Elen Twrdy, Ph. D.
Milan Batista, Ph. D.
University of Ljubljana
Faculty of Maritime Studies and Transportation
Pot pomorščakov 4
6320 Portorož

Slovenia

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A DYNAMICAL MODEL OF CONTAINER THROUGHPUT OF THE NORTH ADRIATIC MULTIPORT GATEWAY REGION

SUMMARY

The ports Rijeka, Koper, Trieste, Venice and Ravenna are ports of the North Adriatic multiport gateway region (NA). They have a good geographical location and modern container terminals, but this multiport gateway region has been facing lower rates of container throughput than the rest of the multiport gateway regions in Europe. The paper aims at providing an overview of the dynamics of competition among the NA ports – Koper, Trieste, Venice, Ravenna, Rijeka – and at analysing the throughput in this ports in the last twenty years. Based on these numbers, a simple but efficient model to forecast the possibility of growth or fall of traffic in the next year has been found.

Key words: Multiport gateway region of the North Adriatic, competition, container throughput

1 INTRODUCTION

The North Adriatic multiport gateway region (NA) consists of the ports of Ravenna, Venice, Trieste, Rijeka and Koper [1]. Due to their geographic proximity they share the same hinterland and a limited number of customers. In this view they can be treated as a single port system although they are located in three different countries, with a different economic potential and different development plans.

In general, we can say that the NA ports have, with respect to potential markets (Switzerland, Germany, Austria, Hungary, the Czech Republic, Slovakia), a good geographical location and modern container terminals. However, this multiport gateway region has been facing a stagnation of the container throughput if we compare it with other multiport gateway regions in Europe [1].

The purpose of this paper is to present some simple analytical methods which we have used to detect some internal connection among the ports in the North Adriatic. In particular, we shall present a market share analysis, shift-share analysis and a simple Markov chain method to predict the behaviour of the NA port system with respect to the growth of or decrease in the container traffic.

2 CONTAINER THROUGHPUT DATA IN THE NORTH ADRIATIC PORTS

The starting points of the analysis are the data of the total container traffic in the NA ports in the period from 1990 to 2012. The data have been collected from the ports annual reports and are shown as graphs in Figure 1. A quick regression analysis has shown that in these twenty-two years the total container traffic increased almost exponentially, on an average between 6 % and 7 % per year, but the rate has varied among ports.

It can be noticed from Figure 1 that an almost exponential growth has been realized by the ports of Koper and Venice, where the overall fastest throughput has been recorded at the port of Koper, at an average of 11 % per year, while at the port of Venice the growth has been approximately 7 % per year. The throughput in the rest of the ports has been more irregular. It can also be noticed that, at the port of Ravenna, the traffic has barely increased at all, while the minimum throughput has been realized and remained at the port of Rijeka. The port of Rijeka lost a great deal of traffic in the period from 1997 to about 2003, when the increase in the Rijeka's

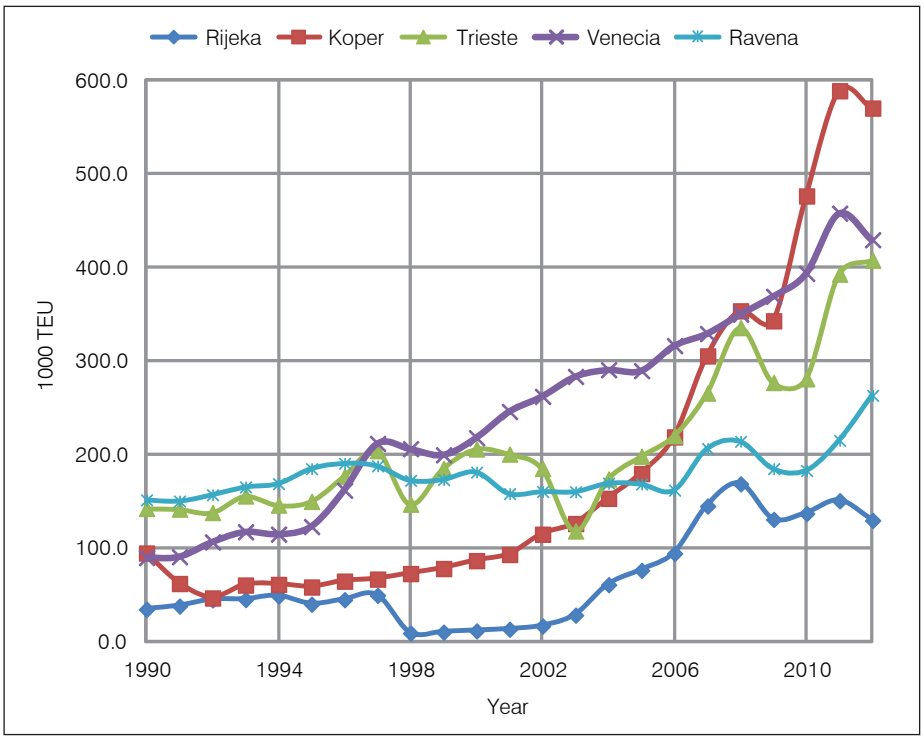

Figure 1 Evaluation of the container throughput for the NA ports in the 1990-2012 periods

container throughput was more in line with that of Koper, Trieste, and Venice.

In the year 2008 and 2009, when the financial and economic crises started, the throughput in the North Adriatic ports decreased for about 15 %, but in such a situation only the port of Venice still had a slow growth (5 %). The largest drop in traffic was recorded in Trieste, a decrease of more than 58,000 TEUs (17.5 %), though by percentage Rijeka fared worse, declining at the rate of 22.5 % (38,000 TEUs fewer).

3 COMPETITION/COOPERATION BETWEEN THE NORTH ADRIATIC PORTS

As NA ports operate in a much closed system, they have to cooperate and compete among each other at the same time and a phenomenon of co-opetition is a natural way for surviving. Branderburger et al [2] defined co-opetition as a mix of the verbs cooperation and competition. It is a synonym for the "win-win" strategy for ports which are very close one to another and have to cooperate, but at the same time are in competition for the market share.

In what follows, we have defined the market share of a port in a particular year:

$$s_i \equiv \frac{TEU_i}{\sum_{j=1}^{N} TEU_j} \qquad (i = 1,\ldots,N) \tag{1.1}$$

where s_i is the market share of i-the port, N is the number of ports and TEU_i is the containers throughput in TEU.

In Figure 2, the dynamics of the market share for the NA ports in the last twenty-three years have been presented. There is a very interesting situation between the ports of Venice and Trieste – they have almost mirrored shares and the same things may be observed if we compare the port of Koper and Ravenna. However, as opposed to the ports of Venice and Trieste, where when one port loses a container throughput the other one takes it over, the share of the port of Koper has practically increased over the years, while, in the same period of time, the share of the port of Ravenna has decreased. Over these years, the port of Ravenna lost its leading position in the container traffic and was forth-placed among the NA ports. Unfortunately, it seems that the port out Rijeka is out of this 'game'.

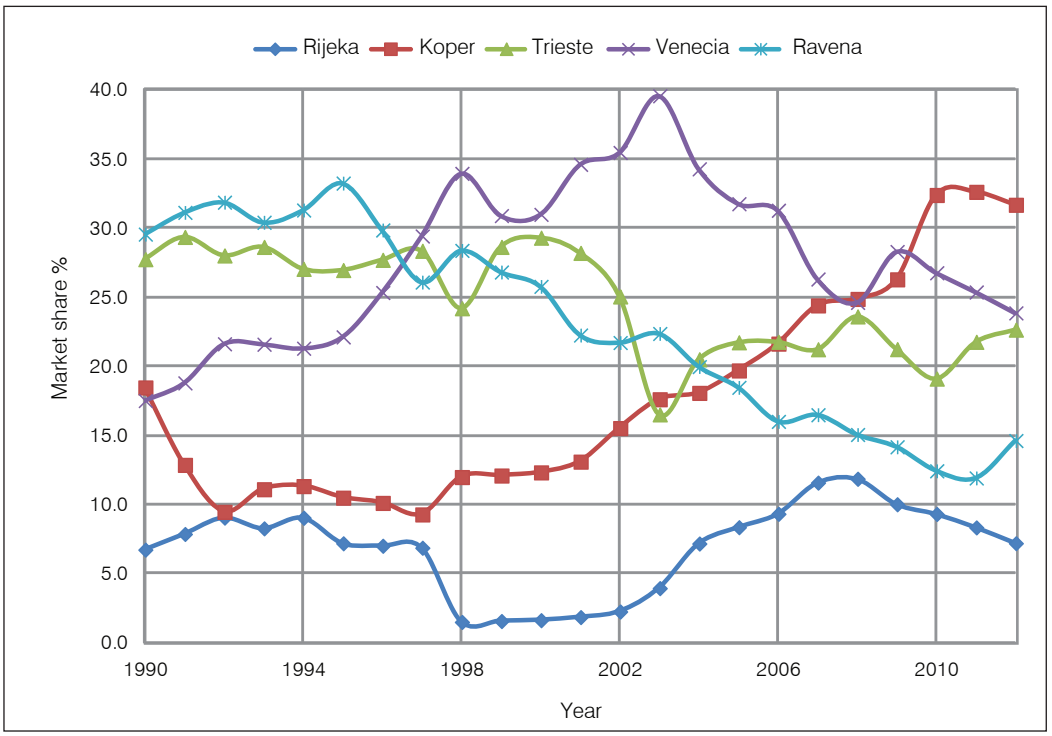

Figure 2 The evaluation of the market share in the containers throughput for the North Adriatic ports (1990-2012)

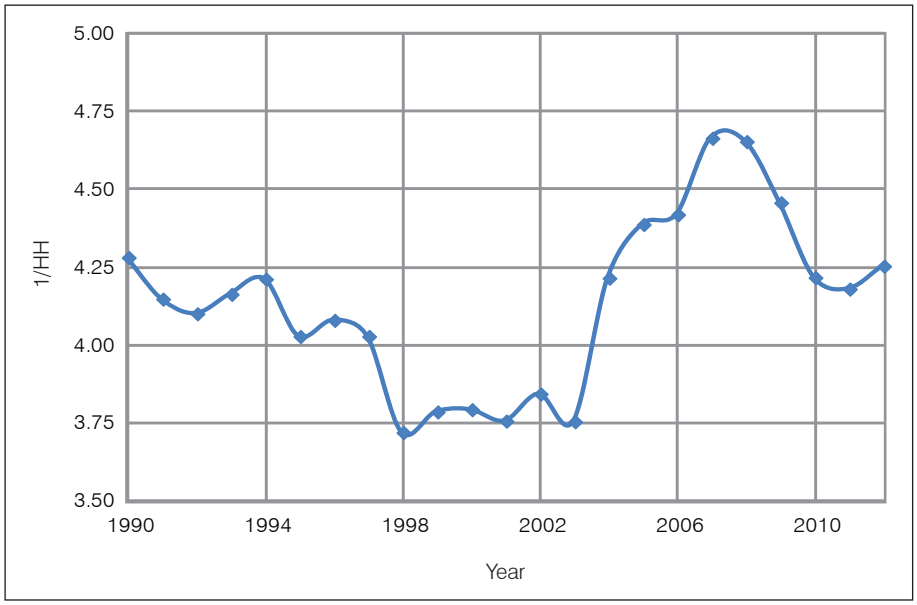

Figure 3 The evaluation of the reciprocal HH index for North Adriatic ports (1990-2012)

To enhance these observations we have used the HH index which is defined as [3]

$$HH=\sum_{i=1}^{N} s_i^2 \qquad (1.1)$$

It can be seen that the reciprocal of the HH index measures the number of effective ports in the region. The evaluation of this index over the past two decades is shown on Figure 3. As revealed in the graph, on an average, the port system acts as there have been only four ports involved.

4 SHIFT-SHARE ANALYSIS

In this chapter, the shift-share analysis is presented according to the methodology proposed by Notteboom [4]. In essence, the shift-share analysis represents the analysis of the absolute growth of the container traffic (ABSGR), the share effect of the port (SHARE) and the total shift of the port (SHIFT) over the years. These quantities are defined as follows

$$ABSGR_i = TEU_i(t) - TEU_i(t_0) \qquad (1.2)$$

$$SHARE_i = \left(\frac{TEU_{TOTAL}(t)}{TEU_{TOTAL}(t_0)} - 1 \right) TEU_i(t_0) \qquad (1.3)$$

$$SHIFT_i = ABSGR_i - SHARE_i \qquad (1.4)$$

where index i stands for *i-th* port, $TEU_{TOTAL}(t)$ is the total port throughputs in the period $t - t_0$, t is the current time (year) and t_0 stands for the initial time (year). While ABSGR is a self evident variable, SHARE and SHIFT variables deserve a bit of explanation. According to Notteboom [4] "share reflects the expected growth of container traffic as if it would simply maintain its market share" while "shift reflects the total number of containers a port has actually lost" i.e. the difference between the expected throughput and the actual throughput. In contrast with Notteboom, who has used a four-year period in his analysis of the European ports [1], we shall present the analysis of the NA ports competition dynamics in the course of one year using the SHIFT variable.

On Figure 4, the evaluation of the shift of containers to the NA ports during the last twenty-three years has been presented. All graphs have shown a kind of an oscillatory behaviour out of which we can see a dynamic of the competition among ports for the container market. There are also several peeks that can be seen on the graphs. Thus, in 1998, the port of Rijeka suffered a relatively great shift of the expected containers to other ports, but the situation recovered in 2003 and 2007. Italian ports have shown an oscillatory shift of containers approximately ranged between ± 30.000 TEU. A bit different situation has been for the port of Koper where we can see that, for a very long period, namely from 1993 to 2011, the port didn't lose any expected containers. However, it may be seen from the graphs that the shift

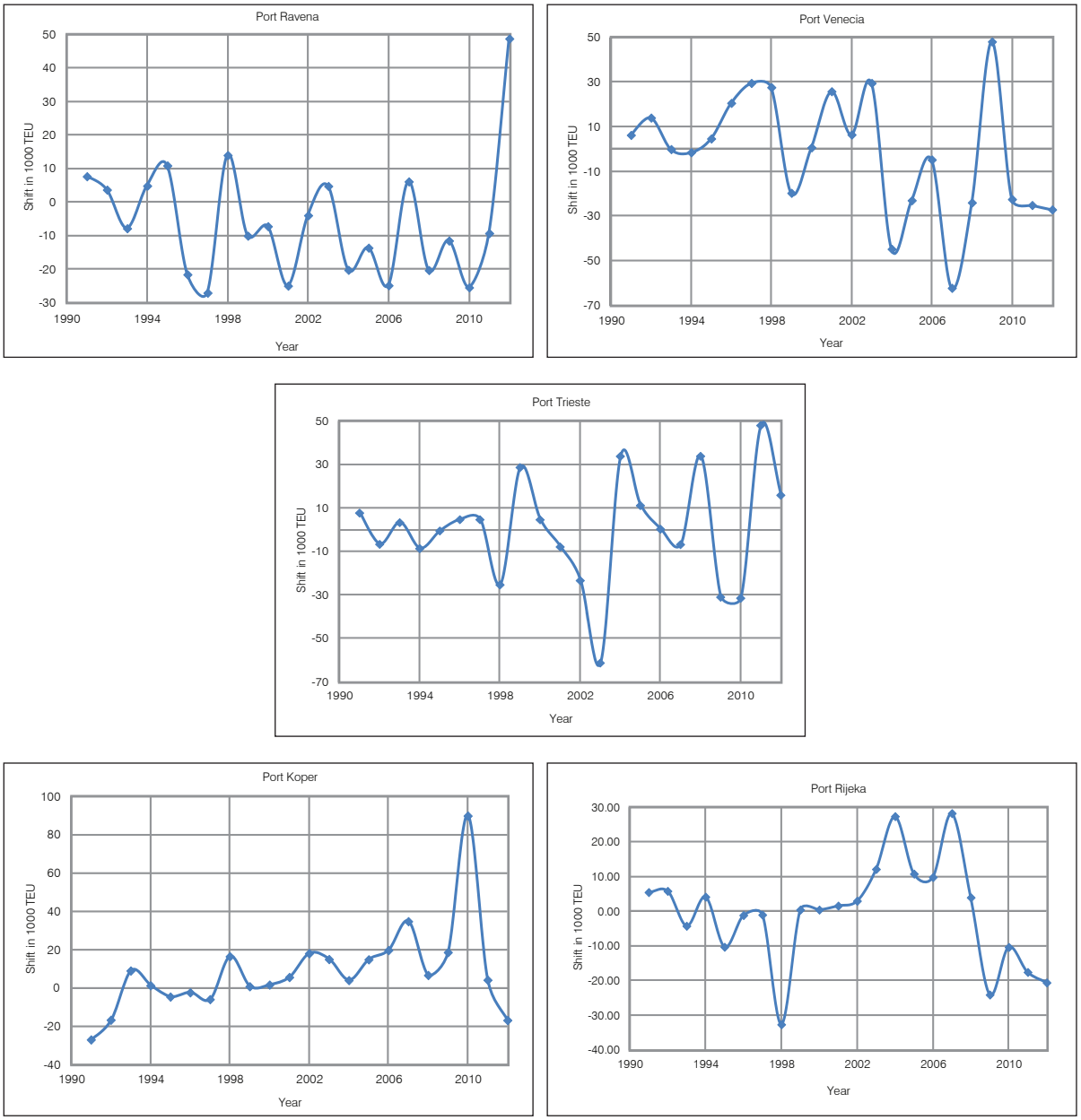

Figure 4 Dynamic (one year) shift of containers in different NA ports over the 1991-2012 period of time

process has recently becomes a bit unstable. Namely, in 2012, the port of Ravenna accommodated more containers than ever in observed period, while, for the first time over a long period of time, the port of Koper lost the expected number of containers.

5 THE MARKOV CHAIN MODEL OF THE CONTAINER THROUGHPUT

The question now arises how to predict the behaviour of the container traffic in NA ports. We want to know, in particular, if the market will grow or will it fall in, for example, the next few years. The usual approach to answer such questions in terms of quantity is to analyse the data by sophisticated time series econometric methods. However, this paper will show use the Markov-chain model by which we will estimate transition probabilities between two possible states: the state when the total throughput is growing and the state when the total throughput is falling. Thus the container traffic growth rate index (CTR) can be defined as

$$CTR_i = \frac{TEU_{TOTAL}(t_{i+1}) - TEU_{TOTAL}(t_i)}{TEU_{TOTAL}(t_i)} \qquad (1.2)$$

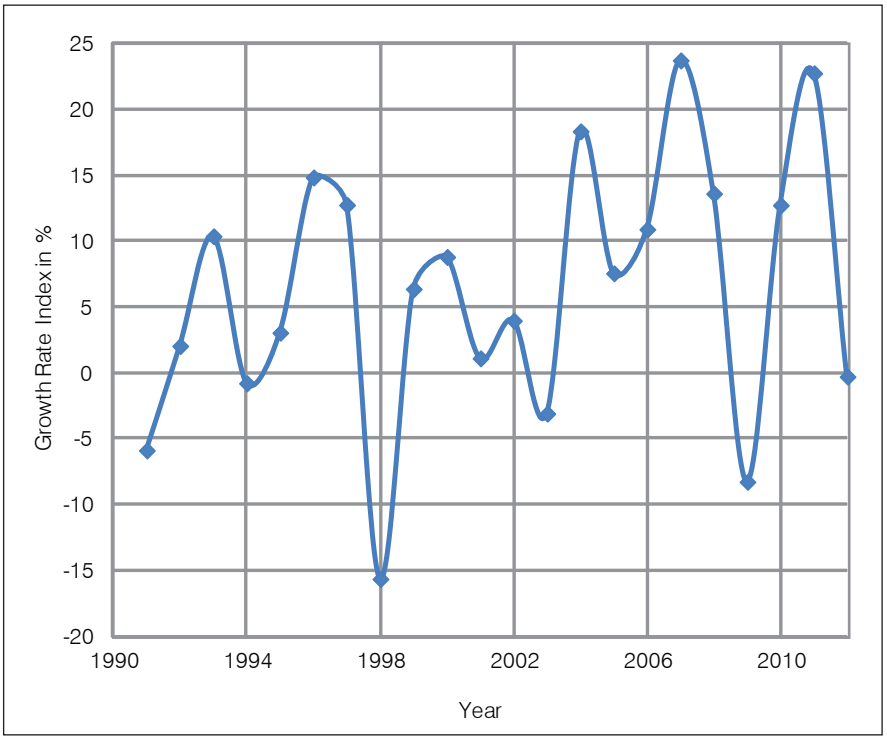

Figure 5 Container traffic growth index for NA ports in the 1991-2012 period of time

where $TEU_{TOTAL}(t_i)$ stands for the total container throughput in a year t_i. The evaluation of the index over the observed period is shown on Figure 5.

A particular state is now simply detected by comparing two successive values of the indices. If $CTR_{i-1} < CTR_i$ then the state at time i is the state of a traffic growth and when $CTR_{i-1} > CTR_i$ the state at time i is the state of a traffic fall. Out of these graph, we can now count the number of transitions between the states:

- we have 5 transitions from the state of traffic growth to the state of traffic growth;
- we have 7 transitions from the state of traffic growth to the state of traffic fall;
- we have 6 transitions from the state of traffic fall to the state of traffic growth;
- we have 2 transitions from the state of traffic fall to the state of traffic fall.

Hence it follows that the calculated probability to remain in the state of the marked growth is 42 % and the one to transit to the state of the market fall is 58 %. If we are in the state of the market fall then the probability is 25 % to stay in this state over the next year and 75 % refers to the probability to go back to the state of the market growth. The Markov chain model with these transition probabilities and the Markov chain model with the transition probabilities obtained from 1991 to 2002 are shown on Figure 6. With this model we can do some future

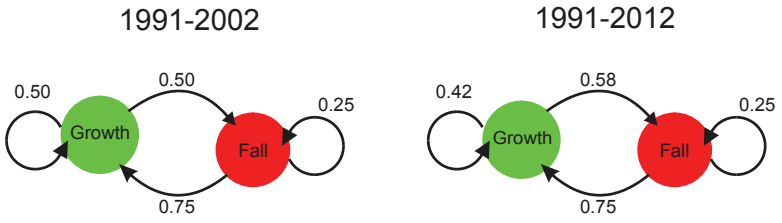

Figure 6 The Markov chain model for the growth or fall of the relative rate of the total container throughputs in the NA ports.

assessments. For example, the probability that the market fall for two successive years is around 6 % and that the fall remains successively three years the probability is around 2 %. The probability that the market grows in the two successive years is about 18 % and about 7 % if the market grows in the three successive years. It is obvious from this that the NA ports system will most probably oscillate between the two states every year.

6 CONCLUSIONS

The NA ports of the multiport gateway region of the North Adriatic have a very good location especially for containers arriving from the Far East and intended for the market of Central and South-East Europe. Even if these ports have modern container terminals, they are facing lower rates of container throughput than the rest of the multiport gateway regions in Europe.

The market potential for the NA ports in the container market in 2030 appears to be ambitious in terms of the absolute growth as it implies +348 % traffic growth out of the year 2010 as compared to the 73 % growth in the market as a whole and, in terms of the market share, growing from the current 4.3 % to reach 11.3 % in 2030 [5]. Every port in the NA port region is trying to increase its throughput but not all are successful in doing so.

Co-opetition in this multiport gateway region is very much present as these ports share the same hinterland. It is also evident that the shift of the container throughput and of the market share is strongly emphasized between them.

The paper has revealed a simple model that will be of great help to forecast the state of the NA ports for the next year. Among others, it is shown that the most probable state of the growth of throughput is annually alternating between grow and fall, while, with a relatively high probability, these ports will have a container growth. The authors are aware that more data should be available to build more reliable models.

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