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Why Basel II Market Risk VaR is Too Conservative

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Requiring banks to maintain exorbitantly high levels of capital can certainly ensure capital adequacy during crisis periods but would be overly burdensome at most other times and is thus likely to hurt the competitiveness and growth of large financial institutions. The question addressed here is whether the new Basel II Value at Risk (VaR) rule (Basel Committee on Banking Supervision [2009]) with an added stressed VaR component has gone too far in this sense and whether it is indeed necessary to go this far. Using the U.S. market portfolio, the S&P 500, as an example, we show in this article that the new Basel II rule significantly overshoots its capital adequacy objective.

Furthermore, although many have attributed banks' inadequate capital during the financial crisis to the VaR failing as a measure of tail risk or the normal distribution being too thin-tailed, we provide evidence against such hypotheses by applying a newly proposed VaR measure, the Extended VaR (EvaR), to the S&P 500. The EvaR measure uses a composite volatility measure developed here in an otherwise simple VaR framework with normality assumption. The EvaR still produces the desired level of solvency during the financial crisis without being too stringently high under normal circumstances. EvaR's adaptability is a result of the composite volatility measure that it employs, which builds in recently realized volatility and expected (implied) volatility in a dynamically weighted fashion, as well as incorporating volatility during a prior stressful period. Thus, the capital inadequacy of banks during the financial crisis seems principally due to a failure to anticipate and incorporate the surge in market volatility.

NEW (JULY 2009) BASEL II RULE

Ignoring incremental and comprehensive charges, *the market risk general capital charge* or *minimum capital requirement*, C, on a given day t under the pre-2009 Basel II rule (the 1996 Amendment to the Capital Accord to incorporate market risks) and the new July 2009 Basel II rule are as follows:

$$C_{pre\text{-}2009,t} = [Max\ (VaR_{t-1},\ m_c\ VaR_{Avg})] \quad (1)$$

$$C_{2009,t} = (Max\ [VaR_{t-1},\ m_c\ VaR_{Avg}]) + Max\ (sVaR_{t-1},\ m_s\ sVaR_{Avg}) \quad (2)$$

VaR_{t-1} is the one tail 99% VaR over 10 business days for the current (previous day) trading book, with the VaR model inputs calibrated to or estimated from a historical observation (sample) period of at least 12 consecutive months. VaR_{Avg} is the average of VaR_{t-1} calculated on each of the previous 60 business days. The $sVaR_{t-1}$ and $sVaR_{Avg}$ are calculated in a similar fashion, except that the sample period must be a period of 12 consecutive months of significant financial stress relevant to the bank's current (previous day) trading book. The multiplicative factors m_c and m_s, ranging between three and four, are to be determined by the supervisory authority based on the results of back testing the regular or non-stress VaR model only. As under the previous rule, the new rule leaves the choice of the VaR model to the individual banks.

The *stress VaR component* is the cornerstone of the new Basel rule designed to ensure a sufficient level of capital adequacy in stressful circumstances and to build a capital buffer in normal circumstances. Under normal market conditions, however, the capital requirement according to the new rule could easily be three or more times greater than the requirement under the pre-2009 rule because of the stress VaR component. Consequently, banks are saddled with carrying a significant amount of economically excess capital most of the time. The new rule also requires updating the VaR dataset every month (instead of an optional update once every three months), and supervisors have the discretion of shortening the sample period to less than one year during times of heightened market volatility. These efforts are far from the built-in or automated dynamism that is highly desirable when coping with changing market conditions. Furthermore, the new rule is likely to compound model risk and reduce the transparency of the capital estimates because of the additional internal modeling of the stress VaR component.

COMPOSITE VOLATILITY MEASURE AND EVaR

Examining the S&P 500 and equally weighted portfolios of 31 major U.S. stocks, Chaudhury [2014] reported that the empirical ex-post 99% daily VaR during the height of the financial crisis was fairly close to 2.3263 times (as associated with the 99% VaR of a normal distribution) that of the crisis period standard deviation, amounting to more than nine times the pre-crisis standard deviation. Hocquard, Ng, and Papageorgiou [2013] reached similar conclusions. In other words, if the high levels of volatility during the crisis were anticipated or otherwise incorporated into the VaR calculation, even with the simplest possible distribution (normal), one would have accurately predicted the unprecedented (Black Swan) ex-post tail risk observed in the fall of 2008.

Based on this intuition, we propose a composite volatility measure, σ^*, which is the weighted average of an estimate of portfolio daily return volatility both under market conditions that would be stressful for the current portfolio (σ^S) and under current market conditions (σ^C):

$$\sigma^* = \lambda\sigma^S + (1 - \lambda)\,\sigma^C \tag{3}$$

in which $\sigma^C = a\,\sigma^I + (1 - a)\,\sigma'$; $a = \sigma^I/(\sigma^I + \sigma')$; σ' is the portfolio daily return volatility under market conditions observed in the recent past, generally the last 60 trading days; σ^I is the predicted portfolio daily return volatility based on market implied volatility assessments for the key market benchmarks, estimated as $\sigma^I = \Sigma_i\, w_i|\beta_i|\sigma_{HIV,i}/\sqrt{R^2}$, with $w_i = \beta_i^2\,\sigma^2_{HIV,i}/\Sigma_i\,\beta_i^2\,\sigma^2_{HIV,I}$; β_i is the beta of the current portfolio with respect to the i-th market benchmark or risk factor, estimated using the market model over the last 252 trading days; $\sigma_{HIV,I}$ is the average implied volatility of the bucket of high implied volatility options on the i-th market benchmark or risk factor over the last 20 business days; and R^2 is the R^2 value of the market model regression of current portfolio return on the selected market benchmarks or risk factors.

The interval of estimation for the various parameters are merely suggested, in line with the Basel rules and industry practices, and can be modified appropriately for various intended uses.

We now suggest a new market risk measure (EVaR) for n days, based on the aforementioned composite volatility measure:

$$\text{EVaR} = [\Phi^{-1}(1 - \pi)]\,\sigma^*\sqrt{n} \tag{4}$$

where π is the targeted solvency standard or confidence level; Φ is the standard normal distribution function; and σ^* is the proposed composite volatility of daily portfolio return. The EVaR measure is to be converted to a dollar amount of capital by applying the EVaR measure (in percent) to the current market value of the portfolio. Essentially, EVaR is designed to be a (fixed) weighted average of the VaR in a period of stress for the current portfolio as well as its VaR under current market circumstances. Under the normal distribution, VaR is proportional to the standard deviation. Accordingly, the implicit stress VaR in EVaR, $[\Phi^{-1}(1 - \pi)]\sigma^S\sqrt{n}$, is proportional to σ^S, the portfolio volatility expected in a stressful period. Similarly, the implicit VaR under current market conditions, $[\Phi^{-1}(1-\pi)]\sigma^C\sqrt{n}$, is proportional to σ^C, the portfolio volatility expected under current market conditions.

The weighting parameter λ can be customized to suit various purposes. In our S&P 500 illustration, we set $\lambda = 0.25$. Too low a value (e.g., 0.10 or 0.15) deters building a capital buffer in normal times, whereas too high a value (e.g., 0.60 or 0.65) can make the capital requirement quite burdensome in normal market environments. The time-varying weight a, through its impact on σ^C, makes EVaR promptly responsive to the dynamics of market volatility expectations. The parameter σ^S is intended to capture portfolio volatility in a period of stress. The market implied volatility component σ^I is essentially calculated as a weighted average of the option implied factor volatilities, with the weights (w_i) representing the explanatory power of the factors in a market model.

S&P 500 ILLUSTRATION

To illustrate the behavior of the Basel capital measures and the EVaR based capital, we took the S&P portfolio as the hypothetical bank trading book and used the Basel framework of 99% confidence level (π) and 10 business days (n). To focus on the current portfolio rather than prior portfolios, we set $m_c = m_S = 1$ for the Basel capital measures. For a typical bank trading book, VaR_{t-1} usually dominates $m_c\ VaR_{Avg}$. In keeping with popular industry practice, VaR_{t-1} for the Basel capital measures was estimated via the historical simulation method over the last 504 trading days and equals the one-day VaR multiplied by $\sqrt{10}$.

The Basel stress VaR component, $sVaR_{t-1}$, was taken to be the maximum VaR_{t-1} (19.3377%) over the entire sample period of January 1996 to October 2010. Because this stress VaR was first hit on December 2, 2008, the implied Basel stress period was the two-year period from November 30, 2006 to December 1, 2008. For the stress volatility component σ^S in EVaR, we used the maximum trailing 60-day daily standard deviation (4.6587%) during the entire sample period. Because this level was reached on December 9, 2008, the implied stress period for EVaR was the 60-day period from September 15, 2008 to December 8, 2008.

The end-of-day S&P 500 Index level series and call options data over the sample period were obtained from the OptionMetrics dataset of Wharton Research Data Services. We only chose options with 20 to 70 calendar days of remaining maturity because these options are actively traded but not subject to expiration-related volatility. To further improve the reliability of the options data, we applied several filters, namely, an option bid–ask spread greater than the applicable tick size, an option delta (Δ) ranging from 0.125 to 0.875, the availability of the implied volatility figure in the OptionMetrics database, and an option ask price less than the closing index value. In line with recent research (Bollen and Whaley [2004]; Driessen, Maenhout, and Vilkov [2009]), options were then bucketed into three moneyness categories: out of the money: $0.125 < \Delta \leq 0.375$; at the money: $0.375 < \Delta \leq 0.625$; and in the money (ITM): $0.625 < \Delta \leq 0.875$. Consistent with extensive empirical evidence, the high volatility options are taken to be the ITM or low strike (K) options. Summary statistics on these options are presented in Exhibit 1.

Because the S&P portfolio is the market portfolio, the only risk factor we used is the S&P 500 Index daily return itself; by definition, $\beta_i = 1.0$ and $R^2 = 1.0$. Accordingly, the market risk regulatory capital estimate for the S&P 500, using the EVaR measure, is:

$$C_{EVaR} \text{ for the S\&P 500} = 2.3263\ \{0.75\ [a\,\sigma^I + (1-a)\,\sigma^r] + 0.25\,\sigma^S\}\ \sqrt{10} \tag{5}$$

Exhibit 2 presents summary statistics on the market risk capital measures, 10-day 99% VaR, 10-day forward cumulative loss, the S&P 500 trailing 60-day realized volatility (σ^r) and the S&P 500 ITM call implied volatility (σ^I)

EXHIBIT 1

Summary Statistics on ITM S&P 500 Call Options (sample [end of day period] from January 1, 1996 to October 29, 2010)

	Moneyness: Strike (K)/ S (Index)	Delta	Time to Maturity (Days)	Implied Volatility Annual, %	Option Mid-Quote Price
N	86,109	86,109	86,109	86,109	86,109
Mean	0.9415	$0.7642	45.17	26.38	$81.61
St Dev	0.0362	$0.0728	13.73	12.46	$36.84
Min	0.7177	$0.6250	20	4.12	$9.88
Max	0.9950	$0.8750	70	95.22	$334.10

EXHIBIT 2

Summary Statistics on Basel Capital Estimates with $m = m = 1$

	C Pre2009 (%)	C 2009 (%)	C EVaR (%)	Cumulative Loss Over Forward 10 days (%)	VaR99 10-day (%)	Annual Low K Implied Volatility (%)	Annual Trailing 60-day Realized Volatility (%)
A: April 1, 1998 to October 15, 2010							
N	3,156	3,156	3,156	3,156	3,156	3,156	3,156
Mean	10.089	29.427	16.301	0.088	9.998	24.303	19.239
St Dev	4.417	4.417	3.299	3.697	4.455	9.642	10.217
Min	4.748	24.086	12.059	21.638	4.704	9.238	6.876
Max	19.338	38.675	32.887	25.885	19.338	84.278	73.954
Days below cumulative loss over forward 10 days	43	0	3	0	44		
% of days below cumulative loss over forward 10 days	1.362	0.000	0.095	0.000	1.394		
B: April 1, 1998 to December 31, 1998							
N	191	191	191	191	191	191	191
Mean	8.147	27.485	17.460	0.691	8.049	29.515	19.833
St Dev	1.077	1.077	2.495	4.268	1.153	8.198	7.665
Min	7.016	26.354	14.717	12.407	6.843	17.606	10.866
Max	9.517	28.854	22.105	11.663	9.517	54.098	32.643
Days below cumulative loss over forward 10 days	10	0	0	0	10		
% of days below cumulative loss over forward 10 days	5.236	0.000	0.000	0.000	5.236		
C: January 1, 1999 to December 31, 2006							
N	2,010	2,010	2,010	2,010	2,010	2,010	2,010
Mean	8.630	27.968	15.459	0.115	8.499	21.787	16.902
St Dev	2.180	2.180	2.286	3.187	2.219	7.334	6.591
Min	4.748	24.086	12.059	15.369	4.704	9.238	7.051
Max	10.842	30.180	22.619	16.281	10.842	48.659	37.882
Days below cumulative loss over forward 10 days	15	0	0	0	16		
% of days below cumulative loss over forward 10 days	0.746	0.000	0.000	0.000	0.796		
D: January 1, 2007 to March 31, 2009							
N	565	565	565	565	565	565	565
Mean	9.551	28.888	18.112	0.814	9.546	29.288	25.581
St Dev	4.849	4.849	5.432	4.934	4.853	14.790	17.417
Min	4.748	24.086	12.065	21.638	4.748	10.476	6.876
Max	19.338	38.675	32.887	25.885	19.338	84.278	73.954
Days below cumulative loss over forward 10 days	18	0	3	0	18		
% of days below cumulative loss over forward 10 days	3.186	0.000	0.531	0.000	3.186		
E: April 1, 2009 to October 15, 2010							
N	390	390	390	390	390	390	390
Mean	19.337	38.675	17.449	0.962	19.309	27.496	21.801
St Dev	0.006	0.006	2.251	3.477	0.266	5.820	7.775
Min	19.238	38.576	14.140	11.390	16.701	17.028	11.947
Max	19.338	38.675	23.899	8.852	19.338	50.302	42.729
Days below cumulative loss over forward 10 days	0	0	0	0	0		
% of days below cumulative loss over forward 10 days	0.000	0.000	0.000	0.000	0.000		

Note: Implied and realized volatility of the S&P 500 [illegible] Basel capital and EVaR. All VaR estimates [illegible] 10 days.

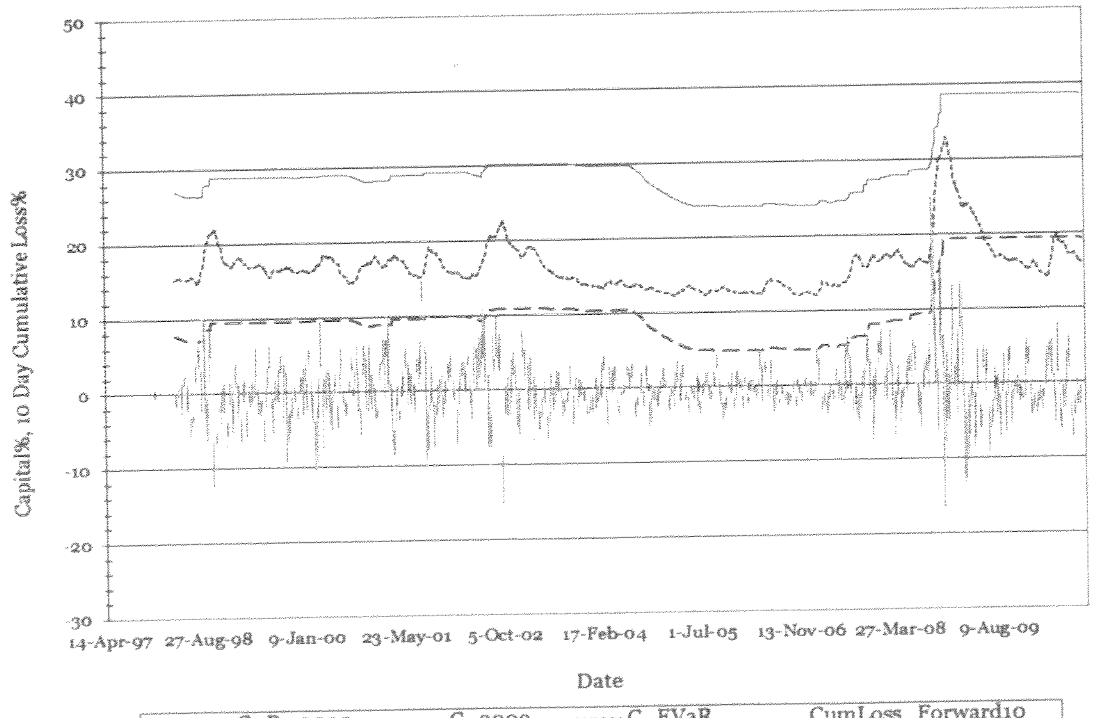
for the sample period and various subperiods. Exhibits 3 and 4 plot the time series of the forward 10-day cumulative loss (negative of cumulative return) on the S&P 500 and the three market risk capital estimates, $C_{pre-2009}$, C_{2009}, and C_{EVaR} for the April 14, 1997 to October 29, 2010 period and the December 29, 2006 to October 29, 2010 subperiod containing the recent financial crisis.

Several observations can be made regarding the capital measures. First, the inadequacy of the pre-2009 Basel capital is quite apparent. During the full sample of April 1, 1998 to October 15, 2010 (Exhibit 2, Panel A), capital was shown to be inadequate on 43 days (1.362% failure rate) to cover the cumulative loss over the next 10 trading days. The failure rate is much higher at 5.236% during the turbulent period of April to December in 1998 (Exhibit 2, Panel B) and 3.186% during the 2007–2009 financial crisis (Exhibit 2, Panel D). Building a capital buffer is also unhelpful, as illustrated by the low value of 4.748% (Panel C, Exhibit 2) capital leading up to the financial crisis.

Second, as expected and as shown in Exhibits 2, 3, and 4, the new Basel II capital is always adequate, with a failure rate of 0% in all periods. During the period of April to December of 1998 (Panel B, Exhibit 2), Basel II's lowest level of 26.35% is more than twice the highest 10-day forward cumulative loss of 12.41%. During the financial crisis (Exhibit 2, Panel D), the lowest new Basel II capital is 24.09%, compared to the highest 10-day forward cumulative loss of 21.64%. Even during a normal period, such as January 1999 to December 2006 (Exhibit 2, Panel C), the new Basel II capital remains quite high at 24.09% or greater. Although this does help build a strong capital buffer before a crisis, such levels appear exorbitantly onerous and unnecessary. Furthermore, because of a lack of automated dynamism, the Basel II capital remains at the high level of more than 38% reached during the crisis well after the end of the crisis (Exhibits 3 and 4). Thus, by all indications, the new Basel II capital is overly conservative, with a long-term average of 29.43% and a range of 24.09% to 38.68% (Exhibit 2, Panel A).

EXHIBIT 3

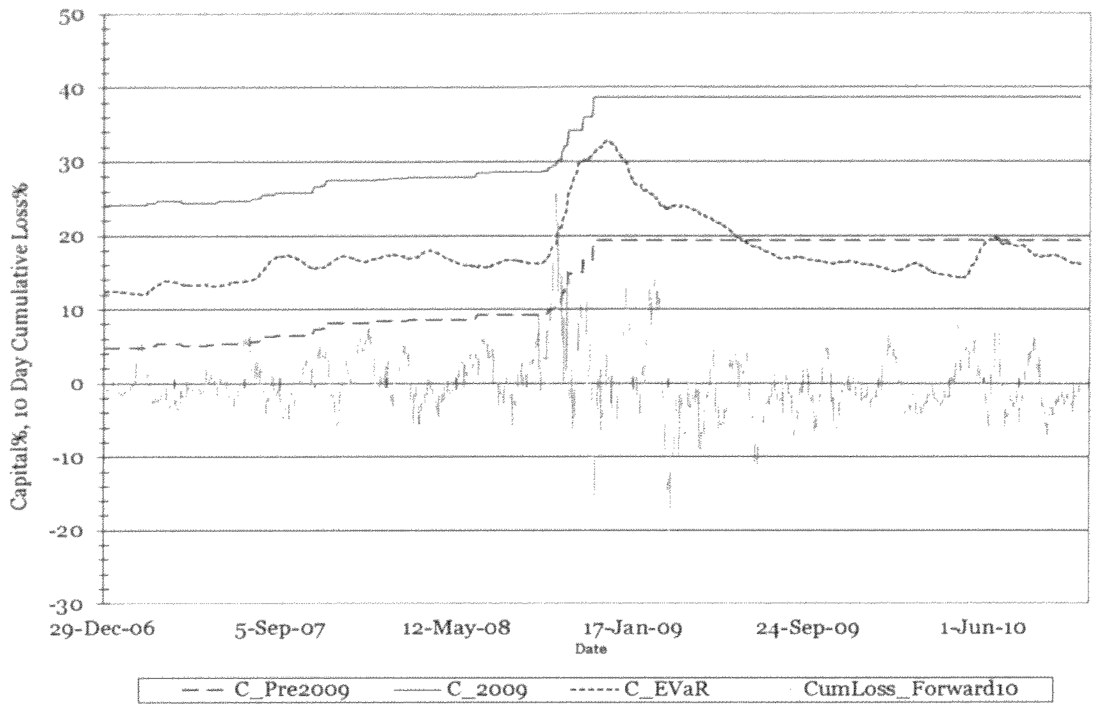
Pre-2009 Basel Capital (C_Pre2009), 2009 Basel Capital (C_2009), and 10-Day Cumulative Loss (CumLoss_Forward10) for the S&P 500 (April 1, 1998 to October 29, 2010)



Note: Basel multiple $m_i = m_s = 1$.

EXHIBIT 4

Pre-2009 Basel Capital (C_Pre2009), 2009 Basel Capital (C_2009), EVaR Capital (C_EVaR), and 10-Day Cumulative Loss (CumLoss_Forward10) for the S&P 500, (December 29, 2006 to October 15, 2010)



Note: Basel multiple $m_c = m_s = 1$.

Third, in contrast, the long-term average EVaR capital is much lower than new Basel II at 16.301% (Exhibit 2, Panel A), but comfortably higher than the pre-2009 Basel II capital average of 10.089%. Because the EVaR features built-in market responsiveness, it has a wide range of 12.06% (low reached in the pre-crisis period, Exhibit 2, Panel C) to 32.89% (attained during the crisis, Exhibit 2, Panel D). The highest (25.885%) and the second highest (24.749%) forward 10-day cumulative losses on the S&P 500 are associated with beginning-of-the-day capital requirements on September 26 and 29 of 2008. These are two of only three dates during the entire sample period when EVaR capitals of 18.740% and 18.931% proved to be inadequate, barely falling short of the forward 10-day cumulative loss on October 2, 2008. Nonetheless, this failure rate of 0.531% during the crisis (a negligible 0.095% considering the long-term experience; see Exhibit 2, Panel A) is well below that permitted by the solvency standard of 99%.

Furthermore, because of market responsiveness, the EVaR capital drops down to its normal range (12%–24%) by June–July of 2009 after reaching its maximum ever level of 32.887% on December 10, 2008. This responsiveness permits the building of a reasonably strong capital buffer compared to the pre-2009 Basel capital but in a much less burdensome manner compared to the new Basel II capital.

CONCLUSIONS

The 2009 Basel II market risk capital rule attempts to address the widespread capital inadequacy of banks during the financial crisis by imposing more stringent capital requirements while retaining the VaR framework. This is accomplished principally by the introduction of a stressed VaR component. As illustrated by its application to the S&P 500 portfolio during the sample period of April 1, 1998 to October 15, 2010, the new rule guarantees capital adequacy even in the worst of times during the crisis and also builds a very strong capital buffer in normal times. These desirable goals are, however, achieved by requiring a capital standard that is too conservative and much too onerous for banks, especially under normal market conditions. Whether such an extreme level of prudence will continue to be warranted in the future remains to be debated, considering the potentially detrimental effect on banks' competitiveness and growth.

In the meantime, we suggest an alternative market risk measure, the EVaR, a simple VaR based on a market responsive composite volatility measure and the popular normal distribution. For the S&P 500, the EVaR seems to provide sufficient solvency during the crisis while being much less onerous than the 2009 Basel II rule in normal as well as crisis times. It also builds a reasonably strong capital buffer in normal times.

Our evidence supports the view that it is not the VaR framework or the normality assumption that proved inadequate during the 2007–2009 financial crisis. Instead, it is the lack of factoring the surging market volatility ahead into VaR measures and doing so in a responsive manner that underlies the observed capital inadequacy of banks during the financial crisis.

ENDNOTES

JEL Classification: G13, G21, G01.

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