RISK MANAGEMENT PRACTICES OF ISLAMIC FINANCIAL INSTITUTIONS IN THE SOUTHERNMOST PROVINCES OF THAILAND

Aris Hassama
Prince of Songkla University, Pattani Campus, Thailand
aris.h@psu.ac.th

Abstract

Risk management practices (RMPs) of Islamic financial institutions (IFIs) is important especially in southernmost of Thailand. IFIs are small in size and scatter which make them facing different types of risks. This study aims to assess the degree to which IFIs in the southernmost provinces of Thailand use risk management practices and techniques in dealing with different types of risk. Eight well-established IFIs in the southernmost provinces of Thailand were selected. Fifteen questionnaires were sent to the institutions for having senior staffs to report on their RMPs in six aspects: understanding risk and risk management (URM), risk assessment and analysis (RAA), risk identification (RI), risk monitoring (RM), credit risk analysis (CRA) and risk management practices (RMPs). Data were collected from 120 staffs. The findings show that the most significant aspects of RMPs of IFIs in this area are RI, RM and CRA. Other two aspects, URM and RAA have no relationship with RMPs. It implies that the staffs' attitude among IFIs on these aspects are still scatter.

Keywords: Risk management practices, Islamic Financial Institution, Southernmost Thailand, Islamic banks, Islamic cooperative

บทคัดย่อ

แนวปฏิบัติการจัดการความเสี่ยง (RMPs) มีความสำคัญต่อสถาบันการเงินอิสลาม (IFIs) โดยเฉพาะอย่างยิ่งในจังหวัดชายแดนภาคใต้ของประเทศไทยที่สถาบันการเงินอิสลามมีขนาดเล็กและกระจายตัวอยู่ในหลายจังหวัด ซึ่งทำให้พวกเขาต้องเผชิญกับความเสี่ยงในลักษณะที่แตกต่างจากสถาบันการเงินโดยทั่วไป การศึกษาครั้งนี้มีจุดมุ่งหมายเพื่อประเมินระดับที่สถาบันการเงินอิสลามในจังหวัดชายแดนภาคใต้ใช้ ตลอดจนแนวทางและวิธีการจัดการความเสี่ยงในแต่ละประเภท ผู้วิจัยได้ทำการคัดเลือกสถาบันการเงินที่มีชื่อเสียงในจังหวัดชายแดนภาคใต้จำนวน 8 แห่ง โดยมีการจัดส่งแบบสอบถามไปยังเจ้าหน้าที่อาวุโสของสถาบันการเงินอิสลามดังกล่าว เพื่อรายงานข้อมูลเกี่ยวกับการจัดการความเสี่ยงของตนใน 5 ด้าน ได้แก่ การทำความเข้าใจเกี่ยวกับความเสี่ยงและการจัดการความเสี่ยง (URM) การประเมินความเสี่ยงและการวิเคราะห์ความเสี่ยงการประเมินความเสี่ยง (RAA) การระบุความเสี่ยง (RI) การติดตามกำกับความเสี่ยง (RM) การวิเคราะห์ความเสี่ยงจากสินเชื่อ (CRA) และแนวปฏิบัติการจัดการความเสี่ยง (RMPs) โดยได้รวบรวมข้อมูลจากเจ้าหน้าที่สถาบันการเงินดังกล่าวจำนวน 120 คน ผลการวิจัยแสดงให้เห็นว่าส่วนที่สำคัญที่สุดของแนวปฏิบัติการจัดการความเสี่ยง (RMPs) ของสถาบันการเงินอิสลามในจังหวัดชายแดนภาคใต้ของไทยคือการระบุความเสี่ยง (RI) การติดตามกำกับความเสี่ยง (RM) และการวิเคราะห์ความเสี่ยงจากสินเชื่อ (CRA) ส่วนความเสี่ยงอีก 2 ด้านคือการทำความเข้าใจเกี่ยวกับความเสี่ยงและการจัดการความเสี่ยง (URM) และการประเมินและการวิเคราะห์ความเสี่ยง (RAA) ไม่มีความสัมพันธ์กับแนวปฏิบัติการจัดการความเสี่ยง (RMPs) แสดงให้เห็นว่าทัศนคติและความเข้าใจของบุคลากรในกลุ่มสถาบันการเงินเหล่านี้ยังคงแตกต่างกันไม่เป็นแนวเดียวกันอยู่

INTRODUCTION

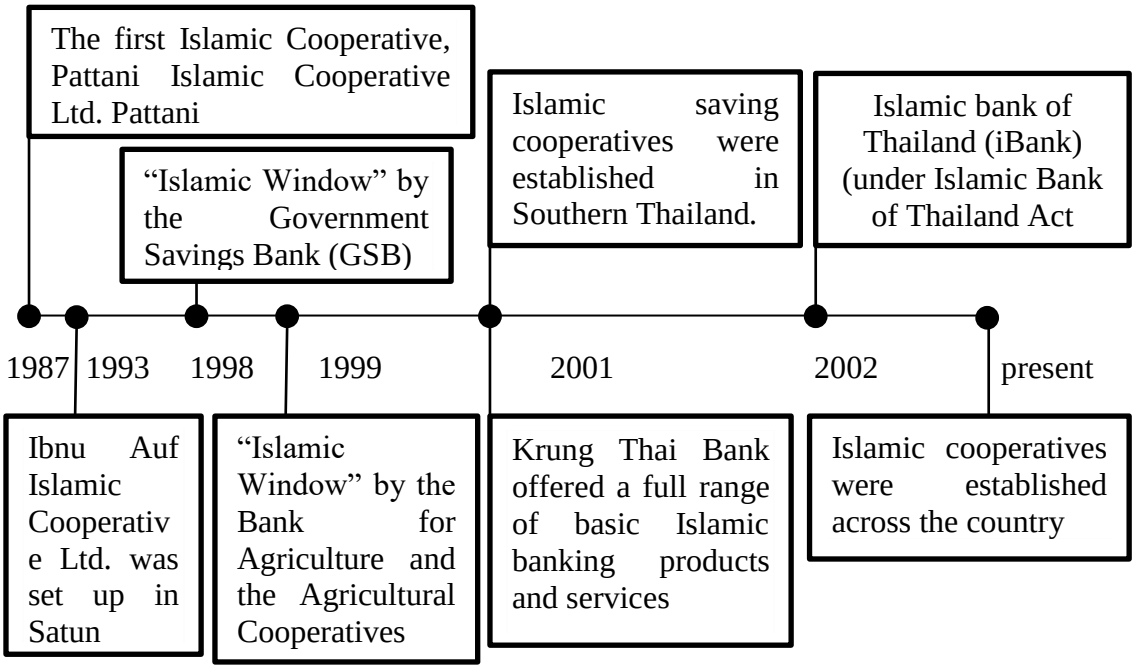
Risk management is a major concern in the management of financial institutions either conventional or Islamic finance system. The lack of adequate risk management practices will lead to the fall of the financial system as well as the economy as a whole (Khan and Ahmed, 2001; Meyer, 2000). Thus, the sound risk management practices (RMPs) can diminish their exposure to risks.

The first Islamic financial institution (IFI) in the southernmost of Thailand, Islamic Cooperative of Pattani Ltd., was established in 1987 and followed by the Islamic cooperatives in nearby provinces such as Ibnu Affan Islamic Cooperative (Pattani-Year), Ibnu Auf Cooperative (Satun-Year) and As-Siddeek Cooperative (Songkla-year). While the Islamic Bank of Thailand, the only full-fledge Islamic bank which was set up under the Islamic Bank of Thailand Act 2003 expanded the branches to the 5 southernmost provinces which are Satun, Songkla, Pattani, Narathiwas and Yala branches and other parts of the country. These IFIs both in form of the bank and cooperative become famous among Muslim clients in these areas. However, there is no any studies in RMPs of IFIs in the southernmost provinces of Thailand. This paper aims to assess the degree to which the Islamic financial institutions in the southernmost provinces of Thailand use effective RMPs.

LITERATURE REVIEW

Islamic Financial institutions (IFIs) in Thailand consist of several forms like bank, cooperative and insurance. They are monitored by different regulatory bodies. One full-fledge Islamic Bank of Thailand is supervised by the Ministry of Finance. The Islamic cooperatives are supervised by the Ministry of Agriculture and Cooperatives. (Haron and Yamaruding, 2003; Noipom, 2014). The Islamic insurance (Takaful) is monitored by Ministry of Finance and Office of Insurance Commission, Thailand. The Islamic banking system products and services were first introduced to the Muslims in Thailand in the form of Islamic cooperative (Pattani Islamic Cooperative Ltd.) in 1987. After that the Government Savings Bank (GSB) introduced the "Islamic Window" in 1998. The year after that the Bank for Agriculture and the Agricultural Cooperatives (BAAC) followed the same operation with GSB (Haron and Yamirudeng, 2003)
In 2001, four Islamic saving cooperatives were established in Southern Thailand, namely, Ibnu Affan Saving Cooperative (Pattani), As-Siddeek Saving Cooperative (Songkla), Saqaffah Islam Saving Cooperative (Krabi), and Al-Islamiah Saving Cooperative (Phuket). In the same year, the Krung Thai Bank set up an Islamic branch. Finally, the first full-fledged Islamic bank in Thailand was established under the Islamic Bank of Thailand Act 2003. (Haron and Yamirudeng, 2003). Currently, Islamic cooperatives have been formed in Muslim communities across the country.

Figure I: Development of Islamic Financial Institutions Timeline



Risk management is the key issue in the management of financial institution. IFI may fail if the IFI's manager and staffpay serious less attention on the aspects of risk management. IFIs in the southernmost provinces of Thailand are small in size and number of branch. They operate similar to Islamic microfinance (Noipom, 2014) which make them facing a large number of risks such as credit risk, liquidity risk, foreign-exchange risk, market risk, and interest rate risk, etc. For this reason, efficient risk management is extremely necessary (Al-Tamimi and Al-Mazrooei, 2007).

According to Rosman (2009), the aspects of risk management processes can be divided in four aspects which are (1) Understanding risk and risk management (URM), (2) Risk identification (RI), (3) Risk analysis and assessment (RAA), (4) Risk monitoring (RM). These aspects of risk management have the relationship with RMPs. Hasan (2009) add the forth aspect of risk, Credit Risk Analysis (CRA), in his paper about the development of risk management in the Islamic banks of Brunei Darussalam.

The literature on RMPs of Islamic banks can be found in a number of papers which are Rosman (2009), Hassan (2009), Khalid & Amjad (2012), Al-Tamimi & Al-Mazrooei (2007), Mokni et el. (2014), Bilal, A.R., Abu Talib, N.B. and Khan, M.N.A.A. (2013) and Al-Janabi, M.A.M. (2008). However, there is no sign of a study in Thailand. Since the first IFI in southernmost provinces of Thailand was set up in 1987, there is no studies on the RMPs of IFI or even RMPs of Islamic bank of Thailand. Thus this research paper is proposed to fill the academic literature gap and start the study on RMPs in IFIs in Thailand.

METHODOLOGY

H_1: There is a positive relationship between RMPs and understanding risk management (URM); risk analysis assessment (RAA); risk identification (RI); risk monitoring (RM); and credit risk analysis (CRA).

The sample in this study includes the Islamic Bank of Thailand (Chabang Tiko branch), Pattani Islamic Cooperative Ltd., Ibnu Auf Islamic Cooperative Ltd., As-Siddeek Saving Cooperative Ltd., Islam Bina Cooperative Ltd., Sahabat Cooperative Ltd., and Huda Cooperative. The sample size for the individual respondents comprised 120 respondents from the staff of those IFIs.

The questionnaire comprises of a number of statements with single variable (Khalid and Amjad, 2012; Hassan, 2009; Al-Tamimi and Al-Mazrooei, .(2007It includes RMP as the dependent variable, and different aspects of risk management as the independent variables. Questionnaire included 47 questions with five questions about respondent's personal data, eight questions about URM, seven questions about RAA, five questions about RI, six questions about RM, seven questions about the CRA and final nine questions about RMPs. Apart from the first five questions, all the questions are statements and are measured as a five point Likert-scale, ranging from strongly agree, agree, neutral, disagree to strongly disagree.

Cronbach's alpha was used to test the reliability of the scales. Spearman's correlation is applied to measure the direction and strength of the relationship between independent variables and between independent and dependent variables. A multicollinearity test is carried out to assess whether there exists the problem of multicollinearity among independent variables. The regression analysis is applied to estimate the relationship between RMP and the five explanatory variables as follows: RMP = f (URM, RI, RAA, RM, and CRA). Incremental regression is applied by removing independent variables one-by-one from regression model and by assessing the effect on R^2. Statistical Package for the Social Sciences is used to do all above calculations.

RELIABILITY OF THE MEASURES

Reliability of the measures was assessed by using Cronbach's α. Cronbach's α allows us to measure the reliability of different variables. This consists of estimates of how much variation in scores of different variables is attributable to chance or random efforts (Stelltiz, Wrightsman and Cook, 1976). In the estimation, a coefficient greater than or equal to 0.7 is considered acceptable and a good indication of reliability.

In this study, the result of 0.7, according to Cronbach's α is used for the six aspects. Cronbach's α applies to the individual aspect, e.g. URM, RAA, RI, RM, CRA and RMPs are (0.675), (0.847), (0.625), (0.875), (0.805), and (0.880), respectively. Results show in Table I that all of these six aspects are reliable. The overall Cronbach's alpha for the six aspects of risk management process is 0.942. It means that there is an acceptable degree of consistency among the responses against each item.

Table I: Six risk management aspects and their internal consistency

	Risk measurement aspects	Cronbach's α
1	Understanding risk and risk management	0.675
2	Risk assessment and analysis	0.847
3	Risk identification	0.625
4	Risk monitoring	0.875
5	Credit risk analysis	0.805
6	Risk management practices	0.880
	Overall reliability of variables	0.942

EMPIRICAL RESULTS

Understanding risk and risk management

Table II shows that the mean of responses on the eight questions regarding URM is 3.85. The respondent's answers on these eight questions specify, by giving a positive answer to the first question, that the IFIs' staff URM. It also indicates the relative importance of the eight questions, although Table II does not show a big difference between the highest and lowest means of the eight questions. The highest mean is 4.44 for question eight, applications of risk management techniques reduce costs or expected losses. The lowest mean is 3.61 for question three, in which respondents viewed that accountability for risk management is clearly set out and understood throughout the IFI. It is obvious that the IFIs staff has a good URM, which gives an indication about the ability of these Islamic banks to manage risk efficiently in the future course of action. These results confirm the findings in Rosman (2009), Al-Tamimi and Al-Mazrooei (2007) and Hassan (2009), Khalid and Amjad (2012). In Table II, the highest standard deviation is 3.329 for question eight, meaning that the data points are far from the mean value of 4.44, while the lowest standard deviation is 0.729, meaning that the data points are close to the mean value of 3.49.

Table II: Respondents' answers on understanding risk and risk management

	Questions	Mean	SD
1	There is common understanding of risk management across the IFI	3.49	0.729
2	Responsibility for risk management is clearly set out and understood throughout the IFI	3.63	0.933
3	Accountability for risk management is clearly set out and understood throughout the IFI	3.61	0.948
4	Managing risk is important to the performance and success of the IFI	4.18	0.808
5	It is crucial to apply the most sophisticated techniques in risk management	3.85	0.915
6	Your objective of IFI is to expand the applications of advanced risk management techniques	3.76	0.958
7	It is important for your bank to emphasize on the continuous review and evaluation of the techniques used in risk management	3.89	0.900
8	Applications of risk management techniques reduce costs or expected losses	4.44	3.329
	Average	3.85	

Risk assessment and analysis

The outcome of the responses is shown in Table III. The average mean of the responses to the seven questions is 3.78, which indicates that the IFIs are efficiently assessing and analyzing risk, and represents a positive response to our research hypothesis. It can also be seen from Table III that there is not a large difference between the means of the seven questions, which shows that respondents viewed moderately in respect of these questions.

The highest mean is 4.01 for question four, indicates that IFIs analyse and evaluate the opportunities to achieve their objectives. This result of RAA is consistent with Hassan (2009) and Khalid and Amjad (2012). The lowest mean is 3.70 for question three, indicates that IFIs' risk is assessed by using qualitative analysis methods. It does not show a big difference between the highest and lowest means of the seven questions, which specifies that participants analyzed the statements of RAA quite similarly. This result is consistent with the result of the study conducted by Al-Tamimi and Al-Mazrooei (2007). Almost all the standard deviations are small, which indicates that participants argued on seven questions of RAA quite equally.

Table III: Respondents' answers on risk assessment and analysis

	Questions	Mean	SD
1	IFI assesses the likelihood of occurring risk	3.73	0.886
2	IFI's risk is assessed by using quantitative analysis method	3.58	0.744
3	IFI's risk is assessed by using qualitative analysis methods	3.70	0.822
4	Your IFI analyses and evaluates the opportunities that it has to achieve objectives	4.01	0.720
5	Your IFI's response to analysis risk includes assessment of the costs and benefits of addressing risk	3.91	0.715
6	Your IFI's response to analyze risk includes prioritizing of risk and selecting those that need active management	3.75	0.788
7	Your IFI's response to analyze risk includes prioritizing risk treatments where there are resource constraints on risk treatment implementation	3.75	0.893
	Average	3.78	

Risk identification

Table IV shows the average value of RI is 3.65, which indicate that IFI have clearly identified the potential risks relating to their declared aims and objectives. The answers on the five questions about RI represent that the more the staff understand the risk, the more easily they can identify it.

Table IV also indicates the relative importance of each question. The first question obtained the highest mean value of 3.84, signifying that IFIs have carried out a comprehensive and systematic identification of its risks relating to each of its declared aims and objectives. The lowest mean is 3.29 for question two/or the second question, indicating difficulty for IFIs to prioritize their main risk. IFIs in southernmost provinces of Thailand need to know how to prioritize their main risk efficiently. This results on RI is consistent with the result of Hassan (2009) and Khalid and Amjad (2012). Above all, the standard deviation values of five questions are small, which indicates that data points are closer to the mean values.

Table IV: Respondents' answers on risk identification

	Questions	Mean	SD
1	The IFI carries out a comprehensive and systematic identification of its risks relating to each of its declared aims and objectives	3.84	0.754
2	The IFI finds it difficult to prioritize its main risk	3.29	0.874
3	Changes in risk are recognized and identified with the IFI's roles and responsibilities	3.76	0.830
4	The IFI is aware of the strengths and weaknesses of the risk management systems of other IFIs	3.64	0.783
5	IFI has developed and applied procedures for the systematic identification of investment opportunities	3.72	0.861
	Average	3.65	

Risk monitoring

Table V summarizes the responses on RM's questions. The average of the sample's responses on the six questions is 3.71, which indicates that the IFIs have an efficient RM and controlling system. It can also be seen from Table V that there is a slight difference between the means of the six questions, which indicates that respondents viewed the questions of RM rather equally. The highest mean is 3.81 for question six, indicating that IFIs' response to risk includes action plans for implementing decisions about identified risks. The lowest mean is 3.56 for the third question, showing that the level of external control by the Islamic banks is appropriate for the risks being faced. There is not a huge variation between highest mean and lowest mean, which shows that the questions of RM were responded equally. This result is similar with Hassan (2009), Khalid and Amjad (2012) and Al-Tamimi and Al-Mazrooei (2007).

Table V: Respondents' answers on risk monitoring

	Questions	Mean	S.D.
1	Monitoring the effectiveness of risk management is an integral part of routine management reporting	3.75	0.776
2	The level of internal control by the IFI is appropriate for the risks that it faces	3.68	0.856
3	The level of external control by the IFI is appropriate for the risks that it faces	3.56	0.828
4	Reporting and communication processes within your IFI support the effective management of risk	3.70	0.774
5	The IFI's response to risk includes an evaluation of the effectiveness of the existing controls and risk management responses	3.76	0.772
6	The IFI's response to risk includes action plans for implementing decisions about identified risks	3.81	0.854
	Average	3.71	

Credit risk analysis

CRA is the important aspect of RMPs. The credit risk is the most important type of risk within the IFI system (Khalid and Amjad, 2012). Table VI provides information about the responses to the seven questions. The average mean of the responses is 3.97, which provides evidence about the efficiency of the management of credit risk in the IFIs. The highest mean is 4.29 for question four, stating that it is essential to require sufficient collateral from the borrowers. The lowest mean is 3.53 for question six, which states that it is preferable to require collateral against some loans but not all of them. The highest variation in standard deviation is 1.113,

which tells that data points are far from mean value 3.53. This result confirms the findings in Al-Tamimi and Al-Mazrooei (2007) and Khalid and Amjad (2012). The lowest variation in standard deviation is 0.754 for question four, which indicates that the data points are close to the mean value.

Table VI: Respondents' answers on credit risk analysis

	Questions	Mean	S.D.
1	IFI undertakes a credit worthiness analysis before granting loans	3.87	0.979
2	Before granting loans your IB undertake a specific analysis including the client's characters, capacity, collateral capital and conditions	4.06	0.852
3	IFI's borrowers are classified according to a risk factor	3.96	0.904
4	It is essential to require sufficient collateral from the borrowers	4.29	0.754
5	IFI's policy requires collateral for all granting capital or making transaction	4.00	0.914
6	It is preferable to require collateral against some loans and not all of them	3.53	1.113
7	Level of credit granted to defaulted clients must be reduced	4.08	0.911
	Average	3.97	

Risk Management Practices

In the RMPs, even if the IFIs' staff URM, and adopt sophisticated methods in risk assessment and analysis, it still may not be the case that RMPs are efficient and the risk management policies are being followed (Hassan, 2009; Khalid and Amjad, 2012) Table VII shows the responses of the sample questions. The mean average of the responses to the nine questions is 3.82, which indicates that the IFI staffs do RMPs.

Table VII: Respondents' answers on risk management practices

	Questions	Mean	S.D.
1	The IFI's executive management regularly reviews the organization's performance in managing its business risks	3.99	0.803
2	Your IFI highly effective in continuous review/feedback on risk management strategies and performance	3.64	0.783
3	Your IFI's risk management procedures and processes are documented and provide guidance to staff about managing risks	3.64	0.783
4	Your IFI's policy encourages training programs in the area of risk management as well Islamic Ethics	3.81	0.901
5	This IFI emphasizes the recruitment of highly qualified people having Islamic knowledge in risk management	3.93	0.839
6	Efficient risk management is one of the objective of IFI	4.03	0.811
7	It is too dangerous to concentrate bank's funds in one specific sector of the economy	3.89	0.955
8	The application of Basel Accord II will improve the efficiency and RMPs in the IFI in general - your IFI in particular	3.74	0.807
9	I consider the level of risk management practices of this IFI to be excellent	3.71	0.783
	Average	3.82	

The highest mean value is 4.03, which is for the sixth question. The lowest mean value is 3.64, which is for the second and third questions. This result also confirms that IFIs intend to have efficient risk management. There is not a big difference among the means of the nine questions,

which indicates that respondents viewed the questions of RMPs quite similarly. Question number nine in Table VII is a general question about RMPs, which shows a mean of 3.71 and thus supports efficient RMPs. This result is quite similar with the studies conducted by Hassan (2009), Khalid and Amjad (2012) and Al-Tamimi and Al-Mazrooei (2007). There is not a huge variation between highest mean and lowest mean, which shows that the questions of RMPs were responded equally

Correlation

Table VIII reveals the correlation coefficients among the independent variables. The *"rules of thumb"* test suggested by Anderson, R.A., Sweeney, D.J. and Williams, T.A. (1990) says that any correlation coefficient exceeding 0.7 indicates a potential problem. By eliminating the correlation coefficients exceeding 0.7, the results show that the remaining correlation coefficients are significant at the 0.01 level which mean there is positive relationship between URM and RAA, positive relationship between URM and RI, positive relationship between URM and RMPs, positive relationship between RAA and RM, positive relationship between RAA and CRA, positive relationship between RAA and RMPs, positive relationship between RI and RM, and finally positive relationship between RI and CRA.

Table VIII: Correlation coefficient between independent variables

	URM	RAA	RI	RM	CRA	RMPs
URM	1.000					
RAA	0.681**	1.000				
RI	0.672**	0.706	1.000			
RM	0.729	0.582**	0.617**	1.000		
CRA	0.725	0.602**	0.594**	0.700	1.000	
RMPs	0.647**	0.585**	0.714	0.745	0.736	1.000

Notes: **Correlation is significant at the 0.01 level (1-tailed) and not exceed 0.7.

Regression model

Regression analysis is used to examine the effect of different independent variables on a single dependent variable. In Table IX, R is 0.872, which indicates that 87.2 percent of variations in independent variable are explained by dependent variables. Whereas, R^2 is 0.76, indicating that the five independent variables explain 76 percent of the variations in RMPs. Table X shows the regression results of all independent variable, where, β (the standardized coefficient) compares the contribution of each independent variable in order to explain the dependent variable. In Table X, RI has largest beta coefficient of 0.449, which means that this variable makes the unique and strongest contribution to the explanation of the dependent variable RMPs. Then RM and CRA have beta coefficients of 0.449 and 0.308, respectively. Table X show that two independent variables RM and CRA have positive and significant impact on dependent variable RMPs. RI, RM and CRA are significant at 1 percent as significant value (*p*-value) is 0.000. Hence, there is a positive relationship between RI and RMPs, RM and RMPs, and CRA and RMPs. Then URM and CRA have beta coefficients of 0.184 and 0.199, respectively. Table X shows that the values of variance inflation factors (VIF) range from 2.081 to 2.864, suggesting the absence of multicollinearity among the variables of the model.

On the basis of the above mentioned results, it can be concluded that the research hypothesis of this study is rejected. There is a positive relationship only between RI and RMPs, RM and RMPs, and between CRA and RMPs, significantly. URM and RAA are not significant which show that these aspects of risk management for IFIs have no relationship with RMPs.

Table IX: Model summary for all independent variables

Model	*R*	R^2	Adjusted R^2	*F*	*Sig. F*
1	0.872	0.76	0.742	43.585	0.000

Notes: Predictors: (Constant), CRA, RAA, URM, RI, and RM

Table X: Regression result for all independent variable

Independent variables	Standardized Coefficients β	*t*-value	Sig.	Collinearity Statistics	
				Tolerance	VIF
(Constant)		0.227	0.821		
URM	-0.110	-1.294	0.200	0.480	2.081
RAA	-0.075	-0.801	0.426	0.398	2.513
RI	0.449	4.602	0.000	0.367	2.727
RM	0.376	3.763	0.000	0.349	2.864
CRA	0.308	3.202	0.002	0.376	2.660

Notes: Dependent Variable: RMPs

Incremental regression

The robust incremental regression is performed by removing individual independent variables from the model and by checking the effect on the value of R^2. Incremental regression test highlights the most important variable of the model.

Table XI: Incremental regression

Model	OLS1	OLS2	OLS3	OLS4	OLS5	OLS6
(Constant)	0.227	0.305	0.152	1.475	0.335	0.862
URM	-0.110		-0.11	-0.042	-0.018	-0.067
RAA	-0.075	-0.087		0.148	-0.044	-0.029
RI	0.449***	0.427***	0.402***		0.501***	0.487***
RM	0.376***	0.339***	0.362***	0.445***		0.527***
CRA	0.308***	0.288***	0.301***	0.359***	0.483***	
R	0.872	0.868	0.867	0.828	0.843	0.851
R^2	0.760	0.754	0.752	0.686	0.71	0.725
F	43.585	53.547	54.510	38.181	43.519	46.719
Sig	0.000	0.000	0.000	0.000	0.000	0.000

Notes: Significant at ***1 percent

Table XI shows that among all the variables removed, there is 8 percent decrease in R^2-value by removing the independent variable RI from the model, as the value of the R^2 changes from 76 to 68 percent. This extensive decrease in the value of the R^2 shows the importance of RI in

the model. This consequence is also highlighted in the regression result as the value of coefficient of the variable (0.449) is highest among all the variables. In the OLS equation 4, the case of RI being taken out, there are two variables RM and CRA which are highly significant at 1 percent.

CONCLUSIONS

From the results of the analysis in this study, it can be concluded that:

- There is a general understanding of RMPs throughout the Islamic Financial Institutions system in the southernmost provinces of Thailand. Risk identification (RI), risk monitoring (RM) and credit risk analysis (CRA) have positive relationship with risk management practices (RMPs).
- As the data are nonparametric so spearman's correlation is calculated between independent variables and dependent variable and results shows that there is positive relationship between independent variables such as URM, RI, RAA, RM, CRA and RMPs.
- The RI is the most important and most influential variables in RMPs.
- Linear regression model is used to access the effect of independent variables on dependent variable. In regression model R^2 indicates that the five independent variables explain 76 percent of the variations in RMPs. The estimated coefficients of three independent variables were positive and highly statistically significant in the case of RI, RM and CRA at 1 percent significance level with value *p*-value of 0.000. The estimated coefficients of URM and RAA are insignificant which show that the staffs' attitude among IFIs on these aspects of risk management are still scatter. Thus, URM and RAA have no relationship with RMPs.
- Incremental regression is calculated to indicate the change in R^2 by removing independent variables one-by-one and suggest that by removing RI variable from the model there is 8 percent decrease in R^2-value. Thus, it is to be concluded that RI contributed most towards RMPs and the hypotheses of our research is partly true. There are three variables that have positive relationship with dependent variable. These results are different from Rosman (2009), Hassan (2009), Shafiq and Nasir (2009), Al-Tamimi and Al-Mazrooei (2007) and Khalid and Amjad (2012). It also establishes that the IFIs are practically efficient in managing risk where RI, RM and CRA are the most influential variables in RMPs, which means that Islamic Financial Institutions in southernmost provinces of Thailand need to give more attention towards RI, RM and CRA.

Due to IFIs in the southernmost provinces of Thailand are small in size and number of branch, then the risk characteristics of IFIs differ from the IFIs in other countries which have been established for decades and fully facilitated by legal regulation and government. IFIs have to analyze and understand how to treat them. The IFIs have to increase its attentions towards RMPs and its aspects especially on URM and RAA which the knowledge of those IFIs staffs are still scatter. They may launch the RMPs agreement for every IFI in the country to adopt and follow.

Based on observations and data collected, IFI managers should apply risk management on the whole system rather put it only in the plan. They should employ risk management officers for sustaining risk management's operations. In this early period of IFIs, there is a need for experienced and *shariah* knowledgeable staff for developing their financial products. According to the results, the attitude on risk management among IFIs' staff are still dispersed. One method to increase this awareness is to recruit more experienced staff. Moreover, the

recruited staff should also be trained on *shariah* knowledge for integrating *shariah* principle in the risk management aspects. There is a need to encourage IFIs to have more risk management training program, which will enhance the staff awareness and quality.

References

Al-Janabi, M.A.M. (2008) Proactive risk management in emerging and Islamic financial markets. *Humanomics.* [Online] Emerald Database 24 (20): 74-94. Available from: http://www.emeraldinsight.com. [Accessed: 30th October 2015].

Al-Tamimi, H.A.H. and Al-Mazrooei, F.M. (2007) Banks' risk management: a comparison study of UAE national and foreign bank. *The Journal of Risk Finance*. [Online] Emerald Database 8 (4): 394-409. Available from: http://www.emeraldinsight.com. [Accessed: 30th October 2015].

Anderson, R.A., Sweeney, D.J. and Williams, T.A. (1990) *Statistics for Business and Economics*. West Publishing Company. St Paul. MN.

Ayub, M. (2007) .*Understanding Islamic Finance.* West Sussex. UK. John Wiley & Sons.

Bilal, A.R., Abu Talib, N.B. and Khan, M.N.A.A. (2013) Remodeling of risk management in banking: evidence from the sub-continent and gulf. *The Journal of Risk Finance*. [Online] Emerald Database 14 (5): 468-489. Available from: http://www.emeraldinsight.com. [Accessed: 30th October 2015].

Haron, S. and Yamirudeng, K. (2003) Islamic banking in Thailand: Prospects and Challenges. *International Journal of Islamic Financial Services* 5 (2): 1-11. [Online] http://www.perpustakaan.depkeu.go.id/FOLDERJURNAL/vol5no2art1.pdf [Accessed: 30th October 2015]

Hassan, A. (2009) Risk management practices of Islamic banks of Brunei Darussalam. *The Journal of Risk Finance.* [Online] Emerald Database 10 (1): 23-37. Available from: http://www.emeraldinsight.com. [Accessed: 30th October 2015].

Hassan, M.K. and Dicle, M.F. (2006) *Basel II and capital requirements for Islamic banks.* Working paper. Department of Economics and Finance. University of New Orleans. New Orleans. LA.

Iqbal, Z. and Mirakhor, A. (2007). *An Introduction to Islamic Finance: Theory and Practice*. Wiley. Singapore.

Meyer, L. (2000) *Why risk management is important for global financial institutions?*. Paper presented at the Risk Management of Financial Institutions United Nations Conference Center. Bangkok. [Online] http://www.bis.org/review/r000904b.pdf [Accessed: 30th October 2015].

Khalid, S. and Amjad, S. (2012) Risk management practices in Islamic banks of Pakistan. *The Journal of Risk Finance*. [Online] Emerald Database 13 (2): 148-159. Available from: http://www.emeraldinsight.com. [Accessed: 30th October 2015].

Khan, M.M. and Bhatti, M.I. (2008) Development in Islamic banking: a financial risk allocation approach. *Journal of Risk Finance.* [Online] Emerald Database 9 (1): 40-51. Available from: http://www.emeraldinsight.com. [Accessed: 30th October 2015].

Khan, T. and Ahmed, H. (2001) *Risk management: an analysis of issues in Islamic financial industry.* Occasional Paper No. 5. Islamic Development Bank. Islamic Research and Training Institute. Jeddah. [Online] http://www.cba.edu.kw/elsakka/Risk_ Management_ DrTariqullah_Khan.pdf [Accessed: 30th October 2015].

Mokni, R.B.S. et el. (2014) Risk management tools practiced in Islamic banks: evidence in MENA region. *Journal of Islamic Accounting and Business Research*. [Online] Emerald

Database 5 (1): 77-97. Available from: http://www.emeraldinsight.com. [Accessed: 30th October 2015].

Noipom, T. (2014) Can Islamic Micro-financing Improve the Lives of the Clients: Evidence from a Non-Muslim Country. *Kyoto Bulletin of Islamic Area Studies.* 7 (March 2014), pp.67–97 [Online] http://www.asafas.kyoto-u.ac.jp/kias/pdf/kb7/08esf1_05_tawat.pdf [Accessed: 30th October 2015]

Rosman, R. (2009) Risk Management Practices and Risk Management Processes of Islamic Banks: A Proposed Framework. *International Review of Business Research Papers.* 5 (1) January 2009: 242-254. [Online] http://www.irbrp.com/static/documents/ January/2009/20. Rosman.pdf [Accessed: 30th October 2015]

Stelliz, C., Wrightsman, L.S. and Cook, W. (1976) *Research Methods in Social Relations*. Rinehart and Winston. New York.

AGRICULTURAL COMMODITY FUTURES AND STOCK MARKET: EVIDENCE FROM RSS3 FUTURES IN THAILAND

Yaowaluk Techarongrojwong
Thammasat University, Thailand
yaowalukt@gmail.com

Pathathai Sinliamthong
Assumption University, Thailand
pathathaisnl@au.edu

Rattana Waranyasathit
Assumption University, Thailand
rattanawrn@hotmail.com

Abstract

This study aims to examine the role of RSS3 Futures as the hedge for stock market in Thailand. The data is collected from May 28, 2004 until December 31, 2015, which includes totally 2,833 trading days. The results show that there is no relationship between RSS3 Futures and the stock market implying that RSS3 Futures can be the hedge for stock market in general. However, RSS3 Futures is not the candidate for safe haven of stock market because it shows no hedge property during the period of extremely negative stock returns. The result implies investors in Thailand, especially stock investors, should consider adding RSS3 Futures in their optimal portfolio because it clearly shows that RSS3 Futures can help in diversifying the risk, especially during the periods of stock market downturn.

Keywords: Diversification, Commodity Futures, Agricultural Product, Hedging

บทคัดย่อ

งานวิจัยฉบับนี้มีวัตถุประสงค์ในการทดสอบบทบาทของสัญญาฟิวเจอร์สยางแผ่นรมควันชั้น 3 เป็นเครื่องมือในการลดความเสี่ยงจากการลงทุนในตลาดหลักทรัพย์แห่งประเทศไทย ข้อมูลที่ใช้ในงานวิจัยนี้ถูกรวบรวมในช่วงเวลาตั้งแต่วันที่ 28 พฤษภาคม 2547 ถึงวันที่ 31 ธันวาคม 2558 รวมทั้งสิ้นมีข้อมูลการซื้อขายจำนวน 2,833 วัน ผลการวิจัยพบว่าไม่มีความสัมพันธ์ระหว่างผลตอบแทนที่ได้รับจากสัญญาฟิวเจอร์สยางแผ่นรมควันชั้น 3 และผลตอบแทนโดยเฉลี่ยของตลาดหลักทรัพย์แสดงว่าสัญญาฟิวเจอร์สยางแผ่นรมควันชั้น 3 สามารถใช้เป็นเครื่องมือในการช่วยลดความเสี่ยงจากการลงทุนในตลาดหลักทรัพย์ได้ อย่างไรก็ตามสัญญาฟิวเจอร์สยางแผ่นรมควันชั้น 3 ยังไม่ถือว่าเป็นสินทรัพย์ที่ปลอดภัย (Safe Haven) เนื่องจากการลงทุนในสัญญาฟิวเจอร์สยางแผ่นรมควันชั้น 3 ยังไม่สามารถช่วงลดความเสี่ยงในช่วงที่ผลตอบแทนของตลาดหลักทรัพย์มีการปรับตัวลดลงอย่างรุนแรง ทั้งนี้ผลที่ได้จากการวิจัยครั้งนี้แสดงว่านักลงทุนในประเทศไทยโดยเฉพาะอย่างยิ่งนักลงทุนในตลาดหลักทรัพย์ควรที่จะเพิ่มสัญญาฟิวเจอร์สยางแผ่นรมควันชั้น 3 ลงในพอร์ทการลงทุนเนื่องจากจะช่วยในการกระจายความเสี่ยงในช่วงขาลงของตลาดหลักทรัพย์

INTRODUCTION

The concept of diversification is general in the financial literature after it has been formally conceptualized by Markowitz (1952). Investors can enjoy the average return whereas the risk has been clearly diversified. Once investors include more assets into their portfolio, the level of risk diversification depends on the correlation of the additional assets and current portfolio. If the correlation is lower, the higher level of diversification can be achieved. However, investors who are fully-diversified in the stock market can mitigate the risks from some specific companies but cannot avoid the overall market downturn. Therefore, including other asset classes into the portfolio can help investors to achieve further diversification, especially the asset classes with lower correlation to the stock market.

Commodities become popular for investor due to its prominent characteristic of having lower correlation with other asset classes (Jensen, Johnson, and Mercer, 2000). There are many groups of commodities. In this study, it focuses on the agricultural commodity by using the commodity future market in Thailand. Among many products, Ribbed Smoked Rubber Sheet No.3 Futures or RSS3 Futures is the most popular one. The data is collected from the start of the commodity future market in Thailand, which is May 28, 2004, until December 31, 2015. The results show that RSS3 Futures can be the diversifier for stock investors in Thailand as its low correlation between RSS3 Futures and stock market. Moreover, RSS3 Futures can be the hedge for stock market. During the days with negative stock return, there is a weak negative relationship or no relationship between RSS3 Futures and the stock market. However, during the period of extremely-negative stock return, the result rejects the role RSS3 Futures as the hedge for stock market. In another word, RSS3 Futures is not the candidate for safe haven of stock market in Thailand.

The additional analysis between RSS3 Futures and stock market shows that the return on RSS3 Futures is mostly non-negative during the days with negative stock return. In average, investors who invest in RSS3 Futures will have the better performance than stock investors during the stock market decline. However, a few days later, the average stock return has been recovered but the return of RSS3 Futures becomes lower. Therefore, the positive performance of RSS3 Futures over stock market declines shortly after the days with negative stock return.

LITERATURE REVIEW

The role of commodity futures in the portfolio management has been well-documented in previous literature .Many literatures discussed the benefits of including commodities into traditional investment portfolio like bonds and stocks in order to achieve the benefit of diversification. However, the performance of investment solely in commodity futures is not sound compared to the normal equity investment .In general, the return from commodity futures does not surpass equity investment but the risk is slightly higher due to their unique risk .This underperformance of commodity future makes them unattractive to be invested solely by investor (Edwards and Park, 1996)

Nevertheless, Jensen, Johnson, and Mercer (2000) argued that the commodity futures are attractive for investors because they have relatively low correlation with other assets, especially for equity investment .Therefore, the commodity futures can provide the important role as the diversifiers, especially in the periods of tight monetary policy .

One of the explanation of low correlation between commodities and equites is from their unique characteristics making the difference return behavior during different phases of business cycle (Gorton and Rouwenhorst, 2006). During the different periods over business cycle, commodities and equities perform differently. During the early stage of recession, the equity prices will drop significantly whereas the commodity prices will not change much .The prices may slightly increase or decrease but does not change significantly .However, once the equity prices have recovered at the end of recession, the commodity prices will decease during such period .

Oreg (2011) examined the commodity futures and Shanghai Stock Index in China and found that the correlation between stock index and some commodity futures like heating oil and soya bean, especially during the period of high volatility in the stock market .Therefore, these two commodities should be included to the equity portfolio. Chong and Miffre (2010) studied the conditional correlation between commodity futures and equity market and found that the correlation became lower over time, which implied that the commodity futures can be useful in asset allocation decisions, especially for equity investors. This benefit should be prominent for long-only portfolio managers who seeks for diversification during high volatility periods.

Creti, Joets, and Migon (2013) used the dynamic conditional correlation to study the link between commodities and stock market. They found that each commodity has different correlation behaviors with stock market. For example, the correlation between gold and stock is lower during the period of stock market downturn. This is consistent with other literatures showing the role of gold as safe haven for stock investors. Some agricultural commodities like cocoa and coffee has the unique characteristic that is similar to oil. The correlations with stock market are high during the stock market upturn and become lower during the downturn. Moreover, the correlation between stock market and electricity market is negative because the electricity market is determined by its fundamental factor rather than the economic condition like stock market.

Baur and Lucey (2010) studies the role of gold, which is considered as one of commodities, in the traditional investment portfolio like stocks and bonds. They discussed the difference between the role as the hedge and the safe haven. The hedge means the asset with negative correlation or no correlation with the portfolio. The hedge may reduce the risk of portfolio in average but the hedge may not be able to protect against the loss during the extreme stock market. However, the safe haven means the assets with negative correlation or no correlation with the portfolio during the period of extreme market downturn.

METHODOLOGY

The data used in this study in from the stock market and the commodity futures in Thailand . For the stock market, the Stock Exchange of Thailand has published the stock index named SET Index that is the value-weighted index of all stocks traded in the Stock Exchange of Thailand .This study employs SET Total Return Index as the representative of overall equity investment, which includes the capital gain return from the average change in stock prices and the dividend incomes .For the commodity futures, there are two main markets in Thailand .The Agricultural Futures Exchange of Thailand or AFET has provided agricultural commodity futures like rubber, rice, tropioca, and pineapple .The Thailand Future Exchange or TFEX has provided other futures beside the agricultural products including both commodity futures or financial futures .The commodity futures offered by TFEX include gold and oil .In this study,

only the Ribbed Smoked Rubber Sheet No.3 Futures or RSS3 Futures, which is the most popular agricultural commodity future in Thailand and traded in AFET, will be used .RSS3 was the first product traded in AFET and the first trading day was May 28, 2004 .
The daily price will be collected from May 28, 2004 to December 31, 2015 .The daily returns are computed using the log return .There are totally 2,833 daily returns used in this study .For RSS3 Futures, the spot-month continuous series are used to compute daily returns .The regression analysis used to analyze the hedging property of RSS3 Futures has been adapted from Baur and Lucy (2010) as follows .

$$r_{rss3,t} = a + b_1 r_{stock,t} + b_2 r^*_{stock,t} + e_t, \quad (1)$$

where $r_{rss3,t}$ is the return on RSS3 Futures at day t and $r_{stock,t}$ is the return on stock at day t .$r^*_{stock,t}$ is the return on stock at day t only for the day the stock returns meet a specific condition .The condition is the downturn condition of stock market e.g .the returns on stock only for the day with negative returns and the returns on stock only for the day that the returns are lower than some specified quantile level including 25% quantile, 5% quantile, 2.5% quantile, and 1% quantile.
However, the asset return is characterized by time-vary volatility. In order to capture asymmetric volatility, the exponential generalized autoregressive conditional heteroskedastic or E-GARCH developed by Nelson (1991) should be employed .This study applies EGARCH(1,1) as the variance equation augmented to the mean equation in (1). The specification of EGARCH (1,1) as follows.

$$log(h_t) = \omega + \alpha \left| \frac{\varepsilon_{t-1}}{\sqrt{h_{t-1}}} \right| + \gamma \frac{\varepsilon_{t-1}}{\sqrt{h_{t-1}}} + \beta log(h_{t-1}) \quad (2)$$

After the equation (1) is estimated as the mean equation together with the variance equation in form of EGARCH in (2), the role of RSS3 Futures as the hedge for the stock market can be interpreted .If b_1 is negative, it means that RSS3 Futures can be classified as the hedge in general .Moreover, if the summation of b_1 and b_2 is negative, it means that RSS3 Futures can be classified as the hedge under the specific stock market downturn circumstance .In case that RSS3 Futures is the hedge for stock market in the extreme downturn like 5% quantile, 2.5% quantile, or 1% quantile, RSS3 Futures can be classified as the safe haven for stock investors.

FINDINGS AND ANALYSIS

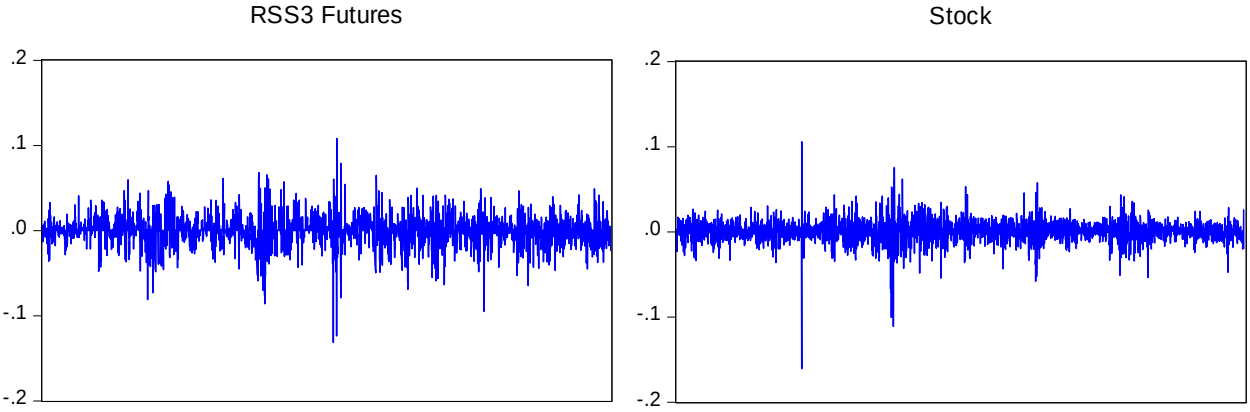
Before the regression analysis, the returns on stock market and RSS3 Futures are examined in form of their description .Table 1 displays the descriptive summary of the return on stock market and RSS3 Futures and Figure 1 displays the time-series plot of the returns on stock market and RSS3 Futures .

As discussed earlier in previous literature, the performance of RSS3 Futures is not attractive to be invested solely .The mean return of RSS3 Futures is clearly lower than stock but the risk as measured by standard deviation is higher .However, the return on stock displays the higher negative skewness and excess kurtosis implying that the stock return is more characterized by extreme negative shock and fat-tailed distribution .The time-series plot in figure 1 also supports the higher volatility of RSS3 Futures .Moreover, the plot also shows that the stock returns have been characterized by time-varying volatility .

Table 1. Descriptive Summary of the Return on Stock and RSS3 Futures

	Stock	RSS3 Futures
Mean	0.000409	-0.000095
Maximum	0.105800	0.108200
Minimum	-0.160600	-0.131200
Std. Dev.	0.013074	0.016929
Skewness	-1.000526	-0.524095
Kurtosis	17.891870	8.560154

Figure 1. The Time-series Plot of Returns on RSS3 Futures and Stock



Regression Analysis

Table 2 reports the regression analysis using the mean equation as in (1) and the variance equation as in (2) in order to interpret the hedge property of RSS3 Futures on the stock return . However, the coefficients from the mean equation as in (1) has been reported .The dependent variable is the return on RSS3 Futures. The explanatory variables are the return on stock and the return on stock only in the particular downturn period.

From table 2, the coefficient of the regression in the first row with only one explanatory variable is negative showing that RSS3 Futures can be the weak hedge for stock return. However, this coefficient is not statistically significant at any convention level. For the second row, the second explanatory equals to the stock return on the day with negative stock return or zero otherwise. The sum of coefficients representing the overall effect during the negative stock return is negative. This means RSS3 Futures can be used as the hedge for stock return during the negative stock return periods. In the third row, the second explanatory equals to the stock return on the day that stock returns lower than 25% quantile or zero otherwise. The sum of coefficients is still slightly negative showing that RSS3 Futures can weakly be used as the hedge for stock return during the period that the stock returns are lower than 25% quantile.

However, the results for 5%, 2.5%, and 1% quantile are different. The second explanatory variable in equals to the stock return on the day that stock returns lower than 5%, 2.5%, 1% quantile or zero otherwise. These circumstances represent the period of extremely negative stock returns. The sum of coefficients for these regressions are clearly non-negative. This

implies that RSS3 Futures cannot be used as the hedge during the period of extremely negative stock returns. In another word, RSS3 Futures is not the safe haven for the stock investors.

Table 2. Regression Results in Various Downturn Scenario

	a	***b1***	***b2***
General	0.000000 *(0.017)*	-0.000064 *(-0.014)*	
Negative Stock Return	0.000001 *(0.103)*	0.000379 *(0.566)*	-0.000463 *(-0.052)*
Stock Return < 25% quantile	0.000000 *(0.047)*	0.000012 *(0.086)*	-0.000013 *(-0.075)*
Stock Return < 5% quantile	-0.000000 *(-0.006)*	-0.000005 *(-0.017)*	0.092992 *(5.637)**
Stock Return < 2.5% quantile	-0.000000 *(-0.001)*	-0.000001 *(-0.043)*	0.021017 *(3.690)**
Stock Return < 1% quantile	0.000001 *(0.019)*	0.000013 *(0.010)*	0.261697 *(8.129)**

Note .The number in parenthesis is z-statistic and * indicates significant at 5 %

Additional Analysis

In order to show the role of RSS3 Futures as the hedge for stock investment, the further examination is done on the days with negative stock returns. Table 3 summarizes the distribution of return on stock and RSS3 Futures on the day of and after negative stock returns.

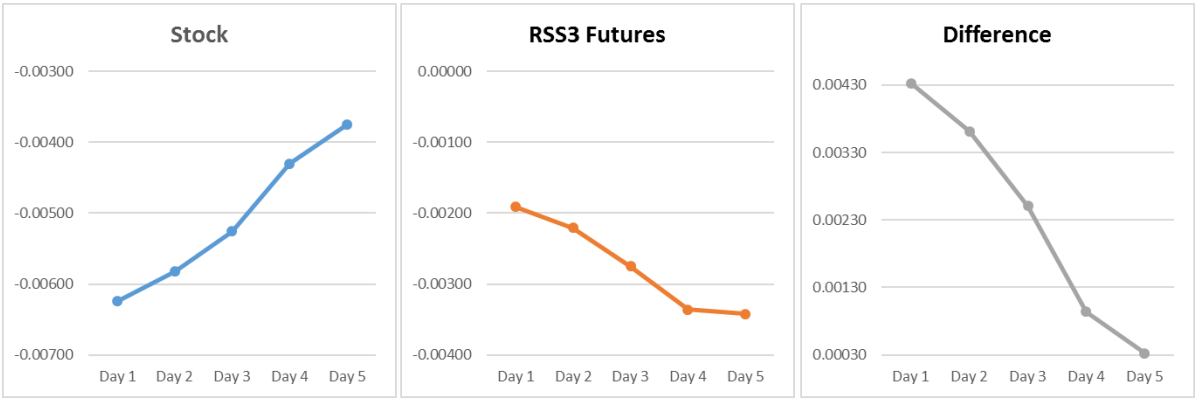
Table 3. Distribution of Return on the Days with Negative Stock Returns

One-day Returns	**Negative Return**	**Non-Negative Return**
Stock Market	1,315 (100.00%)	0 (0.00%)
RSS3 Futures	472 (35.89%)	843 (64.11%)
Three-day Returns	**Negative Return**	**Non-Negative Return**
Stock Market	858 (65.25%)	457 (34.75%)
RSS3 Futures	645 (49.05%)	670 (50.95%)
Five-day Returns	**Negative Return**	**Non-Negative Return**
Stock Market	787 (59.85%)	528 (40.15%)
RSS3 Futures	669 (50.87%)	646 (49.13%)

From 2,833 trading days used in this study, the stock return shows the negative figure for 1,315 times. The returns on RSS3 Futures are non-negative for 843 times or 64.11% of 1,315 times and become negative for only 472 times or 35.89%. This result supports that RSS3 Futures can be used as the hedge during the period of negative stock returns.

If the behavior of stock returns is further examined, it can be seen that the cumulative stock returns are still negative for 858 times or 65.25% of 1,315 times for three days after negative stock return and the cumulative stock returns are negative for only 787 times or 59.85% for five days after the negative stock return. However, the cumulative returns on RSS3 Futures are negative for 645 times or 49.05% for three days after negative stock return and the cumulative returns on RSS3 Futures are negative for 669 times or 50.87% for five days after the negative stock return.

Figure 2. Cumulative Return of Stock and RSS3 Futures



The above result shows that the cumulative stock returns start recovering whereas the cumulative returns on RSS3 Futures becomes more negative after the negative return days. The chance that RSS3 Futures can be used as the hedge for negative stock returns has disappeared shortly after the days of negative stock return. Figure 2 also confirm this issue. After the negative stock return days, the stock return has recovered whereas the return on RSS3 Futures becomes lower day by day for five days after. Therefore, the outperformance of RSS3 Futures over stock will decline over time after the days with negative stock return.

CONCLUSION

This study aims to examine the role of RSS3 Futures as the hedge for stock market in Thailand. The data is collected from May 28, 2004 that is the first trading day of the Agricultural Futures Exchange of Thailand until December 31, 2015, which includes totally 2,833 trading days. The test equation has been adapted from Baur and Lucy (2010) using EGARCH model to capture the asymmetric effect of conditional volatility in the market.

The results show that RSS3 Futures can be the diversifier for stock investors in Thailand as its low correlation between RSS3 Futures and stock market. During the days with negative stock return, there is no relationship (weakly negative) between RSS3 Futures and the stock market. This means that RSS3 Futures can be the hedge for stock market in general. However, RSS3 Futures is not the candidate for safe haven of stock market because it shows no hedge property during the period of extremely negative stock returns.

The result implies investors in Thailand, especially stock investors, should consider adding RSS3 Futures in their optimal portfolio. Although it cannot protect investors from extremely negative stock market, it clearly shows that RSS3 Futures can help in diversifying the risk, especially during the periods of stock market downturn.

References

Baur, D. G., & Lucey, B. M. (2010). Is gold as hedge or a safe haven? An analysis of stocks, bonds, and gold. *Financial Review, 45*(2), 217-229.

Chong, J., & Miffre, J. (2010). Conditional correlation and volatility in commodity futures and traditional assets markets. *Journal of Alternative Investments, 12*(3), 61-75.

Creti, A., Joets, M., & Mignon, V. (2013). On the links between stock and commodity markets' volatility. *Energy Economics, 37*, 16-28.

Edwards, F. R., & Park, J. M. (1996). Do managed futures make good investments? *Journal of Futures Markets, 16*(5), 475-517.

Gorton, G., & Rouwenhorst, K. (2006). Facts and fantasies about commodity futures. *Financial Analysts Journal, 62*(2), 47-68.

Jensen, G. R., Johnson, R. R., & Mercer, J. M. (2000). Efficient use of commodity futures in diversified portfolios. *Journal of Futures Market, 20*(5), 489-506.

Markowitz, H. M. (1952). Portfolio Selection. *Journal of Finance, 7*(1), 77-91.

Nelson, D. B. (1991). Conditional Heteroskedasticity in Asset Returns: A New Approach. *Econometrica, 59*(2), 347-370.

Oleg, M. (2011). Volatility interrelationship between commodity futures, Shanghai stock and 10 year bond indices in China. *International Journal of Economics and Finance, 3*(6), 265-274.

ASSESSMENT OF THE LEVEL OF AWARENESS AND PERCEPTION OF MOTOR THIRD PARTY INSURANCE IN KAMPALA, UGANDA

Juliet Namukasa
Makerere University Business School, Kampala, Uganda
jnamukasa@mubs.ac.ug

Johnson Ssekakubo
Makerere University Business School, Kampala, Uganda

Bonny Bagenda
Makerere University Business School, Kampala, Uganda

Abstract

The study sought to establish the level of awareness about Motor Third Party Insurance amongst motorists in Uganda and how it affected their claims. A quantitative and cross-sectional survey was adopted and data was collected using a self-administered questionnaire. Findings from the study indicate that most motorists are not aware of the procedures of motor third party insurance and very few of them seek for compensation from insurance companies. This could be because of the perception among some individuals that insurance is a form of tax and a luxury. Reasons which were given for low claim rates were; the general lack of insurance knowledge amongst the populace and the cumbersome procedures for seeking compensation. With regards to perception towards insurance, the study confirmed that there was a general negative perception towards motor third party insurance. It is recommended that education on insurance be increased, government's supervision of insurance operations be strengthened, and that insurance companies improve their client orientation about the use of motor third party insurance so as to redeem the negative perceptions that majority of the motorists have towards this type of insurance.

Keywords: Motor third-party insurance (MTPI), Awareness, Perception, Insurance, Claims.

บทคัดย่อ

งานวิจัยนี้ได้ทำการศึกษาระดับของความตระหนักถึงการประกันภัยรถยนต์สำหรับบุคคลที่สามในประเทศยูกันดาและผลกระทบต่อการเรียกร้องสินไหมทดแทน โดยใช้การวิจัยเชิงปริมาณแบบตัดขวางและรวบรวมข้อมูลด้วยวิธีการสำรวจโดยใช้แบบสอบถามที่ผู้ตอบตอบแบบสอบถามด้วยตนเองเป็นเครื่องมือ ผลที่ได้พบว่าผู้ขับขี่ส่วนใหญ่ไม่ได้ตระหนักถึงการประกันภัยรถยนต์สำหรับบุคคลที่สามและมีเพียงส่วนน้อยที่ได้ทำการเรียกร้องสินไหมทดแทนจากบริษัทประกันภัย เนื่องจากมองว่าการประกันภัยเป็นภาษีรูปแบบหนึ่ง เหตุผลที่มีอัตราการเรียกร้อยสินไหมทดแทนต่ำเนื่องจากประชาชนขาดความรู้ด้านการประกันภัยและกระบวนการในการเรียกร้องสินไหมทดแทนมีความยุ่งยาก นอกจากนี้ผลการวิจัยยังยืนยันได้ว่าประชาชนมีมุมมองเชิงลบต่อการประกันภัยรถยนต์สำหรับบุคคลที่สาม ดังนั้นจึงมีข้อเสนอแนะให้เพิ่มระดับความรู้ความเข้าใจเกี่ยวกับการประกันภัย การควบคุมกระบวนการประกันภัยให้แข็งแกร่งขึ้นโดยรัฐบาล รวมถึงบริษัทประกันภัยควรปรับปรุงให้มุ่งเน้นการให้บริการลูกค้าเป็นสำคัญสำหรับการประกันภัยรถยนต์สำหรับบุคคลที่สามเพื่อลดมุมมองเชิงลบของประชาชนที่มีต่อการประกันภัยรถยนต์สำหรับบุคคลที่สาม

INTRODUCTION

Motor insurance is probably the most important type of insurance sold in developing countries and the first class of insurance with which the general public has an acquaintance. In most countries, motor third-party insurance (MTPI) is compulsory in order to protect the public. World Bank studies in Africa, Central Asia, and Europe have shown that motor insurance premiums represent at least 30 percent of all non-life premium income. This phenomenon may be explained by the rapid rise of motor fleets. MTPI has been introduced in the formerly centrally planned economies only in the past decade, and it is poorly understood (Serap, 2009) Motorists are inclined to view it as a form of tax that they are at liberty to evade, rather than as a protection against their personal liability, a concept that is not familiar to the general public (Serap, 2009).

However Ssempijja (2012) noted that members of the public took advantage of the royal way media's fourth banking, finance and insurance expo under which members of the public expressed their discontentment about the trend of events through which they (people) were served by the financial sector; the insurance subsector took a lion's share of the raised complaints, with matters largely rotating around the motor third party insurance policy. Speaker after speaker from an audience of about 800 people, at least 90% of them from the informal sector, talked ill of how insurance companies had fleeced public through evading claim compensation under the policy in question (Ssempijja, 2012).

World Bank studies have shown that motor accidents causing deaths and injuries occur in developing countries adding up to eight times the rate in industrial countries. In some countries, the insurance industry shares responsibility for preventing road injuries and organizations funded by the insurance industry make a valuable contribution to road safety. For example, Folksam in Sweden and the Insurance Institute for Highway Safety in the United States provide objective information about the crash performance of new cars and other safety issues. Data are collected by such groups for example the Finnish Insurers' Fund, the Turkish data collection system, both of which investigate every fatal crash occurring nationally, carry out safety studies, and provide information to the public which is not the case for Uganda.

Motor insurance therefore has the potential of becoming a powerful tool in the promotion of personal responsibility if communicated effectively, as this could improve on the knowledge and change the pessimistic perceptions that Ugandan motorists have towards motor third-party insurance (MTPI)

OVERVIEW OF THE INSURANCE INDUSTRY IN UGANDA

The insurance industry plays a very critical role in the economy of Uganda by militating against the risks associated with every aspect of life from personal health to business (Lutwama, 2014). Modern insurance was introduced in Uganda during the colonial era. The first locally owned insurance company, the East Africa General Insurance Company Ltd (EAGEN) was incorporated in 1946, followed by National Insurance Corporation (NIC) in 1964. The industry remained unregulated until 1978 when the Insurance Decree was passed. The decree was not very effective in addressing the insurance challenges at the time. In April 1996, the Insurance Statute was enacted. The Statute among others established the Uganda Insurance Commission (UIC) as an independent body mandated with ensuring effective administration, supervision, regulation and control of the insurance business in Uganda.

Before 1996, anyone could start an insurance business as long as the company had a board of directors (Nsubuga, 2002). In response to this situation, the government promulgated the Uganda Insurance Statute of (1996) and the Insurance Regulations of (2002). To regulate the market and protect consumers, the 1996 statute created the Insurance Commission which controlled and oversaw the entire industry. The statute required insurers to join the Uganda Insurance Association (UIA) and adhere to its code of conduct. In so doing, the statute gave certain powers to the association to issue and revoke licenses.

Currently the main law governing insurance business in Uganda is the Insurance Act, (Cap 213) laws of Uganda, 2000 as amended by the insurance amendment Act, 13, 2011 and the regulations made there under. This Act renamed the Uganda Insurance Commission as the Insurance Regulatory Authority of Uganda which is the main body governing insurance activities in Uganda. Its main objective is to ensure effective administration, supervision, regulation and control of insurance businesses in Uganda. The establishment of the Insurance Regulatory Authority of Uganda was a result of government's adoption of the liberalization and privatization policies which ended its role of directly engaging in the provision of goods and services and taking on the role of supervisor or regulator.

Customers in this industry expect a lot from their insurers or service providers. They expect; prompt delivery of competent and efficient services paramount among which is payment of claims, knowledgeable and serviceable frontline staff that are ever prepared to give information on request and reliable feedback among others (Amartey, 2007). Understanding customer expectations is an important and essential element in service delivery. According to Zeithaml et al, (2003) customer expectation is basically a belief about the service delivery. Customer satisfaction is an overall attitude towards a product or an organization that provides services or customer's reaction towards the difference between customer's expectation and what is received concerning the satisfaction of needs, desires or goal (Hansemark and Albinson, 2004).

Good customer value can be achieved only when service quality, product quality and the value-based prices exceed the customer satisfaction. If one of these is neglected then customer satisfaction will suffer a tremendous setback. Even if price and the product are good but the service is bad, the entire image of the company product will be bad and the customer will certainly not be happy (McNeil and Crotts, 2005). According to Hoyer and Maclnnis (2001) customers that are not satisfied may decide to stop patronizing a business to purchase insurance products and services, they may complain to a third party or the business organization and they may also give negative word of mouth (Boadu, 2014), this is evidenced by the high numbers of customer complaints lodged to the Insurance Regulatory Authority for example the aggregate net incurred claims in both life and non-life was estimated at about Ushs 85.4 billion in 2013 compared to Ushs 78 billion in 2012. (Insurance regulatory authority report, 2013).

Customer dissatisfaction usually comes about as a result of poor business management and business practices Broadbridge and Marshall (1995). Therefore insurance companies should do something in order to improve on the quality of services they offer to their clients especially under third party insurance because that is where most complaints come from.

Today the insurance sector has continued to post significant growth over the years; during 2013, gross insurance premium written rose to Ushs 463 billion from Ushs 352.2 billion in 2012, representing a phenomenal 31% growth in the industry. Health membership organizations' contributed Ushs 56 billion; Non-life insurance premium totaled Ushs 351.4 billion up from Ushs 313 billion registering an increase of 12.3%. Life premium on the other

hand totaled Ushs 55.40 billion against Ushs 39.26 billion in 2012, posting a 41.1% increase in the volume of business. (Insurance regulatory authority report, 2013).

However Lutwama (2014), notes that the Ugandan insurance sector is one of the least developed in the region that the total asset base of the insurance industry in Uganda only accounts for less than 1% of the gross domestic product compared to 3.2% in Kenya and 12% in South Africa. Considering a population estimate of 34 million, the insurance premium per capita was US$ 3 compared to over US$ 1000 for South Africa and US$ 30 for Kenya. Oluka (2016) also asserts that insurance penetration rates in Uganda are the lowest in the East African region estimated at 0.85% compared to Kenya's 3.7%, Rwanda's 2% and Tanzania's 1%.

Much as the state of the insurance industry may look appalling when compared to other markets, it only points to the untapped potential in this industry. However Lutwama (2014) further notes that unlocking this growth potential would require massive capital investment to address the various challenges currently constraining the growth of this industry. He further notes some of the challenges that face the insurance industry in Uganda like negative perceptions about insurance and the low levels of awareness about insurance policies are challenges that would take some time to address because they require a paradigm shift among Ugandans.

In the same perspective, the (insurance regulatory authority report, 2013), indicated that insurance penetration continued to be far below the desired benchmark; the contribution of total insurance premiums to GDP, which measures insurance penetration, in real terms, was 0.85% as against 15.4% in South Africa and 3.4% in Kenya. The Table below shows the gross premium income, growth rate and insurance penetration in Uganda from 2009 to 2013.

Table 1: Gross Premium Income and Insurance Penetration

Year	Premium Income (Ushs)	Growth Rate (%)	Insurance Penetration (%)
2009	202,054,031	20.81	0.59
2010	239,983,035	18.77	0.65
2011	296,830,675	23.69	0.65
2012	352,231,429	18.66	0.66
2013	461,262,909	31	0.85

Source: Insurance Regulatory Authority of Uganda Annual Reports for 2009 -2013
*2013 industry performance includes health membership organizations figures

Technically, promotion of public awareness about insurance activities in Uganda has not been emphasized. The only link to the promotion of insurance, interpreted in the broadest sense, is the requirement that all vehicles have third party liability insurance which is intended to protect the public from careless drivers and thus might, theoretically at least, generate confidence in the market, which would be promotional.

Public experience with mandatory third party liability insurance, however, has had the opposite effect since historically valid claims were rarely paid (depending on the insurance company), resulting in generally poor public confidence in insurance. Although this situation has improved, much of the market still remembers the past performance (Tumuhaise, 2012) the above background serves as a great motivation for this study.

Statement of the Problem.

The Motor vehicle Insurance Third Party Risks Act of (1989) established a compulsory insurance policy; the motor vehicle third party insurance policy in a bid to curtail careless driving/riding and to also help in the settlement of liability in event of minor motor accidents. However according to Serap (2009) the policy is poorly understood because motorists view it as a form of tax rather than as a form of protection against their personal liability. In the same perspective, the access insurance initiative report (2008) indicates that most Ugandans especially those in the low income tier have limited knowledge of insurance. Tumuhaise (2012) attributes most of the insurance woes to lack of public sensitization, arguing that some people don't even understand how the policy is supposed to help them or what qualifies them for compensation. Sebiyam (2005) further posits that most drivers regard having insurance only as a means to pass through the checkpoints with the minimum of fuss by the police. It is therefore upon this background that the study seeks to establish the perceptions of motorists' to the compulsory motor third party insurance policy in Uganda.

General objective

To establish the perception of motorists towards motor third party insurance (MTPI) policy in Uganda.

Specific objectives

i. To establish the level of awareness about motor third party insurance amongst motorists in Uganda.
ii. To find out the motorists' perception of motor third party insurance in Uganda
iii. To assess the impact of awareness and perception of motor third party insurance on claims status of motorists in Uganda.

Research Questions

i. What is the level of awareness about motor third party insurance amongst motorists in Uganda?
ii. What is the motorists' perception towards motor third party insurance in Uganda?
iii. What is the impact of awareness and perception of motor third party insurance on claims status of motorists in Uganda?

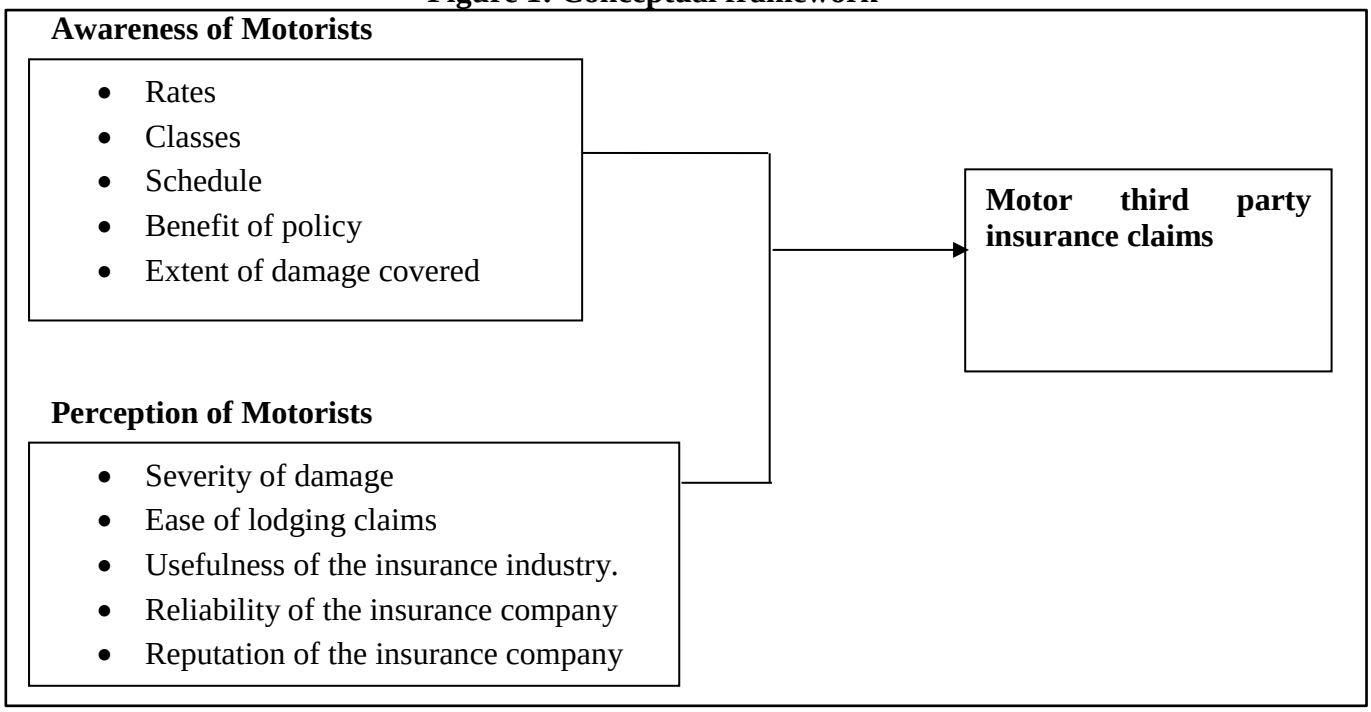
Significance of the study

The findings would assist Uganda's insurance companies to better diagnose the needs and expectations of their customers through developing MTPI awareness hubs in order to enable them achieve the highest level of their clients' expectations.

The study will find out the impact of awareness and perception of motor third party insurance on claims status of motorists in Uganda. This will contribute to the scarce literature about the general perception of motor third party insurance policy in Uganda.

The findings would assist Uganda's insurance companies to better diagnose the needs and expectations of their customers.

Figure 1: Conceptual framework



Source: developed by the researcher

Motorists Awareness and Motor third party insurance claims

Sebiyam (2005) indicated that most of Uganda's drivers regarded having insurance only as a means to pass through the checkpoints with the minimum of fuss by the police. This generally indicates a low level of awareness about the purpose of motor third party insurance which affects their claiming ability. Therefore there is need for motorists to understand what MTPI insurance is all about in order to appreciate its benefits especially when a claim is made. Hence it is anticipated that the motorists' awareness of MTPI (in terms of rates, classes, benefit of policy and extent of damage covered has a significant influence on their MTPI claim status.

Perception of Motorists towards motor third party insurance claims

Public experience with mandatory motor third party insurance has had negative perception since historically valid claims were rarely paid resulting in generally poor public confidence in insurance. Although this situation has improved, much of the market still remembers the past experience. This is further emphasized by (Sebiyam, 2005) who indicated that drivers who had undertaken motor vehicle insurance found it difficult to make claims whenever there was an accident without resorting to hiring a lawyer. Therefore this made majority of clients who were rightfully entitled to admissible claims to get fed up in the process and stopped pursuing the claims. It is therefore presumed that motorist's perception of MTPI affects their claim status.

LITERATURE REVIEW

Definitions of Concepts

Insurance

Is a mechanism whereby the risk of financial loss is transferred from an individual, company, organization or other entity to an insurance company (Insurance Regulatory Authority, 2010). Insurance can also be defined as the pooling of risks by individuals, where part of the payment of the many is used to pay to the few who suffer losses (Sebiyam, 2005; Rejda, 1992; Gart and David, 1990; Troxel and Comick, 1983). Anderson and Brown (2005) stated that under a formal insurance arrangement, each insurance policy purchaser (policyholder) still implicitly pools his risk with all other policyholders. Insurance itself may not exactly prevent risks but it helps in covering loss and compensating the insured.

Emergencies of all types are by nature, rather unpredictable. Given these, they have the tendency to render their victims vulnerable, given their concomitant financial shocks. In instances where these persons are not prepared financially particularly for the emergencies, they suffer double agony. The poor generally, but particularly those in developing countries, are ordinarily vulnerable to emergencies and disasters. Cushioning individuals, families and communities against the financial burden of catastrophes and periods of incapacity and old age, is what insurance schemes seek to do. Insurance is therefore a risk-sharing arrangement (Leppert et al, 2012).

From this definition of insurance, motor vehicle insurance can be defined as the transfer of risks occasioned by motor vehicle accidents to insurers, who agree to indemnify the motorists, their passenger or other third parties for such losses and to provide other pecuniary benefits on the occurrence of motor vehicle accidents, or to render services connected with the risk. The insured thus, does not receive any tangible product in exchange for the premium paid, rather he is given an intangible product in the form of promise if the event described in the policy occurs (Okehi, 2005). Insurance is designed to meet the financial wellbeing of an individual, company or other entity in the case of unpredicted losses. Some forms of insurance are compulsory while others are optional (Hoyoake and Weipers, 1999).

In Uganda, there is still a misconception that insurance services are a luxury for the rich (Sebiyam, 2005). From the above definition, therefore there is need for people to understand what insurance is all about in order to appreciate its benefits.

Motor insurance

A policy purchased by vehicle owners to mitigate costs associated with getting into an auto accident (Insurance Regulatory Authority, 2010). Instead of paying out of pocket for auto accidents, people pay annual premiums to an auto insurance company. In many jurisdictions it is compulsory to have vehicle insurance before using or keeping a motor vehicle on public roads. Motor insurance is compulsory by law, meaning that if the person wants to buy vehicle, they must have motor insurance first before using that vehicle on public roads. Most jurisdictions relate insurance to both the car and the driver; however the degree of each varies greatly from country to country.

Forms of motor insurance cover

From the third party risks Act of (1989) there are three forms of motor insurance cover:
Third Party; Third party is the minimum legal level of insurance. The first two parties are the insurance company and the driver. Third party insurance covers one's liabilities in respect of injuries to others like passengers and other persons outside the car and damage to other peoples' properties.

Third Party, Fire and Theft. This covers the aforementioned third party risks plus theft, and damage to one's vehicle caused by attempted theft and fire.
Comprehensive insurance cover (first party). This covers third party, fire and theft risks plus accidental damage to one's vehicle, malicious damage to one's vehicle, personal accident and medical expenses up to a certain limit.

The primary use of motor insurance is to provide financial protection against physical damage or bodily injury resulting from traffic collisions and against liability that could have risen from the specific terms of vehicle insurance. In this study, motor insurance is a type of insurance purchased for cars, trucks, motorcycles and other road vehicles. For purposes of this study, we are going to focus on motor vehicle third party insurance.

Motor third party insurance (MTPI)

Is a type of insurance that provides compensation to third parties who suffer death or bodily injury caused by or arising out of the use of a vehicle on the road. It was set up by an Act of Parliament (Motor Vehicle Insurance Third Party Risks Act 1989 (Ch 214)), revised in 2000. The Act requires that in the event of an accident, the vehicle or motorcycle involved (first party), the occupants of the vehicle (second party) and the other vehicle, person or property involved (third party) be compensated by the insurance company. The main purpose of this policy is to provide an affordable social protection to the public road users. The motor vehicle owner is protected against potentially catastrophic effects of an adverse judgment, whereas the victim is assured of quick compensation.

However Ssempijja (2012) indicated that most of the motorists that had talked to business vision in different exclusive interviews claimed to have either fallen victims of non-compensation themselves or heard of a similar case happening to other people for example Mohammad Sherief, a cross-border trailer driver confirmed that claim compensation under third party insurance policy was increasingly becoming a nightmare more in Uganda than any other East African country. Tumuhaise (2012) also noted that prior to the enactment of the motor third party insurance policy, innocent third parties or members of the public were unduly exposed to uninsured risks and were therefore left to suffer as there was no form of compensation or relief accessible to them. Therefore it is important for the public to understand what MTPI is all about since all vehicles to be used on public roads must have valid third party insurance apart from vehicles owned by Government of Uganda.

Third Party

Tumuhaise (2012) defined third parties as all road users including pedestrians, cyclists, vehicle occupants and passengers in other vehicles excluding the vehicle owner, his/her immediate family members and employees while the Insurance Regulatory Authority of Uganda (2010) defined a third party as anyone else who is involved in a loss event, which may or may not

result in a claim. For example, in motor insurance a third party may be another vehicle owner, property owner, or persons such as passengers or pedestrians. The definition provided by Tumuhaise (2012) has been used for this study.

Perception

Perception is the process by which people select, organize and interpret information to form a meaningful picture of the world (Chaffe, 1997). Therefore some people normally assume that what they perceive is what is actually taking place, only to find out that their perceptions of the same event differs from the perceptions of others. For the purpose of this research, perceptions refer to the way in which things are seen, understood to be like, and interpreted as (Crowther, 1998).

Awareness

The tripartite theory of knowledge defines knowledge as justified true belief. Crowther (1998) defines it **as** awareness or familiarity; person‘s range of information, understanding of subject; information; and sum of what is known. While Lankshear et al: (1997) defined knowledge as any set of ideas and practices accepted by a social group or people as being real and meaningful for them. Philosophers typically divide knowledge into three categories: personal, procedural, and propositional. Personal knowledge or knowledge by acquaintance is a type of knowledge that people are claiming to have when they say things. Procedural knowledge is a type of knowledge based on skills while propositional knowledge is a type of knowledge based on facts.

Kadunabi (2012) noted that in Uganda even those who are insured don’t know the procedures to follow in case of a mishap that needs compensation. He further observed that there was need for customer awareness for them to know what they are entitled to and how to secure it. In the same perspective, (Zake, 2012) also agreed that the insurance industry in Uganda had not done enough in educating the public about insurance.

Therefore knowledge is thus the awareness and understanding of facts, truths or information gained in the form of experience or learning hence the need to carry out awareness about insurance services in Uganda in order to reduce on the misperception about insurance services held by majority of the people in Uganda.

What is the level of awareness about motor third party insurance amongst motorists in Uganda?

Motor insurance is probably the most important type of insurance sold in developing countries and the first class of insurance with which the general public has an acquaintance. In most countries, motor third-party insurance (MTPI) is compulsory in order to protect the public. World Bank studies in Africa, Central Asia, and Europe have shown that motor insurance premiums represent at least 30 percent of all non-life premium income. This phenomenon may be explained by the rapid rise of motor fleets. MTPI has been introduced in the formerly centrally planned economies only in the past decade, and it is poorly understood (Serap, 2009) Motorists are inclined to view it as a form of tax that they are at liberty to evade, rather than as a protection against their personal liability, a concept that is not familiar to the general public (Serap, 2009).

Motor insurance therefore has the potential of becoming a powerful tool in the promotion of personal responsibility if communicated effectively, as this could improve on the awareness and change the pessimistic perceptions that Ugandan motorists have towards motor third-party insurance (MTPI)

What is the motorists' perception towards motor third party insurance in Uganda?

Ssempijja (2012) noted that members of the public took advantage of the royal way media's fourth banking, finance and insurance expo under which members of the public expressed their discontentment about the trend of events through which they (people) were served by the financial sector; the insurance subsector took a lion's share of the raised complaints, with matters largely rotating around the motor third party insurance policy. Speaker after speaker from an audience of about 800 people, at least 90% of them from the informal sector, talked ill of how insurance companies had fleeced public through evading claim compensation under the policy in question (Ssempijja, 2012).

World Bank studies have shown that motor accidents causing deaths and injuries occur in developing countries adding up to eight times the rate in industrial countries. In some countries, the insurance industry shares responsibility for preventing road injuries and organizations funded by the insurance industry make a valuable contribution to road safety. For example, Folksam in Sweden and the Insurance Institute for Highway Safety in the United States provide objective information about the crash performance of new cars and other safety issues. Data are collected by such groups for example the Finnish Insurers' Fund, the Turkish data collection system, both of which investigate every fatal crash occurring nationally, carry out safety studies, and provide information to the public which is not the case for Uganda.

What is the impact of awareness and perception of motor third party insurance on claims status of motorists in Uganda?

In Uganda, MTPI policy is poorly understood and motorists view it as a form of tax rather than as a protection against their personal liability (Serap, 2009). Public experience with mandatory motor third party liability insurance has had negative effects since historically valid claims were rarely paid resulting in generally poor public confidence in MTPI. "It is very common to hear people remarking that insurance companies are quicker in receiving premiums but slower when it comes to claims payment"; insurance companies have always been blamed for late delivery of services. It is common place to hear people complaining of undue delay in responding to customers' requests" (Boadu, 2014).

Although this situation has improved, much of the market still remembers the past performance. Sebiyam (2005) further stated that drivers who had undertaken motor vehicle insurance found it difficult to make claims whenever there was an accident without resorting to hiring a lawyer. While majority of clients who were rightfully entitled to admissible claims got fed up in the process and stopped pursuing the claims. Therefore it is presumed that awareness and perception of motor third party insurance has an impact on claims status of motorists in Uganda.

Review of related empirical studies

A few studies have been conducted in the field of motor insurance in certain countries although none of such study has been conducted in Uganda. Knowledge gaps have been identified from the following reviewed studies.

Level of awareness about motor third party insurance amongst motorists

Tumuhaise (2012) attributes most of the insurance woes to lack of public sensitization; "some people don't even understand how the policy is supposed to help them or what qualifies them for compensation. In the same perspective, the access insurance initiative report (2008) also indicates that Ugandans especially low income Ugandans have limited knowledge of motor third party insurance.

Ackah and Owusu (2012) revealed that many people have heard of the word insurance. They revealed that the determinants of awareness are age, gender and educational status of respondents. Age is a statistically significant variable and positively predicts insurance literacy and attitude towards insurance. Older individuals are generally more knowledgeable in insurance. Higher literacy scores coincide with respondents being male and enjoying a better education.

Gine et al. (2008) stated that there is lack of awareness of the existence of insurance products, and a poor understanding of the concept of insurance. They add that a number of factors have contributed to the low awareness of insurance and these include household wealth, credit constraints, risk aversion, trust, and endorsement from social networks, hyperbolic preferences, and particular marketing methods.

Therefore it is presumed that there is a low level of awareness about the importance of MTPI amongst motorists

Perception of motor third party and motor third party insurance claims

In Uganda, MTPI policy is poorly understood and motorists view it as a form of tax rather than as a protection against their personal liability (Serap, 2009). Public experience with mandatory motor third party liability insurance has had negative effects since historically valid claims were rarely paid resulting in generally poor public confidence in MTPI. "It is very common to hear people remarking that insurance companies are quicker in receiving premiums but slower when it comes to claims payment"; insurance companies have always been blamed for late delivery of services. It is common place to hear people complaining of undue delay in responding to customers' requests" (Boadu, 2014)

Although this situation has improved, much of the market still remembers the past performance. Sebiyam (2005) further stated that drivers who had undertaken motor vehicle insurance found it difficult to make claims whenever there was an accident without resorting to hiring a lawyer. While majority of clients who were rightfully entitled to admissible claims got fed up in the process and stopped pursuing the claims.

The reluctance by some insurers to pay clients claims had eroded public confidence and tainted the insurance sectors image (Oluka, 2016). Oluka adds that most people especially boda boda

riders who are the biggest victims of road accidents do not claim compensation because they do not know their entitlement.

An investigation into the reasons for the high claim rejection rates by Seth (2008) identifies it as false statements made, failure to disclose relevant facts, claims not falling within the items insured under the policy, failure of the insured to comply with the terms of the agreement, fraud, inordinate and unreasonable delay for the reporting of the incident, no consequential losses covered under policies and false statements made when applying for insurance. Since the repudiating a claim is subject to legal implications involving cost the insurers should be cautious in denying liability under a policy.

Kishan (2006) says the real credibility and trustworthiness of a general insurance company is put to test when a claim actually arises. In other words an insurance company's reputation is evaluated by its ability to fulfill its promise of being there when the customer needs them the most. Moreover, an insurance company also has an arduous task to ensure an equitable and rational claims settlement. A sound claims settlement mechanism plays an intrinsic role in ensuring consumer centric insurance solutions. This therefore means that if a company has an efficient claim management system then its reputation will be improved and thus increase on the claim rate.

Giesbert et al (2011) concluded that insurance is considered a risky venture by their respondents, based on their finding that risk-averse households and households which considered themselves to have increased/higher risk were less likely to participate in the life insurance scheme. Giesbert et al. (2011) also found that adverse selection, and a life-cycle effect affected uptake of the insurance they studied.

A study by Alma and Rajeev (2004) aimed at investigating the effect of automobile insurance and accident liability laws on traffic fatalities in 50 U.S states using an instrumental variables approach. Findings indicated that there was evidence that automobile insurance had moral hazard costs that led to an increase in traffic fatalities. This study did not look at peoples' perception towards the compulsory automobile insurance which would have been useful in determining its effect on traffic fatalities.

The Australian Quantum Market Survey Research Report (2014) aimed at empowering consumers to make better, more informed decisions by demystifying insurance its findings indicated that a high proportion of those with third-party only insurance were either unsure or perceived that they were definitely uncovered for majority of the incidents. While 59% acknowledged that they didn't understand all the details in their policy documents. However this study was carried out in Australian context not Ugandan context hence the motivation to carry out a similar study in Uganda since there is insufficient research about perception of motorists towards third party insurance in Uganda which could be useful in assessing the level of clients' knowledge about motor-third party insurance. Results will enable insurance companies improve on knowledge dissemination style to their clients.

Folake and Kunle (2010) carried out a study in Nigeria whose aim was to find out peoples' perception of motorcycle insurance while comparing the perceptions of insurance companies' staff with that of their customers (the motorcyclists) and also finding out the major causes of motorcycle accidents in Nigeria. Questionnaire was used for sampling, The Kolmogorov Smirnov test was used to test the hypothesis. Their findings indicated a general negative

perception of insurance services by the motorcyclist and a large disparity in the responses of the motorcyclists and the insurance companies' staff.

Although the above study attempted at finding out peoples' perception of motorcycle insurance while comparing the perceptions of insurance companies' staff with that of their customers (the motorcyclists), it only focused on motorcyclists and left out motor vehicle motorists which could have been useful in assessing the clients' level of awareness and perception of motor third party liability insurance.
Lili and Zhengyu (2014) carried out a study of the deficit of the third party liability compulsory insurance of motor vehicle in China; Data was analyzed using comparative analysis, this study analyzed the reasons why third party liability compulsory insurance of motor vehicle practicality came up with huge losses and then provided some policy implications to improve the third party liability compulsory insurance of motor vehicle. The study concluded by giving some reasonable suggestions on how to make the compulsory motor vehicle liability insurance Act better.

Although the above study concluded by giving some reasonable suggestions on how to make the compulsory motor vehicle liability insurance Act better, it did not address the perception of Chinese motorists towards the compulsory motor third-party liability insurance which is a great motivation for this study.

From the literature it can be seen that a number of researchers have tried to find out the awareness levels of insurance and their perception towards insurance. It can therefore be seen that there is low level of insurance and negative perception about MTPI and this has greatly affected the claim rate.

RESEARCH METHODOLOGY

Research Design

The study employed a cross sectional research design. Descriptive statistics was used to establish the awareness levels and perception towards MTPI by motorists. Analysis of variance (ANOVA) and chi square was also used to establish relationships between variables.

Target Population

The study targeted motorists in the suburbs of Kampala district. The categories included; public service vehicles; taxi drivers and bus drivers, private car drivers. Kampala district was considered appropriate because most insurance companies are located there.

Sample size and Sampling Design

The study employed multistage sampling approach. The population was divided into two groups namely; public and private car drivers. In order to ensure that all classes of motorists are considered stratified sampling was used. However when it came to the respondents in the different strata, convenient sampling was used and respondents were selected depending on availability and willingness of the driver to participate in the study. This was because of the mobile nature of the respondents. According to the Uganda Revenue Authority (URA) the

number of vehicles in Uganda today is estimated at 635,656. Given this population size, the appropriate sample size according to Krejcie and Morgan (1970) will be 382 respondents.

Data Collection Methods

A structured questionnaire was used to collect primary data from the respondents. The questionnaires were largely self-administered by the respondents but in the event that the sampled motorist was not able to fill it out, the enumerator would read the questions to the motorist in a language they understand.

Validity and Reliability

For purposes of language clarity, relevance and comprehensiveness of content, the researcher sought guidance from various research experts to correct any errors in the questionnaire. Then, the final questionnaire were pre- tested on selected respondents in order to check for validity of the data collection tool. Cronbach Alpha Coefficient was used to test for reliability and all the variables scored values about 0.7

Data Analysis

The study employed the descriptive statistics to establish the extent of awareness and perception of MTPI by the respondents. Analysis of variance and chi-square tests were also used to test for association between variables about MTPI.

Limitations of the study

The major limitation of the study related to the high mobility of the persons in the population which affected the response rate. There was also lack of an appropriate sampling frame for the segment of the population due to lack of appropriate data concerning motorists in Kampala. However the above challenge was addressed by conveniently sampling motorists depending on their willingness to provide data and answering the questionnaires.

INTERPRETATION AND DISCUSSION OF FINDINGS

Chi-square and Analysis of variance (ANOVA) was used in determining the relationships and significance of the variables and results from this study were used to reach the conclusions.

Level of awareness about motor third party insurance amongst motorists in Uganda?

The table below reveals the results concerning the level of awareness of both the private and public motorists on the different aspects of MTPI insurance and whether the level of awareness of these aspects differs across the two categories of motorists.
Concerning knowing the purpose for MTPI insurance, 80% of the private motorists stated that they knew the purpose of MTPI insurance and 50% of the public car motorists knew the purpose of MTPI. This meant that more private car motorists knew the purpose of MTPI compared to the public car motorists. This could probably explain why motorists, most especially the public ones did not ever attempt to place a claim when they got an accident that involved a third party.

When asked whether they have ever got an accident that involved a third party it was revealed that 48.4% of private motorists had ever been involved in an accident compared to the 50.0% of public drivers. This indicates that more public car drivers got accidents that involved a third party compared to the private car drivers.

On the aspect of placing a claim when they got an accident, 50% of the private motorists stated that they have ever attempted to place a claim when they got an accident that involved a third party while only 38.9% among the public motorists claimed to have done so. This meant that the percentage of claims under third party was more amongst private motorists compared to public motorists.
Concerning knowing who a third party is, 86.7% among the private said they knew who a third party was and 85.7% of the public driver knew who a third party was. These percentage indicate that more public motorists did not know who a third party is compared to the private motorists. When asked about whether they knew about the claim settlement procedures, findings show that 57.1% of the private drivers knew the claim procedures compared to 53.3% of the public drivers. These results indicate that more public motorists did not know the claim settlement procedures under third party compared to the private motorists.

Table 3: Level of awareness about motor third party insurance amongst motorists in Uganda (both private and public motorists).

Variable	Category	Private	Public	Chi	Sig.
Do you know the purpose for MTPL insurance?	Yes	80.0%	50.0%	17.589	0.000
	No	20.0%	50.0%		
Have you ever got an accident that involved a third?	Yes	48.4%	50.0%	0.04	0.842
	No	51.6%	50.0%		
Do you know the different classes of MTPI insurance?	Yes	43.3%	42.9%	0.003	0.955
	No	56.7%	57.1%		
Did you ever attempt to place a claim when you got an accident that involved a third?	Yes	50.0%	38.9%	1.003	0.317
	No	50.0%	61.1%		
Do you know who the third party is?	Yes	86.7%	85.7%	0.026	0.871
	No	13.3%	14.3%		
Were you indemnified when you placed a motor third party insurance claim?	Yes	35.5%	12.5%	9.462	0.002
	No	64.5%	87.5%		
Do you know the claim settlement procedures?	Yes	57.1%	53.3%	0.199	0.656
	No	42.9%	46.7%		
Do you know how many times you are supposed to pay for MTPI insurance?	Yes	56.7%	85.7%	12.216	0.000
	No	43.3%	14.3%		
Do you know your MTPI insurance benefits?	Yes	60.0%	50.0%	1.555	0.212
	No	40.0%	50.0%		
Are you aware of the extent of damage covered under the MTPI insurance?	Yes	50.0%	48.3%	0.045	0.832
	No	50.0%	51.7%		

Of these issues about which either categories had knowledge, they were two where the percentages of the different categories differed significantly and these included; the awareness of the purpose for MTPI insurance ($\chi^2 = 17.589, P < .001$) and the number of times one was supposed to pay for MTPI insurance ($\chi^2 = 12.216, P < .001$). You note that more private motorists knew about the purpose for MTPI insurance and more public motorists knew about the number of times one was supposed to pay for MTPI insurance.

From the findings above it has been seen that there is less awareness about MTPI and this explains why there are few claims by the victims. Most of the respondents did not know the claim settlement procedures meaning once affected they didn't know where to go. Respondents were even not aware of the different classes of MTPI. Most of the motorists were not aware of their entitlements in case of accidents. This therefore shows that there is less awareness about motor third party insurance.

Motorists' perception towards motor third party insurance in Uganda

Table 4 summarizes the motorists' perception towards MTPI. The results showed that motorists of the different categories perceived MTPI differently, for instance; private motorists thought that MTPI insurance was a form of tax that had to be paid by all motorists and that insurance services were a luxury and meant for the rich.

Table 4: Shows a summary about the motorists' perception about MTPI

	Category	**N**	**Mean**	**SD**	**F Statistic**	**Sig.**
MTPL insurance is a form of tax that has to be paid by all motorists	Private	186	1.81	1.15	39.77	0.00
	Public	48	2.00	1.24		
MTPL insurance is meant for severe accidents only	Private	186	2.10	1.23	4.23	0.04
	Public	48	2.50	1.13		
In event of an accident it is easy to lodge claims for indemnification under MTPL insurance	Private	186	4.03	1.23	0.25	0.61
	Public	48	4.13	0.61		
Insurance companies are professional in their business dealings	Private	186	3.71	1.12	4.10	0.04
	Public	48	4.38	0.49		
Generally insurance services are a luxury and meant for the rich	Private	186	2.58	1.44	0.58	0.45
	Public	48	2.75	1.10		

When asked on whether MTPI insurance was meant for severe accidents only majority of the respondents agreed with this statement (Mean = 2.10) meaning that for minor accidents insurance is not necessary.

Majority of the respondents thought that in event of an accident it was not easy to lodge claims for indemnification under MTPI insurance and thus were not certain about the idea that; in event of an accident it would be easy to lodge claims for indemnification under MTPI insurance. This explains why majority of the victims did not claim their compensation.

Majority of the respondents had a perception that insurance companies were not professional in their business dealings and this could be attributed to the delays in processing of their claims. Further still, the two categories differed in their perception about certain aspects of MTPI, and these included; 1. MTPI insurance being a form of tax that had to be paid by all motorists (F Statistic = 39.77, P<.01), 2. MTPI insurance being meant for severe accidents only (F Statistic = 4.23, P<.05) and 3. Insurance companies being professional in their business dealings (F Statistic = 4.10, P<.05).

From the findings above it can be seen that there is a poor perception about insurance and especially motor third party insurance. Other than it being compulsory, motorists take insurance to be a luxury which is suitable for the rich. Others believe that insurance is only helpful in case of server accidents and that it is hard to lodge claims for indemnification.

Impact of awareness and perception of motor third party insurance policy on motor third party insurance claims

Table 5 helps to inform whether the MTPI claims status of the motorists depended on their level of awareness. Results indicated that the MTPI claims status of the motorists depended on their level of awareness of the claim settlement procedures $(\chi^2 = 27.435, \mathrm{P} < .001)$, knowledge of MTPI insurance benefits $(\chi^2 = 27.435, \mathrm{P} < .001)$ and their awareness of the extent of damage covered under the MTPI insurance $(\chi^2 = 50.794, \mathrm{P} < .001)$. However awareness of the number of times one was supposed to pay for MTPI insurance did not influence their MTPI claims status $(\chi^2 = 2.564, \mathrm{P} > .05)$.

Table 5: Showing the relationship between the awareness variables and motor third party insurance claims.

Awareness Variables	**Pearson Chi Square**	**P Value**
Do you know the claim settlement procedures?	27.435	0.000
Do you know how many times you are supposed to pay for MTPI insurance?	2.564	0.076
Do you know your MTPI insurance benefits?	27.435	0.000
Are you aware of the extent of damage covered under the MTPI insurance?	50.794	0.000

Table 6: Showing the relationship between motorists' perception towards MTPI insurance and motor third party insurance claims.

	F Statistic	**Sig.**
MTPL insurance is a form of tax that has to be paid by all motorists	2.704	.102
MTPL insurance is meant for severe accidents only	31.675	.000
In event of an accident it is easy to lodge claims for indemnification under MTPL insurance	24.503	.000
Insurance companies are professional in their business dealings	11.759	.001
Insurance services are a luxury and meant for the rich	2.250	.136

The relationship between the perception towards MTPI insurance amongst motorists and motor third party insurance claims was determined by results in table 5. The results showed that the MTPI claims depended on the motorists' perception of whether MTPI was meant for severe accidents only or not (F Statistic = 31.675, P<.01), how easy it is to lodge claims for indemnification under MTPI insurance in event of an accident (F Statistic = 24.503, P<.01) and about whether insurance companies were professional in their business dealings (F Statistic = 11.759, P<.01).

Overall Conclusion

This study revealed that majority of Ugandans generally were aware of third party insurance, since it is compulsory however there was a general feeling that beyond awareness, Ugandans generally did not know about the operations of the third party insurance scheme nor understand how it operated. There was a negative perception towards motor third party insurance as majority of the respondents thought that insurance was for the rich, only helpful in case of fatal accidents and they knew it as a form of tax. This was because of the challenges they faced while claiming for indemnification. This meant that insurance regulatory authorities in Uganda needed to advise the affected stakeholders where to seek redress in case insurance companies refused to compensate the affected victims even after them handing in the requested documents. Therefore the study recommended that the compulsory insurance policies stipulated by the insurance act be properly sold in the society and well publicized so that the concerned stakeholders get to know its major purpose.

References

Ackah, C and Owusu. A. (2012). Assessing the Knowledge of and Attitude towards Insurance in Ghana. Institute of Statistical, Social and Economic Research (ISSER) University of Ghana

Access to insurance initiative (2008). *Making insurance services work for the poor*: micro insurance policy, regulation and supervision Uganda case study.

Anderson, J. F. & Brown, R. L. (2005). *Risk and Insurance*. Education and Examination of the Society of Actuaries. Available: http://www.soa.orgfilespdfP-21-05.pdf.

Amartey, V. E. (2007). Principles of life insurance. Combert impressions, Accra.

Alma, C & Rajeev, D. (2004). *The effect of automobile insurance and accident liability laws on traffic fatalities. Journal of Law and Economics.* Vol. XLVII .The University of Chicago.

Boadu, F., Fokuo, E.D., Boakye, J.K, Frimpong, A. O. (2014). *Assessing the life insurance industry in Ghana*. European Journal of Business and Management, Vol.6, No.21, pp.1-2.

Broadbridge, A., & Marshall, J. (1995). *Consumer Complaint Behaviour: the Case of Electrical Goods*.International Journal of Retail & Distribution Management Vol. 23, No.9, pp. 8-18.

Crowther, J. (1998). *Oxford Advanced Learner Dictionary*. Special price edition. Oxford University press.

Chaffe, J. (1997). *Thinking Critically*. 5th Edition. Houghton Miffin Company. Boston. New York.

Folake. O., & Kunle, A (2010). Perception of Parties to Third Party Motorcycle Insurance Policy in Lagos Metropolis, Nigeria. International Journal of Economic Development Research and Investment, Vol. 1 Nos. 2 & 3.

Gart, A. & David J. (1990). *Insurance Company's Finance*. Insurance Institute of America, Pennsylvania.
Giesbert, L., S. Steiner, M. Bendig. 2011. Participation in micro life insurance and the use of other financial services in Ghana. *The Journal of Risk and Insurance*, 78(1): 7-35.
Gine, X., R. M. Townsend, and J. Vickery. 2008. Patterns of rainfall insurance participation in rural India. World Bank Economic Review, 22(3): 539-566.
Hansemark, O. C., & Albinson, M. (2004). *Customer satisfaction and retention.* The experiences of individual employees, managing service quality Vol.14, No. 1, pp. 40-57.
Hoyer, W. D., & MacInnis, D. J. (2001). *Consumer behaviour* (2nd ed.). Boston, Houghton Mifflin Company.
Holyoake, J., & Weipers, N. (1999). *Insurance.* CIB Publishing, Canterbury.
Insurance Regulatory Authority of Uganda annual report (2013). Retrieved from http://www.ira.go.ug/report2014.pdf
Insurance Regulatory Authority of Uganda Annual Insurance Market Report, (2010). Retrieved from http://www.ira.go.ug/report2010.pdf
Kadunabi, A. I. I. (2012). *Insurance Authority to Focus on Awareness.* Retrieved from http://iiu.ac.ug/23/04/ / insurance-authority-to-focus-on-awareness.
Krejcie, R.V. and Morgan, D.W. (1970), *Determining Sample Size for Research Activities, Educational and Psychological Measurement*, Sage Publications, London.
Leppert, J., P. Degens, and L.-M. Ouedraogo. 2012. ―Emergence of micro health insurance in Sub-Saharan Africa‖, in H. J. Rosner, G. Leppert, P. Degens and L.-M. Ouedraogo. (Eds.)., Handbook of micro health insurance in Africa.‖ (pp. 37-58), Berlin: LIT Verlag.
Lili. B., & Zhengyu, G (2014). *A Study of the Deficit of the Third Party Liability Compulsory Insurance of Motor Vehicle.* Vol. 3, No. 1; ISSN 1927-5986 E-ISSN 1927-5994.
Lutwama, J.S (2014). *Policy and planning capital markets authority.* Retrieved from: http://uia.co.ug/capital-markets-opportunities-for-growth-of-the-insurance-industry-in-uganda
McNeil, R & Crotts. J (2005). *Selling hospitality: A situational approach*. Clifton Park, N.Y: Delmar/Thompson Publishing.
Nsubuga. L, (2002). *Uganda gets its own reinsurance firm*. The East African, July 15.
Okehi, O. O. (2005). *Insurance Marketing and Strategies*. Lagos: Audrey Ventures.
Rejda, G. E. (1992). *Principles of Risk Management and Insurance*. Herper Collins Publishers, New York.
Ssempijja, D. (2012). *Customers, insurers clash over third party.* Retrieved from: http://www.newvision.co.ug/section/53-1-National.html
Serap O. G (2009). *Motor third-party liability insurance in developing countries: Raising awareness and improving safety.* The International Bank for Reconstruction and Development/The World Bank 1818 H Street, NW Washington, DC 20433.
Sebiyam, M. (2005). *The impact of Insurance on Transport Business in Ghana:* A case Study in Sunyani Municipality. Sunyani Polytechnic, Sunyani, Ghana.
The Australian Quantum Market Survey Research Report (2014). Understanding Insurance Motor Research Report.
Tumuhaise, D. (2012). *Get your problem solved: Motor Third Party Insurance*. Retrieved from http://www.monitor.co.ug/Business/Prosper/-/688616/1247474/-/b4af75/-/index.html
Third Party Risks Act (1989). Available at: www.ulii.org/ug/legislation/consolidated-act/214
Troxel, E., & Comick, D. (1983). *Property-Liability Insurance Accounting and Finance*. American Institute of Property and Liability Underwriters, Pennsylvania
Zake, R. (2012). *Challenges of Insurance*. Retrieved from http://www.scluniversity.com.

THE EFFECTIVENESS OF CONFIRMING INDICATORS: A CASE STUDY OF STOCKS IN THAILAND

Shivathep Srichawla
Assumption University, Thailand
shivathep@gmail.com

Suppanunta Romprasert
Srinakharinwirot University, Thailand

Abstract

This paper developed a model that tested trading signals (including double and triple indicators) on the security traded in the Stock Exchange of Thailand (SET). One indicator from each of the six groups of technical indicators, including MACD, Parabolic SAR (PSAR), RSI, Twiggs Money Flow, Volume Oscillator, and Bollinger Bands, were tested in order to determine whether their use could generate excess returns for investors. PSAR was the most profitable indicator as it alone or when used in combined with other indicators could generate excess returns. The findings showed that the AND function could be used to combine trading signals but with proper interpretation of inputs. Findings also showed that combined indicators increase abnormal profits above individual indicators. A combined indicators model had the best performance in terms of End of Period Wealth and the least downside risk which was measured by Maximum Drawdown. The significance of this research is that it identifies confirming indicators that can be used effectively to generate excess profits, although the findings do have some limitations which is discussed in this paper however further study on similar concept is highly recommended.

Keywords: Confirming indicators, Double Indicators, Technical analysis, Stock Exchange of Thailand, Parabolic SAR, Combined indicators

บทคัดย่อ

บทความฉบับนี้ได้พัฒนารูปแบบจำลองการทดสอบสัญญาณการซื้อขาย (โดยรวมถึงตัวชี้วัดคู่และตัวชี้วัดสามตัว) ในการซื้อขายหลักทรัพย์ในตลาดหลักทรัพย์แห่งประเทศไทย โดยได้มีการตรวจสอบตัวบ่งชี้ชนิดใดชนิดหนึ่งจากดัชนีชี้วัดทางเทคนิค 6 กลุ่ม ได้แก่ MACD, Parabolic SAR (PSAR), RSI, Twiggs Money Flow, Volume Oscillator และ Bollinger Bands เพื่อตรวจสอบว่าการใช้ตัวบ่งชี้ดังกล่าวสามารถก่อให้เกิดผลตอบแทนที่มากขึ้นสำหรับนักลงทุน PSAR เป็นตัวบ่งชี้ที่สามารถใช้ในการทำกำไรมากที่สุด ไม่ว่าจะใช้เพียงลำพังหรือเมื่อใช้ร่วมกับตัวบ่งชี้อื่น ก็สามารถทำให้เกิดผลตอบแทนที่มากขึ้น ผลการวิจัยแสดงให้เห็นว่าฟังก์ชัน AND สามารถใช้ในการรวมสัญญาณการซื้อขายเข้าด้วยกันได้แต่จำเป็นต้องมีการตีความข้อมูลให้เหมาะสมเสียก่อน ผลการวิจัยยังแสดงให้เห็นว่าการใช้ตัวบ่งชี้หลายตัวร่วมกันช่วยเพิ่มผลกำไรที่สูงเกินคาดหมายเหนือกว่าการใช้ตัวบ่งชี้แต่ละตัวเพียงลำพัง แบบจำลองที่ใช้ตัวชี้วัดหลายตัวรวมกันมีประสิทธิภาพสูงสุดในการให้ความมั่งคั่งเมื่อสิ้นสุดระยะเวลาและทำให้เกิดความเสี่ยงขาลงน้อยที่สุด ซึ่งถูกวัดค่าโดยวิธี Maximum Drawdown ดังนั้นความสำคัญของงานวิจัยนี้คือการระบุตัวชี้วัดที่ผ่านการยืนยันว่าสามารถนำมาใช้อย่างมีประสิทธิภาพเพื่อสร้างผลกำไร อย่างไรก็ดีแม้ว่าผลการวิจัยจะมีข้อจำกัดบางอย่างที่กล่าวถึงในเอกสารนี้ แต่กระนั้นการศึกษาเพิ่มเติมเกี่ยวกับแนวคิดที่คล้ายกันนี้ก็สมควรที่จะทำเป็นอย่างยิ่ง

INTRODUCTION

There is a fundamental conflict between different schools of thought on predicting market performance. One school of thought – the economic viewpoint - is that the market price of a single stock is essentially a random walk and cannot be accurately predicted (Ji, Zhang, & Guo, 2008) which is a follower of Eugene Fama's Efficient Market Hypothesis. In contrast, the technical analysis viewpoint holds that historical performance of the stock itself can be used to predict its performance (Ji, et al., 2008). A third viewpoint that of fundamental analysis, argues that indicators of the firm's fundamental performance characteristics, such as its profit ratio, can be used to predict stock performance (Ji, et al., 2008). This research is mainly concerned with the technical analysis viewpoint, which relies on the use of trading signals, or indicators that a given stock should be bought or sold based on some element of its current price performance (Kaufman, 2013). This research in a way also tested the Weak-Form Efficient Market Hypothesis which stated that "future prices cannot be predicted by analyzing prices from the past". Technical analysis techniques will not be able to consistently produce excess returns if the market is in Weak-Form Efficient Market state. The trading signal typically comprises the movement of a stock's price, based on some technical movement analysis, and is used by traders to determine trading positions on a given stock (Colby, 2002). Trading signals are not used in isolation, but are instead used in combination in order to determine trading movements (Kaufman, 2013). However, it is not at all clear that technical analysis, with its use of trading signals, is an effective approach to predicting price performance or generating excessive returns in exchange trading (Balsara, Chen, & Zheng, 2007; Bessembinder & Chan, 1998). While some research, such as the study conducted by Balsara, et al. (2007) does indicate some usefulness of trading signals, other research suggests that the technical analysis approach is not effective as a trading tool (Bessembinder & Chan, 1998).

The main objective of this research is to develop a model that integrates technical indicators and determine which of these indicators is effective at capturing market characteristics and generating excess returns from trading the security. This research addresses a number of different aspects of importance to the literature review. First, there has been relatively little research in the area of technical analysis on the SET, and the majority of this research compares the SET to other markets instead of analyzing it on its own terms (Ardliansyah, 2012; Chuang, Lee, & Wang, 2014). There has also been limited research conducted into the combined effect of multiple trading indicators, even though in practice traders do rely on multiple indicators (typically a small subset of those available) instead of single indicators (Grimes, 2012). Furthermore, improving algorithmic and computational approaches to technical analysis increase the potential for accurate forecasting from technical indicators (Atsalakis & Valavanis, 2009). Thus, given the lack of evidence for SET, the conflicting evidence on the utility of technical analysis in general, and the low level of research on the use of multiple indicators, there is a strong reason for conducting this research and examining the problem at hand.

REVIEW OF LITERATURE

Technical analysis

The technical analysis approach relies on data mining and statistical analysis of the performance of the stock price in order to identify trends, forecast price and identify appropriate

trading points (Edwards, et al., 2013). Technical analysis relies on technical indicators, or statistical transformations of standardized data (such as daily prices and fluctuation) (Edwards, et al., 2013). Technical indicators are typically accompanied by trading signals, or critical points where BUY/SELL is indicated (Colby, 2002; Wagner, 2011). Due to the complexity and resources required to compute and understand technical indicators, most traders use only a small number of indicators, often in combination with data derived from fundamental analysis and news (Edwards, et al., 2013; Kaufman, 2013).

The evidence for the efficacy of technical analysis is mixed. Theoretical models of technical analysis argue that historical prices reflect latent information that is otherwise poorly communicated or hidden beneath trading noise, making price and volume information the most reliable source of data (Blume, Easley, & O'Hara, 1994; Brown & Jennings, 1989). From a psychological perspective, technical analysis reflects the effect of confirmation bias, or traders making decisions based on what they already know (Friesen, Weller, & Dunham, 2009). A number of empirical studies do support that specific uses of technical analysis can be effective; for example, one study found that it was effective over a six and sixteen-month horizon, though not at one month (Abbodante, 2010). One group of authors has posited that technological advances in technical analysis, such as the use of standardized algorithmic techniques rather than hand-charting, could have made it more effective (Lo, Mamaysky, & Wang, 2000). However, there is also a bulk of studies, including recent studies deploying algorithmic techniques, that show that technical analysis is of limited utility (Chang & Osler, 1999; Marshall, Cahan, & Cahan, 2010; Menkhoff, 2010). These studies found for example heavy psychological biases in interpretation of technical indicators (Menkhoff, 2010) and equivalent returns for far simpler trading rules (Chang & Osler, 1999). Many studies have shown either high transaction costs for technical analysis that wipe out trading gains (Bessembinder & Chan, 1998) or conflicting or contradictory findings for different markets and technical analysis techniques (Atsalakis & Valavanis, 2009; Park & Irwin, 2007; Schulmeister, 2009). Thus, it cannot be stated that technical analysis *as a whole* is effective – instead, it needs to be considered as a body of techniques that are variably effective at delivering abnormal returns depending on usage context.

Technical indicators

There are thousands of technical indicators in use, although only a relatively small number of these indicators are commonly used (Marshall, et al., 2010). Six groups of technical indicators can be identified, each of which offers different information about the stock (Colby, 2002). These include: moving average oscillators; trend indicators; momentum oscillators; money flow; volume indicators, and volatility indicators.

Moving average oscillators

A moving average is the mean of the most recent X observations from a sequential series (Schizas, 2013). The moving average oscillator is calculated as a fixed window, typically of 10 to 200 days to capture short-term or long-term price trends. However, they can be calculated as a fluctuating window (Schizas (2013). Moving averages are generally calculated as simple moving average (MA) or exponential moving average (EMA) (Colby, 2002). MA and EMA indicators are popular with traders and analysts because they are relatively simple and easy to use (Chiarella, He, & Hommes, 2006). However, due to long-term destabilization of moving averages and tendency toward random walk behavior, recommendations for use of MA indicators are for short term trend detection and cyclical analysis, rather than in long-term

analysis (Chiarella, et al., 2006). Of the MA indicators, Moving Average Convergence Divergence (MACD) is the most reliable short-term indicator (Colby, 2002; Liu & Xiao, 2009).

Trend indicators

Like moving average oscillators, trend indicators identify trends in the movement of stock price and volume (Kaufman, 2013). However, it is different from an oscillator because the trend indicator does not oscillate around a zero axis, but instead indicates absolute value in the trend (Fernández-Blanco, Bodas-Sagi, Soltero, & Hidalgo, 2008). Trend indicators, the oldest class of indicators, are commonly simple and easy to calculate, though some like Average Directional Index (ADX) are more complex (Rosenbloom, 2010). Some common trend indicators include Simple Moving Average (SMA), ADX, and Parabolic Stop and Reversal (Parabolic SAR) (Rosenbloom, 2010). There is no clear evidence for which of these indicators is best, but Parabolic SAR is known to be commonly used, easy to calculate and generates a clear signal (Di Lorenzo, 2013). Thus, it was chosen for the analysis.

Momentum oscillators

Momentum is a change in price between the current price and the price in the past, most typically the most recent period (for example, comparing Ct with Ct-1) (Etzkorn, 1997). A momentum oscillator is designed to identify the extremes of a cyclical market, based on the momentum or speed of change in the underlying indicator such as price or volume (Etzkorn, 1997). Momentum oscillators typically revolve in a fixed range around 0 (Fernández-Blanco, et al., 2008). Relative strength index (RSI) is the ratio of the smoothed moving average of gains and losses over a period of some days (Colby, 2002). It has been supported as a profitable indicator in several previous studies (Adariani, 2012; Chong & Ng, 2008; Liu & Xiao, 2009; Stasinakis & Sermpinis, 2014; Wong, Manzur, & Chew, 2010). It is also simple to calculate on trading platforms and reduces problems from points dropping of the end of the scale, though it can also show significant volatility (Colby, 2002). Thus, it was chosen for the analysis.

Money flow indicators

Money flow is the price velocity times the volume of the underlying instrument (Colby, 2002). The money flow indicator, therefore, relates the price of the instrument to its trading volume (Colby, 2002). There are relatively few money flow indicator measures available, given the simplicity of the calculation (Colby, 2002). One of the most common money flow indicators is the Chaikin money flow indicator (Colby, 2002). However, a found that the Chaikin money flow, while it could deliver a profit, less profitable than all other indicators used, including Moving Average, Bollinger Bands, Relative Strength Index, and Stochastic Momentum Index (Kannan, Sekar, Sathik, & Arumugam, 2010). The Twiggs Money Flow is an adaptation of Chaikin money flow, which has been modified for substitution of daily high minus low with true range and using EMA instead of SMA (Twiggs, 2014b). These changes are designed to overcome problems with the original indicator, such as failing to identify price gaps and spikes or dips from inclusion or exclusion of data in the moving average window (Twiggs, 2014b). Thus, it was chosen for analysis.

Volume indicators

The volume of the stock or other traded instrument simply refers to the total number of units (in the case of stocks, shares) traded over a specific period, such as one trading day (Kaufman, 2013). Thus, volume indicators are those that measure stock performance based on volume

(Kaufman, 2013). Early volume indicators were unreliable and often did not have valuable information about performance (Penn, 2005). However, more recent evidence suggests volume indicators may be more informative in developing markets (Tsang & Chong, 2009). Common volume indicators include Volume, Volume Rate of Change (VROC), and Volume Oscillator (VO) (Kirkpatrick & Dahlquist, 2010). The Percentage Volume Oscillator (PVO) is a momentum oscillator for volume. PVO measures the difference between two volume-based moving averages as a percentage of the larger moving average. Increasing volume can validate a support or resistance break. This made it most appropriate to be used in conjunction with other indicators and was chosen for the analysis.

Volatility indicators

In mathematical or statistical terms, volatility is measured using the dispersion of an indicator such as price or volume between periods, using tools like standard deviation or variance (Freund, Mohr, & Wilson, 2010; Kaufman, 2013). Volatility communicates the extent of uncertainty or variation surrounding the instrument's performance (Grimes, 2012). Volatility indicators are commonly used in practice (Chen, 2011; Edwards, et al., 2013; Kaufman, 2013), though there is weak evidence for recommending their use based on technical analysis theory because it is complex and unpredictable (Kaufman, 2013; Northington, 2009). One of the most commonly used volatility indicators is Bollinger bands, which use a baseline of 20-day SMA, combined with resistance lines two standard deviations above and below this line (Colby, 2002). Bollinger bands are flexible and simple to interpret, and have other advantages like identifying points where instruments are in oversold or overbought conditions (Stasinakis & Sermpinis, 2014). Bollinger Bands have also been shown to reduce the associated risk of trades (Adariani, 2012). Thus, it was chosen for analysis.

Confirming indicators

A confirming indicator is a supplementary indicator that either reinforces or rejects the perception of a trend or otherwise deepens the information received from the original indicator (Kirkpatrick & Dahlquist, 2010). The purpose of the confirmatory indicator is to provide additional information about the technical indicators discussed above and the information they communicate (Kaufman, 2013). Convergence means the original and confirming indicator communicate the same signal, while divergence means they disagree (Bollinger, 1992). Confirming indicators have been used since the days of paper charting, as a double-check on identified trends (Chen, 2011; Etzkorn, 1997; Kaufman, 2013; Kirkpatrick & Dahlquist, 2010). Different confirming indicators may be used together. For example, RSI is commonly used as a confirming indicator with MACD (Adariani, 2012; Liu & Xiao, 2009; Stasinakis & Sermpinis, 2014). It is also common for authors to state that volume indicators provide valuable confirmatory evidence for price-based trend and oscillator indicators (Blume, Easley, & O'Hara, 1994; Kirkpatrick & Dahlquist, 2010; Penn, 2005). However, confirming indicators have not been studied in terms of their effectiveness or ideal combinations in the academic literature, even though it is known that they are used (Penn, 2005).

METHODOLOGY

Data collection and preparation

Data collection was conducted using three randomly selected SET50 firms, Inter Far East Energy Corporation Plc. (IFEC), PTT Exploration and Production Public Company Limited (PTTEP), and The Siam Commercial Bank Public Company Limited (SCB). Data was collected for the period of January 2008 to December 2014, including daily open, close, high, low, and volume which are required in the calculation of technical indicators. The source of the data was the SET market data database, which provides performance indicators and raw data for all firms traded on the Stock Exchange of Thailand.

The data preparation process used standard data mining data preparation techniques and practices (Chen, Liu, Chen, Cui, & Fang, 2008; Heaton, 2009; Maimon & Rokach, 2010). Data was manually and algorithmically checked for outliers and errors, and errors were cleaned.

Research model formation

The model formation was iterative, beginning from testing of single indicators in each of the six categories and through the other four stages of the testing process. This is similar to the techniques used by other authors that have used neural networks for model formation, as well as a general approach to model formation for different concepts (Atsalakis & Valavanis, 2009; Chen, et al. 2008; Fernández-Blanco, et al., 2008; Kordos & Cwiok, 2011; Lam, 2004; Maimon & Rokach, 2010). Each single indicator was tested using the algorithm. Then, the AND function was applied iteratively in order to combine indicators. The AND function is selected because it is a binary function that can detect non-simultaneous indicators (or those that are offering conflicting BUY/SELL signals). If both indicators are returning the same BUY/SELL signal, then AND will return TRUE. Otherwise, it will return FALSE. Multiple ANDs will work in the same way. Thus, using AND will generate a clear BUY/SELL signal from multiple indicators. The AND function was then used to combine two indicators (the double indicators stage) (15 indicators). Next, AND was used again to combine three indicators (triple indicators stage) (20 indicators). Models were specified and tested against the market simulation. This cyclical process gradually identified the most accurate models, including the specific indicators combined in the integrated indicator and whether the AND function performs more effectively.

Indicators included

There were six indicators included in the test. These included MACD, PSAR, RSI, Twiggs Money Flow, Percentage Volume Oscillator, and Bollinger bands. The indicators were selected as the most common representatives of the classifications of indicators identified by Colby (2002). The calculation and BUY/SELL conditions are explained in detail in Table 1.

These indicators were previously supported as potentially producting abnormal profits over the baseline (Adariani, 2012; Chong & Ng, 2008; Colby, 2002; Di Lorenzo, 2013; Edwards et al., 2013; Kordos & Cwiok, 2011; Liu & Xiao, 2009; Park & Irwin, 2007; Stasinakis & Sermpinis, 2014; Wong et al., 2010). In some cases, including MACD, RSI, Parabolic SAR, and Bollinger Bands, they have also been supported as complementary or confirming indicators for each other (Kirkpatrick & Dahlquist, 2010; Kordos & Cwiok, 2011; Liu & Xiao, 2009; Lo, et al., 2000; Stasinakis & Sermpinis, 2014).

Table 1: Summary of technical indicators and trading signals

Indicator Class	Technical Indicator	Trading Signal
Moving Average Oscillator	Moving Average Convergence Divergence (MACD)	• **BUY**: MACD crosses signal line from below • **SELL**: MACD crosses signal line from above
Trend Indicator	Parabolic Stop and Reversal (SAR)	• **BUY**: Stock Price > PSAR • **SELL**: Stock Price < PSAR
Momentum Oscillator	Relative Strength Index (RSI)	• **BUY**: RSI > Oversold line (30) • **SELL**: RSI > Overbought line (70)
Money Flow	Twiggs Money Flow	• **BUY**: Money flow > 0 • **SELL**: Money flow < 0
Volume Indicator	Percentage Volume Oscillator	• **BUY**: PVO crosses signal line from below • **SELL**: PVO crosses signal line from above
Volatility Indicator	Bollinger Bands	• **BUY**: Price is two standard deviations or below 20-day MA (LOWER BAND) • **SELL**: Price is two standard deviations or above 20-day MA (UPPER BAND)

Source: Developed for this study

Model Judgment Criteria

Maximum Wealth (Baht)

The first judgment criterion used will be the maximum portfolio wealth. During the simulation process the portfolio wealth will be calculated throughout as the number of shares in portfolio multiply with the price of shares add with the amount of money in the portfolio.

In this research, the portfolio wealth will be calculated per trade using an automated data collection technique. This will be calculated for all trades performed including single indicator, double indicators, and triple indicators. This will help determine which method performs better in this area. It will also help determine the overall effectiveness of each of the models.

Wealth at the End of Period (Baht)

The second judgment criterion that will be used in the analysis is the Wealth at the End of Period. The Wealth at the End of Period refers to the amount of equity collected over a series of trades. In other words, it represents the total profit associated with a trading decision. The Wealth at the End of Period shows the accumulation of equity or profits over a period of time. This is helpful in understanding how a given trading model is performing.

In this analysis, the Wealth at the End of Period will be calculated for the trades' simulations over the period of analysis. This will help determine which of the models is more effective in the sense that it leads to higher accumulations of net equity for the simulated study. This will show in a numeric representation which approach is better in the long run. It is also consistent with the visual representation of performance that is a feature of technical analysis.

Maximum Drawdown (%)

The third judgment criteria used is Maximum Drawdown. A maximum drawdown is one of the most important risk measures. It is the maximum loss from a peak to a trough of a portfolio (before a new peak is attained). Maximum Drawdown is an indicator of downside risk over a specified time period.

In this analysis, the drawdown will be calculated for the trades' simulations over the period of analysis. This will help determine which of the models is more effective in the sense that it minimizes the drawdown for the simulated study.

RESULTS AND DISCUSSION

Model characteristics

The transaction cost for an entry-level investor (< THB5 million) is 0.2578%, excluding the Value Added Tax if traded with an exchange trader (Marketing Officer), or 0.2078% if the investor does Internet trading (Thanachart Securities PCL, 2015). The transaction cost is divided into Brokerage Fee, Trading/Regulatory Fee, and Clearing Fee. The 0.2578% figure was selected as the highest transaction cost. This simulation study includes the effect of transaction cost if there is any impact on the trades. To shorten the calculation process, for every purchases, the security price is multiplied by 1.00275846 (1 + 0.00275846), for every sale, the security price is multiplied by 0.99724154 (1 - 0.00275846).

The buy-and-hold strategy portfolio was created to compare with the developed models. It is the investment in the same security at the start of the period, holding it regardless of market conditions and calculating the net worth of the holding at the end of the period.

Results in Table 2 shows the performance of benchmark portfolio (Buy & Hold Strategy) for three securities. For IFEC, the portfolio's maximum wealth reached as high as Baht 21,383.629.11 The Wealth at the End of Period for benchmark portfolio was Baht 17,476,375.85 and the Maximum Drawdown which is a risk measures was -65.85%. For PTTEP, the portfolio's maximum wealth reached as high as Baht 1,304,577.13 The Wealth at the End of Period for benchmark portfolio was Baht 702,465.13 and the Maximum Drawdown which is a risk measures was -72.14%. For SCB the portfolio's maximum wealth reached as high as Baht 2,431,480.79 The Wealth at the End of Period for benchmark portfolio was Baht 2,240,660.29 and the Maximum Drawdown which is a risk measures was -64.37%.

Table 2: Simulation results of the benchmark portfolio

SECURITIES	Maximum Wealth of Buy & Hold Strategy (Baht)	Wealth at the End of Period of Buy & Hold Strategy (Baht)	Maximum Drawdown of Buy & Hold Strategy
IFEC	21,383,629.11	17,476,375.85	-65.85%
PTTEP	1,304,577.13	702,465.13	-72.14%
SCB	2,431,480.79	2,240,660.29	-64.37%

Source: Developed for this study

Simulation of a single indicator

The simulation results of single indicators on IFEC are presented in Table 3. The portfolio that used single indicator PSAR resulted in Maximum Portfolio Wealth of THB 24,109,581.68 (+2310.96%) which was higher than those of Benchmark Portfolio's. The Wealth at the End of Period for PSAR was also the highest at THB 16,586,067.32 (+1558.61%) which was lower than of Benchmark Portfolio's. 61.54% of the Buy/Sell signals generated from PSAR were profitable trades. Its Maximum Drawdown was -17.59% which was a very good improvement comparing to those of Benchmark Portfolio's.

Table 3: Outcome of single indicator tests for IFEC

MODEL	Max.Wealth (Baht)	Max.Gain (Percentage)	Total Number of Buy&Sell (times)	Total Number of Profitable Trades (times)	Percentage of Profitable Trade	Wealth at the End of Period (Baht)	Gain from Investment (Baht)	Maximum Drawdown
MACD	11,505,787.62	1050.58%	51	24	47.06%	8,309,224.45	730.92%	-34.37%
RSI	1,259,913.89	25.99%	17	9	52.94%	1,213,516.73	21.35%	-54.27%
PSAR	24,109,581.68	2310.96%	52	32	61.54%	16,586,067.32	1558.61%	-17.59%
TWIGGS	5,325,509.63	432.55%	49	19	38.78%	3,609,837.41	260.98%	-38.36%
BBANDS	1,566,423.01	56.64%	14	11	78.57%	1,372,546.56	37.25%	-44.41%
PVO	3,386,387.97	238.64%	109	52	47.71%	2,650,063.17	165.01%	-39.64%

Source: Developed for this study

The simulations results of single indicators on PTTEP are presented in Table 4. The portfolio that used single indicator TWIGGS resulted in Maximum Portfolio Wealth of THB 1,363,998.88 (+36.40%) which was higher than those of Benchmark Portfolio's. Wealth at the End of Period for BBANDS was the highest at THB 734,468.31 (-26.55%) which was higher than of Benchmark Portfolio's but in loss. 64.71% of the Buy/Sell signals generated from RSI were profitable trades. The Maximum Drawdown of BBANDS portfolio was -20.41% which was a very good improvement comparing to those of Benchmark Portfolio's.

The simulations results of single indicators on SCB are presented in Table 5. The portfolio that used single indicator BBANDS resulted in Maximum Portfolio Wealth of THB 1,628,213.04 (+62.82%) which was lesser than those of Benchmark Portfolio's. Wealth at the End of Period for BBANDS was also the highest at THB 1,555,175.36 (+55.52%) which was higher than of Benchmark Portfolio's. 66.67% of the Buy/Sell signals generated from RSI were profitable trades. The Maximum Drawdown of BBANDS portfolio was -18.65% which was a very good improvement comparing to those of Benchmark Portfolio's.

Table 4: Outcome of single indicator tests for PTTEP

MODEL	Max.Wealth (Baht)	Max.Gain (Percentage)	Total Number of Buy&Sell (times)	Total Number of Profitable Trades (times)	Percentage of Profitable Trade	Wealth at the End of Period (Baht)	Gain from Investment (Baht)	Maximum Drawdown
MACD	1,272,764.99	27.28%	63	22	34.92%	568,461.60	-43.15%	-45.75%
RSI	1,222,502.97	22.25%	17	11	64.71%	569,259.30	-43.07%	-45.54%
PSAR	1,178,247.96	17.82%	69	28	40.58%	470,992.21	-52.90%	-51.56%
TWIGGS	1,363,998.88	36.40%	128	42	32.81%	358,542.55	-64.15%	-64.80%
BBANDS	1,186,429.78	18.64%	15	9	60.00%	734,468.31	-26.55%	-20.41%
PVO	1,153,168.31	15.32%	140	63	45.00%	279,207.98	-72.08%	-70.09%

Source: Developed for this study

Table 5: Outcome of single indicator tests for SCB

MODEL	Max.Wealth (Baht)	Max.Gain (Percentage)	Total Number of Buy&Sell (times)	Total Number of Profitable Trades (times)	Percentage of Profitable Trade	Wealth at the End of Period (Baht)	Gain from Investment (Baht)	Maximum Drawdown
MACD	1,021,620.68	2.16%	72	22	30.56%	552,114.63	-44.79%	-64.58%
RSI	1,175,788.26	17.58%	18	12	66.67%	1,046,538.85	4.65%	-32.45%
PSAR	1,030,521.36	3.05%	66	27	40.91%	719,771.37	-28.02%	-42.02%
TWIGGS	1,155,929.45	15.59%	115	35	30.43%	479,365.55	-52.06%	-58.15%
BBANDS	1,628,213.04	62.82%	18	10	55.56%	1,555,175.36	55.52%	-18.65%
PVO	1,092,680.56	9.27%	134	62	46.27%	509,513.50	-49.05%	-57.70%

Source: Developed for this study

Integration of indicators using AND function

One problem arose for AND function integration during simulation study because the buy and sell signals for different indicators did not match on the same day. Therefore the integration using AND function failed and no trade simulations has occurred. To solve this problem a minor interpretation of signals needed to take place. There were two methods tested for the interpretation of signals.

For the first method, if two signals showed Hold Cash at the same time, then the function will result in Hold Cash. Everything else will result in Hold Asset. Results are shown in Table 6.

Table 6: Test of AND function (Method 1)

Trading Signal of Indicator 1	Position of Indicator 1	Trading Signal of Indicator 2	Position of Indicator 2	AND FUNCTION Method 1 (Position)	Action taken
	Hold Cash	Sell	Hold Cash	Hold Cash	
Buy	Hold Asset	Sell	Hold Cash	Hold Asset	Buy
	Hold Asset	Sell	Hold Cash	Hold Asset	
	Hold Asset	Buy	Hold Asset	Hold Asset	
Sell	Hold Cash	Buy	Hold Asset	Hold Asset	
	Hold Cash	Buy	Hold Asset	Hold Asset	
	Hold Cash	Sell	Hold Cash	Hold Cash	Sell

Source: Developed for this study

For another method, if two signals showed Hold Cash at the same time, then the function will result in Hold Cash. Everything else will result in Hold Asset. Results are shown in Table 7.

Table 7: Test of AND function (Method 2)

Trading Signal of Indicator 1	Position of Indicator 1	Trading Signal of Indicator 2	Position of Indicator 2	AND FUNCTION Method 2 (Position)	Action taken
	Hold Cash	Sell	Hold Cash	Hold Cash	
Buy	Hold Asset	Sell	Hold Cash	Hold Cash	
	Hold Asset	Sell	Hold Cash	Hold Cash	
	Hold Asset	Buy	Hold Asset	Hold Asset	Buy
	Hold Asset	Buy	Hold Asset	Hold Asset	
Sell	Hold Cash	Buy	Hold Asset	Hold Cash	Sell
	Hold Cash	Buy	Hold Asset	Hold Cash	

Source: Developed for this study

Table 8: Outcome of Double indicators (AND function) for IFEC

MODEL	Max.Wealth (Baht)	Max.Gain (Percentage)	Total Number of Buy&Sell (times)	Total Number of Profitable Trades (times)	Percentage of Profitable Trade	Wealth at the End of Period (Baht)	Gain from Investment (Baht)	Maximum Drawdown
MACD&RSI(1)	6,292,801.68	529.28%	46	23	50.00%	4,544,522.29	354.45%	-36.23%
MACD&RSI(2)	2,150,055.75	115.01%	22	14	63.64%	2,070,878.43	107.09%	-41.92%
MACD&PSAR(1)	20,067,653.16	1906.77%	48	27	56.25%	14,640,503.04	1364.05%	-17.97%
MACD&PSAR(2)	15,247,191.97	1424.72%	53	30	56.60%	10,383,130.86	938.31%	-25.69%
MACD&TWIGGS(1)	18,605,399.48	1760.54%	58	22	37.93%	13,876,351.86	1287.64%	-18.49%
MACD&TWIGGS(2)	3,329,895.67	232.99%	40	19	47.50%	2,185,572.02	118.56%	-41.38%
MACD&BBANDS(1)	10,617,533.38	961.75%	42	24	57.14%	9,232,800.32	823.28%	-31.90%
MACD&BBANDS(2)	1,435,245.12	43.52%	22	13	59.09%	1,242,082.53	24.21%	-53.51%
MACD&PVO(1)	13,094,506.25	1209.45%	85	39	45.88%	11,174,252.19	1017.43%	-23.90%
MACD&PVO(2)	6,300,126.25	530.01%	72	35	48.61%	4,625,153.04	362.52%	-36.08%
RSI&PSAR(1)	16,653,236.62	1565.32%	44	27	61.36%	11,456,512.03	1045.65%	-21.17%
RSI&PSAR(2)	2,011,927.42	101.19%	23	18	78.26%	1,937,836.77	93.78%	-42.59%
RSI&TWIGGS(1)	5,833,005.25	483.30%	50	21	42.00%	3,953,838.50	295.38%	-37.88%
RSI&TWIGGS(2)	1,130,580.25	13.06%	16	7	43.75%	1,069,731.00	6.97%	-56.47%
RSI&BBANDS(1)	1,550,587.07	55.06%	16	11	68.75%	1,358,670.60	35.87%	-45.99%
RSI&BBANDS(2)	1,183,637.29	18.36%	15	9	60.00%	1,183,637.29	18.36%	-54.43%
RSI&PVO(1)	6,925,444.70	592.54%	73	38	52.05%	6,007,721.21	500.77%	-35.89%
RSI&PVO(2)	1,508,968.33	50.90%	50	23	46.00%	1,172,618.61	17.26%	-55.38%
PSAR&TWIGGS(1)	24,685,297.06	2368.53%	54	27	50.00%	16,732,650.90	1573.27%	-17.59%
PSAR&TWIGGS(2)	5,832,847.57	483.28%	42	23	54.76%	4,012,679.94	301.27%	-37.88%
PSAR&BBANDS(1)	21,798,317.43	2079.83%	42	25	59.52%	17,874,220.54	1687.42%	-15.15%
PSAR&BBANDS(2)	1,621,055.78	62.11%	20	15	75.00%	1,420,417.55	42.04%	-44.12%
PSAR&PVO(1)	34,707,705.82	3370.77%	69	41	59.42%	30,108,421.94	2910.84%	-6.35%
PSAR&PVO(2)	5,433,434.08	443.34%	89	37	41.57%	3,737,905.03	273.79%	-37.94%
TWIGGS&BBANDS(1)	5,968,417.86	496.84%	54	25	46.30%	4,045,625.64	304.56%	-37.70%
TWIGGS&BBANDS(2)	1,421,015.57	42.10%	6	5	83.33%	1,245,136.81	24.51%	-53.29%
TWIGGS&PVO(1)	12,927,712.20	1192.77%	99	44	44.44%	9,801,458.57	880.15%	-31.21%
TWIGGS&PVO(2)	3,070,746.12	207.07%	52	26	50.00%	2,381,572.05	138.16%	-40.56%
BBANDS&PVO(1)	7,917,326.01	691.73%	72	36	50.00%	6,868,163.19	586.82%	-35.58%
BBANDS&PVO(2)	1,442,249.61	44.22%	45	22	48.89%	1,263,741.94	26.37%	-52.52%

Source: Developed for this study

Results of the double indicators using AND function for IFEC (Table 8) showed that double indicators combinations of PSAR&TWIGGS(1), PSAR&BBANDS(1) and PSAR&PVO(1) resulted in their Maximum Portfolio Wealth were higher than those of Benchmark Portfolio's. The Wealth at the End of Period of PSAR&PVO(1) combination was the highest of Baht

30,108,421.94 (+2910.84%). 59.42% of the trades following signals from PSAR&PVO(1) were profitable. Its Maximum Drawdown was -6.35% which was a very good improvement comparing to those of Benchmark Portfolio's and was much better than those of PSAR as a single indicator.

Results of the double indicators using AND function for PTTEP (Table 9) showed that double indicators combinations of MACD&BBANDS(1), MACD&PVO(1), RSI&PSAR(1), RSI&PVO(2), TWIGGS&BBANDS(2), TWIGGS&PVO(1), and BBANDS&PVO(2) resulted in their Maximum Portfolio Wealth were higher than those of Benchmark Portfolio's. The Wealth at the End of Period of RSI&BBANDS(1) combination was the highest of Baht 852,476.53 (-14.75%). 61.11% of the trades following signals from RSI&BBANDS(1) were profitable. Its Maximum Drawdown was -12.75% which was a very good improvement comparing to those of Benchmark Portfolio's and was much better than those of BBANDS as a single indicator.

Table 9: Outcome of Double indicators (AND function) for PTTEP

MODEL	Max.Wealth (Baht)	Max.Gain (Percentage)	Total Number of Buy&Sell (times)	Total Number of Profitable Trades (times)	Percentage of Profitable Trade	Wealth at the End of Period (Baht)	Gain from Investment (Baht)	Maximum Drawdown
MACD&RSI(1)	1,265,743.86	26.57%	45	18	40.00%	513,258.73	-48.67%	-46.18%
MACD&RSI(2)	1,018,353.36	1.84%	36	15	41.67%	560,955.07	-43.90%	-46.17%
MACD&PSAR(1)	1,233,041.88	23.30%	61	25	40.98%	598,238.89	-40.18%	-40.89%
MACD&PSAR(2)	1,264,656.99	26.47%	71	23	32.39%	465,424.32	-53.46%	-54.98%
MACD&TWIGGS(1)	1,264,299.16	26.43%	90	31	34.44%	512,753.04	-48.72%	-46.37%
MACD&TWIGGS(2)	1,098,700.31	9.87%	98	34	34.69%	406,378.82	-59.36%	-60.75%
MACD&BBANDS(1)	1,345,709.02	34.57%	37	18	48.65%	652,868.17	-34.71%	-36.20%
MACD&BBANDS(2)	1,044,093.52	4.41%	40	16	40.00%	646,576.97	-35.34%	-37.11%
MACD&PVO(1)	1,573,712.73	57.37%	91	41	45.05%	726,650.37	-27.33%	-21.55%
MACD&PVO(2)	1,156,876.82	15.69%	102	39	38.24%	489,446.16	-51.06%	-47.37%
RSI&PSAR(1)	1,400,833.63	40.08%	48	25	52.08%	448,405.90	-55.16%	-57.52%
RSI&PSAR(2)	1,101,777.63	10.18%	37	15	40.54%	651,396.31	-34.86%	-36.74%
RSI&TWIGGS(1)	1,193,746.65	19.37%	93	35	37.63%	284,371.18	-71.56%	-64.80%
RSI&TWIGGS(2)	1,121,871.91	12.19%	52	17	32.69%	669,025.96	-33.10%	-34.77%
RSI&BBANDS(1)	1,314,840.39	31.48%	18	11	61.11%	852,476.53	-14.75%	-12.75%
RSI&BBANDS(2)	1,009,409.48	0.94%	14	8	57.14%	497,748.87	-50.23%	-46.42%
RSI&PVO(1)	1,169,234.17	16.92%	85	43	50.59%	399,396.59	-60.06%	-63.34%
RSI&PVO(2)	1,561,192.32	56.12%	69	31	44.93%	774,207.26	-22.58%	-16.80%
PSAR&TWIGGS(1)	1,260,771.61	26.08%	91	26	28.57%	477,390.96	-52.26%	-50.69%
PSAR&TWIGGS(2)	1,161,626.07	16.16%	100	36	36.00%	396,143.05	-60.39%	-63.67%
PSAR&BBANDS(1)	1,283,494.70	28.35%	40	23	57.50%	614,773.71	-38.52%	-40.50%
PSAR&BBANDS(2)	1,000,000.00	0.00%	38	15	39.47%	630,074.76	-36.99%	-38.04%
PSAR&PVO(1)	1,266,207.74	26.62%	90	39	43.33%	473,298.81	-52.67%	-50.79%
PSAR&PVO(2)	1,188,194.69	18.82%	109	46	42.20%	628,128.89	-37.19%	-38.26%
TWIGGS&BBANDS(1)	1,080,875.64	8.09%	82	31	37.80%	410,350.25	-58.96%	-60.16%
TWIGGS&BBANDS(2)	1,411,829.41	41.18%	58	17	29.31%	652,502.96	-34.75%	-36.51%
TWIGGS&PVO(1)	1,770,468.07	77.05%	128	48	37.50%	490,182.10	-50.98%	-46.77%
TWIGGS&PVO(2)	1,113,996.83	11.40%	121	51	42.15%	478,288.84	-52.17%	-49.89%
BBANDS&PVO(1)	1,152,796.54	15.28%	73	37	50.68%	569,975.09	-43.00%	-43.03%
BBANDS&PVO(2)	1,616,410.57	61.64%	77	36	46.75%	779,929.06	-22.01%	-16.06%

Source: Developed for this study

Results of the double indicators using AND function for SCB (Table 10) showed that double indicators combinations of PSAR&BBANDS(1) resulted in its Maximum Portfolio Wealth were higher than those of Benchmark Portfolio's. The Wealth at the End of Period of PSAR&BBANDS(1) combination was the highest of Baht 2,484,619.46 (+148.46%). 61.54% of the trades following signals from PSAR&BBANDS(1) were profitable. Its Maximum

Drawdown was -7.36% which was a very good improvement comparing to those of Benchmark Portfolio's and was much better than those of BBANDS as a single indicator.

Table 10: Outcome of Double indicators (AND function) for SCB

MODEL	Max.Wealth (Baht)	Max.Gain (Percentage)	Total Number of Buy&Sell (times)	Total Number of Profitable Trades (times)	Percentage of Profitable Trade	Wealth at the End of Period (Baht)	Gain from Investment (Baht)	Maximum Drawdown
MACD&RSI(1)	1,021,620.69	2.16%	52	18	34.62%	693,615.35	-30.64%	-45.75%
MACD&RSI(2)	1,000,000.00	0.00%	37	18	48.65%	724,311.72	-27.57%	-44.39%
MACD&PSAR(1)	1,020,173.28	2.02%	69	25	36.23%	644,826.68	-35.52%	-49.43%
MACD&PSAR(2)	1,021,620.69	2.16%	68	22	32.35%	631,793.46	-36.82%	-52.10%
MACD&TWIGGS(1)	1,109,486.86	10.95%	101	29	28.71%	452,913.04	-54.71%	-63.67%
MACD&TWIGGS(2)	1,007,914.33	0.79%	85	27	31.76%	553,853.86	-44.61%	-63.67%
MACD&BBANDS(1)	1,529,896.40	52.99%	48	18	37.50%	1,289,713.20	28.97%	-19.65%
MACD&BBANDS(2)	1,000,000.00	0.00%	39	19	48.72%	676,892.57	-32.31%	-44.72%
MACD&PVO(1)	1,465,803.38	46.58%	96	44	45.83%	944,693.59	-5.53%	-38.43%
MACD&PVO(2)	1,038,155.03	3.82%	99	33	33.33%	440,627.49	-55.94%	-61.84%
RSI&PSAR(1)	1,570,526.32	57.05%	46	23	50.00%	1,288,912.14	28.89%	-21.43%
RSI&PSAR(2)	1,051,973.76	5.20%	37	19	51.35%	635,612.83	-36.44%	-49.91%
RSI&TWIGGS(1)	1,505,511.86	50.55%	66	25	37.88%	1,063,208.07	6.32%	-35.57%
RSI&TWIGGS(2)	1,051,973.76	5.20%	66	19	28.79%	458,832.92	-54.12%	-66.99%
RSI&BBANDS(1)	1,779,338.38	77.93%	19	12	63.16%	1,635,627.37	63.56%	-17.12%
RSI&BBANDS(2)	1,029,380.61	2.94%	17	10	58.82%	981,694.40	-1.83%	-35.05%
RSI&PVO(1)	1,066,170.90	6.62%	87	41	47.13%	602,912.97	-39.71%	-46.19%
RSI&PVO(2)	1,596,552.10	59.66%	63	31	49.21%	1,076,822.12	7.68%	-26.73%
PSAR&TWIGGS(1)	1,272,161.56	27.22%	92	30	32.61%	648,283.86	-35.17%	-46.09%
PSAR&TWIGGS(2)	1,088,456.76	8.85%	86	31	36.05%	585,272.84	-41.47%	-61.97%
PSAR&BBANDS(1)	2,853,569.50	185.36%	39	24	61.54%	2,484,619.46	148.46%	-7.36%
PSAR&BBANDS(2)	1,000,000.00	0.00%	40	18	45.00%	500,953.04	-49.90%	-56.78%
PSAR&PVO(1)	1,376,998.90	37.70%	91	41	45.05%	780,114.40	-21.99%	-38.83%
PSAR&PVO(2)	1,175,842.42	17.58%	96	38	39.58%	704,838.06	-29.52%	-49.04%
TWIGGS&BBANDS(1)	2,051,163.99	105.12%	56	22	39.29%	1,609,774.01	60.98%	-17.43%
TWIGGS&BBANDS(2)	1,089,779.26	8.98%	70	22	31.43%	481,345.04	-51.87%	-65.90%
TWIGGS&PVO(1)	1,159,618.97	15.96%	105	39	37.14%	696,999.92	-30.30%	-49.25%
TWIGGS&PVO(2)	1,189,399.63	18.94%	124	48	38.71%	504,908.37	-49.51%	-59.87%
BBANDS&PVO(1)	1,233,255.12	23.33%	79	42	53.16%	918,070.68	-8.19%	-36.61%
BBANDS&PVO(2)	1,702,176.45	70.22%	68	34	50.00%	1,235,532.65	23.55%	-25.10%

Source: Developed for this study

Results of the triple indicators using AND function for IFEC (Table 11), the best combination was model PSAR&TWIGGS&PVO(1), where the Maximum Portfolio Wealth reached Baht 35,711,020.15 (+3471.10%) higher than those of Benchmark Portfolio's, Single Indicator's and Double Indicators'. The Wealth at the End of Period for the same model was the highest of Baht 27,075,175.87 (+2607.52%) higher than of Benchmark Portfolio's, Single Indicator's but lower than Double Indicators model PSAR&PVO(1). Profitable trades under PSAR&TWIGGS&PVO(1) were 55.38%. Its Maximum Drawdown was -10.49% which was a very good improvement comparing to those of Benchmark Portfolio's and was much better than those of PSAR as single indicator. But not as good as Double Indicators of PSAR&PVO(1)

Table 11: Outcome of Triple indicators (AND function) for IFEC

MODEL	Max.Wealth (Baht)	Max.Gain (Percentage)	Total Number of Buy&Sell (times)	Total Number of Profitable Trades (times)	Percentage of Profitable Trade	Wealth at the End of Period (Baht)	Gain from Investment (Baht)	Maximum Drawdown
MACD&RSI&PSAR(1)	11,791,259.59	1079.13%	42	26	61.90%	8,602,401.01	760.24%	-34.37%
MACD&RSI&PSAR(2)	2,161,465.76	116.15%	22	16	72.73%	2,081,868.31	108.19%	-41.59%
MACD&RSI&TWIGGS(1)	11,722,272.47	1072.23%	47	21	44.68%	8,742,751.71	774.28%	-33.88%
MACD&RSI&TWIGGS(2)	1,286,503.25	28.65%	9	6	66.67%	1,239,126.86	23.91%	-54.04%
MACD&RSI&BBANDS(1)	7,885,384.30	688.54%	42	25	59.52%	6,856,976.98	585.70%	-35.86%
MACD&RSI&BBANDS(2)	1,607,275.48	60.73%	20	14	70.00%	1,607,275.48	60.73%	-43.78%
MACD&RSI&PVO(1)	10,536,766.65	953.68%	57	29	50.88%	8,991,594.92	799.16%	-31.90%
MACD&RSI&PVO(2)	1,771,538.17	77.15%	29	16	55.17%	1,706,300.02	70.63%	-42.68%
MACD&PSAR&TWIGGS(1)	24,072,568.13	2307.26%	53	24	45.28%	17,953,897.62	1695.39%	-12.86%
MACD&PSAR&TWIGGS(2)	4,326,972.17	332.70%	40	22	55.00%	2,946,609.69	194.66%	-38.60%
MACD&PSAR&BBANDS(1)	20,332,822.78	1933.28%	38	24	63.16%	17,681,027.69	1668.10%	-15.85%
MACD&PSAR&BBANDS(2)	1,761,880.72	76.19%	20	14	70.00%	1,535,318.51	53.53%	-43.78%
MACD&PSAR&PVO(1)	24,705,390.64	2370.54%	65	36	55.38%	21,082,450.14	2008.25%	-12.38%
MACD&PSAR&PVO(2)	5,942,761.36	494.28%	70	33	47.14%	4,046,941.64	304.69%	-37.70%
MACD&TWIGGS&BBANDS(1)	16,533,149.99	1553.31%	50	23	46.00%	12,330,819.16	1133.08%	-20.95%
MACD&TWIGGS&BBANDS(2)	1,142,718.23	14.27%	7	5	71.43%	995,775.83	-0.42%	-58.41%
MACD&TWIGGS&PVO(1)	17,682,959.02	1668.30%	81	36	44.44%	13,188,373.52	1218.84%	-19.45%
MACD&TWIGGS&PVO(2)	2,550,303.50	155.03%	42	23	54.76%	1,673,888.41	67.39%	-43.74%
MACD&BBANDS&PVO(1)	13,053,097.55	1205.31%	56	28	50.00%	11,138,916.59	1013.89%	-24.04%
MACD&BBANDS&PVO(2)	1,367,599.09	36.76%	26	15	57.69%	1,127,494.63	12.75%	-55.38%
RSI&PSAR&TWIGGS(1)	15,682,585.19	1468.26%	44	22	50.00%	10,630,264.87	963.03%	-24.75%
RSI&PSAR&TWIGGS(2)	1,173,428.15	17.34%	11	6	54.55%	1,130,215.90	13.02%	-55.38%
RSI&PSAR&BBANDS(1)	16,568,370.90	1556.84%	41	26	63.41%	13,585,760.02	1258.58%	-18.91%
RSI&PSAR&BBANDS(2)	1,496,176.86	49.62%	19	14	73.68%	1,496,176.86	49.62%	-44.08%
RSI&PSAR&PVO(1)	25,219,693.41	2421.97%	45	30	66.67%	21,877,711.03	2087.77%	-12.38%
RSI&PSAR&PVO(2)	1,486,979.79	48.70%	35	16	45.71%	1,409,996.82	41.00%	-44.13%
RSI&TWIGGS&BBANDS(1)	6,446,339.06	544.63%	49	25	51.02%	4,369,579.86	336.96%	-36.38%
RSI&TWIGGS&BBANDS(2)	1,186,668.88	18.67%	6	5	83.33%	1,186,668.88	18.67%	-54.43%
RSI&TWIGGS&PVO(1)	12,510,132.88	1151.01%	64	30	46.88%	9,484,861.27	848.49%	-31.21%
RSI&TWIGGS&PVO(2)	1,112,715.17	11.27%	14	6	42.86%	1,071,738.72	7.17%	-56.05%
RSI&BBANDS&PVO(1)	8,224,994.96	722.50%	68	37	54.41%	7,135,062.12	613.51%	-34.61%
RSI&BBANDS&PVO(2)	1,317,967.73	31.80%	41	21	51.22%	1,272,738.04	27.27%	-47.30%
PSAR&TWIGGS&BBANDS(1)	18,476,525.51	1747.65%	47	21	44.68%	12,524,106.17	1152.41%	-20.80%
PSAR&TWIGGS&BBANDS(2)	1,094,646.78	9.46%	6	4	66.67%	959,162.03	-4.08%	-58.90%
PSAR&TWIGGS&PVO(1)	35,711,020.15	3471.10%	65	36	55.38%	27,075,175.87	2607.52%	-10.49%
PSAR&TWIGGS&PVO(2)	3,384,115.23	238.41%	42	25	59.52%	2,328,087.11	132.81%	-40.86%
PSAR&BBANDS&PVO(1)	28,821,955.18	2782.20%	42	28	66.67%	25,002,620.63	2400.26%	-12.38%
PSAR&BBANDS&PVO(2)	1,245,134.81	24.51%	28	14	50.00%	1,062,334.73	6.23%	-56.77%
TWIGGS&BBANDS&PVO(1)	13,606,588.11	1260.66%	64	31	48.44%	10,316,165.00	931.62%	-31.21%
TWIGGS&BBANDS&PVO(2)	1,347,019.91	34.70%	6	4	66.67%	1,180,299.30	18.03%	-55.13%

Source: Developed for this study

Results of the triple indicators using AND function for PTTEP (Table 12), the highest Maximum Portfolio Wealth model was MACD&TWIGGS&PVO(1) which reached Baht 1,651,457.61 (+65.15%) higher than those of Benchmark Portfolio's and Single Indicator's. The Wealth at the End of Period for RSI&PSAR&PVO(2) was the highest of Baht 903,128.40 (-9.69%) Profitable trades under same model were 46.94%. Its Maximum Drawdown was -6.98% which was a very good improvement comparing to those of Benchmark Portfolio's and was much better than those of BBANDS as single indicator.

Table 12: Outcome of Triple indicators (AND function) for PTTEP

MODEL	Max.Wealth (Baht)	Max.Gain (Percentage)	Total Number of Buy&Sell (times)	Total Number of Profitable Trades (times)	Percentage of Profitable Trade	Wealth at the End of Period (Baht)	Gain from Investment (Baht)	Maximum Drawdown
MACD&RSI&PSAR(1)	1,256,454.99	25.65%	40	21	52.50%	572,841.03	-42.72%	-42.60%
MACD&RSI&PSAR(2)	1,018,353.36	1.84%	35	14	40.00%	659,501.01	-34.05%	-34.89%
MACD&RSI&TWIGGS(1)	1,285,273.11	28.53%	59	25	42.37%	468,539.46	-53.15%	-51.63%
MACD&RSI&TWIGGS(2)	1,068,523.45	6.85%	38	14	36.84%	684,644.22	-31.54%	-27.64%
MACD&RSI&BBANDS(1)	1,518,441.33	51.84%	37	19	51.35%	739,017.89	-26.10%	-20.30%
MACD&RSI&BBANDS(2)	1,044,093.52	4.41%	32	12	37.50%	627,410.14	-37.26%	-38.98%
MACD&RSI&PVO(1)	1,261,313.99	26.13%	52	30	57.69%	591,119.41	-40.89%	-41.62%
MACD&RSI&PVO(2)	1,045,073.39	4.51%	45	19	42.22%	713,128.22	-28.69%	-25.19%
MACD&PSAR&TWIGGS(1)	1,241,779.48	24.18%	78	26	33.33%	593,956.01	-40.60%	-41.47%
MACD&PSAR&TWIGGS(2)	1,165,400.31	16.54%	91	33	36.26%	436,093.06	-56.39%	-59.54%
MACD&PSAR&BBANDS(1)	1,422,367.22	42.24%	33	19	57.58%	753,431.36	-24.66%	-18.12%
MACD&PSAR&BBANDS(2)	1,003,941.52	0.39%	38	15	39.47%	687,081.77	-31.29%	-27.49%
MACD&PSAR&PVO(1)	1,299,177.55	29.92%	71	32	45.07%	587,639.63	-41.24%	-42.50%
MACD&PSAR&PVO(2)	1,156,876.82	15.69%	93	32	34.41%	480,029.06	-52.00%	-49.66%
MACD&TWIGGS&BBANDS(1)	1,236,015.97	23.60%	50	23	46.00%	569,968.41	-43.00%	-44.50%
MACD&TWIGGS&BBANDS(2)	1,149,143.93	14.91%	42	12	28.57%	642,002.20	-35.80%	-37.96%
MACD&TWIGGS&PVO(1)	1,651,457.61	65.15%	86	35	40.70%	624,706.90	-37.53%	-39.50%
MACD&TWIGGS&PVO(2)	1,053,960.44	5.40%	96	37	38.54%	441,023.23	-55.90%	-58.24%
MACD&BBANDS&PVO(1)	1,333,423.08	33.34%	46	28	60.87%	732,967.07	-26.70%	-20.53%
MACD&BBANDS&PVO(2)	1,143,085.72	14.31%	51	23	45.10%	730,045.23	-27.00%	-21.37%
RSI&PSAR&TWIGGS(1)	1,282,396.53	28.24%	59	21	35.59%	448,239.16	-55.18%	-57.91%
RSI&PSAR&TWIGGS(2)	1,090,658.82	9.07%	37	13	35.14%	784,035.41	-21.60%	-15.05%
RSI&PSAR&BBANDS(1)	1,380,642.75	38.06%	38	24	63.16%	716,601.53	-28.34%	-21.84%
RSI&PSAR&BBANDS(2)	1,000,000.00	0.00%	30	11	36.67%	680,979.92	-31.90%	-33.39%
RSI&PSAR&PVO(1)	1,266,207.74	26.62%	50	29	58.00%	449,719.08	-55.03%	-57.29%
RSI&PSAR&PVO(2)	1,199,895.84	19.99%	49	23	46.94%	903,128.40	-9.69%	-6.98%
RSI&TWIGGS&BBANDS(1)	1,193,746.65	19.37%	77	30	38.96%	460,093.86	-53.99%	-56.49%
RSI&TWIGGS&BBANDS(2)	1,224,603.82	22.46%	42	13	30.95%	711,518.75	-28.85%	-25.74%
RSI&TWIGGS&PVO(1)	1,163,251.09	16.33%	68	27	39.71%	405,632.60	-59.44%	-62.68%
RSI&TWIGGS&PVO(2)	1,229,053.48	22.91%	41	17	41.46%	877,191.45	-12.28%	-12.06%
RSI&BBANDS&PVO(1)	1,124,557.36	12.46%	71	36	50.70%	587,731.59	-41.23%	-42.39%
RSI&BBANDS&PVO(2)	1,643,499.84	64.35%	64	28	43.75%	799,861.01	-20.01%	-12.87%
PSAR&TWIGGS&BBANDS(1)	1,275,684.10	27.57%	47	19	40.43%	617,306.05	-38.27%	-39.68%
PSAR&TWIGGS&BBANDS(2)	1,207,871.24	20.79%	39	13	33.33%	715,858.97	-28.41%	-24.62%
PSAR&TWIGGS&PVO(1)	1,238,836.09	23.88%	84	29	34.52%	454,967.61	-54.50%	-56.72%
PSAR&TWIGGS&PVO(2)	1,128,269.44	12.83%	96	38	39.58%	483,370.99	-51.66%	-48.26%
PSAR&BBANDS&PVO(1)	1,266,207.74	26.62%	45	27	60.00%	594,470.77	-40.55%	-40.91%
PSAR&BBANDS&PVO(2)	1,264,115.92	26.41%	54	24	44.44%	845,064.52	-15.49%	-12.75%
TWIGGS&BBANDS&PVO(1)	1,163,251.09	16.33%	61	26	42.62%	490,147.14	-50.99%	-46.91%
TWIGGS&BBANDS&PVO(2)	1,240,154.13	24.02%	47	17	36.17%	716,151.95	-28.38%	-21.98%

Source: Developed for this study

Results of the triple indicators using AND function for SCB (Table 13), the highest Maximum Portfolio Wealth model was RSI&PSAR&BBANDS(1) which reached Baht 2,827,092.70 (+182.71%) higher than those of Benchmark Portfolio's and Single Indicator's. The Wealth at the End of Period for the same model was the highest of Baht 2,454,894.03 (+146.49%) Profitable trades under same model were 62.16%. Its Maximum Drawdown was -12.06% which was a very good improvement comparing to those of Benchmark Portfolio's and was much better than those of BBANDS as single indicator.

Table 13: Outcome of Triple indicators (AND function) for SCB

MODEL	Max.Wealth (Baht)	Max.Gain (Percentage)	Total Number of Buy&Sell (times)	Total Number of Profitable Trades (times)	Percentage of Profitable Trade	Wealth at the End of Period (Baht)	Gain from Investment (Baht)	Maximum Drawdown
MACD&RSI&PSAR(1)	1,165,497.46	16.55%	46	20	43.48%	983,601.40	-1.64%	-39.64%
MACD&RSI&PSAR(2)	1,000,000.00	0.00%	33	17	51.52%	748,635.43	-25.14%	-39.90%
MACD&RSI&TWIGGS(1)	1,291,939.81	29.19%	53	20	37.74%	922,426.35	-7.76%	-39.45%
MACD&RSI&TWIGGS(2)	1,000,000.00	0.00%	38	15	39.47%	717,590.68	-28.24%	-47.86%
MACD&RSI&BBANDS(1)	1,528,981.03	52.90%	44	17	38.64%	1,264,542.40	26.45%	-23.25%
MACD&RSI&BBANDS(2)	1,000,000.00	0.00%	33	18	54.55%	766,185.28	-23.38%	-41.67%
MACD&RSI&PVO(1)	1,579,975.35	58.00%	58	28	48.28%	1,117,412.35	11.74%	-24.76%
MACD&RSI&PVO(2)	1,397,841.97	39.78%	40	20	50.00%	1,030,314.49	3.03%	-34.64%
MACD&PSAR&TWIGGS(1)	1,053,390.04	5.34%	91	29	31.87%	552,935.81	-44.71%	-56.74%
MACD&PSAR&TWIGGS(2)	1,007,914.33	0.79%	80	27	33.75%	573,516.83	-42.65%	-58.09%
MACD&PSAR&BBANDS(1)	2,126,487.57	112.65%	39	21	53.85%	1,883,372.83	88.34%	-14.48%
MACD&PSAR&BBANDS(2)	1,000,000.00	0.00%	34	17	50.00%	626,371.86	-37.36%	-45.84%
MACD&PSAR&PVO(1)	1,546,329.66	54.63%	81	39	48.15%	969,757.75	-3.02%	-34.96%
MACD&PSAR&PVO(2)	1,038,155.03	3.82%	88	30	34.09%	606,029.87	-39.40%	-44.57%
MACD&TWIGGS&BBANDS(1)	1,925,198.77	92.52%	43	17	39.53%	1,523,750.74	52.38%	-19.00%
MACD&TWIGGS&BBANDS(2)	1,010,324.64	1.03%	37	16	43.24%	689,498.76	-31.05%	-47.37%
MACD&TWIGGS&PVO(1)	1,111,938.42	11.19%	83	30	36.14%	760,249.00	-23.98%	-39.84%
MACD&TWIGGS&PVO(2)	1,053,281.19	5.33%	89	28	31.46%	482,043.34	-51.80%	-63.69%
MACD&BBANDS&PVO(1)	1,921,155.22	92.12%	53	28	52.83%	1,521,920.42	52.19%	-19.40%
MACD&BBANDS&PVO(2)	1,148,186.80	14.82%	42	19	45.24%	875,605.20	-12.44%	-39.13%
RSI&PSAR&TWIGGS(1)	1,874,642.06	87.46%	48	22	45.83%	1,350,427.49	35.04%	-21.93%
RSI&PSAR&TWIGGS(2)	1,051,973.76	5.20%	41	16	39.02%	600,237.97	-39.98%	-50.14%
RSI&PSAR&BBANDS(1)	2,827,092.70	182.71%	37	23	62.16%	2,454,894.03	145.49%	-12.06%
RSI&PSAR&BBANDS(2)	1,000,000.00	0.00%	34	17	50.00%	601,173.75	-39.88%	-52.43%
RSI&PSAR&PVO(1)	1,430,423.15	43.04%	55	29	52.73%	1,029,979.80	3.00%	-33.50%
RSI&PSAR&PVO(2)	1,378,056.25	37.81%	40	19	47.50%	995,758.13	-0.42%	-38.28%
RSI&TWIGGS&BBANDS(1)	2,154,222.26	115.42%	51	21	41.18%	1,690,647.57	69.06%	-13.89%
RSI&TWIGGS&BBANDS(2)	1,000,000.00	0.00%	57	16	28.07%	475,213.99	-52.48%	-61.66%
RSI&TWIGGS&PVO(1)	1,406,320.54	40.63%	52	25	48.08%	1,067,613.79	6.76%	-30.31%
RSI&TWIGGS&PVO(2)	1,272,083.64	27.21%	52	21	40.38%	833,882.05	-16.61%	-43.29%
RSI&BBANDS&PVO(1)	1,272,447.82	27.24%	70	37	52.86%	981,148.21	-1.89%	-38.49%
RSI&BBANDS&PVO(2)	1,598,023.83	59.80%	53	27	50.94%	1,248,422.14	24.84%	-21.38%
PSAR&TWIGGS&BBANDS(1)	2,534,127.05	153.41%	39	19	48.72%	1,995,440.81	99.54%	-13.24%
PSAR&TWIGGS&BBANDS(2)	1,000,000.00	0.00%	43	15	34.88%	466,829.22	-53.32%	-65.51%
PSAR&TWIGGS&PVO(1)	1,347,166.04	34.72%	77	29	37.66%	825,044.16	-17.50%	-39.96%
PSAR&TWIGGS&PVO(2)	1,087,997.10	8.80%	89	32	35.96%	623,801.38	-37.62%	-45.89%
PSAR&BBANDS&PVO(1)	2,209,731.55	120.97%	45	28	62.22%	1,738,191.23	73.82%	-14.85%
PSAR&BBANDS&PVO(2)	1,178,026.03	17.80%	40	18	45.00%	906,504.79	-9.35%	-37.52%
TWIGGS&BBANDS&PVO(1)	1,688,140.95	68.81%	44	21	47.73%	1,378,518.94	37.85%	-21.27%
TWIGGS&BBANDS&PVO(2)	1,308,010.12	30.80%	54	20	37.04%	777,478.62	-22.25%	-41.29%

Source: Developed for this study

Discussion

The most noticeable finding of this research is that the performance of PSAR was noticeably better than other indicators in single, double, and triple indicators tests, and inclusion of PSAR in multi-indicator tests improved performance above the Benchmark Portfolio. This is consistent with other studies, which have also confirmed the efficacy of PSAR as a technical indicator, either a primary indicator or a confirming indicator (Di Lorenzo, 2013 Kirkpatrick & Dahlquist, 2010; Kordos & Cwiok, 2011; Liu & Xiao, 2009; Lo, et al., 2000; Metghalchi, Chang, & Garza-Gomez, 2012; Stasinakis & Sermpinis, 2014). This finding was consistent with the expectations set by the literature, although the literature did not show that the PSAR indicator would be so much more effective than the alternative technical indicators. This is likely because there is a dearth of comparative literature and literature that assesses multi-indicator models rather than single-indicator models.

The outcome of the technical indicators did somewhat support its use. The Weak-Form Efficient Market Hypothesis does not hold in this case. However, the other indicators did not perform as consistently well as PSAR. This supports the contention of other researchers, who have argued that in the long term, technical analysis cannot beat the performance of a buy and hold strategy (Chen & Metghalchi, 2012; Chong, Cheng, & Wong, 2010; Coe & Laosethakul, 2010). These authors have generally found that the performance of technical indicators compared to buy and hold strategies is not supported in the long term, and the findings of this study do not contradict those findings (although they do point to the short-term viability of technical indicators compared to buy and hold).

It can also be found that the better performed models of which had higher End of Period Wealth also had lower downside risk since its Maximum Drawdown was lesser. Using PSAR or BBANDS alone their Maximum Drawdown were much lower than those of Benchmark Portfolio, by using it with other confirming indicator the maximum drawdown changed in two directions, with proper-matched confirming indicators the Maximum Drawdown was reduced, with other indicators the Maximum Drawdown was increased.

CONCLUSION AND RECOMMENDATIONS

This study provided a solution for an investor for use when the trading signals from different indicators do not match on the same day. Using the AND function, if the signal provided by confirming indicators does not match no trade can occur and there could be a loss of opportunity to trade for the entire period. This study considered the portfolio's position as a result of single indicators trading signal instead of the trading signals calculated.

The simulation study showed that the AND function can be used to combine the trade signals from technical indicators successfully. Combining the signals from multiple indicators improve the performance of trading model both in higher wealth and lower risk. This study has also included the highest transaction cost to the simulation process, which is important when considering the total cost of trade and the potential profits.

The results of this study do call into question the weak form of the efficient market hypothesis (EMH). The findings showed that technical indicators can be used to out-perform buy and hold strategies, although not all technical indicators had the same effectiveness. The conclusion of this research is that there is at least the potential that technical indicators could be used for effective trading with abnormal returns above those provided by a buy and hold strategy. However, this should not be taken as absolute proof, given the limitations of the study and the conditions under which it is undertaken. There is still a need for more research in this topic area, which has received little empirical support despite its active use on the trading floor.

The main implication of this finding is that, at least within the scope of this study, technical analysis can be an effective short-term trading strategy when using the right indicators and combinations. However, care must be taken in replicating The success of the study depended on several conditions, including include (1) inclusion of technical indicators from different categories, (2) daily data of the security using the highest market capitalization of each industry, (3) transaction cost was included in the calculation, (4) an alternative method of combining trading signals was used, and (5) the study period covers all economic circumstances. Thus, when attempting to replicate the results or use the established model in practice, these factors do need to be taken into account.

There are several limitations to this study. The main limitation is that only three securities were included in the analysis, and all securities were from the Stock Exchange of Thailand (SET) over a limited period. Another limitation is that not all industries are represented in the study. The study did not compare performance of technical indicators between industries. It also included a limited number of indicators, which was necessary because the potential list of technical indicators is too large for a single study. This study used closing price as price in the calculation where in real life trading you may or may not be able to buy stocks at closing price. The closing price is only useful during periods when a company has not issued any cash dividends or conducted any corporate actions, such as stock splits, reverse stock splits and stock dividends. This study assumed no dividend payment nor any impact from dividend payment on the closing price. The simulated model assumes that the investor can buy and sell at the informed price and the required volume but in reality the price may go up or down and the securities might not be available at the required volume.

This offers the opportunity for expanding research, including analysis of different indicators, different signals combination technique, comparison of developing versus developed markets, and more extensive long-term analysis of the effectiveness of technical indicators against other strategies. Similar ideas can also be adapted to other financial markets such as derivatives market, commodity market, and foreign exchange market.

References

Abbodante, P. (2010). Trading volume and stock indices: A test of technical analysis. American *Journal of Economics and Business Administration*, 2 (3), 287-292.

Adariani, M. R. (2012). Evaluation of the Profitability of Technical Analysis for Asian Currencies in the Forex Spot Market for Short-Term Trading. *AU-GSB E-Journal*.

Ardliansyah, R. (2012). *Stock market integration and international portfolio diversification between U.S. and ASEAN equity markets*. Glasgow, Scotland: University of Glasgow Adam Smith Business School.

Atsalakis, G. S., & Valavanis, K. P. (2009). Surveying stock market forecasting techniques, part II: Soft computing methods. *Expert Systems with Applications*, 36, 5932-5941.

Balsara, N. J., Chen, G., & Zheng, L. (2007). The Chinese stock market: An examination of the random walk model and technical trading rules. *Quarterly Journal of Business and Economics*, 46 (2), 43-63.

Bauer, R. J., & Dahlquest, J. R. (1999). Technical markets indicators: Analysis and performance. Hoboken, NJ: John Wiley and Sons.

Bessembinder, H., & Chan, K. (1998). Market efficiency and the returns to technical analysis. *Financial Management*, 27 (2), 5-17.

Blume, L., Easley, D., & O'Hara, M. (1994). Market statistics and technical analysis: The role of volume. *The Journal of Finance*, XLIX (1), 153-181.

Bollinger, J. (1992). Using Bollinger Bands. Stocks and Commodities, 10 (2), 47-51.

Brown, D. P., & Jennings, R. H. (1989). On technical analysis. *The Review of Financial Studies*, 2 (4), 527-551.

Chang, P. H., & Osler, C. L. (1999). Methodological madness: technical analysis and the irrationality of exchange-rate forecasts. *The Economic Journal*, 109, 636-661.

Chen, C. P., & Metghalchi, M. (2012). Weak-Form Market Efficiency: Evidence from the Brazilian Stock Market. *International Journal of Economics and Finance*, 4 (7), 22-32.

Chen, J. (2011). *Essentials of technical analysis for financial mark*ets. Hoboken, NJ: John Wiley and Sons.

Chen, J., Liu, Y., Chen, Q., Cui, J., & Fang, f. (2008). A neural network model for concept formation. *Fourth International Conference on Natural Computation*, 2008. ICNC'08. . IEEE.

Chiarella, C., He, X., & Hommes, C. (2006). A dynamic analysis of moving average rules. *Journal of Economic Dynamics and Control*, 30 (9-10), 1729-1753.

Chiu, D., & Chian, S. (2010). Exploring stock market dynamism in multi-nations with genetic algorithm, support vector regression, and optimal technical analyssi. *2010 Sixth International Conference on Networked Computing and Advanced Information Management* (NCM) (pp. 694-699). Seoul: IEEE.

Chong, T. T., & Ng, W. (2008). Technical analysis and the London Stock Exchange: Testing the MACD and RSI rules using the FT30. *Applied Economics Letters*, 15 (14), 1111-1114.

Chong, T. T., Cheng, S. H., & Wong, E. N. (2010). A Comparison of Stock Market Efficiency of the BRIC Countries. *Technology and Investment*, 235-238.

Chuang, W., Lee, B., & Wang, K. (2014). US and domestic market gains and Asian investors' overconfident trading behavior. *Financial Management*, 43 (1), 113-148.

Coe, T. S., & Laosethakul, K. (2010). Should Individual Investors Use Technical Trading Rules to Attempt to Beat the Market? *American Journal of Economics and Business Administration*, 2 (3), 201-209.

Colby, R. W. (2002). *The encyclopedia of technical market indicators*. New York: McGraw-Hill Professional.

Di Lorenzo, R. (2013). Basic technical analysis of financial markets. New York: Springer.

Edwards, R. D., Magee, J., & Bassetti, W. H. (2013). *Technical analysis of stock trends* (10th ed.). Boca Raton, FL: CRC Press.

Etzkorn, M. (1997). *Trading with oscillators: Pinpointing market extremes*. Hoboken, NJ: John Wiley and Sons.

Fernández-Blanco, P., Bodas-Sagi, D. J., Soltero, F. J., & Hidalgo, J. I. (2008). Technical market indicators optimization using evolutionary algorithms. *Proceedings of the 2008 GECCO conference companion on Genetic and evolutionary computation*. ACM.

Freund, R. J., Mohr, D., & Wilson, W. J. (2010). *Statistical methods* (3rd ed.). Burlington, MA: Academic Press.

Friesen, G. C., Weller, P. A., & Dunham, L. M. (2009). Price trends and patterns in technical analysis: A theoretical and empirical examination. *Journal of Banking and Finance*, 33 (6), 1089-1100.

Grimes, A. (2012). *The art and science of technical trading*. Hoboken, NJ: John Wiley and Sons.

Han, Y., Yang, K., & Zhou, G. (2013). A new anomaly: The cross-sectional profitability of technical analysis. *Journal of Financial and Quantitative Analysis*, 48 (5), 1433-1461.

Harris, M. (2008). *Profitability and systematic trading*. Hoboken, NJ: John Wiley and Sons.

Heaton, J. (2009). *Introduction to neural networks with Java*. Chesterfield, MO: Heaton Research.

Ji, L., Zhang, Z., & Guo, T. (2008). To buy or to sell: cultural differences in stock market decisions based on price trends . *Journal of Behavioral Decision Making*, 21 (4), 399-413.

Kannan, K. S., Sekar, P. S., Sathik, M. M., & Arumugam, P. (2010). Financial stock market forecast using data mining techniques. *Proceedings of the International MultiConference of Engineers and Computer Scientists* . Hong Kong.

Kaufman, P. J. (2013). Trading systems and methods. Hoboken, NJ: John Wiley and Sons.

Kirkpatrick, C. D., & Dahlquist, J. (2010). *Technical analysis: The complete resource for financial market technicians*. London: FT Press.

Kordos, M., & Cwiok, A. (2011). A new approach to neural network based stock trading strategy. *Intelligent Data Engineering and Automated Learning - IDEAL 2011* (pp. 429-436). Berlin: Springer.

Lam, M. (2004). Neural network techniques for financial performance prediction: Integrating fundamental and technical analysis. *Decision Support Systems*, 37 (4), 567-581.

Lee, S. J., Ahn, J. J., Oh, K. J., & Kim, T. Y. (2010). Using rough set to support investment strategies of real-time trading in futures market. *Applied Intelligence*, 32, 364-377.

Liu, Z., & Xiao, D. (2009). An automated trading system with multi-indicator fusion based on D-S evidence theory in forex markets. *2009 Sixth International Conference on Fuzzy Systems and Knowledge Discovery*.

Lo, A. W., Mamaysky, H., & Wang, J. (2000). Foundations of technical analysis: Computational algorithms, statistical inference and empirical implementation. *The Journal of Finance*, 55 (4), 1705-1765.

Maimon, O., & Rokach, L. (2010). *Data mining and knowledge discovery handbook*. New York: Springer Science+Business.

Marshall, B. R., Cahan, R. H., & Cahan, J. (2010). Technical analysis around the world: Does it ever add value? Retrieved from Social Science Research Network (SSRN): http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1181367

Menkhoff, L. (2010). The use of technical analysis by fund managers; International evidence. *Journal of Banking and Finance*, 34 (11), 2573-2586.

Metghalchi, M., Chang, Y. H., & Garza-Gomez, X. (2012). Technical Analysis of the Taiwanese Stock Market. *International Journal of Economics and Finance*, 90-102.

Northington, K. (2009). *Volatility-based technical analysis: Strategies for trading the invisible*. Hoboken, NJ: John Wiley and Sons.

Park, C., & Irwin, S. H. (2007). What do we know about the profitability of technical analysis? *Journal of Economic Surveys*, 21 (4), 786-826.

Penn, D. (2005). "V" is for volume. *Working Money*, 12.

Rachev, S. T., Stoyanov, S. V., Biglova, A., & Fabozzi, F. J. (2005). An empirical examination of daily stock return distributions of US stocks. In *Data analysis and decision suppor*t (pp. 269-281). New York: Springer.

Rosenbloom, C. (2010). *The complete trading course: Price patterns, strategies, setups and execution tactics*. Hoboken, NJ: John Wiley and Sons.

Schizas, P. (2013). Market timing methods and results. In H. K. Baker, & G. Filbeck (Eds.), *Portfolio theory and management* (pp. 438-465). Oxford, UK: Oxford University Press.

Schulmeister, S. (2009). Profitability of technical stock trading: Has it moved from daily to intraday data? . *Review of Financial Economics*, 18 (4), 190-201.

Stasinakis, C., & Sermpinis, G. (2014). Financial forecasting and trading strategies: A survey. In C. Dunis, S. Likothanassis, A. Karathanasopoulos, G. Sermpinis, & T. K (Eds.), *Computational intelligence techniques for trading and investment*. New York: Routledge.

Tsang, W. W., & Chong, T. T. (2009). Profitability of the on-balance volume indicator. *Economics Bulletin*, 29 (3).

Twiggs, C. (2014b). Twiggs money flow. Retrieved from Incredible Charts: http://www.incrediblecharts.com/indicators/twiggs_money_flow.php

Wagner, D. (2011). *Trading ETFs: Gaining an edge with technical analysis*. Hoboken, NJ: John Wiley and Sons.

Wong, W. K., Manzur, M., & Chew, B. (2010). How rewarding is technical analysis? Evidence from Singapore Stock Market. *Applied Financial Economics*, 13 (7), 543-551.

Zhou, R. T., & Lai, R. N. (2009). Herding and information based trading. *Journal of Empirical Finance*, 16, 388-393.

MACROPRUDENTIAL STRESS TESTING FOR CREDIT RISK: EMPIRICAL EVIDENCE FROM THE THAI HOUSING LOAN

Chanont Sontha
Credit Risk Analyst, Krungthai Bank
casgio.sertellon@gmail.com

Thitivadee Chaiyawat
Associate Professor, Chulalongkorn Business School, Chulalongkorn University
thitivadee@cbs.chula.ac.th

Abstract

This study aims to assess credit risk regulatory capital requirement under a stress scenario of non-performing housing loan during 2013-2014. Therefore, this paper uses Vector Autoregressive (VAR) model to analyze the impact of macroprudential policies and macroeconomic environment on credit risk of housing loan. The result indicates that macroeconomic factors; e.g., gross domestic product (GDP) and consumer price index (CPI) have a significant negative impact on non-performing loan (NPL). Furthermore, the result also suggests that loan-to-value (LTV) ratio as a macroprudential instrument is correlated with a change in non-performing housing loan. The deceasing of the past four period LTV ratio generates non-performing housing loan of the current period. The regulator should therefore effectively deploy macroprudential policies to slowdown the NPL and create financial stability, thus securing the resilience of the financial system. This study also found that the Bank of Thailand has overestimated the loan provision requirement of 1.00 percent of total outstanding debt. In addition, the study reveals that under a stress the Thai commercial bank should increase loan-loss provision level when an economic downturn sets in. Under a stress and economic crisis this study shows that value-at-risk (VaR) is not the proper approach to determine the regulatory credit risk capital. Therefore, conditional value-at-risk (CVaR) may represent an additional insight for estimating capital buffer from severe credit risk especially under systemic risk environment. Additional capital buffer of 0.0044-0.0064 percent of credit housing loan is also required to enhance bank's financial stability under a stress scenario.

Keywords: Credit Risk, Probability of Default, Macroprudential Policy, Capital, NPL

บทคัดย่อ

การศึกษานี้มีวัตถุประสงค์เพื่อ ประเมินเงินกองทุนของตวามเสี่ยงด้านเครดิตของสินเชื่อเพื่อที่อยู่อาศัยของประเทศไทย ภายใต้ภาวะวิกฤติ ตามนโยบายมหภาคแบบรอบคอบ ในช่วงเวลา ปีค.ศ. 2013-2014 รวมทั้งวิเคราะห์นโยบายมหภาคแบบรอบคอบที่ให้ความสำคัญกับสัดส่วนการให้สินเชื่อต่อมูลค่าหลักประกัน โดยวิเคราะห์ร่วมกับกับตัวแปรเศรษฐกิจมหภาคคือ ผลิตภัณฑ์มวลรวมภายในประเทศ ดัชนีราคาผู้บริโภค ดัชนีบ้านเดี่ยวพร้อมที่ดิน ที่ส่งผลต่อหนี้ที่ไม่ก่อให้เกิดรายได้ของสินเชื่อเพื่อที่อยู่อาศัย การศึกษานี้ได้ใช้แบบจำลอง Vector Autoregressive (VAR) และใช้การวัดมูลค่าความเสี่ยง (VaR) และการวัดมูลค่าความเสี่ยงแบบมีเงื่อนไข (CVaR) เพื่อประเมินเงินกองทุนของความเสี่ยงด้านเครดิต และประเมินเงินกองทุนส่วนเพิ่ม ภายใต้ภาวะวิกฤติตามนโยบายมหภาคแบบรอบคอบ ผลการศึกษาชี้ให้เห็นว่า การกำหนดอัตราส่วนการให้สินเชื่อต่อหลักประกัน มีความสัมพันธ์กับการเปลี่ยนแปลงของหนี้ที่ไม่ก่อให้เกิดรายได้ของสินเชื่อเพื่อที่

อยู่อาศัย โดยเมื่อสัดส่วนของการให้สินเชื่อต่อหลักประกันมีค่าลดลงผ่านไปสี่ไตรมาส จะส่งผลให้หนี้ที่ไม่ก่อให้เกิดรายได้ของสินเชื่อเพื่อที่อยู่อาศัยในไตรมาสปัจจุบันลดลงมากที่สุด นอกจากนี้ งานวิจัยนี้ยังชี้ให้เห็นว่า การกันสำรองของลูกหนี้ปกติที่ธนาคารแห่งประเทศไทยกำหนดในปัจจุบันคือร้อยละ 1.00 ของยอดหนี้ทั้งหมดนั้น เป็นการกันสำรองที่สูงเกินกว่าความเสี่ยงที่แท้จริง สำหรับการดำรงเงินกองทุนของความเสี่ยงด้านเครดิตนั้น งานวิจัยนี้แสดงให้เห็นว่า การใช้วิธีการประเมินมูลค่าความเสี่ยงนั้น ไม่มีความเหมาะสมต่อการกำกับดูแลเงินกองทุนของความเสี่ยงด้านเครดิตเมื่อเกิดภาวะวิกฤติ เนื่องจากมูลค่าความเสี่ยงสูงสุดมีค่าเกินกว่ามูลค่าความเสี่ยงเป็นจำนวนมาก ทำให้ธนาคารต้องดำรงเงินกองทุนส่วนเพิ่มอีกร้อยละ 0.0044 ถึงร้อยละ 0.0064 ของยอดหนี้สินเชื่อเพื่อที่อยู่อาศัย ในไตรมาสที่ 1 และ 2 ของปี คศ. 2014

INTRODUCTION

Financial institution is the medium role of asset allocation. The efficiency of financial system will contribute economic growth. This would be successful under two main factors: 1) the stability of each financial institution and 2) the optimality of the fundamental financial institution system.

Financial system consists of many types of financial institutions such as commercial bank--the largest provider, capital financial institution, state-owned commercial bank, security company, and insurance company. However, the commercial bank is an important part of the financial system and has a close relationship with the economy. Commercial banks can be severely affected from a depressed economy, and vice versa.

In the recent years, there are many financial crisis or cascade of financial institution failures affecting the economy and creating economic cost (output cost). The latest financial crisis, the subprime-mortgage crisis, is a solid example to point out the economic risk caused by the high linkage across the financial institution; i.e., "Systemically Important Financial Institutions (SIFIs))". Thus, the regulator would essentially develop the policy tool to enhance the efficiency of regulatory framework to mitigate risk to the financial system as a whole (systemic risk). Microprudential policy only is not concrete enough since it is a firm-level oversight by regulators to ensure that the balance sheets of individual institutions are robust to shocks. This perspective is opposed to the macroprudential view which focuses on welfare of the entire financial system (Borio, 2003). Macroprudential policy was introduced by the Basel Committee (BASEL) to maintain the balance between the stability of monetary policy and financial institution. Several aspects of the BASEL III reflect a macroprudential approach to financial regulation (Borio, 2011). The macroprudential policy ultimately aims to prevent and mitigate systemic risk, which includes strengthening the resilience of financial system. This particular policy focuses on smoothening the financial cycle avoiding that it reaches a dangerous peak (European Central Bank, 2016). Various instruments have been employed to measure credit-related, liquidity-related, and capital-related types in order to achieve macroprudential objectives (Lim et al., 2011). The macropudential regulation requires banks to have set aside enough capital and capital buffer to cover unexpected loss and keep themselves financial solvent in a crisis. Caps on loan to value should be an important additional ingredients in the macroprudential policy framework to measure the credit flows and to address risks in a country's real estate market (Shin, 2010 and European Central Bank, 2016).

Bank of Thailand announced a new policy of housing loan portfolio for commercial banking. Loan-to-value (LTV) ratio is employed as a macroprudential tool to limit the loan exposure.

This policy is used to reduce the overheated speculation in the residential high-rise and reduce the bubbles in the real estate sector. This policy will affect the capital adequacy ratio (BIS ratio) and it is a mechanism to increase the concentration of the bank's risk management performance. Figure 1 below indicates that the quarterly change in gross domestic product (GDP) since the 1st quarter of 2002 was lower to the change in the housing outstanding loan for the whole studying period. So, it is interesting to study the impact of macroprudential policy on the stability of financial institutions.

Figure 1: Thailand's Gross Domestic Product and Housing Outstanding Loan

Source: Bank of Thailand and Office of National Economic and Social Development Board

Therefore, this paper describes a model to test the efficiency of macroprudential policy and conducts stress test for Thailand housing loan portfolio. The first section explores the relationship and impact of macroprudential policy, represented by the ratio of the loan-to-value (LTV), and macroeconomic variables--gross domestic product (GDP), consumer price index (CPI) and the housing price index (HPI), on housing loan portfolio's probability of default. The second part reveals an assessing and stress testing on the capital adequacy for housing loan credit risk of the Thai banking system.

THEORETICAL FRAMEWORKS AND LITERATURE REVIEWS

This research is based on conceptual framework of banking sector financial instability that can amplify and propagate business cycle. Zhang (2009) used the model builds on Bernanke, Gertler and Gilchrist (BGG) (1999) considering credit demand friction due to agency cost. Financial intermediaries have to share aggregate risk with entrepreneurs and therefore bear uncertainty in their loan portfolios if there is a case of any deviation. Unexpected aggregate shocks will drive loan default rate away from expected, and have an impact on both firm and bank's balance sheet via the financial contract. Low bank capital position can create strong credit supply contraction, and have a significant effect on business cycle dynamics. Therefore, it is necessary to create a macroprudential policy framework and tool to mitigate the unexpected aggregate shock. Macroprudential policy can be divided into two types. First is a macroprudential indicator which is mainly driven by the jump increase in the assets of commercial banks. It can be measured by the ratio of total loans to gross domestic product.

Moreover, if the financial institution is raising secondary source of fund (The central bank uses monetary policy to drive economy) which may affect inflation rate. This can cause economy instability. Second is a macroprudential policy which can help to alleviate the instability of financial institutions and to minimize the impact on economy (economic externalities).

Credit portfolio model is then used to assess housing loan portfolio risk. Three factors which are 1) probability of default (PD), a Bernoulli distribution, and 2) loss given default (LGD), percentage of the loss that may have occurred when the event defaults and 3) exposure at default (EAD), are used to estimate total outstanding debt on the default event. The valuation of the credit risk is done via a calculation of expected loss (EL) and unexpected loss (UL). Commercial bank should set the provision to support EL. However, banks could still experience unexpected credit loss exceeding the expected level. The amount of UL of housing loan is capital requirement that bank must hold due to the susceptibility of credit risk. The capital requirement can be estimated from the difference between the value-at-risk (VaR) and EL.

Stress testing of credit risk is necessary to further conduct and assess the impact of external factors which can generate an adverse effect on loan portfolio status and portfolio quality or PD. Typically, macro stress test of credit risk involves three major tasks which are 1) the development of a model to capture the interrelationship between selected macroeconomics and financial variables, 2) the calibration of parameter vectors linking macroeconomic and financial variables to specific measures of loan performance, and 3) the design of adverse macroeconomics scenarios and the computation of the impacts on credit quality and bank's financial solvency.

RESEARCH METHOD

The stress test framework presented in this paper comprises two components. Therefore, to find the effect of macroprudential policies, represented by LTV ratio, and macroeconomic variables on loan repaying capability this research analyzed such an impact by using Vector Autoregressive (VAR) model. Thus testing Stationary of variables is important which is done through a unit root test by using Augmented Dickey-Fuller test and the unit root test and the equations are shown below.

$$\Delta X_t = \theta X_{t-1} + \sum_{t=1}^{p} \phi_t \Delta X_{t-1} + \varepsilon_t \qquad \text{none} \qquad (1)$$

$$\Delta X_t = \alpha_0 + \theta X_{t-1} + \sum_{t=1}^{p} \phi_t \Delta X_{t-1} + \varepsilon_t \qquad \text{with intercept} \qquad (2)$$

$$\Delta X_t = \alpha_0 + \theta X_{t-1} + \gamma t + \sum_{t=1}^{p} \phi_t \Delta X_{t-1} + \varepsilon_t \qquad \text{with intercept and trend} \qquad (3)$$

The Augmented dickey – Fuller Test hypotheses are as follows:

$H_{0:}$ $\theta = 0$ Non-stationary
$H_{1:}$ $\theta < 0$ Stationary

Then this study analyze a long-term equilibrium relationship (cointegration) as mentioned above using Vector Autoregressive (VAR). VAR approach, developed by Sims (1980), treats every endogenous variable in the system as function of the lagged length of all of the

endogenous variables in the system. The VAR equation is estimated the ordinary least square regressions as shown in equation (4) to equation (9).

$$\mathrm{NPL_t} = a_1 + \sum_{i=1}^{n} A_{1i}\,\mathrm{NPL_{t-i}} + \sum_{i=1}^{n} B_{1i}\,\mathrm{GDP_{t-i}} + \sum_{i=1}^{n} C_{1i}\,\mathrm{CPI_{t-i}} + \sum_{i=1}^{n} D_{1i}\,\mathrm{HPI_{t-i}} + \sum_{i=1}^{n} E_{1i}\,\mathrm{LTV_{t-i}} + \sum_{i=1}^{n} F_{1i}\,\mathrm{DUM_{t-i}} + \epsilon_{1t} \quad (4)$$

$$\mathrm{GDP_t} = a_2 + \sum_{i=1}^{n} A_{2i}\,\mathrm{NPL_{t-i}} + \sum_{i=1}^{n} B_{2i}\,\mathrm{GDP_{t-i}} + \sum_{i=1}^{n} C_{2i}\,\mathrm{CPI_{t-i}} + \sum_{i=1}^{n} D_{2i}\,\mathrm{HPI_{t-i}} + \sum_{i=1}^{n} E_{2i}\,\mathrm{LTV_{t-i}} + \sum_{i=1}^{n} F_{2i}\,\mathrm{DUM_{t-i}} + \epsilon_{2t} \quad (5)$$

$$\mathrm{CPI_t} = a_3 + \sum_{i=1}^{n} A_{3i}\,\mathrm{NPL_{t-i}} + \sum_{i=1}^{n} B_{3i}\,\mathrm{GDP_{t-i}} + \sum_{i=1}^{n} C_{3i}\,\mathrm{CPI_{t-i}} + \sum_{i=1}^{n} D_{3i}\,\mathrm{HPI_{t-i}} + \sum_{i=1}^{n} E_{3i}\,\mathrm{LTV_{t-i}} + \sum_{i=1}^{n} F_{3i}\,\mathrm{DUM_{t-i}} + \epsilon_{3t} \quad (6)$$

$$\mathrm{HPI_t} = a_4 + \sum_{i=1}^{n} A_{4i}\,\mathrm{NPL_{t-i}} + \sum_{i=1}^{n} B_{4i}\,\mathrm{GDP_{t-i}} + \sum_{i=1}^{n} C_{4i}\,\mathrm{CPI_{t-i}} + \sum_{i=1}^{n} D_{4i}\,\mathrm{HPI_{t-i}} + \sum_{i=1}^{n} E_{4i}\,\mathrm{LTV_{t-i}} + \sum_{i=1}^{n} F_{4i}\,\mathrm{DUM_{t-i}} + \epsilon_{4t} \quad (7)$$

$$\mathrm{LTV_t} = a_5 + \sum_{i=1}^{n} A_{5i}\,\mathrm{NPL_{t-i}} + \sum_{i=1}^{n} B_{5i}\,\mathrm{GDP_{t-i}} + \sum_{i=1}^{n} C_{5i}\,\mathrm{CPI_{t-i}} + \sum_{i=1}^{n} D_{5i}\,\mathrm{HPI_{t-i}} + \sum_{i=1}^{n} E_{5i}\,\mathrm{LTV_{t-i}} + \sum_{i=1}^{n} F_{5i}\,\mathrm{DUM_{t-i}} + \epsilon_{5t} \quad (8)$$

$$\mathrm{DUM_t} = a_6 + \sum_{i=1}^{n} A_{6i}\,\mathrm{NPL_{t-i}} + \sum_{i=1}^{n} B_{6i}\,\mathrm{GDP_{t-i}} + \sum_{i=1}^{n} C_{6i}\,\mathrm{CPI_{t-i}} + \sum_{i=1}^{n} D_{6i}\,\mathrm{HPI_{t-i}} + \sum_{i=1}^{n} E_{6i}\,\mathrm{LTV_{t-i}} + \sum_{i=1}^{n} F_{6i}\,\mathrm{DUM_{t-i}} + \epsilon_{6t} \quad (9)$$

Where $\mathrm{NPL_t}$ is the logarithm of the non-performing loan change at period t
$\mathrm{GDP_t}$ is the logarithm of the gross domestic product change at period t
$\mathrm{CPI_t}$ is the change of consumer price index at period t
$\mathrm{HPI_t}$ is the change of housing price index at period t
$\mathrm{LTV_t}$ is loan amount to collateralized asset value at period t
$\mathrm{DUM_t}$ is the dummy variable representing crisis issues at period t

Impulse Response Function derived from Vector Moving Average (VMA) is used to analyze the effect of intermediate changes of a certain variable on changes of other variables in VAR model and analyze how long the short run adjustment would be processed until it reaches the equilibrium. VMA equation is shown in equation (10) (Enders, 2004).

$$\mathrm{Y_t} = \mu + \sum_{i=0}^{\infty} \phi_i\, \varepsilon_{t-1} \quad (10)$$

where ϕ_i is the Impulse Response Function

Both value-at-risk (VaR) and conditional value-at-risk (CVaR) methods are used to estimate loan-loss provision, credit risk capital requirement, and capital buffer that bank needs to cover tail credit losses under the distressed scenario. Monte Carlo simulation is also employed to simulate the probability of default (PD) for a case of base line scenario and stress scenario. PD shows in equation (11) based on Fungacova and Jakubik (2012) studying the Russian credit crisis.

$$\mathrm{PD_t} = \frac{\mathrm{NPL_{t+1}} - \mathrm{NPL_t} - (\mathrm{r} \times \mathrm{NPL_t})}{(\mathrm{Loan_t} - \mathrm{NPL_t})} \quad (11)$$

To come up with the amount of expected loss (EL) and unexpected loss (UL) this study computes EL and UL from the formula stated by the bank of Thailand as shown in equation (12).[1]

[1] Minimum LGD announced by the FPG. 2555/16the credit and operational risks for banks using the IRB approach FIRB collateral Residential Real Estate (RRE) equals 35percent.

$$EL_t = PD_t{}^2 \times \overline{LGD} \times EAD_t \quad (12)$$

VaR at the confidence level 99.9 percent is used to calculate unexpected loss for credit risk capital charge under an assumption of normal economic situation. VaR, expected loss, and unexpected loss as credit risk capital requirement, are calculated for period t as shown in equation (13).

$$Unexpected\ Loss\ (Capital\ Requirement) = VaR_t(0.999) - EL_t \quad (13)$$

Moreover, Adrian and Brunnermeier (2009) suggested a conditional VaR (CVaR), unconditional standard VaR, that bank has to set capital aside in case of credit stress especially under a systemic risk environment. Therefore, CVaR is more appropriate as a measure of risk spillover to determine capital margin (capital buffer) at confidence level of 99.9 percent which is shown in equation (14).

$$Capital\ Buffer = CVaR_t(0.999) - VaR_t(0.999) \quad (14)$$

RESULTS

Table 1 reveals the result of unit root tested by Augmented Dickey–Fuller Test showing that these variables; i.e. the NPLs, the gross domestic product (GDP), consumer price index (CPI) and the housing price index (HPI), have Augmented Dickey–Fuller Test statistic less than Mackinnon critical value at 5% significant level. That means all three models: 1) model without intercept and trend, 2) model with intercept, and 3) model with intercept and trend have stationary at first difference.

Table 1: Unit Root Test using Augmented Dickey–Fuller (ADF) Test

Variable	Models	ADF-Statistics	P-Value	Critical Value at 5%
1st Difference of NPL	With trend and intercept	-4.674360	0.0041	-3.568379
	With intercept	-3.625354	0.0111	-2.963972
	None	-3.566430	0.0009	-1.952473
1st Difference of GDP	With trend and intercept	-7.098509	0.0000	-3.562882
	With intercept	-7.243529	0.0000	-2.960411
	None	-6.616333	0.0000	-1.952066
1st Difference of CPI	With trend and intercept	-5.419517	0.0007	-3.568379
	With intercept	-5.521512	0.0001	-2.963972
	None	-3.705859	0.0006	-1.952473
1st Difference of HPI	With trend and intercept	-4.134298	0.0145	-3.568379
	With intercept	-4.135791	0.0032	-2.963972
	None	-4.004573	0.0002	-1.952473

[2] Bank of Thailand requires commercial banks to estimate the PD or the probability that the debtor defaults on the 1-year period and for small debtors PD must not be lower than 0.03 percent.

Johansen Cointegration test is conducted to trace whether there is a long-run relationship across multiple time series among interested variables (Johansen and Juselius, 1990). Optimal lag length(s) is analyzed to minimize the sum or squared residuals for the VAR. The result in Table 2 shows the maximum number of VAR lags is 4 determined by the lowest AIC, SC/SBC, and HQIC.

Table 2: Appropriate Lag for VAR Model

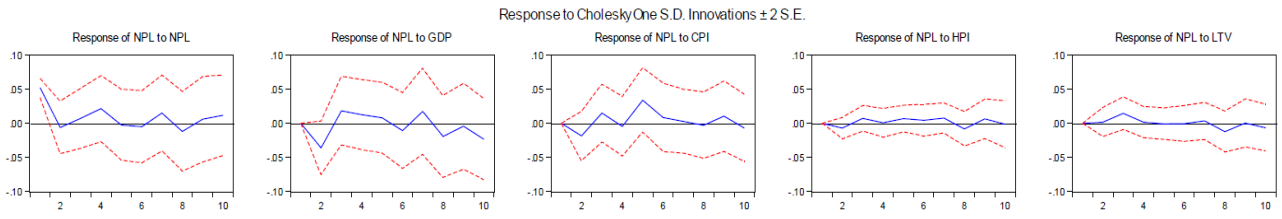
Lag length	AIC	SC or SBC	HQIC
0	1.501542	1.739436	1.574269
1	-0.559768	0.867594	-0.123410
2	-1.077006	1.539825	-0.277014
3	-2.751729	1.054569	-1.588106
4	-5.753033*	-0.757267*	-4.225778*

Note: AIC is Akaike Information Criteria
SC is Schwartz Bayesian Criteria
HQIC is Hannan-Quinn Information Criteria

Table 3 shows the VAR model specification. The result shows that VAR model is appropriate and the adjusted R^2 at 94%

The Impulse Response Function (IRF) provides the reaction information on how variables in the systems response over time to various shocks. The reaction result of each variable is shown in Figure 2. The picture indicates that if the GDP and CPI are shocked, there will affect the NPL in a downward direction during the first two quarters. Then, NPL will adjust to the long-run equilibrium in the 3rd quarter. However, in a short run process adjustments from the HPI and LTV changes have little effect on NPL.

Figure 2: Reaction of Macroeconomics Variable to NPL



The second part of this study is to estimate the banks' reserve for credit risk provision and credit risk capital charge to cover unexpected credit loss. In addition, this part also calculates capital buffer that banks need to hold against tail credit risk under the distressed scenarios. The probability of default will be calculated according to equation (11). Distribution testing of the default probability in normal circumstances (base line which assuming a 4 percent GDP increase from the previous year based on the Office of the National Economic and Social Development Board (NESDB)) and the default probability in the stress scenario (assuming a 1 percent GDP decrease for 4 consecutive quarters) is done by using Kolmogorov-Smirnov test. The result reveals that probability of credit default (PD) of base line and stress situations have beta distribution with p-value greater than alpha at 5 percent. The parameter estimation for beta distribution using maximum likelihood approach is shown in Table 4.

Table 3: Model Specification by using VAR Model

Variables	Lag length	Coefficient	t-statistic
NPL	(-1)	-1.021242*	-2.92875
	(-2)	0.229255	1.08165
	(-3)	2.549690*	3.93325
	(-4)	-0.503233***	-1.82252
GDP	(-1)	-1.140247*	-3.44108
	(-2)	-1.792010**	-2.71294
	(-3)	1.958208*	3.42925
	(-4)	-0.126946	-0.39826
CPI	(-1)	-0.044378*	-2.91766
	(-2)	0.075320*	4.43132
	(-3)	0.003946	0.30659
	(-4)	0.069959*	5.26532
HPI	(-1)	0.003966	1.51822
	(-2)	-0.003818**	-2.18999
	(-3)	-0.007119*	-2.93799
	(-4)	0.004888***	2.02127
LTV	(-1)	1.210901**	2.14155
	(-2)	1.929759**	2.43929
	(-3)	-5.374473*	-3.42661
	(-4)	3.015944*	3.14275
DUMMY	(-1)	0.090886**	2.25637
	(-2)	0.272619*	4.30710
	(-3)	0.189630*	3.36613
	(-4)	-0.008958	-0.21264

Constant	-0.700278	-3.06712
Adjusted R^2	0.946521	
F-statistic	29.02304	
Sample (adjusted):	33	

*significant level at 1% **significant level at 5% *** significant level at 10%

Table 4: Beta Parameters using Maximum Likelihood Method

Parameters	Base Line		Stress	
	Q1/2014	Q2/2014	Q1/2014	Q2/2014
A	0.78853	0.85891	0.77727	0.81481
B	1.92080	2.01260	1.43970	1.51360
δ (Lower Bound)	0.00218	0.00110	0.00227	0.00227
ϑ (Upper Bound)	0.05135	0.05135	0.04247	0.04247

The simulation result of default probability with a beta distribution under the normal case (base line) of the first quarter, 2014shows that the average value of 100,000 simulated PD is 0.01524with and a standard deviation of .0.00965 On the other hand, the result of 100,000 simulated default probability with a beta distribution under stress of the first quarter, 2014 shows that the average value is 0.01544 and a standard deviation is 0.00962.

While treating other macroeconomic variables constant same as Q4-2013, the results of NPL in Q1-2014 and Q2-2014 under a base line and a stress environment are shown in Table 5. The impact of a quarterly 4 percent increase in GDP from Q4-2013 has an impact on NPL and causes NPL ratio growing to 4.11 percent in Q1-2014 and 3.97 percent in Q2-2014. However, under the distressed scenario a quarterly 1 percent decrease in GDP from Q4-2013 has a higher impact on housing credit loss. NPL rises to 4.14 percent and 4.33 percent in Q1-2014 and Q2-2014, respectively under a stress situation.

Table 5: Results of NPL under Base Line and Stress

Macroeconomic Factor	Q4-2013	Q1-2014		Q2-2014	
		Base Line	Stress	Base Line	Stress
NPL ratio	3.6824	4.1100	4.1480	3.9703	4.3342
GDP (%qoq)	1.0000	4.0000	-1.0000	4.0000	-1.0000
CPI (%change)	0.5100	0.5100	0.5100	0.5100	0.5100
HPI (%change)	0.1276	0.1276	0.1276	0.1276	0.1276
LTV (%)	95.0000	95.0000	95.0000	95.0000	95.0000

The result in Table 6 reveals that under normal economy following the assumption of no stress situation the ratio of reserves or provision of total housing loan exposure to total debt (%EL) is 0.4759 in Q1-2014 and it is equal to 0.4720 in the next quarter. The provision value for credit risk is equal to 7,173 million baht in Q1-2014 and 7,288.39 million baht in the next quarter. Under the stress scenario it is however found that percent of expected credit loss is increasing to 0.4840 percent and 0.4845 percent in Q1-2014 and Q2-2014, respectively. The amount of loan provision is equal to 7,294.60 million baht in Q1-2014 and 7,494.70 million baht in Q2-2014.

Table 6: Provision under Base Line and Stress

Provision	Q1-2014		Q2-2014	
	Base Line	Stress	Base Line	Stress
%	0.4759	0.4840	0.4720	0.4854
Million Baht	7,173.00	7,294.60	7,288.39	7,494.70

Housing loan credit risk capital charge and capital buffer are calculated using VaR and CVaR. Under a normal environment VaR is used to estimate credit risk capital requirement as a cushion for unexpected credit loss. Reserving only provision mentioned above is not enough to ensure bank financial solvency. Therefore, bank is required to hold credit risk capital in addition to expected credit loss provision. Credit risk capital requirement would be 5,554.14 million baht in Q1-2014 and 5,791.66 million in Q2-2014. The credit risk capital requirement as mentioned and details of unexpected credit loss under a base line (normal economic situation) using VaR measurement are shown in Table 7.

Table 7: Unexpected Loss using Value-at-Risk and Credit Risk Capital Requirement under a Base Line

Unexpected Loss and Capital Requirement		Q1-2014	Q2-2014
		Base Line	Base Line
Unexpected Loss	$VaR_{0.999}$ (%)	1.3192	1.3204
	%	0.8472	0.8445
	Million Baht	13,080.04	12,727.13
Credit Risk Capital Requirement	Million Baht	5,791.66	5,554.14

CVaR calculation shows that under a stress scenario commercial banks are required to hold additional capital buffer to create more resilience against structural or systemic risk. The capital buffer is 0.0044 percent of total outstanding or 65.94 million baht for Q1-2014. The capital buffer in Q2-2014 is increasing to 0.0064 percent of total outstanding or 99.55 million baht. The details discussed above are shown in Table 8.

Table 8: Conditional Value-at-Risk (CVaR) and Capital Buffer

CVaR and Capital Buffer		Q1-2014	Q2-2014
		Stress	Stress
$CVaR_{0.999}$	$CVaR_{0.999}$ (%)	3.7881	3.7805
	%	0.0044	0.0064
Capital Buffer	Million Baht	65.9398	99.5540

CONCLUSIONS

The study found that the imposition of loan-to-collateral ratio (LTV) as a macroprudential instrument is associated with changes in non-performing housing loans. The adjustment of LTV to reduce NPL would take at least 4 quarters.

In addition, the result of this paper found that macroeconomic factors--GDP, CPI, and HPI--also significantly affect non-performing housing loans. GDP changes have a negative impact on NPL. Therefore, regulator should use both retrospective and prospective macroprudential

policy to control financial institutions. This is because the policy will not immediately affect NPL but it would have a lag time of four quarters to be effective.

This study also found that the Bank of Thailand has overestimated the loan provision requirement of 1.00 percent of total outstanding debt. This is because the evidence shows that the loan provisions as shown in Table 6 are approximately only 0.48 percent of total debt in both scenarios of base line and stress.

In addition, the study reveals that value-at-risk (VaR) measuring credit loss under a baseline economic scenario is not the proper approach to determine the regulatory credit risk capital under a stress. Regulator enforces only credit risk capital requirement would lead bank a capital deficiency under a severe adverse economic scenario. Under a stress environment regulator needs commercial bank to hold additional capital buffer as a cushion to shield against systemic risk. Therefore, conditional value-at-risk (CVaR) may represent a better choice for estimating capital buffer as safeguard for banks taking account of the macro-financial environment. That is shown by the evidence of the highest loss amount under adverse economic shock normally outweighing the unexpected credit loss using VaR measurement.

References

Adrian T. and Brunnermeier M. K., 2009. CoVar: a Method for Macroprudential Regulation. *Federal Reserve Bank of New York Staff Report. 348*.

Bank for International Settlement, 2005. An Explanatory Note on the Basel II IRB Risk Weight Functions.

Bernake B, Gertler M., and Gilchrist S., 1999. The Financial Accelerator in a Quantitaive Business Cycle Framework. *Handbook of Macroeconomics. Vol 1, Part C, 1341-1393.* Elsevier.

Borio, C., 2003. Towards a Macroprudential Framework for Financial Supervision and Regulation? *BIS Working Papers No.128, February.*

Borio, C. 2011. Rediscovering the Macroeconomic Roots for Financial Stability Policy: Journey, Challenges, and a Way Forward. *BIS Working Papers No. 354, September.*

Buncic D. and Melecky M., 2012. Macroprudential Stress Testing of Credit Risk: A Practical Approach for Policy Maker. *Policy Research Working Paper*.

Enders W. 2004. Applied Econometric Time Series. *426*.

European Central Bank, 2016. Principles of Macroprudential Policy.

Forssen D. and Radomski R., 2009. Stress Testing the Corporate Loans Portfolio of the Swedish Financial Sector.

Fungacova Z. and Jakubik P., 2012. Bank Stress Tests as an Information Device for Emerging Markets. The Case of Russia. *BOFIT Discussion Papers*.

Hong Kong Monetary Authority. Loan-to-Value Ratio as a Macroprudential Tool-Hong Kong SAR's Experience and Cross-Country Evidence. *BIS Paper No.57*.

Johansen S. and Juselius K., 1990. Maximum Likelihood Estimation and Inference on Cointegration with Applications to the Demand for Money. *Oxford Bulletin of Economics and Statistics. Vol 52, No.2, 169-210.*

Lim, C., Columba, F., Costa, A., Kongsamut, P., Otani, A., Saiyid, M., Wezel, T., and Wu, X., 2011. Macroprudential Policy: What Instruments and How to Use Them? Lessens from Countries Experiences. IMF Working Paper 11/238. Washington. International Monetary Fund, November.

Lu W. and Yang Z., 2012. Stress Testing of Commercial Banks' Exposure to Credit Risk: A Study Based on Write-Off Nonperforming Loans. *Asian Social Science*.

Shin, H. S., 2010. Macroprudential Policies beyond Basel III. *BIS Paper Series NO.68.*

Sims A. C., 1980. Macroeconomics and Reality. *Econometrica: Journal of the Econometric Society. Vol. 48, No.1. 1-48.*

Tabak B. and Vazquez M., 2012. A Macro Stress Test Model of Credit Risk for the Brazillian Sector. *Journal of Financial Stability*, 69-83.

Zhang L., 2009. Bank Capital Regulation, the Lending Channel and Business Cycles. *Discussion Paper Series 1: Economic Studies No 33/209*.