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PREVENTING SYSTEMIC CRISES THROUGH BANK TRANSPARENCY

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ABSTRACT: Banking system is known to be vulnerable to self-fulfilling crises that are caused by depositors' coordination failure. We show that transparency regulation may prevent systemic crises by eliminating the possibility of the coordination failure. In principle, transparency regulation in our model works like the deposit insurance in the influential articles by Diamond and Dybvig (1983) and Matutes and Vives (1996), where the deposit insurance may prevent systemic confidence crises.

KEYWORDS: banking, disclosure, bank transparency, deposit insurance, financial safety net

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TIIVISTELMÄ: Pankkijärjestelmät saattavat olla epävakaita, koska ne ovat alttiita itsensä toteuttaville kriiseille, joita tallettajien koordinaatio-ongelmat ja epäluottamus pankkijärjestelmää kohtaan saattavat saada aikaan. Tässä tutkimuksessa osoitetaan, että pankkien tiedonantovelvollisuussääntelyllä voidaan estää tämän tyyppisten kriisien syntyminen, sillä pankkitoiminnan avoimuudella voidaan vähentää tilanteita, joissa tallettajien koordinaatio-ongelmat ja odotukset vaikuttavat pankkijärjestelmän toimintaan. Tiedonantovelvollisuussääntely toimii mallissamme periaatteessa vastaavasti kuin talletusvakuutus Diamondin ja Dybvigin (1983) ja Matutesin ja Vivesin (1996) tutkimuksissa, joissa talletusvakuutus vähentää tallettajien luottamuksen romahduksesta syntyviä kriisejä.

AVAINSANAT: pankkitoiminta, tiedonantovelvollisuus, pankkitoiminnan avoimuus, talletusvakuutus, pankkijärjestelmän turvaverkko

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1 Introduction

Banking sector is known to be vulnerable to systemic crises. This concern about the systemic crises has led to the creation of extensive safety nets. However, the existence of a safety net entails a widely recognized moral hazard problem. Safety nets in general, and depositor insurance schemes in particular, provide incentives for excessive risk taking by banks.[1] The aim of this paper is to demonstrate that systemic crises can be prevented without the safety net by enhancing bank transparency.

There is abundant evidence that weak transparency makes banks' asset risks opaque. Stock market participants including the professional analysts, such as Moody's and Standard and Poor's, encounter difficulties in measuring banks' creditworthiness and risk exposures (Poon, Firth, and Fung 1999, Morgan 1999, and Jordan, Peek and Rosengren 2000). And academics face the same problems.[2] It is not easy to interpret banks' accounting data (Beatty, Chamberlain and Magliolo 1995, Collins, and Shackelford and Wahlen 1995) nor disclosures of banks' credit losses (Ahmed, Takeda and Thomas 1999, and US General Accounting Office 1994). Rochet and Tirole (1996) note that interbank lending complicates assessment of banks' actual liquidity and solvency ratios.

A bank can be transparent to market participants both before and after investments are made in the bank. In the *ex post* sense, the degree of a bank's transparency determines the degree of information available to its claim-holders on the bank's financial condition. If it transpires that the value of a bank's assets is low, the bank's creditors, and particularly its uninsured depositors, may withdraw their funds. The threat of a bank run can then discipline bankers in their risk-taking (see e.g., Calomiris and Khan 1991, Chen 1999, and Niinimäki 2001).

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1 There is a sizeable literature on the economics of bank regulation and design of safety nets. See Dewatripoint and Tirole (1994) and Bhattacharya, Boot and Thakor (1998) for general reviews. The link between moral hazard problems and the DIS is also well documented. Kane (1989), for instance, regards the US safety net and fixed-rate DIS as main reasons for the Savings and Loan crisis of the 1980s. Berlin et al (1991) provide a concise review of empirical literature on the DIS and banking problems. Their conclusion is that 'the moral hazard problem is operative and significant' (p. 738). Demirguc-Kunt and Detragiache (1998) find that an explicit DIS has increased the fragility of the banking system around the world.

2 As Kaminsky and Reinhart (1999, p. 476) put it, 'Indicators of business failures and nonperforming loans are also usually available only at low frequencies, if at all; the latter are also made less informative by banks' desire to hide their problems for as long as possible.'

Ex ante transparency implies that *potential* depositors and other creditors can appreciate a bank's financial condition prior to placing funds in it. This strengthens market discipline, because the better investors are able to evaluate banks' risk positions, the more risk-sensitive the banks' funding costs should be. The supply of funds to a bank is also directly related to the perceived soundness of the bank. The contention that lower quality banks attract fewer uninsured deposits than higher quality banks has sound empirical support (see e.g., Park 1995, Billet, Garfinkel, O'Neal 1998, Park and Peristiani 1998, Martinez Peria and Schmukler 1998, and Jagtiani and Lemieux 2000). Despite its importance, the ex ante transparency and its effect on market discipline are relatively seldom addressed in a conceptual framework. For this reason, we equate transparency to its ex ante dimension, although the key insights in this paper are independent of the type of transparency.

To enhance the transparency of banking sectors, various international institutions, such as the Basel Committee on Banking Supervision, G7 Finance Ministers, International Monetary Fund and the World Bank, have campaigned for improved accounting and disclosure practices (see e.g., Basel Committee 1998, 1999a, 1999b). Numerous scholars, such as Berlin, Saunders and Udell (1991), Edwards and Mishkin (1995), Bhattacharya, Boot and Thakor (1998), Mayes and Vesala (1998), Rosengren (1998), and Jordan, Peek and Rosengren (1999, 2000), also advocate a transparent banking system.

The calls for increased transparency seem to be well-founded given the experience of recent banking crises around the world. For instance, Rosengren (1998) argues that transparency reduces the cost of crises, Jordan et al (1999) suggest that transparency improves market discipline in crises, Summers (2000) consider transparency the best way to prevent crises and an effective policy response to crises, and Vishwanath and Kaufmann (2001) regard transparency regulation as a part of the institutional structure that enhance financial stability. Perhaps the most rigorous argument for the increased transparency is provided by Giannetti (2001) who shows how asymmetric information between investors and banks explains contagious banking crises both within a country and across countries.

Building on the idea in Matutes and Vives (1996) we propose a novel justification for transparency regulation. We show that when banks' risk profiles are unobservable, depositors' self-fulfilling expectations lead to multiple equilibria. Possible equilibria include a complete collapse of the banking sector stemming from depositors' coordination failure. This is consistent with the celebrated model by Diamond and Dybvig (1983) where the banks' liquidity service renders them susceptible to runs in which depositors panic and attempt to withdraw their deposits simultaneously. A bank run may also be caused by the ex post transparency, in which case the run is triggered by adverse information about the quality of the bank's loan portfolio (Chari and Jagannathan 1988). In our model, there can be a systemic collapse that is caused by *lack of* the ex ante transparency. The transparency requirement works like the deposit insurance in Diamond and Dybvig (1983) and Matutes and Vives (1996) in removing the 'bad' equilibrium, i.e., the collapse of the banking sector.

Our analysis is also related to the literature dealing with the moral hazard problem caused by a DIS. The proposed remedies include risk-based insurance premiums, capital adequacy requirements, incentive-compatible DISs, banks' equity investments, and intertemporal asset diversification (see e.g., Chan, Greenbaum and Thakor 1992, Craine 1995, Santos 1999, and Niinimäki 2001). We complement these efforts by studying how the transparency requirement can be substituted for the DIS.

The rest of the article proceeds as follows. In section 2, we set out a model of horizontal differentiation where banks compete for depositors on the basis of asset quality. To keep our analysis as simple and comparable with the previous literature as possible, we adopt the standard model of spatial competition developed by Salop (1979). This model - and its cousin, the Hotelling line - has been used extensively in the banking literature, e.g., in Besanko and Thakor (1992), Chiappori, Perez-Castrillo and Verdier (1995), Matutes and Vives (1996), and Villas-Boas and Schmidt-Mohr (1999). In particular, the setup in Cordella and Levy Yeyati (1998a) is quite similar to ours. In section 3 we prove our main finding. Transparency regulation may improve welfare by preventing the collapse of the banking sector. Concluding remarks are given in section 4.

2 The Model

Consider a universally risk-neutral economy with a horizontally differentiated banking industry where there are n banks, indexed by $i = 1, \ldots, n$. The banks locate themselves symmetrically on a unit circle.[3] There is a continuum of potential depositors uniformly distributed along the circle. All depositors incur a 'transportation cost' (i.e., transaction or participation cost) when traveling to a bank, and the cost per unit of 'distance' is τ. We normalize the size of deposits to unity and denote bank i's repayment obligation by r_i. Because our aim of is to show how systemic crises can be prevented without a safety net, there is no deposit insurance scheme in our model.

The banks invest the funds collected in risky projects (loans). The probability that a unit of deposit funds invested in bank i's portfolio will yield a positive return is denoted by p_i. The gross return on the investment portfolio for a unit of funds invested is y, resulting in a profit margin per deposit unit of $y - r_i$. The probability of a zero return is $1 - p_i$. If a bank's projects fail, the bank itself also fails. We assume that the only cost of a bank failure is that its depositors suffer the loss of their funds.

Banks' lending and monitoring decisions affect the probability of bank failures. The success probability of a bank reflects the bank's screening and monitoring decisions and ultimately its ability to gather information for building a high-quality loan portfolio. In the spirit of modern banking theory, increasing p_i is costly because of information gathering costs such as ex ante, interim and ex post monitoring costs. Some of the information gathering cost varies with the size of the asset portfolio, but some at least is periodic. The costs that are independent of the portfolio cannot fully be conveyed to deposit interest rates and therefore reduce bank profits. These costs might reflect maintenance of risk management infrastructure, including information systems, basic databases and credit scoring models, as well as the periodic wages of monitoring personnel and the cost of sustaining a branch network to gather local information.

3 Following the usual practice we take the number of banks, n, as given, and focus entirely on symmetric equilibria.

We build a general model where the cost of monitoring consists of information gathering costs $c(p_i)$ that vary with the size of the portfolio, and the periodic costs of maintaining a monitoring infrastructure $C(p_i)$ that are independent of the size of the portfolio. Both cost functions are strictly increasing and convex in the success probability of a bank, i.e., $\partial c/\partial p_i > 0$, $\partial^2 c/\partial p_i^2 > 0$, $\partial C/\partial p_i > 0$ and $\partial^2 C/\partial p_i^2 > 0$. Throughout the paper we assume that these monitoring cost functions are sufficiently convex to satisfy the second-order conditions and keep the model well-behaved. To ensure an interior solution, the usual boundary conditions are also assumed: $\partial c(0)/\partial p_i = \partial C(0)/\partial p_i = 0$, and $\partial c(1)/\partial p_i = \partial C(1)/\partial p_i = \infty$.

A bank competes for depositors via its interest rate and monitoring decisions, i.e., its success probability. In practice, it is easy to verify the bank's interest rate offer from catalogs and advertisements, but the same does not necessarily apply to the monitoring decision. We thus assume the bank can commit itself to its interest rate announcements but encounters moral hazard temptations regarding the monitoring decision (see also Cordella and Levy Yeyati 1998b and Rochet and Tirole 1996). As a result, the level of p is only imperfectly known to depositors before they invest their funds. In line with Boot and Schmeits (2000), we assume that with probability α the depositors are able to 'detect' the actual monitoring choice of banks. With the complementary probability, p_i remains undetected. In such a case, the depositors rationally evaluate bank i's asset risk positions according to the expectation $E(p_i) = p_i^e$. In equilibrium, these beliefs are fulfilled, as the depositors infer that the banks' failure probabilities are those that prevail in the Nash equilibrium.

The observability of the monitoring level depends on the information disclosure policy of the banks. Without loss of generality we normalize the banks' voluntary information disclosure to zero so that we can identify α as *a transparency requirement* imposed by the regulatory authority.

The timing of events is that depositors are endowed with a common assessment of the success problem of each bank p_i^e. Prior to placing their funds, the depositors also observe the catalog deposit interest rates and a repayment probability (e.g., from bank credit ratings). The depositors then choose their banks, knowing that the banks can fully commit themselves ex ante only to the interest rate offer. The more transparent the banking sector is, the higher the degree of the commitment to the repayment probability. Finally, the banks simultaneously choose their monitoring effort and deposit interest rates.

Let us now focus on the behavior of a depositor located at distance $x \in [0, 1/n]$ from bank i. Depositing in bank i yields an expected return of $E(R_i)=[\alpha p_i+(1-\alpha)p_i^e]r_i$. The bank is able to attract the depositor only if the expected return covers the cost and if its repayment contract is more lucrative than those offered by rival banks, i.e., if $E(R_i)-1-\tau x \geq E(\overline{R})-1-\tau(1/n-x)$ where $E(\overline{R})=[\alpha \overline{p}+(1-\alpha)\overline{p}^e]\overline{r}$ with $\overline{p} = p_j$ and $\overline{r} = r_j$ for $j\neq i$.

In the terminology of Villas-Boas and Schmidt-Mohr (1999), we focus on *full-scale competition*, i.e., we assume that τ is small enough to guarantee that the market will be covered in equilibrium.[4] Under full-scale competition, the total supply of funds for bank i is

$$D_i = \frac{1}{n}+\frac{1}{\tau}\left[\alpha\left(p_i r_i - \overline{pr}\right)+(1-\alpha)(\overline{p}^e r_i - \overline{p}^e\overline{r})\right]. \tag{1}$$

The profits of the bank can then be written as

$$\pi_i = A_i D_i - C(p_i). \tag{2}$$

where $A_i \equiv p_i(y-r_i)-c(p_i)$ captures the profit per deposit unit.

Bank i chooses p_i and r_i so as to maximize the profits in (2). By using symmetry and rational prior beliefs, $p_i = p_i^e = \overline{p} = \overline{p}^e \equiv p$ and $r_i = \overline{r} \equiv r$, the first-order conditions $\partial\pi/\partial p=0$ and $\partial\pi/\partial r=0$ can be simplified to

$$\frac{\alpha r A}{\tau}+\frac{\partial A}{n\partial p}-\frac{\partial C}{\partial p}=0 \tag{3}$$

and

$$A - \frac{\tau}{n} = 0\,, \tag{4}$$

where $A=p(y-r)-c(p)$ is the equilibrium profit per deposit unit. Equations (3) and (4) implicitly determine the equilibrium success probability and the deposit interest rate as a function of the model parameters. It is straightforward but tedious to isolate the effect of the transparency requirement, α, on the success probability, p.[5]

Remark. Increasing the level of transparency discourages risk taking.

Proof. In the appendix.

The reason for this finding is simply that enhancing bank transparency strengthens market discipline. The supply of funds to a bank is directly related to the perceived soundness of the bank. However, as we discuss in detail in our companion paper (Hyytinen and Takalo 2001), this argumentation has a prominent defect, since it ignores direct and indirect compliance costs of transparency. In the paper we argue that a proper evaluation of this market-discipline argument for transparency necessitates the incorporation of these costs into the model. The main point of this paper is to show that there is another, previously overlooked rationale for transparency.

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4 An implication of this assumption is that we leave aside the local monopoly and touching markets cases. For a characterization of such market structures and the associated equilibria, see e.g., Salop (1979), Matutes and Vives (1996), Villas-Boas and Schmidt-Mohr (1999). A further restriction on the scope of the present analysis is that we focus on local interactions between banks, i.e., on local competition, so that the potential market share of a bank consists of depositors located between the bank and its immediate neighbours (see Stole 1995).

5 For brevity, we abstract from analyzing the effects of parameters τ, and n in detail. Similarly, we abstract from analyzing the sign of $dr/d\alpha$. These comparative statics exercises are available from the authors on request.

3 A Rationale for Transparency

It is often argued that deposit insurance is needed in order to avoid systemic crises arising from the inherent fragility of the banking industry. It turns out that the same argument applies to the transparency requirement. Matutes and Vives (1996) show how the banking sector may be vulnerable to self-fulfilling crises if there is a minimum size requirement for banks. If a bank does not obtain the minimum market share, it cannot invest and fails with probability one. Depositors' expectations then become self-fulfilling and the model therefore exhibits multiple equilibria, one of which is a collapse of the entire banking system. In Matutes and Vives (1996) the introduction of deposit insurance prevents financial collapse by eliminating the 'no-banking' equilibrium.

Let us now consider the role of transparency in a model where a minimum market share is needed to make a bank operative. The presence of the economies of scale in banks' production technology might give a raise to such minimum size requirement (Williamson 1986, Matutes and Vives 1996). As we shall show at the end of this section, the minimum size requirement can also emerge from the economies of scale created by a balance sheet constraint.

Suppose initially that no transparency regulation is in place. Depositors then know that the banks cannot commit themselves ex ante to the repayment probability. Because there is no deposit insurance, the depositors can lose the amount deposited if their bank fails. As a result, there is a coordination game on the depositors. A coordination failure causing systemic crisis may occur.

PROPOSITION 1. Without transparency regulation, a collapse of the banking system is possible.

Proof. When $\alpha = 0$, all depositors rationally evaluate bank i's asset risk positions according to the expectation $E(p_i) = p_i^e$ and $E(R_i)=r_ip_i^e$. If all depositors expect that $p_i = 0$, i.e., that $p_i^e = 0$, then $E(R_i)=0$, and bank i has no customers for any p_i that it may choose. Because bank i cannot acquire the minimum market share, it cannot credibly choose a positive repayment probability. Bank i is then certain to fail. As i is arbitrary, the same reasoning applies to the entire industry, i.e., if α = 0, a systemic collapse with D_i = 0 and p_i = $p_i^e = 0$ (i = 1,2, …,n) is possible.

Q.E.D

This result follows from the depositors' self-fulfilling expectations leading to systemic confidence crisis. Without transparency, the depositors' expectations of $p_i^e = 0$ are realized in the equilibrium, and no one finds it profitable to unilaterally deviate from these strategies.

The systemic-crisis equilibrium coexists with the interior symmetric equilibrium characterized by full-scale competition in (3)-(4). It is, however, possible to eliminate the systemic-crisis equilibrium by enhancing bank transparency,

PROPOSITION 2. A sufficiently stringent transparency regulation eliminates the systemic-crisis equilibrium.

Proof. When $\alpha \rightarrow 1$, there is no room for moral hazard and therefore depositors' decisions cannot based on expectations. Because the depositors' expectations play no role, bank i can attract more customers by increasing p_i. Bank i can acquire the minimum market share under the assumption of full-scale competition and, accordingly, it can choose a positive repayment probability and the systemic crisis equilibrium is eliminated.

Q.E.D

In our model transparency requirement works like the deposit insurance in Diamond and Dybvig (1983) and Matutes and Vives (1996) in removing the 'bad' equilibrium, i.e., the collapse of the banking sector. A similar equivalence result of transparency and deposit insurance can be found in Cordella and Levy Yeyati (1998b) and Matutes and Vives (2000) who prove that full transparency and a risk-based deposit insurance scheme lead to an equal risk-taking incentive. The advantage of transparency regulation over the deposit insurance is that it does not cause moral-hazard problems. In contrast, it reduces them, as proven in Remark.

In assessing the reliability of this finding, however, a caveat should be borne in mind. Instead of moral hazard temptations, transparency regulation may cause compliance costs for banks. In Hyytinen and Takalo (2001) we consider both the direct costs of complying with disclosure requirements and the indirect transparency costs stemming from imperfect property rights governing information. Nonetheless, our key argument here remains robust even if achieving transparency is costly for banks. Transparency regulation is needed to avoid self-fulfilling crises arising from a minimum size requirement for banks.

Finally, we make the minimum size requirement explicit. There are various ways to introduce the economies of scale into the model. We simply assume that the bank's balance sheet holds, i.e., that

$$a_i + C_i/D_i + c_i = 1, \tag{5}$$

where a_i denotes bank i's asset portfolio investments per deposit unit. When the balance sheet constraint is imposed, bank i's deposits have to cover all its investment expenses so that bank i can lend only amount a_i. The funds invested in monitoring directly reduce the amount of funds invested in the projects. The profits of bank i from (2) can in this case be rewritten as

$$\pi_i = [p_i(ya_i - r_i) - c_i]D_i - C_i. \tag{6}$$

Solving (5) for a_i and substituting it for (6) yields

$$\pi_i = [p_i(y - r_i) - c_i(1 + p_i y)]D_i - C_i(1 + p_i y). \tag{7}$$

Comparing (7) with (2) clearly demonstrates the existence of economies of scale. Despite our assumption that $\partial c(0)/\partial p_i = \partial C(0)/\partial p_i = 0$, the derivative of (7) with respect to p_i when evaluated at $p_i = 0$ (and at $D_i = 0$) is negative. In other words, under a binding budget constraint, it is optimal for bank i not to be operative. This is consistent with the depositors' expectations. Thus, because of the costs caused by monitoring investments, bank i needs a minimum market share to operate.

4 Conclusions and Policy Implications

In this paper we propose a novel justification for transparency regulation. It may prevent a complete collapse of the banking sector arising from the self-fulfillment of depositors' expectations. Transparency regulation in our model works like the deposit insurance in the influential articles by Diamond and Dybvig (1983) and Matutes and Vives (1996), where it may prevent systemic confidence crises. Deposit insurance, however, entails a widely recognized moral hazard problem. By enhancing bank transparency, systemic crises can be avoided without the creation of the safety net. Hence, the adverse incentive effects of the insurance can also be avoided.

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Appendix: Proof of Remark

Let us first explicitly write the first-order-conditions as

$$F^p \equiv \frac{\alpha A(p, c(p))}{\tau} - \frac{\partial A(p)}{n \partial p} - \frac{\partial C(p)}{\partial p} = 0, \tag{A1}$$

$$F^r \equiv A(p, c(p)) - \frac{\tau}{n} = 0, \tag{A2}$$

where $A(p) = p(y\text{-r})\text{-}c(p)$. Equations (A1) and (A2) determine p and r as functions of α. The comparative statics can then be derived in a standard way:

$$\begin{bmatrix} \frac{\partial F^p}{\partial p} & \frac{\partial F^p}{\partial r} \\ \frac{\partial F^r}{\partial p} & \frac{\partial F^r}{\partial r} \end{bmatrix} \begin{bmatrix} dp \\ dr \end{bmatrix} = - \begin{bmatrix} \frac{\partial F^p}{\partial \alpha} \\ \frac{\partial F^r}{\partial \alpha} \end{bmatrix} d\alpha. \tag{A3}$$

The, by using Cramer's rule

$$\frac{dp}{d\alpha} = \frac{1}{|J|} \begin{vmatrix} -\frac{\partial F^p}{\partial \alpha} & \frac{\partial F^p}{\partial r} \\ -\frac{\partial F^r}{\partial \alpha} & \frac{\partial F^r}{\partial r} \end{vmatrix} \tag{A4}$$

where

$$J = \begin{bmatrix} \frac{\partial F^p}{\partial p} & \frac{\partial F^p}{\partial r} \\ \frac{\partial F^r}{\partial p} & \frac{\partial F^r}{\partial r} \end{bmatrix}. \tag{A5}$$

By assuming that the cost-functions c and C are sufficiently convex in p we know that $\partial F^p/\partial p < 0$ and $|J| = \frac{\partial F^p}{\partial p}\frac{\partial F^r}{\partial r} - \frac{\partial F^p}{\partial r}\frac{\partial F^r}{\partial p} > 0$. By noting that $\partial F^r/\partial \alpha. = 0$, the sign of $dp/d\alpha$ is given by the sign of

$$\begin{vmatrix} -\frac{\partial F^p}{\partial \alpha} & \frac{\partial F^p}{\partial r} \\ 0 & \frac{\partial F^r}{\partial r} \end{vmatrix} = -\frac{\partial F^p}{\partial \alpha}\frac{\partial F^r}{\partial r}. \tag{A6}$$

Taking the partial derivatives of F^p and F^r with respect to α and r from (A1) and (A2) yields

$$\frac{\partial F^p}{\partial \alpha} = \frac{\alpha r A}{\tau}, \tag{A7}$$

$$\frac{\partial F^r}{\partial r} = -\frac{p}{\tau}, \tag{A8}$$

Substituting (A7)-(A8) for (A6) and simplifying proves our claim that $dp/d\alpha > 0$.

Q.E.D

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