International Scholars Journals

International Journal of Accounting, Auditing and Taxation ISSN: 2756-3634 Vol. 5 (3), pp. 001-010, March, 2018. Available online at www.internationalscholarsjournals.org © International Scholars Journals

Full Length Research Paper

The interactions among stock returns, the term structure of interest rates and economic activities: Evidence from Taiwan

Yu-Cheng Huang[1] and Hantat Chen[2]*

[1]Department of Banking, the Central Bank of China, Taipei, Taiwan.
[2]Banking Bureau, Financial Supervisory Commission, Taipei, Taiwan.

Accepted 16 November, 2017

Both stock returns and the term structure of interest rates are rich in information, in particular, they could be used to forecast economic activities. Nevertheless, it is necessary to further clarify the relation between stock returns and the term structure of interest rates, and compare the relation of the two variables with economic activities. Our research combined various research methods of time series, including VAR, Granger Causality Test, Impulse Response Function and Variance Decomposition to explore the interactions among stock returns, the term structure of interest rates and economic activities in Taiwan. Research result indicated that the causality existed not only in the relation between stock returns and industrial production but in the relation between stock returns and the spread between long-term and short-term interest rates (hereinafter "the spread"). In addition, when an abrupt shock happened to stock returns, it also had obvious influence on industrial production and the spread. But there is no causality or feedback in the interaction of the spread and industrial production, and the response of industrial production to the spread is not obvious, whether it is in the long-term or short-term. These results indicated that in Taiwan the term structure of interest rates was not a good indicator of economic activities and stock returns were superior to the term structure of interest rates as the leading indicator.

Key words: The term structure of interest rates, stock returns, industrial production, Granger Causality, VAR, impulse response function.

INTRODUCTION

Many researches argued that the term, structure of interest rates was conducive to forecast future economic activities (Harvey, 1988; 1989; Estrella and Hardouvelis, 1991; Davis and Henry, 1994; Haubrich and Dombrosky, 1996; Estrella and Mishkin, 1997, 1998; Stock and Watson, 2003; Bordo and Haubrich, 2004; Estrella, 2005a; Berge and Jordà, 2010a, b). However, some empirical researches did not support the relations between the term structure of interest rates and economic activities (Boulier and Stekler, 2001; Ang et al., 2006). It is widely known that stock returns are useful leading indicators which are ahead of business by one to three quarters (Estrella and Mishkin, 1998). Harvey (1988), Estrella and Hardouvells (1991), Estrella and Mishkin (1998), Panopoulou (2009), Berge and Jordà (2010b) noted that, the term structure of interest rates was ahead of business by four to six quarters. Some researches noted that the forecast power of the term structure of interest rates was even higher than those of the other leading indicators such as stock returns (Estrella and Mishkin, 1998; Mcmillan, 2002). These results seemed to mean that the term structure of interest rates was more adequate for being used as the business indicator than stock returns. Except that the relation between the term structure of interest rates and economic activities need to be clarified,

*Corresponding author. E-mail: p12088@mail.cbc.gov.tw. Tel: 886-2-23571385. Fax: 886-2-2357195.

the relation between stock returns and the term structure of interest rates and the comparison of the relation of the two variables with economic activities are also issues worthy of being concerned. Nevertheless, past literatures did not clarify the interactions among stock returns, the term structure of interest rates and economic activities. Hence, it is necessary to explore them.

There are four characteristics in our research. First, we combined various methods of time series, including VAR, Granger Causality Test, Impulse Response Function and Variance Decomposition to explore the interactions among stock returns, the term structure of interest rates and economic activities. Second, unlike most researches, which studied large economies, our research studied Taiwan—a small open economy to explore the relation between the term structure of interest rates and economic activities. Third, our research model embraces the variables of stock returns that we could compare the merits and demerits of stock returns and the term structure of interest rates as the leading indicator. Fourth, taking industrial production index as the proxy of economic activities enables us to solve the problem of insufficient samples when taking GDP as the proxy of economic activities.

LITERATURE REVIEW

Previous studies found the real term structure was useful to predict real economic growth. Harvey (1988, 1989) showed that there is information about future growth of consumption in real term structure. A positive slope of the yield curve is associated with a future increase in real economic activity: consumption, consumer durables and investment (Estrella and Hardouvelis, 1991). The empirical results of Davis and Henry (1994) indicated that, embracing the term structure of interest rates was conducive to increasing the forecast power of the model. If the term structure of interest rates was excluded from the model, the recession in 1990 would be impossible to be forecasted, which revealed the superior forecast power of the term structure. Estrella and Mishkin (1997) showed that, the term structure had significant predictive power for both real activity and inflation. The yield curve is thus a simple and accurate measure that should be viewed as one piece of useful information which can be used to help guide monetary policy. Stock and Watson (2003) also found that the term spread was a useful predictor of inflation and/or output growth in some countries.

Dueker (1997) and Estrella and Mishkin (1998) used a recession dummy as the dependent variable to focus on the timing of recessions. They found the yield curve remained the best recession predictor. Passaro (2007) investigated the ability of the interest rate spread to predict USA and Germany recessions using a Probit model. The results showed that the slope of the yield curve well predicted recession periods. A great number of researches also noted that the term structure of interest rates was capable of forecasting future economic activities (Harvey, 1991; Hu, 1993; Davis and Henry, 1994; Bernard and Gerlach, 1998; Davis and Fagan, 1997; Bonser-Neal and Morley, 1997; Kozicki, 1997; Attah-Mensah and Tkacz, 2001).

However, a few studies questioned whether the spread was a good cyclical indicator of US economic activity. Boulier and Stekler (2001) indicated that the spread was not a reliable predictor of economic activity. Ichiue (2004) found that the spread using the short end of the yield curve have less predictive power than many other spreads. Ang et al. (2006) built a dynamic model for GDP growth and yields that completely characterizes expectations of GDP. They found that the short rate has more predictive power than the spread. Some empirical researches embraced the stock variables in research model to highlight the superior forecast power of the term structure of interest rates to economic activities and compared the forecast power of the term structure of interest rates with that of stock indices. Harvey (1988) found the real term structure forecasted consumption grwth better than lagged consumption or stock returns. Further, the real term structure appeared to have slightly more forecasting power than the leading commercial econometric models. Davis and Fagan (1997) sought to address the policy issue of the usefulness of financial spreads as indicators of future inflation and output growth. Their results confirmed that for some countries, financial spread variables do contain some information about future output growth and inflation, with the term structure of interest rates and the reverse yield gap performing best. Estrella and Mishkin (1998) examined the performance of various financial variables as predictors of subsequent U.S. recessions. Their results showed that stock prices are useful with 1 to 2 quarter horizons, as are some well-known macroeconomic indicators. Beyond 2 quarters, the slope of the yield curve emerges as the clear choice and typically performs better by itself out of sample than in conjunction with other variables. McMillan (2002) suggested that although the real term structure contains some predictive power for UK output growth, it is less than that reported for other countries. This result is robust to the inclusion of lagged growth and the FT-ALL index return, the latter leading to a marginal improvement in predictive power.

Panopoulou (2009) investigated the predictive ability of financial variables for economic growth through bivariate and multivariate non-parametric Granger causality tests. His multivariate tests suggested that the information content of the term spread is maximised at a 5 to 6 quarter horizon, while the respective horizon for stock market returns is confined to 2 quarters. Berge and Jordà (2010b) found the predictive ability of each leading economic index component varies wildly, depending on the forecast horizon. For example, the spread between 10 year Treasury bond and the federal funds rate works best 18 months into the future.

OPERATIONAL DEFINITION OF VARIABLES

Term structure of interest rates

Yield curves represent the relation of the term structure of interest rates and can be denoted by the difference of long-term and short-term interest rate. When adopting long-term and short-term interest rates and measuring the spread of interest rates, most literatures use 10-year bond yields as long-term interest rates (Estrella and Hardouvells, 1991; Davis and Henry, 1994; Plosser and Rouwenhorst, 1994; Haubrich and Dombrosky, 1996; Estrella and Mishkin, 1998; McMillan, 2002; Hamilton and Kim, 2002; Estrella, 2005a; Berge and Jordà, 2010a; b) because the larger the term difference of the spread, the better the forecast effect. In long-term sample period of most countries, 10-year bond yields were most available. Nevertheless, a few literatures used other terms (Harvey, 1998; Ang et al., 2006) used 5-year bond yields. In terms of short-term interest rates, more alternatives are available, including the overnight offer rate, and 1-month, 3-month or 6-month rates of Treasury Bills. Our research took 10-year bond yields as the long-term interest rates and the overnight offer rate as the short-term interest rates, that is the measurement of the spread of long-term and short-term interest rates in the research is as follows:

$$Spread_t = i_t^l - i_t^s \qquad (1)$$

here, i_t^l and i_t^s denote 10-year bond yields and the overnight offer rate, respectively.

Stock returns

Stock returns are denoted by Taiwan Stock Exchange Capitalization Weighted Stock Index compiled by Taiwan Stock Exchange and measured by annual rate of return.

Economic activities

Most literatures studying the relation of the term structure of interest rates and economic activities took GDP to represent economic activities (Davis and Henry, 1994; Haubrich and Dombrosky, 1996; Harvey, 1997; Estrella and Mishkin, 1998; Boulier and Stekler, 2001; McMillan, 2002; Hamilton and Kim, 2002; Estrella, 2005a; Ang et al., 2006). Plosser and Rouwenhorst (1994) took the index of industrial production to represent real economic activities. Some literatures took several indicators to represent economic activities. In view of the fact that, there are only yearly or quarterly data in GDP and there have been no complete statistics of 10-year bond yields until the first quarter of 1995 in Taiwan, our research took monthly data of the index of industrial production to represent economic activities to avoid insufficient samples.

METHODOLOGY

The research combined various research methods of time series to test and explore the relations of stock returns, the term structure of interest rates and economic activities. The methods we took were as follows: (1) Unit root tests: At first, we took unit root tests to examine the stationarity of time series. (2) Cointegration test or VAR model development: We took Johansen's five VAR models (1988, 1990, 1994) to conduct cointegration test, to explore whether a long-term equilibrium is existed among variables if the series is non-stationary. If the series is stationary, the VAR model development would be conducted. The principal characteristic of VAR is based on the quality of data, taking economic variables as endogenous variables of models and taking the optimal lagged variables as explanatory variables. The model developed could be used to judge the short-term relations among variables. (3) Causality test: We conducted Granger Causality Test to judge whether the relation between variables is one-way lead-lag or two-way causality. (4) Impulse response function (IRF): IRF provides the dynamic response of each variable to innovations of this variable as well as of other variables. We thus used it to explore the cross-period dynamic effect among variables. (5) Variance decomposition (VDC): We used VDC to show the proportion of forecast error variance for each variable that is attribute to its own innovations and to shocks to the other variables and to judge the strength of each variable's exogeneity.

Unit root test

When the non-stationary series is shocked, its effect would not decrease as time goes by. Besides, the use of non-stationary series is apt to cause spurious regression. Moreover, the non-stationary series is not consistent with the progressive hypothesis of traditional regression model. Consequently, the non-stationary series is not adequate for regression model to explain and forecast economic phenomena. In other words, to obtain reliable results, it is necessary to make sure whether the series is stationary before conducting correlation analysis. A non-stationary series should be adequately handled. The unit root test principally aims to examine the stationarity of time series. According to the finding and comparison of various unit root tests by Schwert (1989), the ADF (Augmented Dickey-Fuller) test is most adequate. Consequently, the research took the ADF test to examine how stationary three variable series were. There are three models of the ADF test.

ADF Model 1:

$$Y_t = \rho Y_{t-1} + \sum_{i=1}^{L-1} \delta_i Y_{t-i} + \varepsilon_{it} \qquad (2)$$

ADF Model 2:

$$Y_t = \alpha + \rho Y_{t-1} + \sum_{i=1}^{L-1} \delta_i Y_{t-i} + \varepsilon_{it} \qquad (3)$$

ADF Model 3:

$$Y_t = \alpha + \lambda t + \rho Y_{t-1} + \sum_{i=1}^{L-1} \delta_i Y_{t-i} + \varepsilon_{it} \qquad (4)$$

Model 1 excludes intercept and trend terms. Model 2 includes intercept but excludes trend terms. Model 3 includes intercept and trend terms. Where α denotes intercept, t denotes the trend term of time, L is the lag period and ε is white noise. The study began to analyze the stationarity through Model 3 to test the significance of the trend before using model 2 ... etc.

VAR model

The relations of several series may be concurrent correlation, lead-lag causality or two-way causality. The best way to take into account all possible relations among variables is to develop the model of a set of series instead of developing models of each single series. Thus, the dynamic relation among series could be effectively developed.

Sims (1980) presented the VAR model. The VAR model takes all variables concerned as endogenous variables, selects the optimal lagged variables as the explanatory variables, and enables the model to cover all related information by including the information of a series in the historical data of other series, to effectively develop the dynamic relations among variables and increase forecast accuracy. The VAR model is usually used to forecast the cross-relation of several series and analyze the dynamic influence of systemic variables under random shock. The VAR model of a multi-variables series Y_t can be denoted as:

$$Y_t = \varphi + \sum_{i=1}^{n} \Phi Y_{t-i} + \varepsilon_t \quad (5)$$

Where Φ is the coefficient matrix of k×k, and ε_t is the forecast error of structural disturbance term and can be taken as the random shock term.

The research took stock returns, the term structure of interest rates and industrial production as endogenous variables of the model to conduct VAR model development and present the dynamic relations of the three variables. The VAR model can be denoted as:

$$Z_{t+1} = FZ_t + Ge_{t+1} \quad (6)$$

$$x_t = [I_r 0] Z_t \quad (7)$$

In Equations (6) and (7), Z_t is vector K of variable (SPREAD, STOCK, IP) series, F is the transition matrix, G is the input matrix, e_t are distributed random vectors, x_t are the observation vectors of construct r, I_r is r × r determinant matrix, SPREAD is the difference between 10-year bond yields and the overnight offer rate, STOCK is stock returns and IP is industrial production rate of change.

Causality test

Whether variables X and Y are correlated is subject to the conditions that the coefficient of correlation should be significant, variables change concurrently, as well as X changed prior to Y, that is the two variables had one-way lead-lag relation or two-way mutual lead-lag feedback. Consequently, it is necessary to conduct the lead-lag test before explore the correlation of variables.

$$Y_t = \alpha_0 + \sum_{i=1}^{k} \alpha_{1i} X_{t-1} + \sum_{i=1}^{k} \alpha_{2i} Y_{t-1} + \varepsilon_{1t} \quad (8)$$

$$X_t = \beta_0 + \sum_{i=1}^{k} \beta_{1i} X_{t-1} + \sum_{i=1}^{k} \beta_{2i} Y_{t-1} + \varepsilon_{2t} \quad (9)$$

The test results may be as follows, (1) If $\alpha_{1i} = 0$ and $\beta_{2i} = 0$, it denoted that the two variables are mutually independent. (2) If $\alpha_{1i} \neq 0$ and $\alpha_{2i} = 0$, it denoted that X is ahead of Y. (3) If $\beta_{2i} \neq 0$ and $\beta_{1i} = 0$, it denoted that Y is ahead of X. (4) If $\alpha_{1i} \neq 0$ and $\beta_{2i} \neq 0$, it denoted that the two variables are two-way causality.

Impulse response function

The Granger causality test can only be used to observe the lead-lag relation between variables. It cannot help us understand when a variable encounters an automatic impulse, the cross period dynamic influence caused by the variable itself and other variables. Making use of the analysis of impulse response function enables us to understand whether the response was positive or negative, long-term or short-term and continuous or fluctuated to other variables when an economic variable changes. When variables are cointegrated, the impulse response function conducting with the level term would produce a continuous effect of overestimating the disturbance term and cause spuriously continuous impulse response (Philips, 1994). As a result, if there is no cointegration, we could use the traditional VAR model to conduct the analysis of impulse response function. However, if variables are cointegrated, we could use Johansen's Maximum Likelihood Method, to estimate cointegration vectors then use the Error Correction Model, to conduct the analysis of impulse response function.

The analysis of impulse response takes the variables concerned as endogenous variables, uses the lagged of all variables as explanatory variables and covers all possible information by lag terms. Because complicated feedback may be among variables, it is difficult to directly explain or describe it. Hence, we transform the equations into the vector moving average (VMA) by Wald Decomposition Theorem, to make each variable be denoted by the current and lagged shock terms. We used two variables and first-order lagged variables in the following, to describe the structural VAR model and derive the impulse response function.

$$w_t = \alpha_{10} - \alpha_{12} z_t + \beta_{11} w_{t-1} + \beta_{12} z_{t-1} + \varepsilon_{wt} \quad (10)$$

$$z_t = \alpha_{20} - \alpha_{21} w_t + \beta_{21} w_{t-1} + \beta_{22} z_{t-1} + \varepsilon_{zt} \quad (11)$$

Equations 10 and 11 could be denoted by a reduced form:

$$BY_t = {}_0 + {}_1 Y_{t-1} + \varepsilon_t \quad (12)$$

Where,

$$Y_t = \begin{bmatrix} w_t \\ z_t \end{bmatrix}; \quad B = \begin{bmatrix} 1 & \alpha_{12} \\ \alpha_{21} & 1 \end{bmatrix}; \quad {}_0 = \begin{bmatrix} \alpha_{10} \\ \alpha_{20} \end{bmatrix}; \quad {}_1 = \begin{bmatrix} \beta_{11} & \beta_{12} \\ \beta_{21} & \beta_{22} \end{bmatrix}; \quad \varepsilon_t = \begin{bmatrix} \varepsilon_{wt} \\ \varepsilon_{zt} \end{bmatrix}$$

The VMA model including white noise ε_t could be obtained after derivation:

$$\begin{bmatrix} w_t \\ z_t \end{bmatrix} = \begin{bmatrix} \bar{w} \\ \bar{z} \end{bmatrix} + \sum_{i=0}^{\infty} \begin{bmatrix} \varphi_{11}(i) & \varphi_{12}(i) \\ \varphi_{21}(i) & \varphi_{22}(i) \end{bmatrix} \begin{bmatrix} \varepsilon_{wt-i} \\ \varepsilon_{zt-i} \end{bmatrix} \quad (13)$$

Equation 13 could be denoted as:

$$Y_t = u + \sum_{i=0}^{\infty} \varphi_i \varepsilon_{t-i} \quad (14)$$

Table 1. The results of ADF unit-root tests.

Variable	Optimal model	Level	Optimal model	First difference
SPREAD	1	-1.812* (0.0667)	1	-4.069*** (0.0001)
STOCK	1	-2.167** (0.0296)	1	-5.146*** (0.0000)
IP	3	-3.883** (0.0153)	3	-6.539*** (0.0000)

1. SPREAD, STOCK and IP denote the spread, stock returns and industrial production, respectively; 2. Numbers within parentheses are p values; 3. *, ** and *** indicates significance at 10, 5, and 1% levels, respectively.

Equation (14) is called the impulse response equation, φ_i is the impulse response function. The traditional impulse response function usually uses the Cholesky method to conduct the impulse of VAR model or error correction model through orthogonalized process. However, the result would be different due to variables sorting. Pesaran and Shin (1998) developed the generalized impulse response, a way the orthogonalized process is no longer needed and its result would not be influenced by variables sorting. Consequently, the research used the generalized impulse response function, to observe the cross period interaction of the three variables.

Variance decomposition

To determine the strength of relative exogeneity of each variable, the research conducted the analysis of variance decomposition of stock returns, the spread and industrial production, so that we could judge the proportion of forecast error variance for each variable explained by other variables. The way to forecast variance decomposition is to apply the generalized form of the VAR model, take the variables of the VAR model as endogenous variables, turn the generalized form of the VAR model into moving average representation, remove the cross-related part of impulse terms by orthogonalization and use the coefficient of the moving average method to imitate the dynamic relation of the system.

Sources of data

The stock index came from Taiwan Stock Exchange's Capitalization Weighted Stock Index (monthly average). The long-term interest rates (10-year bond yields) and short-term interest rates (overnight offer rate) were obtained from the Financial Statistics Monthly of the Central Bank of China. The data of the Industrial Production Index came from the database of National statistics of Economic of the Ministry of Economy. Taiwan's 10-year bond yields have no complete statistics until January 1995. Hence, our sample period is from January 1995 to December 2009. We took monthly data and had 180 observations.

EMPIRICAL RESULTS

Unit root test

The research used the ADF method to conduct the unit root test and to examine the stationarity of time series. First, we selected the optimal model of three variables from three models of the unit root test, then used the level term and the difference term to conduct test and ascertain the characteristics of data. The test result is exhibited in Table 1. Under the spread, the results of the ADF test for Model 3 was insignificant (P value = 0.2955) and model 2 was also insignificant (P value = 0.1693) while that of Model 1 was significant. Consequently, we used model 1 to conduct the test for this series. Under stock returns, the results of the ADF test for model 3 was insignificant (P value = 0.5272) and Model 2 was also insignificant (P value = 0.2371) while that of Model 1 was significant. Consequently, we used Model 1 to conduct the test for stock returns. Under industrial production, we used Model 3 to conduct the ADF test first and found that the result was significant at 1% significance level. Hence, model 3 was used to conduct the unit root test for industrial production.

The result of the ADF test in Table 1 indicated that the null hypothesis of the unit root was rejected when conducting the unit root test for the level terms of the series of the spread, stock returns and industrial production under 10, 5 and 1% significance level respectively. It means that all three series are stationary.

According to the research design of the research, if variables were found non-stationary by the unit root test, the cointegration test would be conducted, to observe whether long-term equilibriums exist among variables. If the series were stationary, the VAR model development and the causality test would be conducted. The research continued to conduct the VAR model development to judge the short-term interaction instead of conducting the cointegration test because the three series are all stationary.

VAR model

Next, we use the VAR model to test the short-term interaction among the spread, stock returns and industrial

Table 2. The results of VAR analysis.

SPREAD	STOCK	IP
SPREAD(-1)*,(-2)*	STOCK(-1)*	IP(-1)*,(-2)*
	SPREAD(-1)*	STOCK(-2)*

Note: 1. SPREAD, STOCK and IP denote the spread, stock returns and industrial production, respectively; 2. Numbers within parentheses are the lead length based on AIC for the 'principle of parsimony'; 3. * indicates significance at 5% level.

Table 3. The results of Granger causality tests.

Lead variable	Lag variable	F-value	P-value
STOCK	SPREAD	1.525	0.08498*
SPREAD	STOCK	1.311	0.18621
IP	SPREAD	0.563	0.94295
SPREAD	IP	0.887	0.61680
IP	STOCK	1.135	0.32845
STOCK	IP	1.834	0.02424**

Note: SPREAD, STOCK and IP denote the spread, stock returns and industrial production, respectively.

production. The research used the Akaike Information Criterion as the criterion of judgment for the optimal period of lag order. The result indicated that the optimal period of lag order was two. We could learn from the fit result of the VAR model (Table 2) that in the short-term, industrial production was influenced by stock returns except by itself while the influence of the spread was not obvious. In the short-term, the spread was influenced only by itself while the influences of the spread by industrial production and stock returns were not obvious. In the short-term, stock returns was influenced by both itself and the spread.

Granger causality test

The research conducted the Granger Causality Test to explore whether one-way lead-lag relation or two-way causality exists among stock returns and the spread, the spread and industrial production, or stock returns and industrial production. The test result (Table 3) indicated that the one-way causality existed between stock returns and the spread. There was no one-way causality or two-way causality between the spread and industrial produc-tion. Although some literatures support the causality that the change of the spread is prior to that of economic activities, Taiwan's empirical result is not so. It means that the term structure of interest rates is not a good indicator for economic activities in Taiwan. The one-way causality existed between stock returns and industrial production, which was in conformity with the result most literatures pointed out that stock returns were the leading indicator of business. On the whole, the Granger Causality Test found that stock returns were ahead of industrial production and the spread, but there was no causality between the spread and industrial production.

Analysis of impulse response

The research used the analysis of impulse response to explore what response will be, as time went by, if any variable of the spread, stock returns and industrial production was shocked by other variables, that is the response was positive or negative, long-term or short-term, or continuous or fluctuated. The result of the analysis of impulse response (Figure 1) indicated that in the beginning, the response of the spread to stock returns obviously presented positive and had the largest effect at period three, then turned into negative response at period seven. The response of stock returns to the spread fluctuated around zero from beginning to end, that is both positive and negative responses were not obvious. The response of the spread to industrial production had slight negative response in the beginning, then turned into positive response until the end.

However, its response was not obvious. The response of industrial production to the spread had slight positive response from beginning to end. The response of industrial production to stock returns obviously presented positive response and lasted until period eighteen. The response of stock returns to industrial production presen-ted a slightly negative response and fluctuated around zero after period thirteen.

Analysis of variance decomposition

We could obtain the percentage of variance decomposition

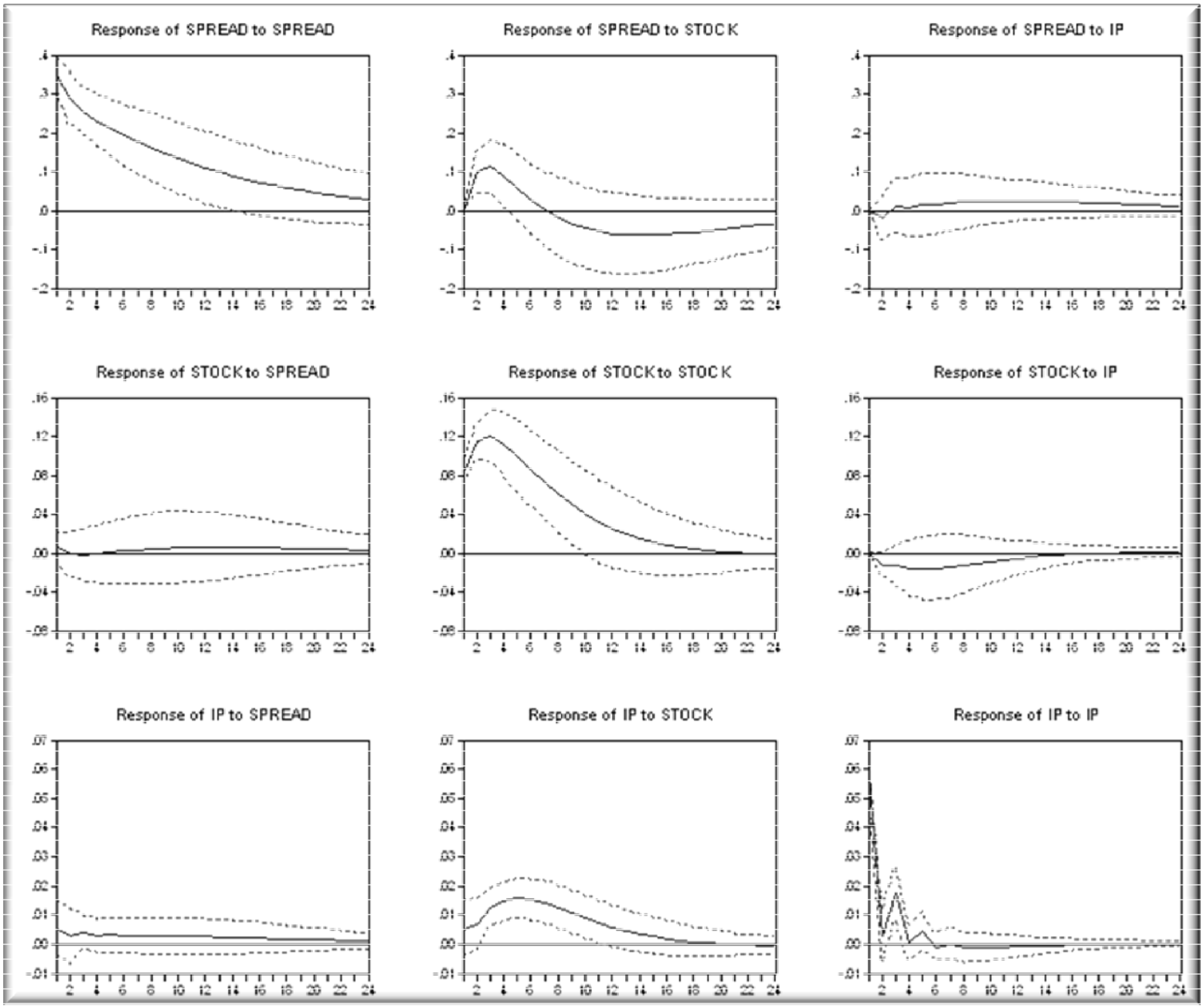

Figure 1. The results of impulse response (response to Cholesky one S.D. Innovations ±2 S.E.

decomposition of the forecast error of variables by empirical study to the spread, stock returns and industrial production. Also, we could understand the degree of the change, a variable could be explained by itself or other endogenous variables and judge the strength of each variable's exogeneity. The research took 6 months as the observation point and, in total, observed 24 months. The empirical result (Table 4) indicated that, in terms of the variance of the spread, stock returns had moderate explanatory power except that, itself had higher explanatory power to its variance. The longer the period, the higher the explanatory power. The explanatory power could reach 11.85% at most. In terms of the variance of stock returns, stock returns were strongly exogenous and were hardly influenced by the other two variables, and itself had rather high explanatory powers (97.2999.55%). In terms of the variance of industrial production, except that itself had higher explanatory power to its variance, stock returns also had a rather high explanatory power, which would increase as the period became longer and could reached 30.33% at most.

To sum up, stock returns played an important part in Taiwan, in explaining the variance of the spread and industrial production. However, the spread was insignificant in explaining the variance of stock returns and industrial production. It indicated that the spread was not adequate for being used as the leading indicator of industrial production in Taiwan.

CONCLUSIONS AND IMPLICATIONS

The research used various time series methods, including unit root test, VAR model development, causality test, impact response function and variance decomposition to explore the interactions among Taiwan's term

Table 4. The result of forecasted variance decomposition.

	Period	SPREAD	STOCK	IP
	1	100.0000	0.000000	0.000000
	6	92.04080	7.723000	0.236204
SPREAD	12	91.52858	7.706451	0.764970
	18	88.38864	10.45008	1.161284
	24	86.82048	11.85879	1.320735
	1	0.449686	99.55031	0.000000
	6	0.064799	98.26686	1.668340
STOCK	12	0.250934	97.66026	2.088807
	18	0.487090	97.40527	2.107641
	24	0.597270	97.29678	2.105951
	1	0.827847	0.850856	98.32130
	6	1.703231	20.33215	77.96461
IP	12	2.304641	29.88887	67.80649
	18	2.773178	30.33528	66.89154
	24	2.968375	30.28238	66.74924

Note: SPREAD, STOCK and IP denote the spread, stock returns and industrial production, respectively.

structure of interest rates, stock returns and industrial production. The result of Granger causality test indicated that stock returns and the spread existed one-way causality, so did stock returns and industrial production. Stock returns were ahead of the spread and industrial production. But the spread and industrial production did not exist any causality or feedback relation.

The result of the analysis of impact response indicated that, when an unexpected shock happened to stock returns, it had obvious influence on industrial production and the spread showed that it was most influential. The influence of stock returns on industrial production showed a continuous positive effect and its influence on the spread showed an obvious positive effect but turned to unobvious negative response after the 7th period. Moreover, the unexpected shock that happened to the spread had a significant but decreasing response on itself, while its influences on stock returns and industrial production were both unobvious. Regarding the unexpected shock that happened to industrial production, it had no obvious influence on the spread and stock returns. Empirical researches found that in variance decomposition, which explained the volatility, stock returns were strongly exogenous, highly self-explanatory and insignificantly influenced by other variables. The spread was also strongly exogenous but significantly influenced by stock returns. Industrial production was relatively less exogenous but better explained by stock returns. The longer the period, the higher the explanatory power.

Having consolidated the above empirical results, the research found the following: First, stock returns have causality relations with industrial production and the spread. When an unexpected shock happens to stock returns, it has an obvious influence on industrial production and the spread. It means that stock returns are good indicators of economic activities and the term structure of interest rates in Taiwan. Second, there is no causality or feedback relation in the interaction between the spread and industrial production, and the response of industrial production to the spread is not obvious, whether it is in the long-term or short-term. It means that the term structure of interest rates in Taiwan is not a good indicator for economic activities. The possible reasons include: (1) Taiwan, a small open economy, has a higher proportion of import and export to GDP, while import and export are easily influenced by foreign factors such as income and foreign exchange rate that makes a weak relation between the term structure of interest rates and economic activities in Taiwan. (2) The number of Taiwan's bond issued is limited while market demand is far in excess of supply, which makes a low transaction quantity, a distorted yield indicator and distortion in the relation between the term structure of interest rates and economic activities; however, this requires further research. (3) Stock returns are ahead of and significantly influence industrial production while the causality and influence of the term structure of interest rates to industrial production are not obvious. It means that stock returns are obviously more adequate to be taken as the leading indicator of economic activities in Taiwan.

REFERENCES

Ang A, Piazzesi M, Wei M (2006). What does the yield curve tell us about GDP growth? J. Econometr., 31(1): 359-403.

Ang A, Piazzesi M (2003). A no-arbitrage vector autoregression of term structure dynamics with macroeconomic and latent variables. J. Monet. Econ., 50(4): 745-787.

Attah-Mensah J, Tkacz G (2001). Predicting recessions and booms using financial variables. Canad. Bus. Econ,. 8(3): 30-36.

Berge JT, Jordà O (2010a). The classification of economic activity into expansions and recessions. Am. Econ. J.: Macroecon. (Forthcoming), 1-50.

Berge JT, Jordà O (2010b). Future recession risks. Federal Reserve Bank of San Francisco. Econ. Lett., 1-4.

Bernard H, Gerlach S (1998). Does the term structure predict reces-sion?The International Evidence. Int. J. Financ. Econ., 3(3): 195-215.

Bonser-Neal C, Morley TR (1997). Does the yield spread predict real economic activity? A multi-country analysis. Federal Reserve Bank of Kansas City. Econ. Rev., 82(3): 37-53.

Bordo MD, Haubrich JG (2004). The yield curve, recessions and the credibility of monetary regime: Long run evidence 1875-1997 (NBER Working Paper No.10431). Cambridge: National Bureau of Economic Research.

Boulier BL, Stekler HO (2001). The term spread as a cyclical indicator: a forecasting evaluation. Appl. Financ. Econ., 11(4): 403-409.

Braun AR, Shioji E (2006). Monetary policy and the term structure of interest rates in Japan. J. Mon. Credit. Bank., 38(1): 141-162.

Davis EP, Fagan G (1997). Are financial spreads useful indicators of future inflation and output growth in EU countries? J. Appl. Econometr., 12(6): 701-714.

Davis EP, Henry SGB (1994). The use of financial spreads as indicator variables: Evidence for the United Kingdom and Germany. Int. Monet. Fund Staff Pap., 41(3): 517-525.

Doldado J, Jenkinson T, Sosvilla-Rivero S (1990). Cointegration and unit roots. J. Econ. Surv., 4: 249-73.

Dotsey M (1998). The predictive content of interest rate term spread for future economic growth. Federal Reserve Bank of Richmond. Econ. Q., 84(3): 31-51.

Dueker MJ (1997). Strengthening the case for yield curve as a predictor of U.S. recessions. Fed. Res. Bank. St. Louis. Rev., 79(2): 41-51.

Eijffinger S, Schaling E, Verhagen W (2000). The term structure of interest rates and inflation forecast targeting (CEPR Discussion Paper No.2375). Washington: Center for Economic and Policy Research.

Estrella A (2005a). Why dose the yield curve predict output and inflation? Econ. J., 115(505): 722-744.

Estrella A (2005b). The yield curve and recessions. Int. Econ., 19(3): 8-38.

Estrella A, Hardouvelis G (1991). The term structure as a predictor of real economic activity. J. Financ., 46(2): 555-576.

Estrella A, Mishkin FS (1997). The predictive power of the term structure of interest rates in Europe and the United States: Implications for the European Central Bank. Eur. Econ. Rev., 41(7): 1375-1401.

Estrella A, Mishkin FS (1998). Predicting U.S. recessions: Financial variables as leading indicators. Rev. Econ. Stat., 80(1): 45-61.

Evans CL, Marshall D (2001). Economic determinants of the nominal treasury yield curve. Unpublished manuscript.

Hamilton JD, Kim DH (2002). A reexamination of the predictability of economic activity using the yield spread. J. Mon. Credit. Bank., 34(2): 340-360.

Hardouvelis G, Malliaropulos D (2004). The yield spread as a symmetric predictor of output and inflation (CEPR Discussion Paper No.4314). Washington: Center for Economic and Policy Research.

Harvey CR (1988). The real term structure and consumption growth. J. Financ. Econ., 22(2): 305-333.

Harvey CR (1989). Forecasts of economic growth from the bond and stock markets. Financ. Anal. J., 45(5): 38-45.

Harvey CR (1991). The term structure and world economic growth. J. Fix Income. 1: 7-19.

Harvey CR (1997). The relation between the term structure of interest rates and Canadian economic growth. Canad. J. Econ., 30(1): 169-193.

Haubrich JG, Dombrosky AM (1996). Predicting real growth using the yield curve. Federal Reserve Bank of Cleveland. Econ. Rev., 32(1): 26-35.

Hu Z (1993). The yield curve and real activity. IMF Staff Papers No.40: 781-806.

Ichiue H (2004). Why can the yield curve predict output growth, inflation, and interest rates? An analysis with an affine term structure model. Econometric Society 2004 Far Eastern Meetings 581. Econometric Society.

Johansen S (1988). Statistical Analysis of Cointegration Vectors. J. Econ. Dyn.. Contr., 12: 231-254.

Johansen S (1994). The Role of the Constant and Linear Terms in Cointegration Analysis of Nonstationary Variables. Econometr. Rev., 13(2): 205-229.

Johansen S, Juselius K (1990). Maximum likelihood estimation and inference on cointegration with applications to the demand form money. Oxf. Bull. Econ. Stat., 52(2): 169-210.

Kozicki S (1997). Predicting real growth and inflation with the yield spread. Federal Reserve Bank of Kansas City. Econ. Rev., 82(4): 39-57.

McMillan DG (2002). Interest rate spread and real activity: Evidence for the UK. Appl. Econs Lett., 9(3): 91-194.

Passaro R (2007). The predictive power of interest rates spread for economic activity, Rivista. Polit. Econ., 97(6): 81-112.

Panopoulou E (2009). Financial variables and euro area growth: A non-parametric causality analysis. Econ. Model., 26(6): 1414-1419.

Plosser CI, Rouwenhorst KG (1994). International term structures and real economic growth. J. Monet. Econ., 33(1): 133-155.

Schwert GW (1989). Tests for unit roots: A Monte Carlo investigation. J. Bus. Econ., Stat. 7: 147-159.

Sims CA (1980). Comparison of interwar and postwar business cycles: Monetarism Reconsidered. Amer. Econ. Rev., 70: 250-257.

Stock J, Watson M (2003). Forecasting output and inflation: The role of asset prices. J. Econ. Lett., 41(3): 788-829.