variables by the two dummy variables), but insignificant values of some parameters have been obtained in a preliminary step. So, we have finally removed those explanatory variables. Table 3 reports final OLS estimates of the linear specification usually used in the literature, with a heteroscedastic-consistent matrix:

Table 3. Standard linear specification

<i>Explanatory variables</i>	<i>Coefficient estimates (probability)</i>
Constant	1012 (0.000)***
Income	0.022 (0.173)
Tax share	-980 (0.027)***
Population	-0.0021 (0.161)
Social housing (without cooperating group)	0.065 (0.000)***
Secondary residence	0.054 (0.02)**
Road length	0.00019 (0.381)
Lm het p-value	0.00 ***
Schwarz B.I.C	757
MAPE	13%
Adjusted R ²	0.66

*Significance level: *** for 1%, ** for 5 % and * for 10 %.*

This specification offers the lowest SBIC value but this can be explained by a fewer number of parameters to be estimated. And the coefficients of the traditional linear specification are not all different from zero at conventional levels of significance. Then, results reveal insignificant values relating to the influence of road length, population and income on local

public expenditure. The coefficients of other variables have the correct sign and remain stable compared to those obtained with the LES.

Then, estimates show that an increase of 100 social housing units will generate an increase of around 6.5 euros in per capita spending when the municipality does not belong to an intercommunity group. The coefficients for tax share and income have also the predicted sign but are statistically different from zero for the tax share only.

We turn now to the distributions of income and price elasticities obtained with the two different specifications, and which are described in the following table:

Table 4. Comparison of income and price elasticities estimated with the different specifications

	<i>Specification</i>	<i>LES</i>	<i>Standard</i>
<i>Price- elasticity</i>	<i>Mean</i>	-0.72	-0.22
	<i>Min</i>	-1.14	-0.36
	<i>Max</i>	-0.10	-0.064
<i>Income- elasticity</i>	<i>Mean</i>	0.69	0.18
	<i>Min</i>	0.32	0.08
	<i>Max</i>	2.32	0.62

Price elasticity obtained with the standard method (last row) and evaluated at the sample mean range from -0.36 to -0.064. Taken as a whole, they are lower (in absolute values) than with the linear expenditure system where price elasticities vary from -1.14 to -0.10. Furthermore, the income elasticities derived from the LES reveal greater values than those

obtained with the standard approach (mean values equal to 0.69 for LES and 0.18 for the standard specification (if we retain the coefficient 0.022)).

Furthermore, the estimated income elasticity is always positive. The price elasticity derived from the linear expenditure system must be greater than -1, by construction. But 10 estimated values lower than -1 are obtained. All other estimated values suit this constraint. Finally, LES specification performs quite well as income and price elasticities have generally the correct sign.

Therefore, the linear expenditure system provides a richer diagnostic of household behavior in terms of demand for local public services than with the traditional specification:

- By separating the variables influencing the municipal expenditure from price and income effects, we are able to measure the share of incompressible municipal expenditure.
- We are able to propose a formulation of the price and income elasticities more flexible than usually. Thus, we obtain higher values than those obtained with the traditional method.
- The knowledge of the determinants of public spending is enriched as we obtain more significant explanatory variables.

5. Concluding remarks

Following Borchering and Deacon (1972) and Bergstrom and Goodman (1973), a sizeable empirical literature has used the median voter model to analyze local public spending decisions. The main innovation in this paper is methodological as the median voter's satisfaction is described by a Stone Geary utility function. Then, we are able to specify the public spending function in a simplified linear expenditure system.

Another attractive feature is that such a specification permits to decompose local public expenditure into two constituent parts: the incompressible part which may be interpreted as a minimum required local public service standard, and the variable part which depends on income and tax share. The main results show that the minimum public spending value is 31 % of the total and decreases with the population level and the membership of an intercommunity group. This confirms the existence of economies of scales in consumption and production. As maintenance costs are compulsory competences in French municipalities, results confirm that per capita public spending increases with the size of the public capital stock.

Furthermore, income and price elasticities derived from the linear expenditure system reveal a greater range of values than those obtained with the standard approach. Therefore, the linear expenditure system retained in this article provides a richer diagnostic of household behavior in terms of demand for local public services. This specification really enriches the empirical literature under study.

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