RESEARCH OF BETA AS ADEQUATE RISK MEASURE-IS BETA STILL ALIVE?

Ante Perković
Faculty of Economics Split
Matice hrvatske 31, 21000 Split
Phone: ++ 38521318120; E-mail: anteperkovic1@net.hr

Abstract

The capital asset pricing model (CAPM) is one of the most important models in financial economics and it has a long history of theoretical and empirical investigations. The main underlying concept of the CAPM model is that assets with a high risk (high beta) should earn a higher return than assets with a low risk (low beta) and vice versa. The implication which can be drawn out of this is that all assets with a beta above zero bear some risk and therefore their expected return is above the return of the risk-free rate. In this research observation on monthly stock prices on Croatian stock market from January 1st 2005 until December 31st 2009 is used to form our sample. CROBEX index is used as proxy of the market portfolio. The results demonstrate that beta can not be trusted in making investment decisions and rejects the validity of the whole CAPM model on Croatian stock market.

Key words: *CAPM, beta coefficients, Markowitz model, Zagreb Stock Exchange.*

1. INTRUDUCTION

The capital asset pricing model (CAPM) of William Sharpe (1964) and John Lintner (1965) marks the birth of asset pricing theory (resulting in a Nobel Prize for Sharpe in 1990). Since its introduction in early 1960s, CAPM has been one of the most challenging topics in financial economics. Almost any manager who wants to undertake a project must justify his decision partly based on CAPM. The attraction of the CAPM is that it offers powerful and intuitively pleasing predictions about how to measure risk and the relation between expected return and risk. Unfortunately, the empirical record of the model is poor—poor enough to invalidate the way it is used in applications. The CAPM's empirical problems may reflect theoretical failings, the result of many simplifying assumptions. But, they may also be caused by difficulties in implementing valid tests of the model. The major focus of the tests has been to check whether returns are statistically related to betas. Recent evidence by Fama and French (1992,1996), Jegadeesh (1992) and others has shown that betas are not statistically related to returns, which has made these authors conclude that beta is totally unsuitable for describing the cross sectional difference in returns and that it is an inappropriate measure of risk. This paper is orientated on testing whether beta is a suitable measure of risk on Croatian stock market, by regressing beta of each stock and expected return of each stock. The results confirm the hypothesis that beta is not appropriate measure of risk on underdeveloped stock markets as Croatian.

2. THE CAPITAL ASSET PRICING MODEL

2.1. The model

This study will focus on the Sharpe-Lintner version of the CAPM, which is based on one period mean-variance portfolio theory of Markowitz. The Markowitz Model assumes that investors are risk averse and only care about risk (variance) and return (mean) of their one-period investment return. Therefore investors choose “meanvariance-efficient” portfolios meaning that they either maximize the expected return, given a certain variance of portfolio return or minimize the variance, given a certain expected return. Sharpe (1964) and Lintner (1965) add some key assumptions to the Markowitz model. Firstly, investors are risk averse as in the Markowitz model and evaluate their investment only in terms of expected return and variance of return measured over the same single holding period. The second assumption is that capital markets are perfect meaning that all assets are infinitely divisible, that no transaction costs, short selling restrictions or taxes occur, that all investors can lend and borrow at the risk free rate and that all information is costless and available for everyone. Thirdly, all investors have the same investment opportunity. Finally, all investors estimate the same individual asset return, correlation among assets and standard deviations of return.

Sharpe and Lintner developed the following formula, which states that the expected return on any asset i, $E(R_i)$ is the risk-free rate, R_f, plus a premium per unit of beta risk, which is calculated by subtracting the risk free rate from the expected return of the market, $E(R_M)$ and multiplying the result with the risk premium in terms of the asset’s market beta, β.

$$E(R_i) = R_f + (R_M - R_f)\beta\, i \tag{1}$$

The market beta of asset *i*, is the covariance of its return with the market return divided by the variance of the market return.

$$\beta_i = \frac{Cov(i, M)}{\sigma^2 M} \tag{2}$$

The main underlying concept is that assets with a high risk (high beta) should earn a higher return than assets with a low risk (low beta) and vice versa. This seems to be a very intuitive concept since no investor would be willing to take on more risk if it is not rewarded by a higher expected return. The implication which can be drawn out of this is that all assets with a beta above zero bear some risk and therefore their expected return is above the return of the risk-free rate. As there is only systematic risk in the CAPM world, assets which are completely uncorrelated to the market and thus have a beta of zero should earn a return which is equal to the risk-free rate. This is a fact because only the systematic risk resulting out of economic activity counts in the CAPM, whereas unsystematic risk can be eliminated by using a high degree of diversification. Consequentialy, there is only one risk-return efficient portfolio, which is also called market portfolio and will be hold by every single investor. Therefore, the investors in the CAPM just have to decide how much to invest in the market portfolio, which has a beta of one and the remainder will be invested in the risk-free rate.

Resulting out of that is the securities market line on which all investors will plot their securities in equilibrium. The above mentioned choice of the investor, to put a part of their investment into the market portfolio and the other one into the risk free rate, determines the location of the portfolio on the securities market line.

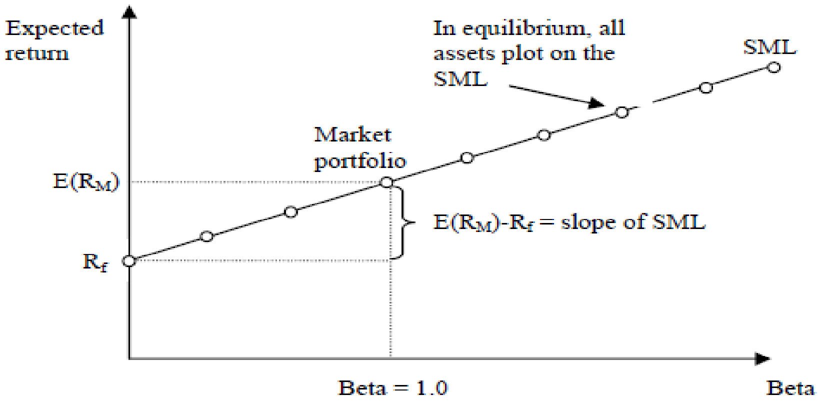

Figure 1: The Securities Market Line (SML)

3. PREVIOUS RESEARCH

The theory itself has been criticized for more than 30 years and has created a great academic debate about its usefulness and validity.

The model was developed in the early 1960’s by Sharpe [1964], Lintner [1965] and Mossin [1966]. In its simple form, the CAPM predicts that the expected return on an asset above the risk-free rate is linearly related to the non-diversifiable risk, which is measured by the asset’s beta. One of the earliest empirical studies that found supportive evidence for CAPM is that of Black, Jensen and Scholes [1972]. Using monthly return data and portfolios rather than individual stocks, Black et al tested whether the cross-section of expected returns is linear in beta. By combining securities into portfolios one can diversify away most of the firm-specific component of the returns, thereby enhancing the precision of the beta estimates and the expected rate of return of the portfolio securities. This approach mitigates the statistical problems that arise from measurement errors in beta estimates. The authors found that the data are consistent with the predictions of the CAPM i.e. the relation between the average return and beta is very close to linear and that portfolios with high (low) betas have high (low) average returns. Another classic empirical study that supports the theory is that of Fama and McBeth [1973]; they examined whether there is a positive linear relation between average returns and beta. Moreover, the authors investigated whether the squared value of beta and the volatility of asset returns can explain the residual variation in average returns across assets that are not explained by beta alone.

In the early 1980s several studies suggested that there were deviations from the linear CAPM risk return trade-off due to other variables that affect this tradeoff. The purpose of the above studies was to find the components that CAPM was missing in explaining the risk-return trade-off and to identify the variables that created those deviations Banz [1981] tested the CAPM by checking whether the size of firms can explain the residual variation in average returns across assets that remain unexplained by the CAPM's beta. The author concluded that the average returns on stocks of small firms (those with low market values of equity) were higher than the average returns on stocks of large firms (those with high market values of equity). This finding has become known as the size effect.

The research has been expanded by examining different sets of variables that might affect the risk return tradeoff. In particular, the earnings yield (Basu [1977]), leverage, and the ratio of a firm's book value of equity to its market value (e.g. Stattman [1980], Rosenberg, Reid and Lanstein [1983] and Chan, Hamao, Lakonishok [1991]) have all been utilized in testing the validity of CAPM. The general reaction to Banz's [1981] findings, that CAPM may be missing some aspects of reality, was to support the view that although the data may suggest deviations from CAPM, these deviations are not so important as to reject the theory.

However, this idea has been challenged by Fama and French [1992]. They showed that Banz's findings might be economically so important that it raises serious questions about the validity of the CAPM. Fama and French [1992] used the same procedure as Fama and McBeth [1973] but arrived at very different conclusions. Fama and McBeth find a positive relation between return and risk while Fama and French find no relation at all. The Fama and French [1992] study has itself been criticized. In general the studies responding to the Fama and French challenge by and large take a closer look at the data used in the study. Kothari, Shaken and Sloan [1995] argue that Fama and French's [1992] findings depend essentially on how the statistical findings are interpreted. Amihudm, Christensen and Mendelson [1992] and Black [1993] support the view that the data are too noisy to invalidate the CAPM. In fact, they show that when a more efficient statistical method is used, the estimated relation between average return and beta is positive and significant. Black [1993] suggests that the size effect noted by Banz [1981] could simply be a sample period effect i.e. the size effect is observed in some periods and not in others.

Despite the above criticisms, the general reaction to the Fama and French [1992] findings has been to focus on alternative asset pricing models. Jagannathan and Wang [1993] argue that this may not be necessary. Instead they show that the lack of empirical support for the CAPM may be due to the inappropriateness of basic assumptions made to facilitate the empirical analysis. In Croatia very little tests have been made, Fruk and Huljak [2004] tested the Sharpe-Lintner Model on the Zagreb Stock Exchange with undefined answers whether beta coefficients can be used to make investment decisions.

To summarize, all the models above aim to improve the empirical testing of CAPM. There have also been numerous modifications to the models and whether the earliest or the subsequent alternative models validate or not the CAPM is yet to be determined.

EMPIRICAL STUDY

In general, the empirical testing of CAPM has two broad purposes (Baily et al, [1998]): (i) to test whether or not the theories should be rejected (ii) to provide information that can aid financial decisions.

Methods of statistical analysis need to be applied in order to draw reliable conclusions on whether the model is supported by the data. This study focuses on examining the relationship between beta and return on Croatian stock market. Therefore, all the data which is used originates in Croatia and is obtained from public web site of Zagreb stock exchange (http://www.zse.hr). The used data set consists of the monthly closing prices of 15 listed Croatian companies for the time period from July 2005. to December 2009. All stock returns used in the study are adjusted for dividends as required by the CAPM. Based on the final prices on the last working day in a month, relative, percentage returns have been calculated in relation to the final prices on the last workday in the previous month. Complex continued access method has been used for the rate of return.

Complex continued return of an individual security is calculated using the next formula:

$$R_i = \ln\left(\frac{P_i(t)}{P_i(t-1)}\right) \tag{3}$$

where $P_i(t)$ is price of stock at the end of period, and $P_i(t-1)$ - price of stock at the beginning of period.

In order of testing whether beta is in relationship with return, we will calculate expected return and beta of each stock using MS Excel software. As a proxy of a market portfolio CROBEX index will be used. Additionally, regression analysis will be made to estimate whether the beta's and return's are in linear relationship. It is important to emphasize that Zagrebačka banka d.d. share (ZABA-R-A) has been corrected. During the second quarter of 2008. stock split has been made and privileged shares have been abolished. Each ZABA's regular share (ZABA-R-A) whose individual nominal value amounts to 380,00 kunas, has been split in 19 shares whose individual nominal value amounts to 20,00 kunas. The price of the ZABA's share has been divided by 19 in order to get adequate data to test the CAPM model. The following table presents the shares chosen for the analysis and the corresponding monthly prices since the January of 2005 until the December of 2009.

To test whether beta is a suitable measure of risk on Croatian stock market the expected return and beta of each share need to be calculated. The following formula is used for the computation of the expected return:

$$E(R_i) = \frac{\sum_{t=1}^{N} R_i(t)}{N} \tag{4}$$

where N stands for the number of the observed data. Formula for the calculation of beta is:

$$\beta_i = \frac{Cov(i,M)}{\sigma^2 M} \tag{5}$$

where $Cov(i,M)$ is covariant of the security i and market portfolio and $\sigma^2 M$ is market portfolio variance.

Table 1 Annual return for selected stock

Stock/Return	2005.	2006.	2007.	2008.	2009.
ADRS-R-A	-0,0757	0,2748	0,3062	-1,1029	0,2967
ATPL-R-A	0,5186	0,0677	1,3652	-1,6425	0,3319
DLKV-R-A	0,4456	0,6808	0,7512	-1,4929	-0,1650
ERNT-R-A	0,2596	0,2569	0,3202	-1,0331	0,1012
FRNK-R-A	0,5220	0,2902	-0,2206	-0,7133	-0,2282
IGH-R-A	0,5194	0,3824	1,2781	-1,3626	-0,3481
JDPL-R-A	-0,1591	0,0034	0,9468	-1,7270	0,1883
KOEI-R-A	0,6271	0,7945	0,6542	-1,1257	0,0819
KRAS-R-A	0,4645	0,2573	0,0149	-0,8587	-0,0367
PBZ-R-A	0,1498	0,6564	0,4559	-1,4109	0,2725
PODR-R-A	0,3355	0,3805	0,0528	-0,6415	0,1268
PTKM-R-A	0,3542	0,4836	0,4670	-1,0000	0,2259
TNPL-R-A	0,3054	0,2168	0,6960	-1,6798	0,1185
VDKT-R-A	1,4879	0,2946	1,1525	-2,5774	-0,0096
ZABA-R-A	0,2903	0,5245	0,3425	-1,2939	0,4872
CROBEX	0,2435	0,4742	0,4900	-1,1125	0,1515

Source: the author

Table 2 Expected return and beta coefficients

Stock	**Expected return**	**Beta**
ADRS-R-A	-0,0602	0,8737
ATPL-R-A	0,1282	1,5080
DLKV-R-A	0,0439	1,3676
ERNT-R-A	-0,0191	0,8525
FRNK-R-A	-0,0700	0,5263
IGH-R-A	0,0939	1,3393
JDPL-R-A	-0,1495	1,3615
KOEI-R-A	0,2064	1,1642
KRAS-R-A	-0,0317	0,6769
PBZ-R-A	0,0247	1,2274
PODR-R-A	0,0508	0,5688
PTKM-R-A	0,1061	0,9392
TNPL-R-A	-0,0686	1,3662
VDKT-R-A	0,0696	2,2088
ZABA-R-A	0,0701	1,1188

Source: the author

During the calculation of the expected returns and the beta corresponding shares, monthly calculations of the returns have been transferred to the annual level; average return for each year has been calculated and then multiplied by the number of months in a year, that is 12. The market line of the securities, that is SML line, reveals that the expected return of each share should be linearly connected with the corresponding beta.

Assuming that the historical data describe genuinely the distribution of the future returns, we set the equation

$$E(Ri) = \alpha + \prod \beta_i + \varepsilon \tag{6}$$

where $E(R_i)$ is dependent variable of the regression line (y variable), β_i is independent variable (x variable), α is intercept, $\prod$ is slope.

Variables ε are random variables which ensure that the model is stochastic, and they represent unknown deviations from the functional relation (this means that the relations between the variables are only approximate).

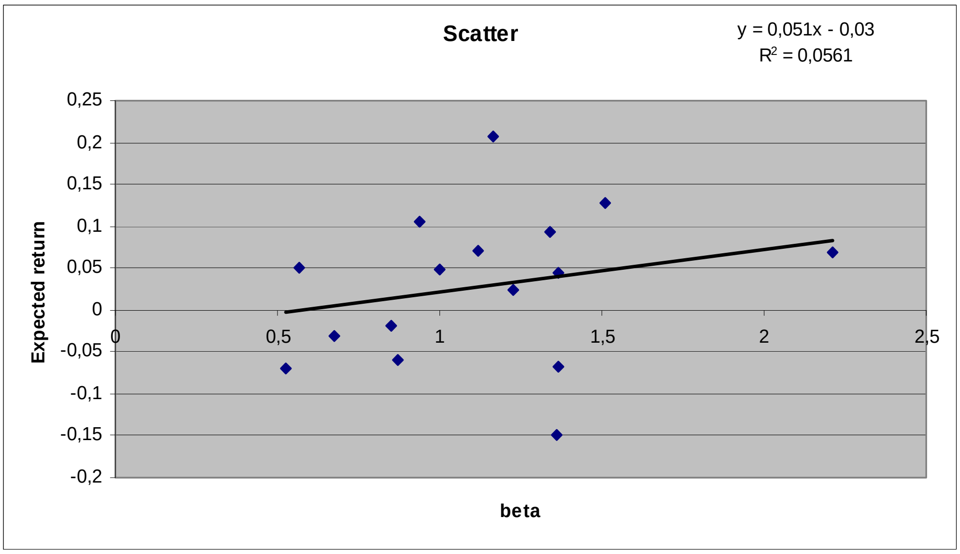

Figure 2: Regression line

The results of the regression analysis are presented in the next equation:

$E(R_i)$ = -0,03361+ 0,052567 β_i

R^2 = 0,059352

The intercept value is -0,03361, and the slope value is 0,052567. Determination coefficient (R^2) is a relative measure of the regression representative quality which shows the percentage of the explained share of the sum of squares of total dependent variable deviations from the average. The closer the determination coefficients' values to 1, (that is to 100%) the more representative is the model. The value of the determination coefficient is within the interval $0 \leq R^2 \leq 1$. The closer this variable is to 1, the more representative is the regression model. The theoretical limit of the model's representative quality is 0,9. in practice, sometimes it is very difficult to find a variable which explains well the dependent variable, thus the representative quality limit goes down even to 0,6. As we can see in our example, the determination coefficient amounts to 0,0593262, which means that the model explains only 5,9362% of the occurrence of variation.

Furthermore, the analysis of variants' deviations (ANOVA) has been made. The data is presented in the following table ANOVA.

SP is the sum of squares of the explained part of the variable y's deviation from the arithmetic mean. SR is the sum of squares of the unexplained part of variable y's deviations from the arithmetic mean, that is the sum of squares of the deviations of variable y's original or empirical values from the estimated values. These deviations are accidental errors *ei.* Finally, ST is the sum of squares of total variable y's deviations from the arithmetic mean.

Table 3 ANOVA

Regression Statistics	
Multiple R	0,2436
R Square	0,0594
Adjusted R Square	-1,1538
Standard Error	0,0934
Observations	1,0000

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	15,0000	SP=0,0071	0,0005	0,8203	
Residual	13,0000	SR=0,1134	0,0087		
Total	28,0000	ST=0,1205			

Source: author

Thus SP plus SR equals ST. By applying the upper equations we reach the fact that the total variation ST amounts to 0,12056. The regression model explains the variation SP = 0,0071554, but it leaves unexplained the variation SR = 0,113404.

Finally, analyzing the expected return and beta through the regression equation, regression coefficient Π amounts to 0,052567, which reveals that if the independent variable, in this case beta, goes up for 1 unit, the dependent variable, that is the expected return will increase for 0,052567.

CONCLUSION

These results show that the regression model is not representative, that is, it denies relationship between beta and return. There are lots of reasons why the testing of the beta has not succeeded. One of the reasons may be the fact that CAPM is worth only for portfolios, and not for individual securities. Maybe the sample of securities used to test the model was not big enough. Also, literature talking about CAPM includes bonds, real estates, even integral properties such as human capital into risky assets.

In his work Roll (1977) says that CAPM model has never been properly tested and probably never will be. He says also that it is impossible find an adequate substitution for the market portfolio; according to him, a real market portfolio should contain also the component of human capital which is difficult to be quantified, also market portfolio should be on efficient frontier. As seen in figure 3 CROBEX index is not on the efficient frontier.

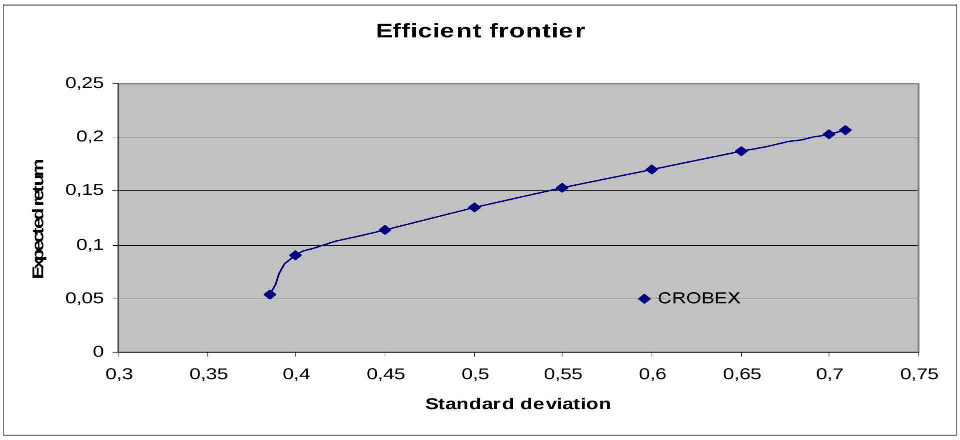

Figure 3: Efficient frontier and CROBEX index

One of the possible reasons why the testing has not succeeded is the fact that it is based on unreal assumptions. Some of these assumptions state that the information is free and available to all the investors or that the capital market is balanced and efficient.

Table 4 Efficient portfolios

Stock/Portfolio	1	2	3	4	5	6	7	8	9	10	11	12
ADRS-R-A	0,0158	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000
ATGR-R-A	0,1504	0,2906	0,3795	0,4444	0,4984	0,5485	0,5568	0,3495	0,2415	0,1553	0,0796	0,0000
ATPL-R-A	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000
DLKV-R-A	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000
ERNT-R-A	0,0963	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000
HT-R-A	0,5785	0,5298	0,3795	0,2609	0,1636	0,0770	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000
IGH-R-A	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000
INA-R-A	0,0181	0,1622	0,2411	0,2947	0,3380	0,3746	0,4432	0,6505	0,7585	0,8447	0,9204	1,0000
INGR-R-A	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000
JDPL-R-A	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000
KOEI-R-A	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000
PODR-R-A	0,1200	0,0175	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000
PTKM-R-A	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000
ULPL-R-A	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000
VIRO-R-A	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000
ZABA-R-A	0,0210	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000
Stabndard deviation	0,0121	0,0130	0,0140	0,0150	0,0160	0,0170	0,0180	0,0190	0,0200	0,0210	0,0220	0,0232
Expected return	0,0007	0,0009	0,0010	0,0010	0,0010	0,0011	0,0011	0,0011	0,0011	0,0011	0,0011	0,0011

This is acceptable in Croatia. In practice, on Croatian market there are transaction expenses, inflation and tax burden, and this is why the assumption that the markets are perfect is rejected.

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