Special Issue, April 2009

青年企業管理評論 | YMC Management Review

i FAIR 2009 特刊

Special Issue, April 2009

i FAIR 2009 特刊

青年企業管理評論

Ymc Management Review

The Annual International Conference on Finance, Accounting, Investment, and Risk Management 2009 (i FAIR Conference 2009)

Proceeding

Wednesday 15 April 2009.

Gold Coast, Australia

PROUDLY HOSTED BY

The Young Men Business Club (YMC) ROC

The YMC Management Review

CO-HOSTED BY

The International Leadership Institute, Australia.

The College of Informatics and Management, Tajen University

The Management School, Dept. of Finance, and Dept. of Accounting and Information System, Chang-Jung Christian University

The College of Finance and Banking, National Kaohsiung First University of Science and Technology, Taiwan

PROUDLY PRESENTED BY

Dept. of Business Administration, Pingtung University of Science and Technology

ORGANIZING COMMITTEE CHAIR

Chang, Alex Kung-Hsiung Ph.D.

The Chairman of Young Men Business Club (YMC) R.O.C. and

The Editor-in-Chief of the YMC Management Review

中華民國青年企業研究社 The Young Men Business Club of ROC
www.YMC.org.tw

ORGANIZING COMMITTEE CHAIR:

Chang, Alex Kung-Hsiung

The Chairman of Young Men Business Club (YMC) R.O.C. and

The Editor-in-Chief of the YMC Management Review

PROGRAM DIRECTORS:

Liu, Victor W.

Chairman of International Bills Financial Corporation and Professor of National Sun Yat-Sen University

Lin, Tsai -Yuan

Professor and Vice Principal of Chang-Jung Christian University

Wu, Chin-Shun

Professor and Vice Principal of National Sun Yat-Sen University

Chiang, Fu-Ming

Professor and Dean of the Informatics and Management School, Tajen University,

Lee, Yuan-Duen

Professor and Den of the management school, Chang-Jung Christian University

Hsu, Shoufen

Professor and the Dean of the College of Finance and Banking, National Kaohsiung First University of Science and Technology

Liaw, Shu-Yi

Director of the Dept. of Business Administration, National Pingtung University of Science & Technology

PROGRAM COMMITTEE CHAIR:

Chen, Tsung-Hao

Assistant Professor, Department of Business Administration, Shu-Te University

i FAIR 2009

*I am a knowledge **f**inder*

*I am an excellent **a**cademic.*

*I have a worldwide **i**ntelligence.*

*I am a pioneer **r**esearcher.*

The detailed program **of *i FAIR 2009*** conference

0830-850	Registration
0900-1000	Opening and Keynote speech **Invisible Leadership For Success In Business** ***Grier Lin*** President International Leadership Institute Australia
1000-1020	Tea Time
1020-1130	***Session F Chair: Dr. Jian-Hsin Chou***
	Securitization and The Subprime Mortgage Crisis of 2008 *Chao-Hui Yeh* **The Interaction Effect of Firm and Industry Characteristics, Economic Conditions on Capital Structure: Evidence from Taiwan** *Hsien-Hung Yeh, Wen-Ying Cheng* **An Exploratory Study of the Earning Growth Curve in Online Auction－Taking the Female Attire and the Clothing Fitting as an Example** *Wen-Ying Cheng, Yu-Xin Chen* **A Study on Risk Factors of Personal Injury Liability Insurance: A Case of "T" Non-life Insurance Company** *Pai-Lung Chou, Jen-Wen Sheu, Chen-Hua Yao* **Using Financial Factors to Investigate Productivity－An Empirical Study in Taiwan** *Shu-Yi Liaw, Chih-Ying Tai*
1130-1200	**Special Topic Speech** **Australia Economy and Real Estate Prospect** ***Paul Shih*** *Australian Taiwanese Chambers of Commerce*
1200-1300	Lunch Time
1310-1430	***Session A Chair: Dr. Alex Kung-Hsiung Chang***
	The Expansion Of Taiwanese Residential Construction In The 2000s: A Supply Led Or Demand Pull Expansion *Henry H. Y. Hsieh, John Forster* **Tourism motivation as an effective platform for improved MICE segmentation marketing strategies for Taiwan** *Che-Chao Chiang, Fu-Ming Chiang, Riccardo Natoli* **The Competitiveness of Semiconductor Corporations in China from Institution Theory and Resource-Based Theory: Case Study of SMIC and TSMC** *Mu Hua Chen, Xin-Min Tian, Wan-Chiang Chen, Bih-Shiaw Jaw* **Does the leadership style influence Employee's Organizational Trust? – The mediating effect of Leader-Member Exchange** *Yuan-Duen Lee, Shih-Hao Chen, Wen-Yu Chiu, Pei-Wen Chao* **Strategy Paradox and Integrated Model of Strategic Management** *Chan We Tsai*

1435-1555	***Session I Chair: Dr. Eduardo D. Roca***
	A Study of Grey Theory on Improving the Investment Performance of Technical Analysis Index —An Example of Shenzhen Index's Component Stocks *Alex Kung-Hsiung Chang, Kuei-Yi Lin* **A Study of Grey Theory on Improving the Investment Performance of Technical Analysis Index —An Example of the Dow Jones Industry Index's Component Stocks** *Alex Kung-Hsiung Chang, Jui-Lin Hsu* **Implementing Option Pricing Models When Asset Returns Follow An Autoregressive Moving Average Process** *Chou-Wen Wang , Chin-Wen Wu* **Are World Socially Responsible Investment Markets Integrated?** *Eduardo D. Roca, Victor S.H. Wong, Gurudeo A. Tularam* **Market Mechanism And Traders' Behavior At The Close** *Yu Chuan Huang, Shu Hui Chan*
1555-1610	Tea Time
1615-1740	***Session R Chair: Dr. Chu-Hsiung Lin***
	Achieving a Higher Accuracy for Hull and White's Method for Estimating Value-at-Risk *Chu-Hsiung Lin, Hsien-Chueh Peter Yang, Chang-Cheng Changchien* **Relationship between Term Structure Information and Hedge Ratio of Treasury Futures Contracts** *Jian-Hsin Chou, Wei-Ming Wu, Chien-Yun Chang* **To Establish Robust Portfolio Insurance Strategy by Artificial Intelligence Method** *Pai-Lung Chou, Jen-Wen Sheu, Chen-Hua Yao* **Assessing the default risk for the residential mortgage loans: as the perspective of the decision cost** *Hsien-Chueh Peter Yang, Tsoyu Calvin Lin, Alex Kung-Hsiung Chang, Tsung-Hao Chen*
1745	*Ending and see you 2010.*

YMC Management Review

Special Issue for the iFAIR Conference, April 2009

Contents

Invisible Leadership for Success in Business

Grier Lin

Professor and President, International Leadership Institute Australia

E-Mail: grier.lin@ili.edu.au

ABSTRACT

The new organisations are dispersed. Workers are employed in many different offices and locations, wear different hats, and do not necessarily owe all their loyalty to one organisation. No longer does everyone have to be in the same place at the same time to get the work done. They do not even need to be on the payroll. Today's organisation is typically a 20/80 place, with only 20 percent of the people involved being employed full time by the organisation. The others are suppliers or contractors, part-timers or self-employed professionals.

A virtual organisation is one that you do not necessarily see, certainly not all together in one place, but that nevertheless delivers the goods. Virtuality means managing people you can not see and cannot control in any detail. This kind of management by remote control can only work when trust goes in both directions.

For a virtual organisation to succeed, it will have to be led by invisible leaders who must possess unique mix of attributes.

This paper presents the special attributes required by an invisible leader for leading the organisation of the future to success.

Invisible Leadership for Future Success in Business

－Leadership is a process of giving purpose (meaningful direction) to collective effort, and causing willing effort to be expended to achieve purpose.

－The attitude of followers toward the leader is another common indication of leader effectiveness

－Individuals or groups have to be trusted to deliver until it is clear that they cannot do so.

－The task of the leader is to make sure that the individuals or groups are competent to exercise the responsibility that is given to them, understand the goals of the organisation and are committed to them.

－ All authority has to be earned before it is exercised.

－ This kind of management by remote control can only work when trust goes in both directions.

－This requires vision and the ability to guide people toward it.

－ Roles in Organisation

Leadership role - Doing the right thing: vision, direction.

Management role- doing things right: implementation.

－ Efficiency is all about implementation

－Attributes of the Leader of the Future

- Leaders do not wait
- Leaders are credible
- Leaders have their heads in the clouds and their feet on the ground
- Leaders build a community of shared values
- Leaders do not do it alone
- Leaders do what they say they will do
- Leadership is everyone's business

－Communicate Persuasively

Securitization and the Subprime Mortgage Crisis of 2008

Chao-Hui Yeh
Associate Professor of Department of Business Administration
I-Shou University , Taiwan, R.O.C
E-Mail: CHY@ius.edu.t

ABSTRACT

This article provides a review of the securitization instruments in the context of the subprime mortgage crisis of 2008. The decreasing housing prices in the U.S. caused the increasing mortgage defaults and the increasing mortgage defaults caused this subprime mortgage crisis and this crisis is exploded by securitization instruments (e.g., CDS) which are just too complex to see their risks. This article will provide a specific classification of securitization instruments and distinguishes between two main classes of securitization instruments.

The first classes are mortgage-backed security (MBS), asset-backed security (ABS), asset-backed commercial paper (ABCP) and cash-flow collateralized debt obligation (CDO).The second category of securitization instruments includes credit default swap (CDS) and synthetic collateralized debt obligation (synthetic CDO). Finally, this article ends with a short discussion of the roles of the credit rating agency (CRA) in the financial crisis.

Keywords: *Securitization, Subprime Mortgage Crisis*

1. INTRODUCTION

To follow the analysis below, the reader should note the following terminology. Subprime mortgage securitization, the type of securitization whose failure initially triggered the chain of failures that became the subprime-mortgage financial crisis (hereinafter the "subprime crisis"), is a subset of mortgage securitization. In the most basic form of mortgage securitization, mortgage-backed securities ("MBS") are issued by a special-purpose vehicle ("SPV"). More complex forms of mortgage-backed securities include collateralized debt obligation ("CDO"), credit default swap (CDS), synthetic CDO, and ABS CDO. Throughout this article, CDS, ABS, MBS, ABCP, CDO and CRA will refer to both the singular and plural form.

When homeowners default, the payments received by MBS investors decline and the perceived credit risk rises. This has had a significant adverse effect on investors and the entire mortgage industry. Those subprime defaults caused this mortgage crisis of 2008. This crisis caused a chain reaction throughout the global financial markets and the banking system, because the NPV of investments related to housing prices decreased big, putting the main financial institutions at a serious disadvantage. Because all financial institutions tightened their lending practices, all personal and all corporate capital spending decreased. This crisis is rooted in about 1997, but is more evident in about 2008. This crisis has passed through various stages. This crisis is revealing universal weaknesses in the global financial system and supervisory structure. Across the globe, all assets prices decreased, volatility levels increased, credit spreads increased big and liquidity demand increased big. Uncertainty is unusually clear in the asset-backed commercial paper (ABCP) market. All financial institutions around the world have reported losses of approximately U.S. $435 billion as of 17 July 2008. Those cause central banks around the world to invest in a large number of cash into their financial markets. The central

banks encourage lending to worthy borrowers and to regain faith in the ABCP markets. The U.S. government also bailed out key financial institutions to undertake significant additional financial promises.

This article proceeds as follows. Section 2 provides an overview of securitization and discusses its specific characteristics. Section 3 provides an overview of CDS securitization and discusses its specific characteristics. Section 4 presents a detailed development of the subprime mortgage crisis. Section 5 concludes and analyses the main channels through which securitization instruments contributed to the initiation and propagation of the subprime mortgage crisis.

2. SECURITIZATION

All assets can be securitized so long as they are associated with cash flow. Securitization is a broad term used to describe a sector of finance that was created to help transfer risk using complex legal and corporate entities. Securitization is the repackaging of cash flows that can transform the risk, return and liquidity characteristics of financial portfolios. Figure 1 provides an overview the transferring the risk/return securitization instruments. Securitization involves the pooling of assets and the subsequent sale to investors of claims on the cash flows backed by these pools.

Typically, several classes (or tranches) of securities are issued, each with distinct risk-return profiles. The word tranche is French for slice, section, series, or portion. The tranching is an important concept in securitization because it is the system used to create different investment classes for the securities that are created in the securitization world. The tranching allows the cash flow from the underlying asset to be diverted to the various investor groups. The tranching of these securities into instruments with different risk/return profiles facilitates marketing of the bonds to investors with different risk appetites and investing time horizons. A suitably large portfolio of assets is "pooled" and sold to a "special purpose vehicle" or "SPV" (the issuer), a tax-exempt company or trust formed for the specific purpose of funding the assets. Once the assets are transferred to the issuer, there is normally no recourse to the originator. The issuer is "bankruptcy remote," meaning that if the originator goes into bankruptcy, the assets of the issuer will not be distributed to the creditors of the originator. To be able to buy the assets from the originator, the issuer SPV issues tradable securities to fund the purchase. Investors purchase the securities, either through a private offering (targeting institutional investors) or on the open market. The issuer (SPV) within a corporate group (American International Group (AIG)) is said to be bankruptcy remote when the insolvency of that SPV does not affect any other company in the group (AIG), particularly any holding company or subsidiary company of the bankruptcy remote vehicle. If the SPV goes into bankruptcy, no other company in the same group (AIG) would be affected. In addition, the credit risk of the collateral asset pool is separated from the credit risk of the originator, through the involvement of a Special Purpose Vehicle (SPV) or Special Purpose Entity (SPE). The special purpose legal vehicle (typically a trust incorporated in the Cayman Islands) that will purchase the assets and issue the CDO's tranches. The principal and the interest of the MBS issued by the SPV depend on the cash-flows produced by the pool of underlying financial assets (such as residential mortgages). The SPV sell these tranches of securities to investors in the capital markets. The originator initially owns the assets engaged in the deal. This is typically a company looking to raise capital, restructure debt or otherwise adjust its finances. Under traditional corporate finance concepts, such a company would have three options to raise new capital: a loan, bond issue, or issuance of stock. Once the assets are transferred to the issuer, there is normally no recourse to the originator. As has

become clear from the introduction above, securitization is strongly interrelated with securitization. Securitization, in a narrow sense, is used almost interchangeably with securitization. In different words, securitization can also be interpreted as a financing mechanism, or a process in which assets are refinanced in the capital markets by issuing securities sold to investors by a SPV. Figure 2 provides an overview of the main securitization instruments.

Securitization is a securitization process, which involves pooling and repackaging of cash flow producing financial assets into securities that are then sold to investors. The name "securitization" is derived from the fact that the form of financial instruments used to obtain funds from the investors is securities. As a portfolio risk backed by amortizing cash flows (and unlike general corporate debt) the credit quality of securitized debt is no stationary due to changes in volatility that are time-dependent and structure-dependent. If the transaction is properly structured and the pool performs as expected, the credit risk of all tranches of structured debt improves; if improperly structured, the affected tranches will experience dramatic credit deterioration and loss.

Securitization is the process through which an issuer creates a financial instrument by combining other financial assets and then marketing different tiers of the repackaged instruments to investors. The process can encompass any type of financial asset and promotes liquidity in the marketplace. The process creates liquidity by enabling smaller investors to purchase shares in a larger asset pool. Using the MBS example, individual retail investors are able to purchase portions of a mortgage as a type of bond. Without the securitization of mortgages, retail investors may not be able to afford to buy into a large pool of mortgages.

This followings will explain the securitizations, which have played the most prominent roles in the subprime mortgage crisis of 2008. There are four types of securitizations: ABS, MBS, ABCP and CDO.

2.1. ABS

In finance, an ABS is a type of debt security that is based on pools of assets, or collateralized by the cash flows from a specified pool of underlying assets. Securitization makes these assets available for investment to a broader set of investors. These asset pools can be made of any type of receivable from the common, like credit card payments, auto loans, student loans, and mortgages, to deep cash flows such as aircraft leases, royalty payments and movie revenues. Representatively, the securitized assets might be highly illiquid and private in nature.

A significant advantage of ABS is that they bring together a pool of financial assets that otherwise could not easily be traded in their existing form. By pooling together a large portfolio of these illiquid assets they can be converted into instruments that may be offered and sold freely in the capital markets. ABS enables the originators of the loans to enjoy most of the benefits of lending money with bearing little the risks involved. ABS is generated through a securitization process by SPE (SPV) in order to transform illiquid assets of the originator into transferable securities. The SPV is designed to separate investors from the credit risk of the originating financial institution. SPV (SIV) issue and sell the ABS to investors. This allows for the issuing institution to be legally separated from the SPV.

The underlying assets (Borrowers) make periodic monthly payments over the life of the loan that includes scheduled and unscheduled principal and interest. If payment is less than the interest then the outstanding principal will increase. The outstanding principal is revolving, not amortizing.

ABS is security that is backed by other assets. When these securities are collateralized by mortgages, they are called MBS.

2.2. MBS

A MBS is an ABS whose assets are mortgage loans. When these securities are collateralized by mortgages, they are called mortgage-backed securities (MBS), including commercial mortgage-backed securities (CMBS) and residential mortgage-backed securities (RMBS). In 1938, a governmental agency named the National Mortgage Association of Washington was formed and soon was renamed Federal National Mortgage Association (FNMA or Fannie Mae). It was chartered by the U.S. government as a corporation which buys Federal Housing Administration (FHA) and Veterans Administration (VA) mortgages on the secondary market, pools them, and sells them as MBS to investors on the open market.

SPV (SIV) issue and sell the MBS to investors. This allows for the issuing institution to be legally separated from the SPV. Mortgages are by far the most important underlying asset of global securitization, with residential mortgages being the most important single asset class. A bank provides mortgage loans to various homeowners A, B, etc., and puts these mortgages together in a pool of many mortgages. Subsequently, this bank that has originated these loans sells the pool of mortgages to a SPV, in return for cash. In this true sale securitization, the mortgage loans disappear from the balance sheet of the bank. In order to finance its purchase of the mortgage pool, the SPV issues residential MBS and sells these securities to various investors. The residential MBS sold are tranched in specific classes according to their credit risk, such as rated by the CRA. Thus, a tranche can be defined as a specific portion of a securitized portfolio of assets, based on a group of assets with similar credit risk characteristics. On the basis of a pool of mortgages of U.S.100 million, RMBS are created which consist of U.S.60 million of investment grade securities, subdivided in tranches rated super-senior AAA, senior AA and mezzanine BBB, and of U.S.40 million of below investment grade securities, with tranches rated subordinated B and unrated (the so-called equity tranche). According to their specific risk preferences, various types of investors buy specific tranches.

MBSs are a perfect example of securitization. By combining mortgages into one large pool, the issuer can divide the large pool into smaller pieces based on each individual mortgage's inherent risk of default and then sell those smaller pieces to investors. MBS had enabled financial institutions and investors around the world to invest in the U.S. housing market.

2.3. ABCP

ABCP is a short-term investment instrument with a maturity that is typically between 90 and 180 days. The security itself is typically issued by a bank or other financial institution. The notes are backed by physical assets such as trade receivables, and are generally used for short-term financing needs. ABCP is a form of commercial paper that is collateralized by other financial assets. They are designed to be used for short-term financing needs. SPV (SIV) issue and sell the ABCP to investors. This allows for the issuing institution to be legally separated from the SPV.

A company looking to enhance liquidity may sell receivables to a bank or other SPV (SIV), which, in turn, will issue them to its investors as commercial paper. The financial assets that serve as collateral for ABCP are ordinarily a mix of many different assets, which are jointly judged to have a low risk of bankruptcy by a ratings agency. However, in 2008 many of these assets performed more poorly than expected, making buyers much less willing to purchase ABCP. As markets became unwilling to purchase ABCP, this caused trouble for financial institutions that had relied on sales of ABCP to obtain funds for use in longer-term investments. The liquidity

and solvency concerns regarding key financial institutions drove central banks to take action to provide funds to banks to encourage lending to worthy borrowers and to restore faith in the ABCP markets, which are integral to funding business operations. Certain investors, or collateral providers which can be banks or other entities, want to obtain financing by selling certain assets to an ABCP SIV.

2.4. "Cash Flow" collateralized debt obligations (CDO)

Collateralized debt obligations are backed by subprime-mortgage bonds, commercial-mortgage loans and other assets. CDO do not specialize in one type of debt but are often non-mortgage loans or bonds. CDO are unique in that they represent different types of debt and credit risk. In the case of CDO, these different types of debt are often referred to as tranches. Each tranche has a different maturity and risk associated with it. The higher the risk, the more the CDO pays. SPV (SIV) issue and sell the CDO to investors. This allows for the issuing institution to be legally separated from the SPV.

The SPV finances its purchase of the pool by issuing a CDO in the form of tranched notes, which are bought by various investors. According to their risk preference, these investors buy either lower or higher-rated tranches, with corresponding higher or lower yields.

These structured CDOs are based on the securitization of another securitization, for example a CDO based on mortgage-backed securities (i.e. CDO of MBS, which is called a collateralized mortgage obligation or CMO). Another example of a structured CDO is a CDO based on other CDO, which is called a CDO*2*.

CDO are constructed from a portfolio of fixed-income assets. CDO are divided by the issuer into different tranches: senior tranches (rated AAA), mezzanine tranches (AA to BB), and equity tranches (unrated). Losses are applied in reverse order of seniority and so junior tranches offer higher coupons (interest rates) to compensate for the added default risk. Since 1987, CDO have become an important funding vehicle for fixed-income assets.

3. CREDIT RISK TRANSFER SECURITIZATIONS

This section explains and details the securitizations, which have played the most prominent roles in the subprime mortgage crisis of 2008. There are two types of credit derivatives: CDS and synthetic CDO.

3.1. Credit default swaps (CDS)

A credit default swap, or CDS, is essentially an insurance policy on a bond acquired by investors to guard against default. AIG wrote tens of billions of dollars worth of these contracts. Credit default swaps are often used to manage the risk of debt default. Under such a credit default swaps, the credit protection seller receives periodic cash payments, called premiums, in exchange for agreeing to assume the risk of loss on a specific asset in the event that asset experiences a default or other credit event. The CDS "buyer" is buying protection and the CDS "seller" is selling protection against a default or other credit event with respect to the underlying debt obligations (underlying asset). The buyer pays the seller a premium for this protection and the seller only pays the buyer if there is a default or other credit event that triggers the CDS contract. The premium—the cost of protection for the buyer—increases as the risk associated with the underlying obligation increases. In other words, as the creditworthiness of the underlying entity goes down, the cost of protection goes up. CDS are insurance contracts typically used to protect bondholders or MBS investors from the risk of default. This created uncertainty across the system, as investors wondered which companies would be forced to pay to cover

defaults.

CDS can be bought by any investors including the underwriter (e.g., investment bank), the asset manager, the trustee and collateral administrator; it is not necessary for the buyer (i.e., Bear Stearns Wachovia, Citigroup, Deutsche Bank, and Merrill Lynch) to own the underlying credit instrument. Like all swaps and other financial derivatives, CDS may either be used to hedge risks (specifically, to insure creditors against default) or to profit from speculation. The volume of CDS outstanding increased 100-fold from 1998 to 2008, with estimates of the debt covered by CDS contracts, as of November 2008, ranging from U.S. $33 to $47 trillion. CDS are lightly regulated. As of 2008, there was no central clearinghouse to fulfil CDS in the event a party to a CDS proved unable to perform his obligations under the CDS contract. Required disclosure of CDS-related obligations has been criticized as inadequate. Insurance companies such as AIG faced ratings downgrades because widespread mortgage defaults increased their potential exposure to CDS losses. These firms had to obtain additional funds (capital) to offset this exposure. AIG has having CDS insuring $440 billion of MBS resulted in its seeking and obtaining a Federal government bailout. AIG destroys itself by selling mispriced CDS. The blunders of the AIG, the world's largest insurance company, offer the first-ever instance of an institution that is "too interconnected to fail" acting to devastate itself, its shareholders, U.S. taxpayers, and the greater financial system— simply by the misuse of CDS. As a result, one of the most successful companies in business history, with over $1 trillion in assets, has been almost entirely nationalized.

Like all other pure gambles, what one party loses under a CDS, the other party gains; CDS merely reallocate existing wealth. Hence the question is which side of the CDS will have to pay and will it be able to do so. When investment bank Lehman went bankrupt in September 2008, it created a great deal of uncertainty regarding which financial institutions would be required to fulfil the CDS contracts on its $600 billion in outstanding debts. Significant losses at investment bank Merrill Lynch were also attributed in part to CDS and especially the drop in value of its unhedged mortgage portfolio in the form of Collateralized Debt Obligations after AIG ceased offering CDS on Merrill's CDO.

3.2. "Synthetic" collateralized debt obligations (CDO)

Securitizations can be conducted basically in two ways. First, in a so-called true sale securitization, the underlying assets are indeed actually sold by the originators (i.e., bank) to the SPV and thus removed from the balance sheet of the originator. Second, in a so-called synthetic securitization, the underlying assets remain on the balance sheet of the originator, and only the credit risk of the underlying assets is transferred to the SPV by buying credit derivatives such as credit default swaps over this assets.

Similar to securitizations, in addition to "cash flow" CDO, there also exist "synthetic" CDO, where the SPE/SPV does not buy physically the portfolio of underlying debt instruments, but sells credit default swaps over the same debt instruments underlying the "cash flow" CDO described above. Thus, the SPE/SPV receives periodic cash payments and bears legal liability without owning the underlying debt, and issues a synthetic CDO to investors.

The originator buys protection through a CDS contract from the SPE/SPV, which is the seller of protection and gets a CDS premium to bear legal liability of the underlying debt. The SPE/SPV transfers the credit exposure by issuing CDO tranches and selling it to investors (through the same process as in the "cash" CDO).

If a default event occurs to the underlying debt, the SPE/SPV pays the CDS protection to the originator. "Synthetic" CDO played a rather active role in the propagation of the financial crisis. In the context of actual and feared further downgrades of various financial guarantors and of CDO by the CRA, a rapid unwinding of "synthetic" CDO positions by in particular hedge funds resulted in a further widening of credit spreads, as demand for these products collapsed. This process spilled over to other securitization products such as residential and commercial mortgage-backed securities (RMBS and CMBS) and other asset-backed securities.

4. SUBPRIME MORTGAGE CRISIS

Many U.S. mortgages issued in recent years are subprime, meaning that little or no down payment was made, and that they were issued to households with low incomes and with troubled credit histories. Subprime mortgages are residential loans that do not conform to the criteria for prime mortgage and so have a lower expected probability of full repayment, because they are made to more risky mortgage borrowers. This assessment is made according to objective criteria such as the borrower's credit score record and loan-to-value ratios. Subprime mortgage borrowers have a less than perfect credit history and are required to pay interest rates higher than what would be available to a traditional agency borrower. Between 2001 and 2008, poor underwriting standards and excessive lending led to a very large number of default-prone home mortgages.

If a borrower is default in making timely mortgage payments to the loan lender, the lender can take possession of the residence and call a foreclosure. The Subprime Mortgage Crisis of 2008 arises because a borrower has the option of defaulting on the loan he owes. Typically, lenders (who were primarily thrifts) undertake the default risk on the mortgages they issued. Over the past 60 years, a variety of financial innovations have gradually made it possible for lenders to sell the right to receive the payments on the mortgages they issue, through a process called securitization. The resulting securities are called MBS. Investors in MBS can insure against default risk by buying CDS.

Credit-default swaps ("CDS") are a valuable financial tool that has created system-wide benefits. At the same time, however, these derivative contracts have also created the potential for relatively few market participants to destabilize the entire economic system. CDS helped support the growth of the sub-prime mortgaged-backed securities asset bubble that has been blamed for igniting the current financial crisis. Although CDS are a valuable tool that has traditionally helped businesses efficiently allocate risk, they do create systemic danger in several ways, some of which have become manifest in the past year. As a result, CDS have intensified the scope of the financial crisis.

As mortgage defaults rose, the likelihood that the sellers of CDS would have to pay their buyers increased. This created uncertainty across the system, as investors wondered if CDS sellers would fulfill their promises. The scope of this crisis were much larger than had been anticipated, due to information indicating further deteriorating conditions in U.S. subprime mortgage markets. Central banks around the world cut interest rates and governments implement economic stimulus packages. These actions were designed to stimulate economic growth and inspire confidence in the financial markets. But uncertainty in securitization markets remained at elevated levels. There is broad consensus that securitization played an important role in the propagation of the subprime mortgage crisis. The subprime mortgage crisis revealed a number of weaknesses of securitization. Banks underestimated and invested too much in securitization instruments.

5. CONCLUSIONS

We want to conclude this article with a short discussion of the role of the CRA in securitization and the financial crisis. The financial crisis of 2008 has revealed substantial shortcomings of the global financial system. Those shortcomings are all about securitization. Those shortcomings have in particular been in the process of the securitization; CRA are of enormous importance, as they rate the bank that originates the securitization, the SPV that creates the securitization and the specific tranches of the securitization. Most investors trust those ratings; however most of those ratings are trustless. This article is to present the fundamentals of securitization and their role in the financial crisis. As aforementioned, the financial crisis comes from securitizations. Thus, securitizations played a crucial role in the development and propagation of the financial crisis.

Essentially, the financial crisis highlighted strong doubts on the ratings methodologies for securitization products. These doubts further increased by substantial ratings' downgrades both in number and severity in the course of 2008. The crisis revealed intrinsic problems with the valuation of securitization products and various incentive problems involving the CRA.

In hopes of minimizing further systemic collapse, this Paper recommends that securitization (e.g., CDS) become regulated in a way that balances the efficiency of a free market with the goal of economic stability

References

Speech by Alan Greenspan, Regulation, Innovation, and Wealth Creation, Federal Reserve Website, Sept. 25, 2008.

Alistair Barr, Greenspan Sees 'Serious Problems' with CDS, Marketwatch.com, Oct. 23, 2008, available at http://www.marketwatch.com (enter search keywords "Greenspan Testimony Credit Default Swaps," then follow first result).

Erik Sirri, Statement to the House Agricultural Committee, to Review the Role of Credit Derivatives in the U.S. Economy, Hearing, Oct. 15, 2008, available at http://agriculture.house.gov/hearings/statements.html.

J. Burns. "Former Ratings-Firm Officials Blame Conflicts for Rosy Views." Wall Street Journal (October 23, 2008), A4.

B. Jameson. "The Blunders that Led to Catastrophe." New Scientist (September 27, 2008),8-9.

ISDA is the largest global financial trade association, with 850 member firms. Chartered in 1985, its role is to promulgate standardized OTC derivatives documentation and lobby on behalf of its member firms, which include all major institutions that participate in the OTC derivatives markets See Pickels (2008), supra note 14.

ISDA Mid-Year 2008 Market Survey Shows Credit Derivatives at $54.6 Trillion, ISDA News Release, Sept. 24, 2008.

DTCC Deriv/SERV Trade Information Warehouse Reports, DTCC Website, available at http://www.dtcc.com/products/deriserv/data/index.php.

Yuliya Demyanyk et al., Understanding the Subprime Mortgage Crisis, Aug. 2008, Working paper, available at http://ssrn.com/abstract=1020396.

See, Carrick Mollenkamp et al., Lehman's Demise Triggered Cash Crunch Around Globe, WALL ST. J., Sept. 29, 2008.

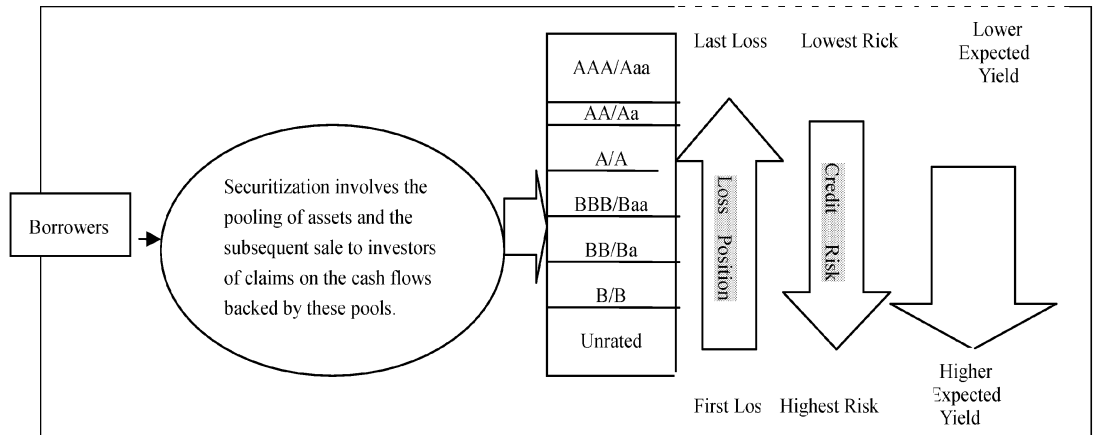
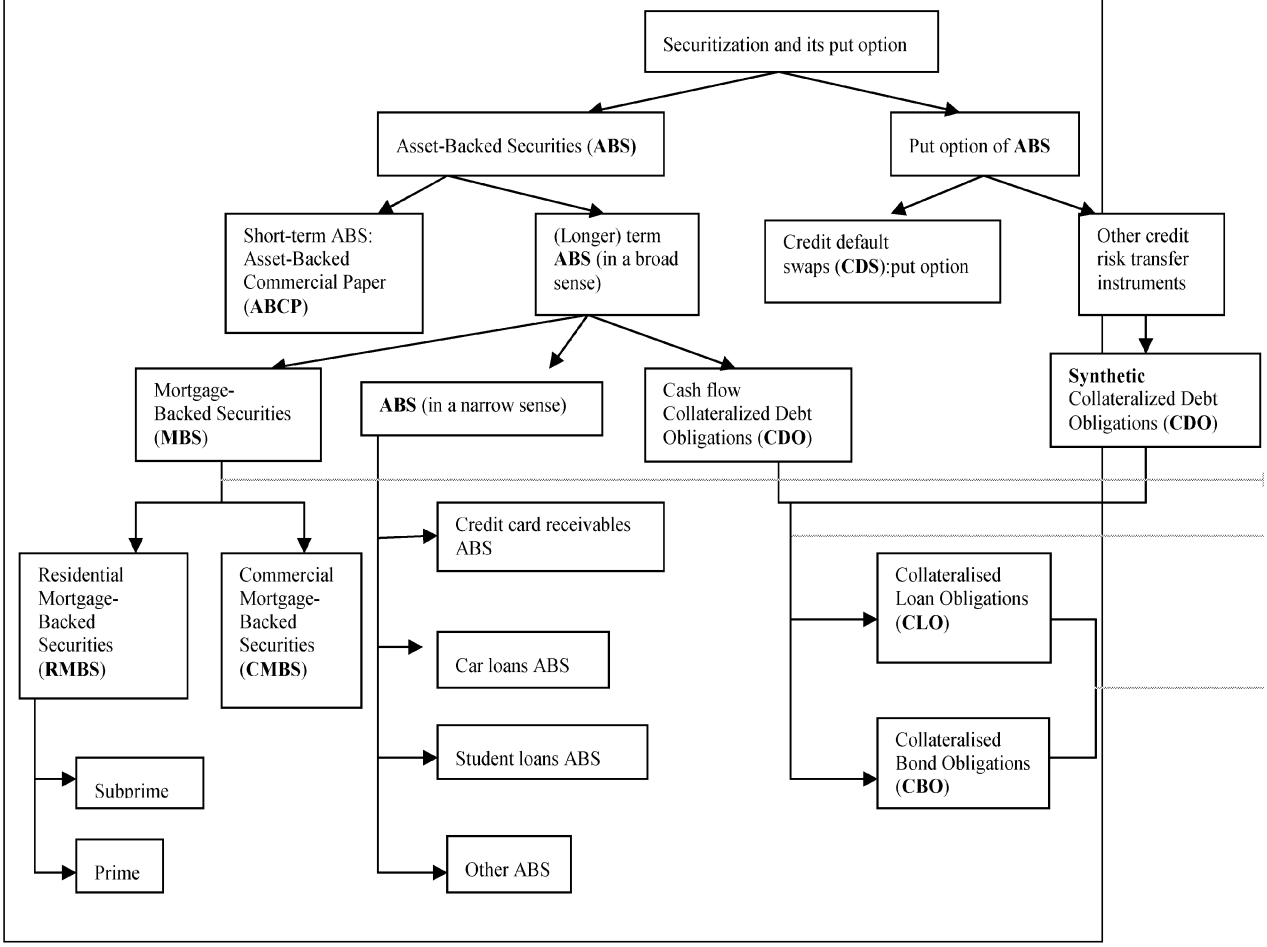


Figure 1 provides an overview the transferring the risk/return securitization instruments.

Figure 2 provides an overview of the main securitization instruments.



Tourism Motivation as an Effective Platform for Improved Mice Segmentation Marketing Strategies for Taiwan

Che-Chao Chiang
PhD Candidate, School of Hospitality, Tourism and Marketing,
Victoria University, Melbourne, Australia
E-Mail: chechao.chiang@live.vu.edu.au

Fu-Ming Chiang
Professor and Dean of the Informatics and Management School
Tajen University Taiwan

Riccardo Natoli
PhD, Victoria University, Melbourne, Australia

ABSTRACT

Market segmentation is frequently recommended as a powerful tool to examine systematic differences of specific determinant factors across a number of segments (Dolnicar and Grün, 2008; Dolnicar, 2004; Baloglu and McCleary, 1999; Richard and Sundaram, 1994). An improved understanding of these differences enabled this paper to identify three key segments pertaining to the Taiwan MICE sector. This improved foundation assisted in the development of efficient strategies for Taiwan marketers to ascertain fresh potential markets as well as to sustain a repeat customer base. This paper utilised this technique, focusing on tourism motivation and its potential impact on marketing strategies in the case of the MICE sector in Taiwan. The paper employed the following analyses: exploratory factor analysis, K-means clustering and ANOVA to identify three different segments (career-enhancement seekers; value maximisation seekers; and education-travel seekers) among MICE attendees in the Taiwan business context. The results are subsequently used to develop prospective marketing strategies for the Taiwan MICE sector.

Keywords: *tourism motivations • market segmentation • factor-cluster method • MICE tourism*

1. INTRODUCTION

Over the past few decades Meetings, Incentives, Conventions and Exhibitions (MICE) has been, on a worldwide scale, the fastest growing sector in the domestic and international tourism industry with total expenditure worldwide expected to reach US$743 billion in 2007 (World Tourism Organization, 2006). Currently, MICE tourism accounts for as much as 70% of total sales volume in major hotels and about 15–20% of sales in smaller hotels (Astroff and Abbey, 1998). This growth meant that Asian cities were increasingly chosen as prospective international meetings and conference destinations (Go and Govers, 1999). The impact of the MICE sector in Taiwan has been quite significant. According to the International Congress and Convention Association (2007), in 2007 Taiwan was ranked 36th on the basis of the number of international conventions held, while Taipei was ranked 18th worldwide and 6th in Asia. To reflect the growing impact of the MICE sector, the Taiwanese tourism authority intends to invest US$642.42 million to construct new exhibition centres and facilities (Taiwan headlines, 2007).

Table 1 ICCA City ranking measured by number of meetings organised in 2007

Rank	City	Meetings
1	Vienna	154
2	Berlin	123
17	London	69
18	***Taipei***	***67***

Source: The International Congress and Convention Association (2008).

Yet despite the acceleration of MICE tourism demand worldwide, and its increasing significance in the Asian Pacific region, there is a noticeable lack of studies undertaken within the Asia-Pacific region particularly related to market segmentation in the MICE tourism industry.

Market segmentation is a useful instrument in tactical marketing that help marketers identify their potential customers desires through a greater understanding of the needs of homogeneous consumer subdivisions (Kotler and Armstrong, 2008; Dolnicar and Grun, 2008; Yuksel and Yuksel, 2002). Specifically, as Kotler and Armstrong (2008) posit, market segmentation is the method that can provide improved information for marketers regarding consumers with different desires. It achieves this by unravelling a market into smaller groups based on identifying significant differences in the characteristics of each group. In a highly challenging market, the use of market segmentation is an important tool for advancing a company's competitive position among its competitors.

A few previous tourism studies have focused on the connected issues of market segmentation *and* the MICE tourism industry (Yoo and Weber, 2005; Baloglu and Assante, 1999). According to their findings, the majority of articles published in five key hospitality management journals for the period from 1990 until 1996, concentrated on topics concerning human resources, lodging and the food service industry. Thus, despite the considerable significance of MICE tourism, in light of its economic importance and fast expansion rate, exceedingly little analysis has been conducted on this topic with regards to market segmentation. Hence, this paper intends to propose more effective marketing strategies for Taiwan's MICE sector through investigating the key determinants of travel motivations, which has been recognized significantly as shaping tourists' travel behaviours.

2. TOURISM MOTIVATION AS PART OF DEVELOPING MARKETING STRATEGIES: A REVIEW

Conceptually, tourism motivation is commonly understood to be a key concept in understanding and managing satisfactory levels of tourists in linking a variety of tourists' behavioural intention in marketing strategies (Yoon and Uysal, 2005; Rittichainuwat, Qu and Leong, 2003; Kozak 2001; Baker and Crompton, 2000; Kozak and Rimmington, 2000). It does this by reflecting the tourists' wants and needs from visiting a tourism destination. There is notable growing evidence that many of the central aspects with regards to motivation can have profound impacts on tourists travel behaviours (Pennington-Gray and Kerstetter, 2001; Sirakaya, Uysal and Yoshioka, 2003; Pearce and Lee, 2005).

It has been well demonstrated that a superior understanding of customer motivations can allow all

companies to more accurately comprehend what their customers want or seek (Fodness, 1994). Gee, Choy and Makens (1997) maintain that travel decisions and tourist behaviours are greatly affected by a variety of motivational factors. On this basis, tourism managers ought to advance their understanding of these factors. In fact, Oppermann (1998) recommends that marketers *must* be acquainted with their customers, including: why do they purchase; how many repeat purchasers exist and; how often have they purchased products. He believes that if managers have only limited understanding of the impacts associated with these questions, it will be very difficult to offer products which meet customers' expectations. Given the significance of understanding tourist motivations for travelling, many researchers argue that a traveler's motivation may be described as a dynamic process of inner psychological factors (needs, wants and goals) that leads the individual person to develop their intention for actual behaviours (Fodness, 1994).

It was Dann (1977, 1981) who developed a push-pull framework examining tourist behaviour via the motivations (feelings or desires) of an individual who was willing to travel. In his work, tourism motivation was characterised as a pull factor which was fundamental in determining travel decisions relating to the selection of a destination, whereas push factors were viewed as a traveler's needs and wants. Baloglu and Uysal (1996) and Uysal and Hagan (1993) claimed that push factors of tourism motivation are traditionally viewed as internal or intrinsic desires of individual travelers. These studies provided a greater understanding of why people travelled and also played a substantial role in predicting tourists' behaviours prior to and during their holidays. A study by Ngamsom and Beck (2000) demonstrated that attending conferences, conventions and exhibitions provides various opportunities for corporate travelers to investigate other opportunities/activities. For instance, outdoor recreation; related business activities; networking; and educational enhancement. Consequently, a major motivation for conference travel is the opportunity to travel to overseas destinations and participate in outdoor recreation activities.

According to the report conducted by the Meeting Professionals International (MPI) (2000), most convention and meeting attendees consider their participation within a range of meetings events as the best way to gain knowledge (learning new skills) towards their future professional development. Furthermore, Rittichainuwat, Beck and Lalopa (2001) identified a number of primary motivations for MICE attendees to participate in conferences. They included: sightseeing; self-enhancement; and business and conference activities. Based on this, it is acceptable to view tourism motivation as a multi-dimensional concept towards in understanding and predicting tourists travel behaviours. Given this, a methodology is needed to reflect this multi-dimensional concept.

3. METHODOLOGY

3.1 Questionnaire development

A multi-item scale was used to obtain an overall estimation of motivation for MICE tourists in participating conventions and meetings events in Taiwan by rating key components of motivational attributes. Twenty-one questions were designed to determine the importance of each motivational attribute in relation to the target respondents' current trip (5-point Likert scale ranging from it is not important at all to it is extremely important). These questions reflected the two key factors of tourism motivation: professional related benefits (business and education aspects); and recreational related benefits. The participants were asked to indicate some

motivational factors which could reflect their reasons for visiting Taiwan. Each attribute was rated in terms of their importance to the traveler for selecting Taiwan. The distinctions of these items would assist the researcher to understand the role of each dimension: professional related benefits (business and education components); and recreational related benefits, in the selection of the destination among business travelers. All of the determinants of motivational attributes were selected from previous relevant tourism motivation studies.

3.2 Data collection

The majority of the sample respondents are business travelers who had undertaken corporate purpose related travel in Taipei. This target population was considered suitable for achieving the key objectives of the study. The surveys were conducted while the respondents were participating in various business related events in the Taipei international convention centre as well as the Taipei world trade centre. A self-administered questionnaire was employed in the data collections stage. This is the most effective and efficient way for gathering a large number of respondents placed in extensive locations. All respondents were 18 years of age or older. Prior to conducting the main survey, a pilot survey was conducted to investigate the reliability of the survey questionnaire using correlation coefficient analysis. The main survey sample comprised of 700 tourists who had visited Taipei for business related purposes, of which 518 were established as useable for analysis subsequent to data clearing treatment.

4. DATA ANALYSIS

The data was analyzed via three major steps: explanatory factor analysis (EFA), K-means cluster analysis and ANOVA analysis. Initially an EFA, frequently recommended as a constructive way for assessing the verification of the research questionnaire construct (Hair, Anderson, Tatham and Black, 1998), was employed to provide in explanation of the complex interrelations among variables. The EFA, with varimax rotation, was applied to reduce the data needed to investigate a number of key dimensions underlying the tourism motivation concept. This technique is considered a suitable statistical procedure, and has been employed in previous segmentation studies (Sarigollu and Huang, 2005; Formica and Uysal, 1998; Madrigal and Kahle, 1994). It also assists with the subsequent phase of analysis.

The employment of the K-means cluster analysis is valuable in its recognition and classification of customers on the basis of the potential similarities concerning their characteristics (Malhotra, 2003; Hair, Anderson, Tatham and Black, 1998; Aldendefer and Blashfield, 1984). In the case of this study, the examination of K-means cluster analysis was carried out on three different cluster solutions (n = 2, 3, 4, 5 and 6) to ascertain the number of homogeneous groups formed by the data. As suggested by Kaufman and Rousseuw (1990), this method is frequently applied with large samples. Consequently, three-clusters were identified as appropriate tourist segments for supplementary analysis since they provided the maximum difference between clusters. As a result an ANOVA analysis, via the F test, was applied to classify the potential differences between the groups of business tourists who visited Taiwan.

5. FINDINGS AND DISCUSSIONS

The socio-demographic profiles of the sampled Taiwan inbound business tourists showed that the majority of categories of respondents were: male (78.2%); 40 to 49 years old (36.5%); masters or doctoral degree

(46.9%); employees (56.8%); director or manager (64.7%); earn US$82501-US$99000 (17.2%); with most born in Japan (32.45%).

Table 2 Factor analysis results of tourism motivation of MICE tourists

Dimensions of Tourism Motivation	Factor Loading			
	F1	F2	F3	F4
Factor 1: EDUCATION BASED VALUE				
Presenting a paper	**0.867**			
Server as chair or moderator	**0.866**			
Education-related purposes	**0.794**			
Self-esteem enhancement	**0.588**			
Factor 2: NOVEL EXPLORATION				
Life experience gained when traveling		**0.814**		
Comfortable place to stay		**0.814**		
See new things		**0.747**		
Escape from routine		**0.610**		
Experience different culture		**0.577**		
Opportunity to relax on vacation		**0.552**		
Factor 3: CAREER ENHANCEMENT				
Work requirement			**0.769**	
Employer funded			**0.765**	
Networking opportunities			**0.719**	
Interesting conference programs			**0.621**	
A good conference package			**0.561**	
Reasonable priced conference			**0.485**	
Factor 4: TRAVELING OPPORTUNITY				
Sightseeing				**0.860**
Opportunity to visit a new town				**0.851**
Combination of leisure and business trips				**0.556**
Opportunity for entertainment				**0.551**
Total Scale Reliability	**0.935**			
Eigenvalue	**9.10**	**2.56**	**1.16**	**1.04**
% of variance explained	**45.5%**	**12.8%**	**5.8%**	**5.2%**
Cronbach's alpha (α)	**0.892**	**0.894**	**0.862**	**0.838**

As demonstrated in Table 2, there are four factors with eigenvalues significant enough to be extracted. The factor analysis was conducted on 20 different motivational items. The four factors explain 69.3% of the general variance after the varimax of the component indicators rotation. Furthermore, the Kaiser-Meyer-Olkin (KMO)

score of sampling adequacy was 0.891, and the Bartlett test's value to establish sphericity was 7746.288, degrees of freedom (df) 190 and 0.00 level of significance. These indicators show that a factor analysis is appropriate to use as a means to provide an enhanced understanding of the key subordinate dimensions towards tourism motivations among business tourists. The name of each factor was decided according to the most significant characteristics of its engaged components. The four factors (educational based value; novel exploration; career enhancement; and travelling opportunity) explained 45.5%; 12.6%; 5.8%; and 5.2% of the variance respectively. Their specific characteristics are listed in table 2. Generally, the findings of table 2 demonstrated that the major motivations (and thus their importance in the decision-making) for MICE tourists visiting Taiwan for business related purposes could be summarised by the aforementioned four-factors.

The major aim of this study is to provide an advanced understanding, and to better develop, tourism marketing segmentation through examining the potential differences regarding tourism motivations between different segments of MICE tourists. Hence, an ANOVA analysis was conducted to identify significant differences in factor means between the three segments. By viewing the findings produced from the F-test outlined in table 3, which indicated the foundational differences on a statistical level to be found between three of determinant groups of MICE tourists who visited Taiwan as a business tourism destination. All of the p-values are significant (0.00). This implies that the results are meaningful for marketers to advance their strategies concerning potential customers.

Table 3: K-Means AVONA for clustering factors of tourism motivations

Overriding Dimension Influence	Factors of Tourism Motivation Dimensions			
	F1	**F2**	**F3**	**F4**
Career enhancement seekers **(N=132, 25.4%)**	1.87	1.51	**2.38**	1.58
Value maximisation seekers **(N=265, 51.1%)**	**3.69**	**3.30**	**3.79**	**3.63**
Education - travel seekers **(N=121, 23.3%)**	**3.63**	1.56	1.97	**3.30**
Total (N=518)				
df	**2**	**2**	**2**	**2**
F Value	**17.597**	**20.958**	**16.074**	**19.324**
P Value	**0.00****	**0.00****	**0.00****	**0.00****

Note: All illustrated p-values are significant at 0.00**

5.1 Cluster 1: Career enhancement seekers

Career enhancement opportunities was the overriding factor for MICE travel for almost 26% of the total sample (n=518). Tourists in this cluster were more likely to be motived by determinant factors concerning their career enhancement, such as networking opportunities, compared to other groups of tourists. Specifically, this dealt with the possibility to seek a superior arrangement of various networking establishments. This finding is consistent with previous studies which claim that motivations related to work should perform a crucial role in determining the decision-making process of business tourists (Severt, Wang, Chen and Breiter, 2006; Ngamsom

and Beck, 2000). Tourists within this cluster ranked lower on factors relating to recreational or leisure related components. This suggests that tourists within this group are less interested in engaging in various leisure activities than the other two groups. A result of this is that this group is less likely to spend money and time on entertainment activities. Given that the opportunity to build up networks is a matter of high importance, a recommendation relating to destination tourism marketers - or services providers - is that they should develop strategies that focus more on establishing fun and interactive social events in order to generate greater spending opportunities and positive memories.

5.2 Cluster 2: Value maximisation seekers

The second cluster comprised approximately 51% of the total sample (n=518). It was demonstrated that this cluster is considerably different to the two other groups. Tourists in this group were more likely to be attracted by *various factors* of tourism motivation regarding aspects of professional and recreational benefits. This indicates that the majority of MICE tourists intend to visit Taiwan for both business and leisure-related purposes. In effect, these respondents were interested in maximising their value while on this trip Significantly, the findings are consistent with previous studies which suggest that prospective recreational activities in a destination should be considered as key points for business tourists to visit a destination (Rutherford and Kreck, 1994). In most cases of business tourism, a combination of business and leisure travel is generally expected before the trip.

Building on this foundation, this study provides further evidence in confirming - and supporting empirically - the earlier study conducted by Ngamsom and Beck (2000), who claimed that the degree of motivation towards travel possibilities also acts as a key determinant of a business tourists' travel decision-making process. Therefore, the service providers should aim to arrange more interesting and attractive MICE events (both social and recreational related activities) in order to satisfy the majority of business travelers who are value maximisation seekers.

5.3 Cluster 3: Education - travel seekers

This cluster of MICE tourists make up roughly 23% of the total sample. In contrast to the other groups, education based value and traveling opportunity were the key influences for travel. It is obvious that this group of tourists intend to participate and enjoy both the educational and leisure sides of their trip. Hence, the expectations (reasons for travel) of this group are two-fold. Firstly, they are excited by opportunities concerning sightseeing, as well as presenting a paper or serving as a chair or moderator. These findings imply the need for related tourism marketers to take into consideration promotional strategies which provide a high-quality leisure travel environment as well as a good quality academic experience.

6. CONCLUSION

The MICE tourism segment is growing at a fast rate, with significant positive impacts for host destinations (Braun, 1992; Braun Rungeling, 1992). This is best exemplified in the Asia region (Muqbil, 1997). In response to such dramatic growth, this study provides valuable information regarding the development of tourism strategies in the MICE sector. This paper investigates the importance of tourism motivation which contributes to a corporate traveler's decision-making process. The findings also identify three main clusters of MICE tourists

differentiated in light of the characteristics of tourism motivation in each group. The identification of various segments is extremely helpful for destination marketers in positioning MICE tourists via a greater understanding of otherwise homogeneous clusters. A factor analysis and K-means cluster analysis were employed to improve the reliability of the survey questionnaire. It also identified different clusters in the survey sample based on significant differences in the attitudes in relation to tourism motivation between the groups. This initial analysis was followed by ANOVA testing to explore the best explanation in describing the general nature and the differences between the clusters.

This study offers some valuable insights toward the MICE sector in Taiwan via its ability to recognize the classification of tourist segments. In light of this improved understanding, the development of supplementary successful tourism strategies can also be established. The sample was collected from Taiwan and thus may not be able to represent the global MICE market. Additionally, other determinant factors – not examined here - are also involved in determining tourists' travel decisions process. Hence, further studies are required.

References

Astroff, MT & Abbey, JR 1998, *Convention Sales and Services*, Waterbury Press, Las Vegas.

Aldenderfer, MS & Blashfield, RK 1984, *Cluster analysis: sage series on quantitative applications in the social sciences*, Sage Publishing, Beverly Hills.

Baloglu, S & Assante, L 1999, 'A Content Analysis of Subject Areas and Research Methods used in Five Hospitality Management Journals', *Journal of Hospitality & Tourism Research* vol. 23 , pp. 53–70.

Baloglu S & McCleary KW 2008, 'A model of destination image formation', *Journal of Travel Research*, vol. 47, no. 1, pp. 63-71.

Braun, BM 1992, 'The economic contribution of conventions: The case of Orlando Florida', *Journal of Travel Research*, vol. 11, no. 4, pp. 32-37.

Braun, BM & Rungeling, B 1992, 'The relative economic impact of convention and tourist visitors on a regional economy: A case study', *International Journal of Hospitality Management*, vol. 11, no. 1, pp. 65-71.

Baloglu S & Uysal M 1996, 'Market segments of push and pull motivations: a canonical correlation approach', *International Journal of Contemporary Hospitality Management,* vol. 8, no. 3, pp. 32-38.

Baker, D & Crompton, J 2000, 'Quality, Satisfaction and Behavioral Intentions', *Annals of Tourism Research*, vol. 27, pp. 785–804.

Dolnicar S 2004, 'Beyond "Commonsense Segmentation": A Systematics of Segmentation Approaches in Tourism', *Journal of Travel Research*, vol. 42, no. 3, pp. 244-250.

Dolnicar S & Grün B 2008, 'Challenging "Factor–Cluster Segmentation"', *Journal of Travel Research*, vol. 47, no. 1, pp. 63-71.

Dann GMS 1977, 'Anomie, ego-enhancement and tourism', *Annals of Tourism Research*, vol. 4, pp. 184–194.

1981, 'Tourism motivation: An appraisal', *Annals of Tourism Research*, vol. 8, no. 2, pp. 187–219.

Formica, S & Uysal, M 1998, 'Market segmentation of an international cultural-historical event in Italy', Journal *of Travel Research*, vol. 36, no. 4, pp. 16-24.

Fodness, D 1994, 'Measuring tourist motivation', *Annals of Tourism Research*, vol. 21, no. 3, pp. 555–581.

Gee, CY, Choy, DJL & Makens, JC 1997, *Travel Industry*, Van Nostrand Reinhold, New York.Go, F & Govers, R 1999, 'The Asian perspective: Which international conference destinations in Asia are the most competitive?' *Journal of Convention and Exhibition Management*, vol. 1, no. 4, pp. 37-50.

Hair, JF, Anderson, RE, Tatham, RL & Black, WC 1998, *Multivariate data analysis*, (5th ed.), Pearson Education, Boston, MA.

International Congress & Convention Association (ICCA) (2007), 'Top 20 country and city rankings', viewed January 10 2008, <http://www.iccaworld.com/npps/story.cfm?ID=1577>.

Kaufman, L & Rousseuw, PJ 1990, *Finding Groups in Data: An Introduction to Cluster Analysis*, Wiley, New York p. 344.

Kotler, P & Armstrong, G 2008, *Principles of Marketing*, (12th ed.), Pearson Education Ltd, New York.

Kozak, M & Rimmington, M 2000, 'Tourist Satisfaction with Mallorca, Spain, as an Off-Season Holiday Destination', *Journal of Travel Research*, vol. 38, no. 3, pp. 260-269.

Kozak, M 2001, 'Repeaters behaviour at two distinct destinations', *Annals of Tourism Research*, vol. 28, no. 3, pp. 784–807.

Madrigal, R & Kahle, LR 1994, 'Predicting Vacation Activity Preferences on the Basis of Value-System Segmentation', *Journal of Travel Research*, vol. 32, no. 2, pp. 22-28.

Muqbil, I 1997, 'The Asian conferences meetings and incentives market', *Travel and Tourism Analyst*, pp. 38-56.

Meeting Professionals International (MPI) 2000, *Annual Report*, MPI Foundation Research, Ottawa.

Ngamsom, B & Beck, J 2000, 'A pilot study of motivations, inhibitors, and facilitators of association members in attending international conferences', *Journal of Convention and Exhibition Management*, vol. 3, no. 3, pp. 45-62.

Nareshk M & David BF 2000, *Marketing Research and Applied Approach*, Pearson Education Ltd, United Kingdom.

Opperman, M 1998, 'Destination Threshold Potential and the Law of Repeat Visitation', *Journal of Travel Research*, vol. 37, no. 2, pp. 131–137.

Pearce, PL 2005, 'Developing the Travel Career Approach to Tourist Motivation', *Journal of Travel Research*, vol. 43, no. 3, pp. 226-237.

Pennington-Gray, L & Kerstetter, D 2001, 'Examining Travel Preferences of Older Canadian Adults Over Time', *Journal of Hospitality and Leisure Marketing*, vol. 8, no. 3-4, pp. 131-146.

Richard, MD, Sundaram, DS & Allaway, AW 1994, 'Service quality and choice', *Journal of the Academy of Marketing Science*, vol. 30, no.3, pp. 202-216.

Rutherford, DG & Kreck, LA 1994, 'Conventions and tourism: Financial add-On or myth? Report of a study in one state', *Journal of Travel & Tourism Marketing*, vol. 3, no. 1, pp. 49–63.

Rittichainuwat B, Ngamson, JA, Beck C, & Lalopa, J 2001, 'Understanding motivators, inhibitors and facilitators of association members in attending international conferences', *Journal of Convention and Exhibition Management*, vol. 3, no. 3, pp. 45–62.

Rittichainuwat B, Qu, H & Leong, JK 2003, 'Travel Motivations of Japanese Overseas Travelers: A Factor-Cluster Segmentation Approach', *Journal of Hospitality & Tourism Research*, vol. 27, no. 2, pp. 217-236.

Sirakaya, E, Uysal, M & Yoshioka, CF 2003, 'Segmenting the Japanese Tour Market to Turkey', *Journal of*

Travel Research, vol. 41, no. 3, pp. 293-304.

Sarigollu, E & Huang, R 2005, 'Benefits segmentation of visitors to Latin America', *Journal of Travel Research*, vol. 43, no. 3, pp. 277–293.

Severt, D, Wang, Y, Chen, P & Breiter, D 2007, 'Examining the motivation, perceived performance, and behavioural intentions of convention attendees: evidence from a regional conference', *Tourism Management*, vol. 28, no. 2, pp. 399–408.

Taiwan headlines (2007), 'Taiwan's convention-and-exhibition industry thinks big', viewed December 11 2007, <http://www.taiwanheadlines.gov.tw/ct.asp?xItem=91343&CtNode=39>.

Uysal, M & Hagan, L 1993, 'Motivation of Pleasure Travel and Tourism', in M. Khan, M. Olsen, & T. Var (eds), *Encyclopaedia of Hospitality and Tourism*, Van Nostrand Reinhold, New York, pp. 798-810.

Wedel, M & Kamakura, W 1998, *Market Segmentation: Conceptual and Methodological Foundations*, Kluwer Academic Publishers, Boston, MA.

World Tourism Organization (WTO) (2006), *Measuring the Economic Importance of the Meetings Industry: Developing a Tourism Satellite Account Extension*, WTO, Geneva.

Yuksel, A & Yuksel, F 2002, 'Market segmentation based on tourists' dining preferences', *Journal of Hospitality and Tourism Research*, vol. 26, no. 4, pp. 315-331.

Yoon, Y & Uysal, M 2005, 'An examination of the effects of motivation and satisfaction on destination loyalty: a structural model', *Tour Management*, vol. 26, no. 1, pp. 45–56.

The Interaction Effect of Firm and Industry Characteristics, Economic Conditions on Corporate Debt Financing: Evidence from Taiwan

Hsien-Hung Yeh*

Wen-Ying Cheng

Lecturer and Associate Professor, Department of Business Administration,
National Pingtung University of Science and Technology, Taiwan, R.O.C
E-Mail: hhyeh@mail.npust.edu.tw

ABSTRACT

This paper includes consideration of economic conditions to investigate the effects of interactions between firm characteristics, industry characteristics and economic conditions on corporate debt financing, which is ignored or only examined partly rather than fully integrated by previous studies. The findings indicate that industry characteristics and economic conditions have no significant effect on corporate debt financing. The effects of some firm characteristics on corporate debt financing are influenced by the impact of industry characteristics and economic conditions. However, we find no significant effect of interaction between industry characteristics and economic conditions on corporate debt financing.

Keywords: *Firm Characteristics, Industry Characteristics, Economic Conditions, Interaction Effect, Corporate Debt Financing.*

1. INTRODUCTION

Since Modigliani and Miller (1958) demonstrated the irrelevance hypothesis of capital structure, researchers have expanded their work on capital structure. According to the irrelevance hypothesis, in a perfect market the total value of a firm is independent of its capital structure. However, given market imperfections, an appropriate mix of debt and equity capital can minimize the cost of capital and maximize the firm value. In addition, the determination of corporate capital structure remains unclear. First, mixed empirical results and conflicting conclusions on the determinants of corporate debt financing have been found, as summarized by Haris and Raviv (1991). Second, timing is critical to corporate debt financing. Studies conducted at different periods of time are subject to the impact of economic fluctuations. Ferri and Jones (1979) found the variation in the firm size effect on the determination of corporate debt financing. Further, Ferri and Jones (1979) also found that the level of corporate debt financing varied between expansionary and recessionary periods depending upon industries. Furthermore, Hall et al. (2000) consider interaction between industry type and firm characteristics, finding that the determination of corporate debt financing in UK unquoted, small and medium-sized enterprises is influenced by interactions between firm and industry Characteristics. However, they did not consider the impact of economic conditions. In addition, many studies use individual variables in firm characteristics and industry characteristics but do not study them as groups to examine the interactions between them. If these areas in firm and industry characteristics and economic

* Corresponding author.
The authors are grateful for the helpful comments and suggestions from Associate Professor John Forster, Griffith University, Australia and Assistant Professor Henry Hsieh, National Pingtung University of Science and Technology, Taiwan.

conditions are important to the determination of capital structure, they should have their impacts modified or intensified by the interactions between these areas. Unfortunately no current theory of capital structure considers these interactions, which makes this an exploratory study. Based upon these ideas, we extend the work on the interaction effect of firm and industry characteristics and economic conditions on the determination of corporate debt financing. The paper is organized as follows. The empirical results and conclusions of the related literature are summarized in the next section. Our data and methodology are described in Section III and empirical results are presented in Section IV. Section V draws conclusions.

2. LITERATURE REVIEW

Business cycle is an economic phenomenon of cyclical changes in gross domestic product according to the principles of Economics. Business activities fluctuate over the periods of economic expansion and recession and corporate performance in the sales level, the growth rate of sales, and profitability that are the determinants of capital structure found in previous studies can vary in different economic conditions. Consequently, corporate debt financing can vary in different economic conditions. The results of Ferri and Jones (1979) suggest that capital structure of firms does not appear stable in different economic conditions. These previous studies suggest that corporate debt financing will be influenced by economic conditions. Moreover, the agency theory of capital structure suggests that firms with limited growth opportunities tend to finance with more debt. Thus, it is expected that firms tend to finance more debt in the period of economic peak. In other words, corporate debt financing will be positively related to the economic conditions.

Ferri and Jones (1979) find that firm size is related to corporate debt financing but their relationship does not conform to the positive in both expansionary and recessionary periods. In addition, Myers (1984) suggests that average debt ratios will vary across industries because asset risk, asset type, and requirements for external funds vary across industries. Further, Hall et al. (2000) find that the interaction between industry type and firm characteristics has impact on the determination of corporate debt financing in the unquoted small and medium-sized enterprises (SMEs) within the UK. Ferri and Jones (1979) also find that industry effect on corporate debt financing does not appear stable across expansionary and recessionary periods and, in addition, corporate debt financing in some industries seems more likely to vary across expansionary and recessionary periods than others. Their finding suggests that corporate debt financing will be influenced by the interaction between industry Characteristics and economic conditions. However, rarely prior studies did address the issue on the interactions among firm-specific variables, industry type and macroeconomic conditions.

3. METHODOLOGY

3.1 Variables and their Measures

The variables and their measures used in this study are referred to the related work and empirical studies except the dependent variable, corporate debt financing. We use the change in debt ratio as a proxy for the adjustment of corporate debt financing. The reasoning behind the measurement of corporate debt financing is that corporate debt financing is likely influenced by previous debt level (McCabe, 1979; Peterson and Benesh, 1983). All of the variables in this study are based on book value and, in addition, average figure is calculated

for each variable in the multi-year period over the research period.[1] In addition to the variables for industry Characteristics and economic conditions in this study, the variables representing firm characteristics include free cash flow, growth, profitability, firm size, non-debt tax shield, operating leverage, and earnings volatility. Furthermore, according to the Business Indicators published by the Council for Economic Planning and Development of the Executive Yuan of Taiwan (2004), the years from 1991 to 1994 and the year of 1997 represent the expansionary periods over the eighth and ninth business cycles of Taiwan, respectively. On the other hand, the year of 1995 and the year of 1998 represent the contraction periods over the business cycles of Taiwan, respectively. The measures of the group variables used in this study, with the exception of interaction variables in our model, are referred to the previous studies.

3.2 Empirical Model

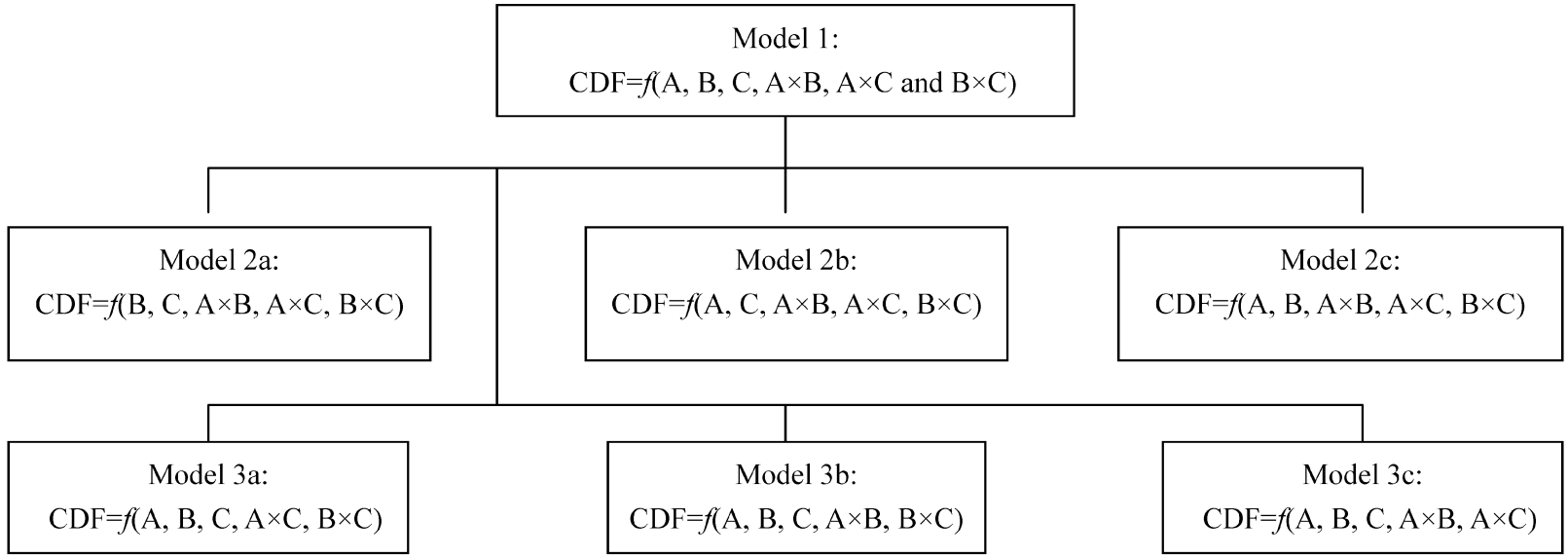
Our regression model is quite similar to that used by most of relevant work except for inclusion of economic conditions and of interactions between firm characteristics, industry Characteristics, and economic conditions to investigate whether these interactions play a part in the determination of corporate debt financing, which is ignored by most of previous studies or only partly rather than fully integrated examined by Hall et al. (2000). In order to examine the effects of interactions between firm characteristics industry characteristics, and economic conditions on corporate debt financing, we classify these independent variables except the interaction variables in our model into three groups: Group A for firm characteristics, Group B for industry characteristics, and Group C for economic conditions. We use the form of product items to represent the interactions between theses group variables (Jaccard and Turrisi, 2003).

In empirical analysis, this study applies the Ramsey's RESET test to examine the effects of group variables including firm characteristics, industry characteristics and economic conditions and the effects of interactions between group variables. The Ramsey's RESET tests on the main effect of each group variable (i.e. A, B, and C) and the effect of interactions between group variables (i.e. A×B, A×C, and B×C) are diagrammed in Figure 1. If main effects or interaction effects are statistically significant, the F value calculated with the formula below would be greater than the critical value of F distribution table. The formula of Ramsey's RESET test (F test) is presented as below (Gujarati, 2003 p. 522).

$$F=[(R_{UR}^2 - R_R^2)/m]/[(1- R_{UR}^2)/(n - k-1)]$$

Where: R_{UR}^2 = coefficient of determination for unrestricted model, R_R^2 = coefficient of determination for restricted model, m = the number of omitted variables in the restricted model, n = the number of sample observations, and k = the number of variables in the unrestricted regression model.

[1] Ferri and Jones (1979) argue that average measurement can give a truer indicator of firm size and thus we follow their approach for all variables in the multi-year period except dummy variables.



Note: (1) CDF: Corporate Debt Financing

(2) Tests of main effects on corporate debt financing for group variables A (firm characteristics), B (industry characteristics), and C (economic conditions):

Models 2a, 2b, and 2c are restricted models of Model 1, respectively.

(3) Tests of interaction effects on corporate debt financing for variables A×B, A×C, and B×C:

Models 3a, 3b, and 3c are restricted models of Model 1, respectively.

Figure 1 Hierarchy of Tests for the Effects and Interaction Effects of Group Variables

Further, the dependent variable, corporate debt financing, will be regressed against the three group variables and their interaction variables in the linear regression model. The interaction variables between firm characteristics, industry Characteristics, and economic conditions are presented in the form of product items (Jaccard and Turrisi, 2003). The empirical model for the determination of corporate debt financing is shown as follows:

$$\begin{aligned} CDF = {} & b_0 + b_1 FCF + b_2 G + b_3 P + b_4 NDTS + b_5 SIZE + b_6 EV + b_7 OL + b_8 INDU + \\ & b_9 EC + b_{10} FCF\times INDU + b_{11} G\times INDU + b_{12} P\times INDU + b_{13} NDTS\times INDU + \\ & b_{14} SIZE\times INDU + b_{15} EV\times INDU + b_{16} OL\times INDU + b_{17} FCF\times EC + b_{18} G\times EC + \\ & b_{19} P\times EC + b_{20} NDTS\times EC + b_{21} SIZE\times EC + b_{22} EV\times EC + b_{23} OL\times EC + \\ & b_{24} INDU\times EC + \varepsilon, \end{aligned}$$

where: b_0: the intercept term in the regression equation; b_i (i=1 to 24): the coefficients of independent variables in the regression equation; CDF: the variable of corporate debt financing; FCF, G, P, NDTS, SIZE, EV, and OL: the firm-characteristics variables including Free Cash Flow, Growth, Profitability, Firm Size, Non-debt Tax Shield, Earnings Volatility and Operating Leverage; INDU: the zero-one dummy variable representing for industry Characteristics with low and high liquidation cost; EC: the zero-one dummy variable of economic conditions indicating economic expansion and contraction and ε : the error term.

The proxies for the dependent and other explanatory variables are presented as follows: corporate debt financing (dTDTA) = the change in total debt ratios; free cash flow (FCFTA) = free cash flow/total assets; growth (gS) = annual growth rate of net sales; profitability (EBITTA) = EBIT/total assets; firm size (*ln*S) = natural logarithm of net sales; non-debt tax shields (NDTS) = total depreciation/total assets; operational leverage (FATA) = fixed assts/total assets; and earning volatility (StdEBITTA) = standard deviation of EBITTA over the current and preceding four years.

3.3 Data and Sample

We follow the method of a Taiwanese empirical study (Chu et al., 1992) for industry classification in this paper and use the dummy variable (INDU) equals to one for the industries including Machinery and Machine Tools, Electric Equipment and Cables, Steel, Motor Vehicles, and Electrics and zero for the other industries. All firms listed on the Taiwan Stock Exchange, with the exception of those in the bank and finance industries that have sufficient data in the eighth and ninth business cycles of Taiwan are included in this study. In addition, in order to investigate the economic impact on the determination of corporate debt financing over business cycles in Taiwan, each business cycle in this study is divided into expansionary and recessionary periods. The period from the trough to the peak in each business cycle is defined as the expansionary period (EC=1) and, on the other hand, the period from the peak to the trough is defined as the recessionary period (EC=0). Note that the expansionary or recessionary period with duration less than a year in each business cycle is excluded. Therefore, there are 920 observations in different economic conditions over two business cycles of Taiwan in the sample.

4. EMPIRICAL RESULTS AND ANALYSIS

The ratios of total debts over total assets for the firms in the sample range from 0.04948 to 0.83997 with a mean of 0.38785 over the Eighth and Ninth Business Cycles of Taiwan. Therefore, the sample firm used in this study is not in financial trouble. Due to high correlation between some independent variables, the centering method of Cronbach (1987) is employed toeliminate the multi-collinearity problem. Table 1 presents the regression results.

Table 1 Regression Results (Change in Total Debt Ratio as Dependent Variable)

Variable	Coefficient	Standard Error	t Value	Pr > |t|	VIF
FCFTA	-0.18399	0.04057	-4.53[a]	<.0001	2.84441
gS	0.01120	0.00355	3.16[a]	0.0016	5.35122
EBITTA	-0.19312	0.06759	-2.86[a]	0.0044	5.12875
lnS	0.00697	0.00377	1.85[c]	0.0652	3.45620
DepTA	0.18978	0.27398	0.69	0.4887	4.40533
FAI	-0.02217	0.02556	-0.87	0.3860	4.16389
StdEBITTA	0.00415	0.00580	0.72	0.4740	3.05625
INDU	-0.00488	0.00735	-0.66	0.5064	2.24591
EC	-0.00106	0.00558	-0.19	0.8496	1.54465
FCFTA×INDU	-0.10939	0.06586	-1.66[c]	0.0970	1.85388
INDgS×INDU	0.07676	0.01759	4.36[a]	<.0001	1.15991
EBITTA×INDU	-0.06654	0.07355	-0.90	0.3659	1.94896
INDlnS×INDU	0.00364	0.00498	0.73	0.4656	2.01023
DepTA×INDU	0.68931	0.39623	1.74[c]	0.0823	2.28679
FATA×INDU	-0.04217	0.03893	-1.08	0.2790	2.41588
StdEBITTA×INDU	-0.00817	0.00753	-1.09	0.2781	1.74467
FCFTA×EC	-0.08875	0.05390	-1.65[c]	0.1000	2.64131
gS×EC	-0.01218	0.00396	-3.08[a]	0.0022	5.20926
EBITTA×EC	-0.15085	0.07365	-2.05[b]	0.0408	4.27541
*ln*S×EC	-0.00480	0.00453	-1.06	0.2899	2.54915
DepTA×EC	-0.35894	0.34555	-1.04	0.2992	3.32621
FATA×EC	0.00163	0.03263	0.05	0.9602	3.31080
StdEBITTA×EC	-0.00508	0.00709	-0.72	0.4736	2.29048
INDU×EC	0.00213	0.01046	0.20	0.8389	2.76638

Notes: (a) [a], [b], and [c] Indicate the significance level of 1%, 5%, and 10%, respectively.

(b) N=920 (c) F-statistic=13.19[a] (d) Adjusted R-Square=0.2415. (e) Durbin-Watson D = 2.190

As shown in Table 1, variance inflation factor (VIF) values of all independent predictors in the regression model are much less than 10 (Hair et al., 1998). Therefore, there is no serious multi-collinearity among the predictor variables in this study (Belsey et al., 1980; Neter et al., 1996). In addition, Durbin-Watson D statistic is 2.190 close to 2, which indicates there is no significant autocorrelation problem. Further, corporate debt financing (dTDTA) is significantly related to the variables of free cash flow (FCFTA), sales growth (gS), profitability (EBITTA), and firm size (*ln*S) in our regression model. The findings on the effects of firm characteristics on corporate debt financing are generally similar to those found by most of previous work. However, corporate debt financing is not significantly related to industry characteristics (INDU), which is similar to the conclusion of Titman (1984) and the result of Titman and Wessels (1988) but not consistent with the result of Chu et al. (1992) in a Taiwanese empirical study. The conflicting finding of industry characteristics is probably due to no inclusion of economic conditions in the study of Chu et al. (1992). Our result provides supporting evidence on the finding of Balakrishnan and Fox (1993) that industry factor on corporate debt financing is not as important as the factors of firm characteristics. On the other hand, corporate debt financing is also negatively but not significantly related to economic conditions (EC), which indicates that corporate debt financing in the expansionary period is not significantly higher than that in the recessionary period. The finding does not support the conclusion of agency theory.

As for the interactions between firm characteristics and industry Characteristics, we find that industry characteristics have impact on some relationship between firm characteristics and corporate debt financing. Corporate debt financing is statistically significant and negatively related to the interaction between free cash flow and industry characteristics (i.e. FCFTA×INDU) and positively related to the interaction between firm growth and industry characteristics (i.e. gS×INDU). Our results indicate that the relationship between free cash flow and firm growth, and corporate debt financing is augmented by the impact of industry characteristics. On the other hand, corporate debt financing is statistically significant and positively related to the interaction between nondebt tax shield and industry characteristics (i.e. DepTA×INDU), which indicates that the effect of nondebt tax shield on corporate debt financing is affected by industry characteristics. As a whole, our results support the findings of Hall et al. (2000).

Similar to the interaction between firm characteristics and industry Characteristics, we find significant effects of interactions between some firm characteristics and economic conditions (i.e. FCFTA×EC, gS×EC, and EBITTA×EC). Our results indicate that the effects of free cash flow and profitability on corporate debt financing is augmented by the impact of economic conditions. In addition, note that the effect of firm growth on corporate debt financing is altered by the impact of economic conditions. In brief, our finding supports the results of Ferri and Jones (1979) and provides further evidence on the impact of economic conditions on corporate debt financing. Moreover, corporate debt financing is not significantly related to the variable (INDU×EC) for interaction between industry characteristics and economic conditions, which indicates that economic conditions have no impact on the relationship between industry Characteristics and corporate debt financing. Our industry classification might be too crude to examine it. We suggest that other operational definition

of industry characteristics may be used in future research to reexamine the interaction effect.

5. CONCLUSION

This paper investigates the interaction effect of firm and industry characteristics and economic conditions on corporate debt financing, which is ignored or partly rather fully integrated examined by previous studies. The results of this exploratory study indicate that some of the relationship between firm characteristics and corporate debt financing is influenced by the impact of industry characteristics and economic conditions. Surprisingly, some relationship between firm characteristics and corporate debt financing can be altered by the impact of economic conditions. However, we find no significant effect of industry characteristics, economic conditions and the interaction between industry characteristics and economic conditions on corporate debt financing. In addition, the findings suggest that the change in total debt ratios is to a large extent explained by other important factors that are not included in our model and most of previous studies as well. Therefore, future research could include other financial and non-financial factors for further evidence.

Based on the findings on the interaction effects in this paper, we suggest that firms should take into account the characteristics of industries in which they operate and the economic conditions in which they are and they are expected to be in the future. In particular, some effects of firm characteristics on corporate debt financing can be altered by economic conditions. At the moment we have no proper explanation for the result, which is left for future research to investigate why it does this way. Finally, our model investigates the interaction effect in this study on the basis of linear relationship between dependent variable and independent variable. We found no effect of interaction between industry characteristics and economic conditions; however, the other forms of interactions between them may be investigated in future research.

References

Balakrishnan, Srinivasan and Isaac Fox, 1993, "Asset Specificity, Firm Heterogeneity and Capital Structure," *Strategic Management Journal*, Vol. 14, pp. 3-16.

Belsley, D. A., E. Kuh, and R. E. Welsch, 1980, *Regression Diagnostics: Identifying Influential Data and Sources of Collinearity*, New York: Wiley, pp. 27-29.

Chu, Po-Young, Soushan Wu, and Shu-Fang Chiou, 1992, "The Determinants of Corporate Capital Structure Choice: Taiwan Evidence," *Journal of Management Science*, Vol. 9, No. 2, pp. 159-177.

Council for Economic Planning and Development, 2004, *Business Indicators*, Vol. 28, No. 11, Council for Economic Planning and Development of the Executive Yuan of Taiwan, pp. 2-24.

Cronbach, L., 1987, "Statistical tests for moderator variables: Flaws in Analysis Recently Proposed," *Psychological Bulletin*, Vol. 102, pp. 414-417.

Ferri, M. and W. Jones, 1979, "Determinants of Financial Structure: A New Methodological Approach," *Journal of Finance*, Vol. 34, pp. 631-644.

Gujarati, Damodar N., 2003, *Basic Econometrics*, 4th ed., McGraw-Hill.

Hair, J. F. Rolph E. Anderson, Ronald L. Tatham, and William C. Black (1998), *Multivariate Data Analysis*, 5th ed., Upper Saddle River, N.J.: Prentice-Hall, pp. 220-236.

Hall, Graham, Patrick Hutchinson, and Nicos Michaelas, 2000, "Industry Effects on the Determinants of Unquoted SMEs' Capital Structure," *International Journal of the Economics of Business*, Vol. 7, No. 3, pp. 297-312.

Harris, Milton and Arthur Raviv, 1991, "The Theory of Capital Structure," *Journal of Finance*, Vol. 46, No. 1, pp. 297-355.

Jaccard, James and Robert Turrisi, 2003, *Interaction Effects in Multiple Regression*. Thousand Oaks, CA: Sage.

McCabe, George M., 1979, "The Empirical Relationship Between Investment and Financing: A New Look," *Journal of Financial and Quantitative Analysis*, Vol. 14, NO. 1, pp. 119-135.

Modigliani, F. and M. H. Miller, 1958, "The Cost of Capital, Corporate Finance and The Theory of Investment," *American Economic Review*, Vol. 48, No. 3, pp. 261-297.

Neter, John, Michael H. Kutner, Christopher J. Nachtsheim, and William Wasserman, 1996, *Applied Linear Regression Models*, 3rd ed. IRWIN, pp. 385-388.

Peterson, Pamela P. and Gary A. Benesh, 1983, "A Reexamination of the Empirical Relationship Between Investment and Financing Decisions," *Journal of Financial and Quantitative Analysis*, Vol. 18, NO. 4, pp. 439-453.

Ramsey, J. B., 1969, "Test for Specification Errors in Classical Linear Least Squares Regression Analysis," *Journal of the Royal Statistical Society*, series B, Vol. 31, pp. 350-371.

Titman, Sheridan, 1984, "The Effect of Capital Structure on a firm's Liquidation Decision," *Journal of Financial Economics*, 13, pp. 137-151.

Titman, Sheridan and Roberto Wessels, 1988, "The Determinants of Capital Structure Choice," *Journal of Finance*, Vol. 43, No. 1, pp. 1-19.

An Exploratory Study of the Earning Growth Curve in Online Auction—Taking the Female Attire And the Clothing Fitting as an Example

Wen-Ying Cheng

Yu-Hsin Chen

Associate Professor and Graduate Student of Department of Business Administration.
National Ping Tung University of Science and Technology, Taiwan, R.O.C
E-Mail: natty@mail.npust.edu.tw
m9658027@mail.npust.edu.tw

ABSTRACT

The main purpose of this paper was to discuss the earning change in different operational scale in online auction of female attire and clothing fitting. The results verified that the gross income and profitability of small-scale firms are in the state of instability, but being in the state of stability and keeping continuous growth under larger scale firms. Furthermore, the gross income and profitability of female attire and clothing fitting in different operational scales were significant difference. It clearly showed that the scale of Online Auctions influences the gross income and profitability. From the estimation of data curve, based on monthly calculation, the positive value of growth rate coefficient b has demonstrated that the gross income and profitability of merchandise category of female attire and clothing fitting have a positive tendency of continuous growth. In addition, the estimate of b (1.6) has fully shown that the growth rate of this period is $e^{1.6}$ times of the previous period. Thus, this research provides very useful and valuable information to help those firms or persons that will undertake Online Auctions to evaluate the capital financing and pre-assess the break-even balance.

Keywords: *Online Auctions, Growth Curve of Gross Income, Operational Scale*

1. INTRODUCTION

Along with internet of widely accepted, the affixture brought is more and more also worth, through the network, consumer can at any time, anywhere, to collect the product information needed (Klein, 1997). Furthermore, the consumers have become much deeper dependence on the Internet service than ever. Thus, many different types of buying stuff on the Internet have been set up, and have also created a very good commercial opportunity to enlarge their perspectives and increase competitive businesses' advantage.

In the last few years the network auctions market to receive the attention, causes increasingly many people to operate the network auctions store, although the network auction behavior may bring the huge opportunity, but this does not mean all networks to auction the business all to be able to make a profit. The main of the cause is the competition to be increasingly intense in online auction market; in addition the consumers compare the price easily, and the low shift cost, therefore the business easy to carve up the market. According to the statistics was engaged in the network to auction below two years the business to have 30% still to be at the loss condition, because consumer to individual electronics

store the loyalty is low. (Chen, etc., 2005)

Although Online Auctions can create a good commercial opportunity to make profits, the profitability of Taiwanese Electronics Shop from 2005 to 2006 has clearly shown, based upon the MIC (Market Intelligence & Consulting Institute) surveys, that only 25% Electronics Shops have made profits, 53% being in the state of loss, and 22% being in the state of break-even balance in 2005. In 2006, only 27% Electronics Shops have made profits, 42% being in the state of loss, and 31% being in the state of break-even balance.

Management magazine referred to the enterprise diagnosis of the cause and is one of the key indicators of financially unstable, and their cash flow problems. We can know the cash flow is one of the key with impact factor among them, cash flow can the true reflection enterprise holds how much cash at that moment, and be advantageous to a flexible use.

Based on discussing in the concept of the sustainable operation, this study is concerned essentially with Yahoo Auctions market in the female attire and the clothing fitting this item of commodity category business income condition. By cash inflow concept of that, deduced in the revenue of online auctions in different operational scales, and by the revenue obtained to estimate the amount of online auction the female attire and the clothing fitting commodity category of earning growth curve. Try to provide investors into this industry when needed to take into account inputs of capital and time reference information.

2. METHODOLOGY

This section will be input by operators of online auction, for a single commodity the revenue information in different scale of operation. A single commodity in the online auction cause by curve is estimated to get and draw the earning growth curve.

2.1Research object

MIC (Market Intelligence & Consulting Institute) has practiced an analysis with respect to the ratio of the number of cyber friend (or internet friend) Online Auctions to the number of total cyber friend in 2007. The results have clearly shown that Yahoo Auctions have become the most important Online Auctions in Taiwan so far, having 87.1% market share. The main purpose of this research was to obtain a better understanding of sales of female attire and clothing fitting on Yahoo Online Auctions and to find the growth curve of gross income.

In addition by Yahoo Auction Member evaluation system that is divided into grades from 0 to 12, and we can by different grades to know the seller's number of transactions and the situation. This study is concerned essentially with female attire and clothing fitting commodity collection of 1 to 12 levels of the seller information for analysis.

Table 1 Yahoo Auction member evaluation system - rating icon Table

grade	The appraisal counts	Graphical representation
0 grade	Under 9	No Graphical representation
1 grade	10~49	
2 grade	50~99	
3 grade	100~249	
4 grade	250~499	
5 grade	500~999	
6 grade	1000~2499	
7 grade	2500~4999	
8 grade	5000~9999	
9 grade	10000~24999	
10 grade	25000~49999	
11 grade	50000~99999	
12 grade	Above 100000	

Data source: Yahoo Auction, 2008.10

Due to online auction be classified virtual type of the store, in evaluate the scale of operation to obtain information, there is no entity the size of the company or the number of employees can to direct measurement. In this part we use some of the correlation variables to measure the scale of operation.

In this study, we took the mean gross income (Average selling prices × Sales =P × Q) as a measure of operational ability of that scale. Average every 20 transactions selling price as an estimate of mean price, cumulate the number of transactions as a measure of sales in the period of per month. The study was conducted by the mean gross income and the related variables to measure the operational ability of different scales.

Following the above, this study collected data in December, 2008. Pick out 10 auction stores randomly per level from the Yahoo Auction Member Evaluation System of 1 grade to 12 grade (got the number of transactions, the average transaction amount, totally 109 cases of data as a basis for analysis).

2.2 K-W Test

In detecting the difference of operation its Internet auction business revenue across different operational scales of female attire and clothing fitting commodity, we used the K-W Nonparametric test analysis to make many group Independent samples to compare. The hypothesis as follows:

H_0 : K groups have the same distribution
H_1 : K groups have the different distribution

Formula:

$$H = \frac{12}{N(N+1)}\left[\sum_{i=1}^{k}\frac{R_i^2}{n_i}\right] - 3(N+1) \quad (1)$$

N：Total number of samples

n_i : Number of samples in each group

R_i : The rank sum in each group

2.3 M-W Test

With M-W Test, to understand the different scale of operation and revenue, online auction for the operation of the impact of performance.

Formula:

$$Z = \frac{R - \frac{n_1(N+1)}{2}}{\left[\frac{n_1 n_2 (N+1)}{12}\right]^{1/2}} \quad (2)$$

n_1：Group A number of samples

n_2：Group B number of samples

N：Total number of samples ($n_1 + n_2$)

R：The ranks for Group A all the DMU

Z：Approximate normal distribution Z value

2.4 Curve estimated

Regarding the regression analysis, first draws up the independent variable with to depend on the variable the dispersion pattern. Then chooses regarding the material in dispersion pattern distribution point must carry on the regression analysis the type. If is unable to determine that should use what kind of function model to be able the closer sample data, this time may use the method which the curve estimated. (Lin, Lin & Liu, 2005).Its step is as follows:

1. According to the actual problem itself characteristic, simultaneously chooses a variety of non-linear model.

2. The SPSS software will complete the model automatically the population estimate, and demonstrated the R^2 and F value, to makes some forecasts.

3. Selection of statistical value of the largest for regression model.

The SPSS curve estimation model according to the different amount of data, and there will be many different type, there are Linear, Logarithmic, Exponential, Power, Logistic, and Growth.

3. RESULTS

3.1 Date Descriptive Statistics

The following Table 2 and figure 1 are the descriptive statistics and curves for revenue of female attire and clothing fitting commodity category of different operational scale.

Table 2 Female Attire and Clothing Fitting commodity category descriptive statistics Table

commodity	period	member evaluation	Average	Standard	Minimum	Maximum
female attire and clothing fitting commodity category	month	1	5707.64	4949.38	307.90	13876.25
		2	7932.63	9381.33	1028.75	32643.90
		3	21994.88	30677.49	1307.00	85485.00
		4	70674.56	79843.93	2804.40	275044.00
		5	54280.49	54140.43	3693.00	176273.40
		6	104061.75	50668.64	32352.80	214228.50
		7	198135.53	144113.43	26526.75	423274.50
		8	182855.80	154187.08	31137.00	528123.05
		9	700302.72	599966.35	358715.00	2361555.00
		10	1526747.75	1237584.33	323148.75	3958070.40
		11	2753006.40	2186975.33	1089292.05	7674707.70
		12	4983409.20	-	4983409.20	4983409.20
		Total	511324.75	1126794.98	307.90	7674707.70

Note: The seller rating of 12 the evaluation number only one, it is not possible to seek its standard deviation

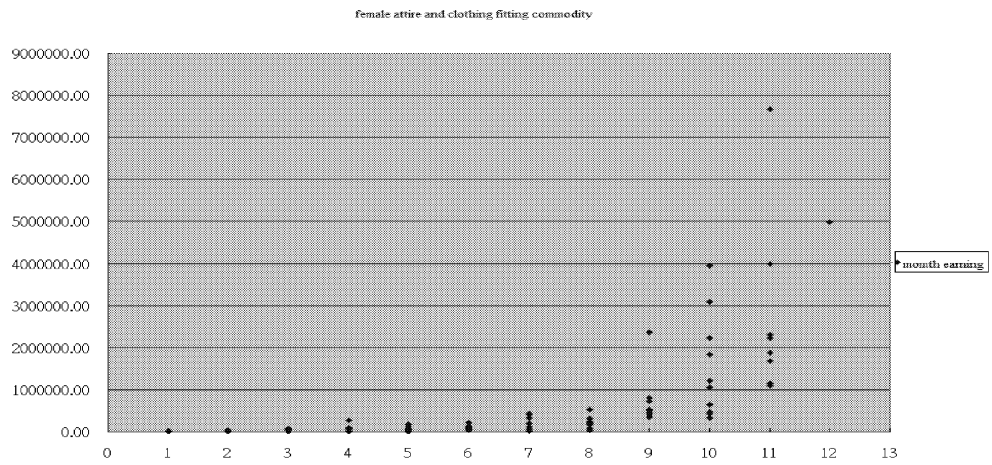


Figure1: female attire and clothing fitting commodity category in revenue on a different scale curve

In Figure 1, we can see from Figure the operating revenue will be higher when invested larger, mainly because when the large scale of operation in the Yahoo Auction has accumulated a lot of Internet surfers and customers, and it in the Yahoo Auction was in this industry operations into a longer time, in goods and services more comprehensive, so the revenue situation in comparison to just entering a new business to stability. In the figure can be found when the scale of 9 grade after entering apparent when revenue growth, and 1 ~ 3 grades of the scale of business in this industry are relatively new entrants, and its operation is still in testing the market and the embryonic state, Therefore, its revenues more volatile situation. In the fifth grade and the eighth grade, due to the cross to another larger scale of operation, it may increase the personnel, to sell merchandise, or other additional expense, which is part of the conversion in the short-term, may be so that more revenue growth slowed, and even the growth rate were slowly than the previous grade.

3.2 K-W Test results

Table 3 K-W Analysis of test results table

category	revenue			
	member evaluation	χ^2	degree of freedom	Rank average (ordering)
female attire and clothing fitting	1	88.613*** (0.000)	10	15.10 (11)
	2			17.80 (10)
	3			24.40 (9)
	4			43.70 (7)
	5			40.90 (8)
	6			57.00 (6)
	7			65.00 (4)
	8			61.90 (5)
	9			87.80 (3)
	10			94.20 (2)
	11			101.00 (1)

Note: ( ) content for the p-value

Seller rating of 12 the number of only one so did not conduct test

3.3 M-W Test results

By K-W test can be found in the operation of different revenue size of the existence of significant differences, and further so Mann-Whitney (M-W) test to detect whether there is any difference between the two groups by the M-W test 12 will be less differences do division.

Information on the different size of chi-square distribution of revenue in the 10 degrees of freedom under the p-value = 0.000 <α = 0.05, said the operation of different revenue size of the existence of significant differences. Sort from high to low by rank averages can be found when operating at larger, its revenue will increase, and revenue from the 9 grade after a substantial growth, mainly because of the operation after 9 grades more sound, with Internet auction sales of more popular and makes buyers also increased. By the sort we can see that 1 ~ 3 grade were like the new entrants, resulting from involvement in the short time it may also operators belonging exploratory stage, so the value of its revenue less revenue than instability. The distribution of revenues will be 1 ~ 11 Grouping by M-W test found that will be divided into 4 groups, respectively, from 1 grade to 3 grade for a group,

of 4 grade to 6 grade for a group, 7 grade to 8 grade for a group, and this 4 group post-test p-value of more than 0.05, it means the average of each group had no significant differences between each group's revenue is not significantly different , in the first group than those who are new entrants are due to input short time it may also operators belonging exploratory stage, so the value of its revenue less revenue than the instability in the industry fall into the life cycle period. While the second group, compared with long-term, this group in order to obtain economies of scale so that lower prices, this is also the fifth-class revenue will be less than fourth-class reasons, this stage of the potential threat to the highest. The third group was the shake period, and this stage there is fierce competition. And will have too much production capacity, while the eighth grade situation similar with the fifth grade, in order to get more economies of scale decline in commodity prices and the formation of its revenue is less than the seventh-grade situation. Finally, the fourth group of mature, entry barriers to raise industrial concentration and higher, so a group of more stable revenue, its revenue growth also showed a significant trend. As the online auction can be the cause of a relatively new, so the less obvious recession.

Table 3 M-W Analysis of test results table

category	revenue		
	group	member evaluation	P-value
female attire and clothing fitting	1	1	＞α＝0.05
		2	
		3	
	2	4	
		5	
		6	
	3	7	
		8	
	4	9	
		10	
		11	
		12	

Note: α=0.05

3.4 Curve of the estimated results

According to statistical analysis described by Figure 1 can be found in different scale of operation of the store operating income under the present growth trend. By way of curve estimate and different curve fitting examination the linear function (Linear), logarithmic function (Logarithmic), exponential function (Exponential), power function (Power) , logic functions (Logistic), and growth function (Growth). From the chart and fitting curve the growth function (Growth) caught the trend and obtained by the statistical value R^2, and F test value the largest.

Therefore, we will take growth function to estimate the scale of operation in different circumstances to estimate revenues on Yahoo Auction female attire and clothing fitting of the merchandise categories of earning growth curve. Based earning growth curve equation is as follows:

$$Y = e^{\beta t} + \varepsilon$$

From the collected data, we got the following estimated equation

$$\hat{Y} = e^{1.61t}$$

Table 4 Growth rate of commodity categories table

category	period	B- value	F -value	P- value	R^2
female attire and clothing fitting	month	1.61	990.56	0.00	90.17%

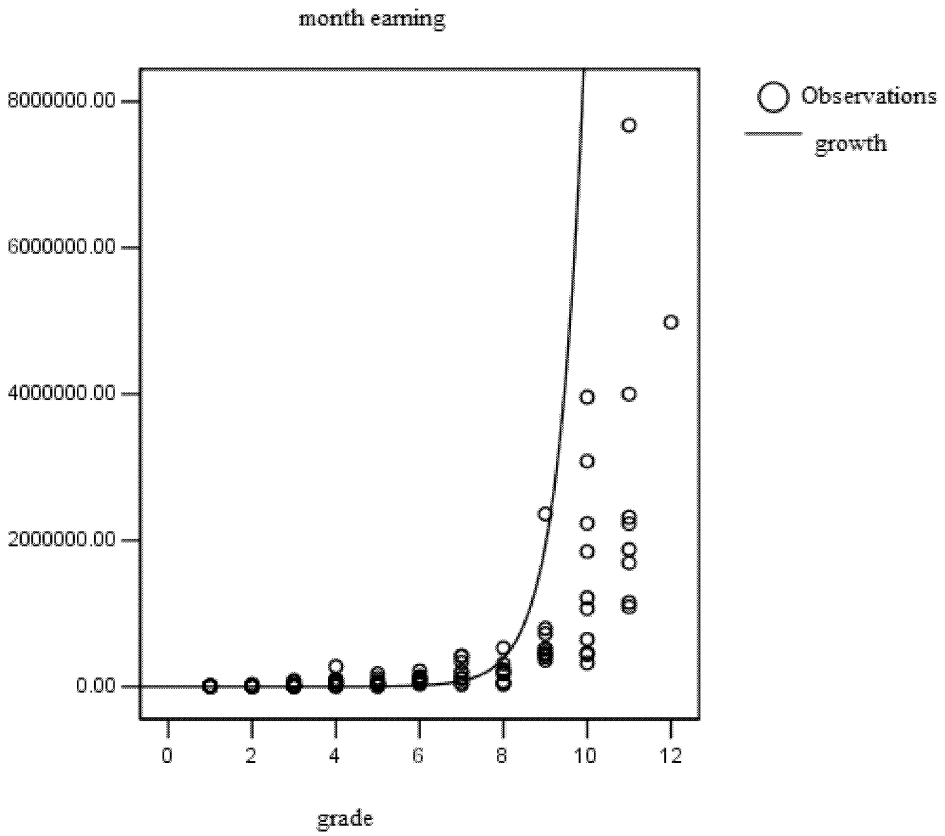


Figure2 female attire and clothing fitting commodity category on different scale revenue growth curve

Table of P values, we can see, female attire and clothing fitting on the growth curve fitting results are significant, and the R^2 equals 90.17%, having high explained validity. The coefficient of growth rate b would be made aware of female attire and clothing fitting commodity category b value is, on behalf of such categories of goods with revenue growth trend, while a b value of 1.61> 1, said its revenue has continued to grow.

4. CONCLUSION

(1) Female attire and clothing fitting commodity category revenue distribution figure can be found selling such goods stores its revenue situation of different operational scales as the expansion of its scale of operation and increase its revenue, while sales of female attire and clothing fitting commodity category of business of its investment revenue curve phenomenon has continued to grow in operational scales over more than 9 grade merchants period is greater than the overall average revenue on average, the grades after 9 grade in the period the were in a more stable revenue situation.

(2) Female attire and clothing fitting commodity category of different operational scales in the amount of revenue also have significant differences, expressed in different scale of operation the next phase of revenue will vary, determined by scale of operation will affect revenue. By M-W test after 1st grade to 11th grade do so after the four sub-groups, and by the Industry Life Cycles were named. In the first group due to the short time into the more volatile revenue are like the leading-in period in Industry life cycle. The second group is growing, the third group for the shake period, and the final group is the fourth stage which to raise entry barriers. From the information described in the analysis can be found at the beginning of this industry into the seller rating in the 1-class to 3-class because of the smaller operational scales merchants were belonging to new entrants, so at this stage of testing was still subject to market so its operation more instability, and comparison of flat revenue growth in profit. When the seller rating equivalent to more than 6-class, because the market has made quite a number of customers and has good revenue, which is why it has invested time and stores the operational scales of the difference in revenue will have a significant impact, female attire and clothing fitting evaluation of commodity category, the merchants had stable customer in the 7-class, so they had the stable revenue. In the fifth-class to eighth-class to get more economies of scale make it the fall in commodity prices the formation of revenue were lower than the previous-class, on the threshold of another large scale of operation at the commodity price movements can generate economies of scale. We can see that when the level of more than 9-class this stage have a significant growth trend by the data analysis results also can be seen. And we can see that the level of business revenue due to different operators will also be differences in operational scales.

(3) By the earning growth curve can be found with the women's apparel accessories category of merchandise revenue growth have shown the situation has continued to grow, by the b value equal to 1.61, it compared to the previous-class of revenue growth up to 1.61 times. As can be seen when the input into the longer and larger the range of its growth will be greater on revenue growth from when we can see the expansion of the of its operational scales monthly operating cash inflow will increase, only to explore this part of revenue. If you want to know the net profit on the need to consider the cost factors that need further consideration before it can be seen as a sales female attire and clothing fitting commodity category of merchandise in different operational scales obtained under the condition of net profit.

(4) This part only discusses the cash inflows, after this, we will put the cost concept to further obtain

the investment curve. Analyze the profit changing in different operational scales.

References

Alba, Joseph, John Lynch, Barton Weitz, Chris Janiszewski, Richard Lutz, Alan Sawyer and Stacy Wood (1997), "Interactive Home Shopping: Consumer, Retailer, and Manufacture Incentives to Participate in Electronic Marketplace," Journal of Marketing, Vol. 61, July, pp. 38-53.

Beam, C. and Segev, A. (1998), Auctions on the Internet: A Field Study, pp.1-30.Unpublished manuscript, Haas School of Business University of California, Berkeley.

Clinton, W. J. & Gore J.,(1997), "A Framework for Global Electronic Commerce"
http"//www.iitf.nist.gov/eleccomm/ecomm.htm

Greenstein, M. & Feinman T. M.,(2000), Electronic Commerce: Security, Risk Management and Control, NY: McGraw-Hill.

Heck, E. V. and P. M. Ribbers (1997), "Experiences with Electronic Auctions in the Dutch Flower Industry," Electronic Markets, Vol. 7, pp. 429-34.

Kalakota, R. & Whinston A. B.,(1996,1997), Frontters of Electronic Commerce: MA: Addison-Wesley.

Klein, S. (1997), "Introduction to Electronic Auctions," Electronic Markets , Vol. 7,No 4, pp.3-6.

Kotler, P., (1999), Kotler on Marketing-How to Create, Win, and Dominate Markets, New Jersey: The Free Press.

Lin, J.B., Lin C.H. and Liu, M.T.(2005),SPSS 12 Statistical modeling and analysis program, Wen kui Information, Taipei.

Reck, M., (1997), "Trading-Process Characteristics of Electronic Auctions, " Electronic Markets, Vol. 7, No 4, pp.17-23.

Turban, E. et al.,(1999) ,Information Technology for Management, NY: John Wiley & sons.

Zwass, V., (1996), "Electronic Commerce:Structures & Issues", International Journal of Electronic Commerce, Vol. 1, No. 1, pp. 3-23.

Risk Factors of Personal Injury Liability Insurance: a Case Study of "T" Non-Life Insurance Company in Taiwan

Pai-Lung Chou

Associate professor, Department of Risk Management and Insurance,
National Kaohsiung First University of Science and Technology,,Taiwan, R. O. C.
E-Mail: plchou@ccms.nkfust.edu.tw

Jen-Wen Sheu

Ph. D. candidate , Institute of Management,
National Kaohsiung First University of Science and Technology,Taiwan, R. O. C.

Chen-Hua Yao

Doctoral Student, Institute of Management,
National Kaohsiung First University of Science and Technology,Taiwan, R. O. C.

ABSTRACT

Insurance companies have started selling injury insurance and related merchandise recently. There are great differences between these products and traditional insurance policies. In order to ensure operational performance and to enhance profitability, it is necessary to carry out analysis and filtering. This paper explores sampling data of personal injury and liability insurance policies from a well-known insurance company, and attempts to establishes a model through use of this evidence resulting in a lower probability of high insurance liabilities, specifically. If these research findings can be effectively analyzed, the results will contribute to process refinement of claims and underwriting; greater customer satisfaction, sustainable enterprise development and promotion of social and public welfare.

Keywords: *Non-life insurance company, Injury insurance, Logistic regression.*

1. INTRODUCTION

The advancement of technology and the over-exploitation on the natural environment bring human beings the convenience and the disaster as well. As a result, people often live in an environment where accidents frequently occur. These accidents not only inflict heavy losses on individuals but also families; moreover, they become a heavy burden to our society. Hence, insurance becomes a crucial instrument to lower down the degree of the losses to people. Among various insurance products, injury insurance is an essential must.

Injury insurance is a part that is not negligible to the insurance businesses. However, insurance companies spend less time and posses fewer experiences in non-life insurance than in life insurance. In addition, their managing non-life insurance businesses perhaps aims simply to obtain the predominance in the market and increase the market share. It, thus, is necessary for our government, the insurance companies and the scholars to collect experiences, develop a system and build up a data base for non-life insurance.

This study aims to establish a model and conduct an analysis. By means of logistic regression, the impact that the risk factors of injury insurance have on the insurance claim rate is analyzed. With this analysis, we hope to help enhance customers' satisfaction with the insurance companies in the

process of handling underwriting and claims. This will ensure the sustainability of the enterprise's development and promote the public welfare in our society.

There are five sections in this study. In the first section the motivation, the background and the significance of this study are introduced. In the second section, the background of injury insurance is discussed with a review of the related literature, which discusses the characteristics of injury insurance and the status quo of managing this. The third section is about the result and analysis, explicating the construction of the empirical model, the statistic analysis and the findings. And finally in the fourth section, conclusions and suggestions are presented.

2. REVIEW OF LITERATURE

2.1 The status of managing injury insurance by insurance companies

In the past, insurance companies were not allowed manage injury insurance on account of the restrictions imposed by the insurance laws. In January, 1998, the Ministry of Finance allowed non-life insurance companies to sell injury insurance products in the form of supplemental provisions. Since then, various insurance products with injury insurance included have been promoted in the insurance market. However, such way of managing the injury insurance businesses still caused a lot of inconveniences to the insurance companies. To solve the problems, the Legislative Yuan, in July, 2001, passed the amendment bill to allow the insurance companies to sell the injury insurance policies independent of other insurance types. Since then, injury insurance, gradually becoming crucial, has become the battle field for the insurance companies, which became more active in expanding their market share in this part.

As a matter of fact, insurance companies provide buyers with various products related with injury insurance. For example, in the body injury of Compulsory Automobile Third Party Liability, the target of the injury insurance is the "body" of a person. If consumers do not include the injury insurance into the non-life insurance products, a regretful situation may occur that the third-person can claim the insured indemnification while the insured person or the person responsible for the accident can not due to the negligence of their own benefits. To consider thoroughly, buyers may appeal to taking out insurance in other insurance companies. But to consumers, buying different insurance products in different insurance companies cause a lot of inconveniences in the spent time, the place and even the claim expense out of the insurance. Moreover, the insurance premium may thus increase, leading to heavier financial burden on the consumer side. Therefore, the insurance companies should provide people, from the position of the consumers, with complete injury insurance products so that the protection on people's life and security may be increased.

As for the income of insurance premium, according to the Non-Life Insurance Association, the total insurance premium of injury insurance reached N.T. 7.189 billion dollars in 2004; N.T. 8.431 billion dollars in 2005, increasing 17.28%; and N.T. 9.271 billion dollars in 2006, only less than the insurance premium of automobile insurance and that of fire insurance. Compared with the high growing ratio of the non-life insurance companies, the business of life insurance companies dropped drastically from 2004 to 2007. The annual growing ratio dropped from 8~13% to minus (see Table 1).

As for the indemnification, non-life insurance businesses have been managed for only four years while the amount of the indemnification increases annually. In contrast, the amount of the indemnification remains constant (see figure 1). It is thus evident that managing injury insurance significantly influences the whole insurance industry. To the non-life insurance companies, the matter of how to stand firmly in this new-growing market certainly will influence their future development, which in turn will have a great impact on this market.

Table 1 The **insurance** premium statistic of **personal injury insurance** for life insurance and non-life insurance

unit：million

Year	**Injury Insurance** of non-life Insurance	Growth Rate	**Personal Injury Insurance** of life Insurance	Growth Rate
1998	-		37,023	13.85%
1999	-		40,045	8.16%
2000	-		44,544	11.23%
2001	-		47,920	7.58%
2002	-		51,944	8.40%
2003	-		52,044	0.19%
2004	7,189		48,706	-6.41%
2005	8,431	17.28%	49,059	0.72%
2006	9,271	9.96%	49,537	0.97%
2007	9,864	6.39%	50,100	1.14%

Resource：Taiwan Insurance Institute database and this research

Note：「-」represents 2003 before that the insurance premium of injury insurance in non-life insurance companies is merged into other insurance products.

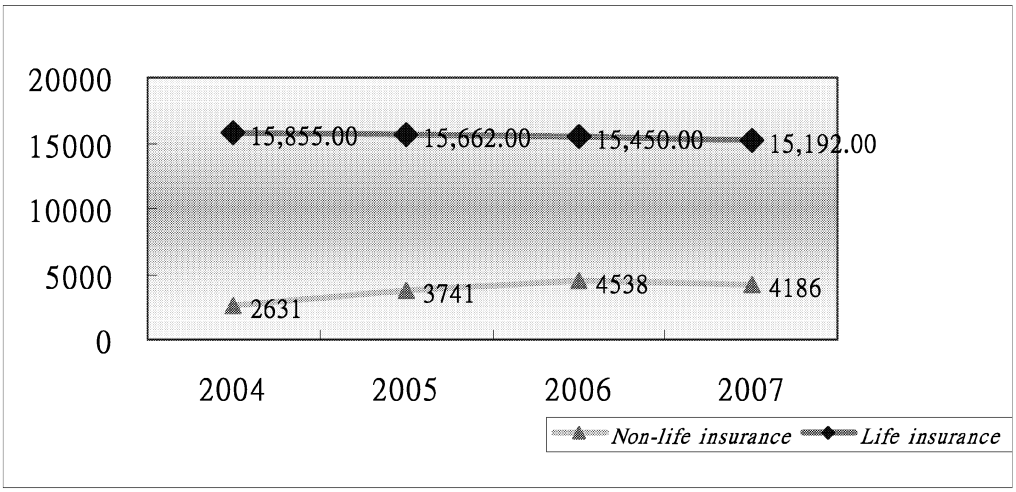


Figure 1 The reparation trend chart of **injury insurance** for life insurance and non-life insurance

2.2 A review of the related literature of injury insurance

In the following, several studies on the issue of injury insurance will be discussed before we continue our study.

Through discussing the managing experiences on the parts of accidental death and dismemberment covered in personal injury insurance, Chang (2003) and Hsu(2006) studied the situations current personal injury insurance businesses encountered, analyzed personal injury insurance products, and then conducted a statistic survey on the losses the life insurance companies had on the part of personal injury insurance. The major findings are as follows:

(1) There is a high demand on personal injury insurance, so there is still plenty of opportunities for either life or non-life insurance companies to develop in this part.

(2) Life insurance companies should place importance on the moral risk issue in personal injury insurance.

(3) It is necessary to decrease the number of such cases as giving commissions or discounts to enhance the sales of insurance products; instead, the service quality and the arrangement service of re-insuring to the buyers should be valued.

(4) Product differentiation and price differentiation are two possible developing directions of personal injury insurance.

Analyzing the related figures, provided by the studied insurance company, of insurance-taking and indemnification from 2002 to 2004, and then discussing thoroughly the ratio of experience loss in managing injury insurance, Huang (2004) and Chuang (2007) conducted a research on the fairness of formulating the ratio of injury insurance premium, taking into account the factors influencing the ratio of injury insurance premium, namely, occupation, gender, age, region. The major findings are as follows:

(1) The premium ratio relation among the regulated occupation types does not exist.It is proposed that formulating the premium ratio of injury insurance should based on experience loss ratio, with the factors such as age, gender and region being considered.

(2) The gross death rate of males is 2.5 the multiple of that of females; the accident-occurring rate rises as the age goes up.

(3) In terms of region premium ratio, the northern region is the cheapest, with Taichung region next more expensive, Taoyuan-Xinzhu-Miaoli even more expensive, and the southern region (including the eastern region) the most expensive.

In sum, the past studies all focused on the discussions of evaluating and improving the effects that life and non-life insurance companies managed injury insurance. This study, in contrast, aims not only to analyze the status quo of how life and non-life insurance companies manage the business of injury insurance, but also to collect the insurance buyer data from a non-life insurance company managing injury insurance and then try to find out whether the insurance buyer data counts as a risk factor of the

insurance claim probability. The result will be helpful to the insurance companies in the related processes of handling underwriting and claims. And with the assistance provided by non-life insurance companies, the accident-occurring probability on the buyer side will decline, and the satisfaction degree of the insurance buyer will rise, both of which will help ensure the sustainability of the enterprise's development and promote the public welfare in our society.

3. METHODOLOGY

3.1 Logistic regression analysis

In this study, logistic regression model is adopted to construct an empirical model, by which it will be found out whether the basic data of the insure will influence the occurrence of the insurance claim and the non-claim. logistic regression model is a statistic analysis method to deal with the relationship between dependent variables and categorical variables. Since dependent variables may have many different types, logistic regression model is often used to analyze a binary response variable. The characteristic is in using logistic variable conversion, which converting response variable into the probability values between 0 and 1. Here we define responsible variable Y for 1 (representing the insurance claim) and 0 (representing the non-claim) If there exists an independent variable *p*-1, let its vector denote $x=(x_1,x_2,\ldots,x_{p-1})$, then the condition probability of response variable is defined as $P(Y=1/x)=\pi(x)$, representing the probability of the insurance claim under the basic data of the insurants.

$$\pi(x)=\frac{e^{g(x)}}{1+e^{g(x)}}\ ,\ 0\le\pi(x)\le 1$$

Logistic Regression Model is generally represented as follows:

$$g(x)=\ln\left[\frac{\pi(Y=1|x)}{1-\pi(Y=1|x)}\right]=\beta_0+\beta_1x_1+\ldots+\beta_{p-1}x_{p-1}$$

After the conversion of logit, $g(x)$ is the linear combination of the parameter. There is a linear relation between $g(x)$ and variable X, with a feature of monotonically increasing/decreasing, which can handle better the problem of the accident-occurring probability range limit for $P(Y=1|x)=\pi(x)$. Maximum likelihood estimator of regression-coefficient possesses advantages of the statistical consistence and the effectiveness. The larger $g(x)$ becomes, the larger the accident-occurring probability is. It is feasible to set a critical probability value to judge whether it is a case of the insurance claim. If the probability of the insurants is larger than the critical probability, it is judged to be a case of the insurance claim..

3.2 Descriptive statistic analysis

(1) Source of data

The sampling data of 58550 pieces collected in this study is provided by a well-known non-life

insurance company. It consists of the insurance premium of personal injury liability insurance policies in 2006 and the information in those insurance policies that have been paid with claim expense within that year.

(2) Directions on the data categories

The selected dependent variable is insurance claim status; independent variables are gender, age, Insurance claim region, occupation, and business source respectively. The insurance buyers' basic data is categorized in Table 2.

Table 2 Descriptive Statistics of Insurants

Variable	Classification	opulation	Percentage	Variable	Classification	Population	Percentage
Insurance claim status	**Insurance non-claim**	1689	2.9	**Occupation**	**Scholars:** public utilities, cultural and educational institutes, public order groups, soldiers	7445	12.7
	Insurance claim	56861	97.1		**Farmers:** Farming and fishery	1441	2.5
gender	male	35623	60.8		**Artisans:** forestry, construction, transportation, manufacturing, mining industry	29611	50.6
	female	22927	39.2		**Merchants:** service industry, entertainments, journalism and advertising, information service, restaurants and hotels	11045	18.9
Insurance claim region	**Northern**	30784	52.6	**Sources of business**	Banking	18714	32.0
	Central	11496	19.6		Life insurance	18821	32.1
	Southern	13800	23.6		Insurance brokers	14227	24.3
	Eastern	2470	4.2		Others	6788	11.6
Total sample		58550	100	**Total sample**		58550	100

4. RESULTS

In Table 3, we find that the whole significant test of this model $\chi^2 = 267.309^{***}$ shows that it is significant; and the test value of Hosmer-Lemeshow is 6.843 (p>0.05) , showing it is not significant. These tell us that Goodness of Fit of the established regression model, based on the 12 independent variables, is perfect.

From the aspect of the significance of individual parameters, we see the parameter value of age is a minus and the insurance claim probability ratio in relation to the non-claim is 0.991. This tells us that the younger the insurance buyer is, the higher the insurance claim probability becomes. In terms of injury liability insurance of T company, the company developed the insurance products particularly for those children under fourteen years old and those females of the young generation, in order to create a product differentiation and to make their products more competitive in the market. Conducting an analysis on the insurants, we find that they are active, out-going and with a high probability of going out. The insurance claim risk is thus higher compared with others.

As for the insurance-taking region, the parameter values in Central region and Southern region are plus, and the insurance claim probability ratio in relation to the non-claim are 1.27 and 1.297 respectively. This shows that the insurance polices taken out in Central region and Southern region have a higher insurance claim probability. Northern region is the place where the capital is located. Most of the insurers here are members of white-collar class or people who serve in the army, the government and the education circle, with a higher living level than those insurers in Central region and Southern region. The job types of the insurers in Central region and Southern region are generally laborers and farmers, so insurance claim risk is thus higher compared with that in Northern region.

As for the occupation, the parameter of scholars (including people who serve in the army, the government and the education institutes) is a minus, and the insurance claim probability in relation to the non-claim is 0.644. This shows that insurers of the scholars occupation have a higher probability of the non-claim. Generally speaking, insurers who serve in the army, the government and the education circle usually have a higher education level and living level. Their jobs belong to the first occupation category, with the lowest risk. In addition, they generally have a positive view toward insurance and know how to make a better plan on the risk control and insurance planning. Therefore, there are fewer cases of moral risks or adverse selections.

Finally, as for the business source, the parameter of banks is a minus, and the insurance claim probability ratio in relation to the non-claim is 0.482. This means that the insurance businesses coming from the banks have a higher probability of the non-claim. In contrast, the parameter of life insurance companies is a plus, and the insurance claim probability in relation to the non-claim is 1.202. This means that the insurance businesses coming from the life insurance companies have a higher. In recent years, to explore for diverse channels, enhance the business sales and expand the market share, non-life insurance companies have appealed to form a strategy alliance with several banks and life insurance companies. They even developed the insurance products, exclusively sold by a specific bank or a life insurance company, to attract the insurance buyers of these specific banks or life insurance companies.

Conducting an analysis on the business source from the banks, most of the insurers are the acquainted clients to the bank workers or their family. These applicants belong to the white-collar class, with a more stable living environment, and thus have a lower insurance claim probability. In contrast, analyzing the business source from life insurance companies, the insurance range of their own injury insurance is smaller, and their insurance buyers come from different walks of life. In addition, life insurance companies, managing injury insurance for a long period of time, are usually sensitive to the factor of risk. But in order to make the best insurance planning for their buyers, the life insurance workers often give up their own insurance products to take the injury insurance products presented by non-life insurance companies. As a result, the quality control of the taken insurance is not easy to keep, compared with those non-life insurance workers, and the risk thus becomes higher.

The whole differentiation accuracy rate of this study is 97.1%. The established regression model, based on the six independent variables of age, insurance claim in Central region and Southern region , occupation of scholars (people who serve in the army, the government and the education institutes) , and business source from banks and life insurance companies, possesses a pretty high differentiation accuracy rate on the relation variable of the insurant's insurance claim ratio.

Table 3 Result of risk factors of injury liability insurance for insurants

Dependent Variable (Insurance non-claim) / Independent Variable	Insurance claim			
	B	S.E.	Wald value	Exp(B)
Gender	-0.029	0.054	0.302	0.971
Age	-0.009***	0.002	17.551	0.991
Insurance claim region				
Northern	0.132	0.136	0.943	1.141
Central	0.244*	0.140	3.053	1.277
Southern	0.260*	0.138	3.535	1.297
Occupation				
Scholars	-0.439***	0.119	13.707	0.644
Farmers	0.045	0.166	0.072	1.046
Artisans	-0.049	0.083	0.345	0.953
Merchants	0.145	0.090	2.606	1.157
Sources of business				
Banking	-0.730***	0.093	61.606	0.482
Life insurance	0.184**	0.082	5.049	1.202
Insurance brokers	0.071	0.087	0.667	1.074
Constant	-3.190***	0.201	252.084	0.041
Goodness of Fit Test	$\chi^2 = 267.309***$			
	Hosmer-Lemeshow Test Value = 6.843			

Note:1. S.E is standard deviation ; 2.*** P<0.01 ; ** P<0.05 ; * P<0.1 ; 3. Resource: this research

5. CONCLUSION

With the advancement of technology and humanities, human beings invent and keep improving insurance to reduce the influence by natural and man-made calamities. What need to be thought about are matters such as how insurance companies develop products that attract buyers, how they pursue after more profits, how risk planners pursue after a better insurance with the least amount of money, and how they make a balance between them to create a win-win situation. To find answers to these matters, we need to not only constitute complete and precise laws and regulations that all insurance companies can follow, but also establish an evaluating model to provide the companies with a stable and effective basis for underwriting so that it can even help these companies that aim to run in a long term reduce the premium ratio of the related insurance products.

With the logistic regression analysis, we learn that the younger the insurers are, the higher the insurance claim probability is; the insurance claim in Northern region has a lower insurance claim probability, compared with that in Central region and Southern region; the insurers who serve in the army, the government and the education institutes have a lower insurance claim probability than those of other occupations; the insurance businesses coming from banks have a lower insurance claim probability than those from sources; and finally, gender does not have a significant influence on the insurance claim probability

References

The Non-life Insurance Association of the Republic of China ,http://www.nlia.org.tw/

Life Insurance Management Institute of the Republic of China , http://www.limi.org.tw/

Department of Health Executive Yuan R.O.C.(statistic data)http://www.doh.gov.tw/statistic/data/

Hung-I Hsu "A study About Conduct of Accident Insurance on Property Insurance Company in Taiwan", Chaoyang University of Technology of master paper, 2006.

Su-Ping Chang，"A current study of the experience issues of accident insurance on Taiwan-Life and Non-Life"，Feng Chia University of master paper, 2003.

Rwei-Ju Chuang "Study of the Female Credit Card Scoring via the Modeling of Logistic Regression and Tree Structure", Fu Jen Management Review,vol.14(1)(2007), pp.127-154。

Ching-Lan Huang,"A Study on Taiwan Casualty Insurance Premium of Property Insurance Industry", Feng Chia University of master paper, 2004.

Hsien-Wei Liao ," Utilizing Logistic Regression Model in the Management of Life Insurance Fraud", National Kaohsiung First University of Science and Technology of master paper, 2001.

Using Financial Factors to Investigate Productivity– An Empirical Study in Taiwan

Shu-Yi Liaw

Chih-Ying Tai

Associate Professor and graduate student, Department of Business Administration
National Ping Tung University of Science and Technology, 912, Ping Tung, TAIWAN
E-Mail: syliaw@mail.npust.edu.tw

ABSTRACT

In terms of financial ratios, a firm's management performance can be evaluated; to use financial factors to efficient management is proposed as the key element for upgrading a firm's productivity. This study investigates productivity in terms of certain financial factors of large-scale manufacturing firms in Taiwan. We first determine several influential financial factors using factor analysis. Based on these factors, fuzzy clustering approaches are then employed to categorize the manufacturing firms into several patterns with distinct characteristics of financial factors. Using the characteristics of productivity and financial factors for each pattern, pattern analysis is made, and some suggestions to improve the firms' productivity are proposed.

Keywords: *Productivity, Financial factor, Factor analysis, Fuzzy clustering analysis*

1. INTRODUCTION

The U.S. subprime mortgage issue has reminded the enterprises and industries of the region to emphasize effective management [7,11]. To promote national competition and firms' productivity, efficient and effective management is necessary to sustain the growth of manufacturing industry [9]. In general, the managing performance of a business unit can be evaluated from its published financial statements. Using the financial data from financial statements, a variety of financial ratios are usually used to examine the functionality of a business unit from different perspectives. Meanwhile, productivity is also considered as an aggregate index for measuring business unit's efficiency, since a business unit with higher productivity is generally more profitable.

Since various financial ratios are used to measure the performance of particular management functions, the relationship between these ratios and productivity deserves further investigation [8]. Then, based on that understanding, managers can adopt appropriate strategies to improve the associated financial ratios better and there by improve the unit's total productivity. In order to illustrate this idea, this paper focuses on the investigation of productivity of large-scale manufacturing firms in Taiwan as shown by their financial ratios. For measuring productivity of the firms, an aggregate productivity index (Total Factor Productivity, *TFP*) is adopted in this study. In addition, 48 general financial ratios listed in the Taiwan Economics Database are used to evaluate the management performance of the sample firms. We first apply correlation analysis to find the financial ratios that are more closely correlates with the *TFP*. Factor analysis is then conducted to determine the more critical financial factors. Based on these financial factors, fuzzy clustering analysis is employed to categorize the sample firms into several groups. Each group of firms is characterized with a set of financial factors

and a weighted average *TFP*. Finally, appropriate strategies can be proposed to promote productivity within each group of firms according to their respective financial characteristics.

2. PRODUCTIVITY MEASUREMENT

Productivity is often used to evaluate the aggregate performance of a business unit, generally defined as the ratio of outputs to inputs. However, for different applications and research domains there are different definitions of productivity. Taylor and Davis [10] presented a model of Total Factor Productivity (TFP) to assess the productivity of an enterprise [3]. In this model, the concept of value-added is used as the output, and labor and capital inputs are included in the input items for measuring the added value by a production unit per unit of input. In this paper, the TFP model is adopted, since it is informative to explain a manufacturing firm's performance. Mathematically, the TFP is defined as

$$TFP = \frac{\text{Value} - \text{added}}{(\text{Labor inputs} + \text{Capital inputs})}$$

In this formula, the denominator is the firm's inputs, and the numerator is the firm's output. They are further described in the following.

(1) Inputs: Labor inputs are defined as all the related human resource costs, including salary, after-hour allowance, pension, and bonus for direct labor, indirect labor, salesmen, supervisors, and managers. The measurement of capital inputs in this study will refer to the concept of "service volume" presented by Craig and Harris [5] to take into account both the fixed capital and operating capital.

(2) Output: We use value added as the output determinant of productivity. In business accounting, value added is the capital profit generated by a business unit through production and operation activities within a certain period of time.

For determining a firm's TFP, certain financial data have to be gathered to calculate labor input, capital input, and value added. We acquired most this financial data from relevant financial statements in the published financial database, the Taiwan Economics Database. In addition, some data were provided by the sample firms through questionnaires for information, such as personnel expenses, parts and material costs and so on, if it could not be found from the database. The sample of Taiwanese firms consists of large-scale manufacturing enterprises in Taiwan, since these firms have economic scale of production so that the investigation of productivity in terms of financial factors is logical. The large-scale manufacturing firms in this study are located in the list of Taiwan's top 1000 manufacturing firms and are first-category companies in the stock market. A total of 117 firms satisfy this condition, and 63 firms answered the questionnaires. After calculations based on the equation, the average TFP of the sample is 2.8958, with a maximum value of 7.6736 and minimum value of -0.0454. Via Normal Q-Q Plot, the productivity distribution of the sample firms is determined to be normal.

3. CRITICAL FINANCIAL FACTORS

In order to investigate productivity in terms of the performance of the sample firms' management functions, certain critical financial factors are determined [4]. First, 48 kinds of financial ratios for the sample firms were solicited from the Taiwan Economics Database and adopted in this study. We perform correlation analysis to find the financial ratios more correlated with productivity, with an absolute value of correlation coefficient larger than 0.2. A total of 15 financial ratios are found and used in the subsequent analysis. An F-test is performed to further examine the relationship of these ratios with productivity of the sample firms. A significant conclusion is made (p-value = 0.008351) for this test, indicating that these ratios are effective to describe productivity. And then, factor analysis is applied to find critical financial factors. After performing certain approaches of factor analysis, such as principal component method and orthogonal rotation, four critical financial factors are determined. The accumulated ratio of variation explained by the four factors is more than 80%. The financial ratios with absolute value of factor loading larger than 0.7 are selected as indicating financial factor. Two of these 15 financial ratios, earnings per share and fixed assets growth ratio, have absolute values of factor loading too small to be grouped into any factor. Consistency test is also conducted to check the similarity of financial ratios in each factor to determine whether the factor analysis is appropriate. The four financial factors and their tests are described as follows.

(a) profitability factor (F1):

Five financial ratios in this factor. There are after-tax return on net worth, return on total assets, before-tax return on net worth, pre-tax income per share, and operating income per share and are all profitability-related indices, therefore this factor is referred to as the profitability factor. Considering business performance, this factor reveals a firm's capability for investment profit and the profitability of fund management.

(b) assets turnover factor (F2):

In this factor, there are four financial ratios, namely total assets turnover, fixed assets turnover, net worth turnover and sales per share. These ratios are all related to assets turnover or business income, therefore we refer to it as the assets turnover factor. This factor can be used to measure a firm's financial efficiency and the robustness of its total assets investment. When this factor is higher, the firm's ability to raising funds and appropriate investments is better.

(c) inventory turnover factor (F3):

Three financial ratios, namely inventory turnover, net operating cycle, and days-inventory turn, are incorporated in this factor. The latter two ratios have negative values of factor loading, indicating that the higher these two indices, the worse this factor. However, the factor loading of inventory turnover is positive, which shows that the higher the index, the better this factor. Therefore, this financial factor can indicate the capability of a firm's interior financial management, as well as the integration of manufacturing and marketing.

(d) effective tax ratio factor (F4):

Only one financial ratio, the effective tax ratio in this factor, therefore it is referred to as the effective tax ratio factor. Consistency test is not conducted, since only one variable is included into this factor. Based on the definition of effective tax ratio, the lower the ratio is the better, which makes a firm's profit strength advantageous due to reduced income taxes, such as official tax incentives for the strategic industries of a country.

Using the factor scores of the four financial factors, clustering algorithms are applied to categorize the sample firms into several distinct patterns for investigating productivity in terms of financial factors.

4. ANALYSIS

For the investigation of productivity in terms of financial factors, we employ clustering to find the characteristics of the sample firms' productivity. Instead of traditional statistical clustering approaches, fuzzy clustering algorithms are adopted to conduct data clustering in this study, since traditional clustering approaches assign a sample firm to a single class, assuming that the boundaries between classes are well defined. This may not reflect actual situations, where the boundaries are ambiguous. However, fuzzy approaches can assign a membership degree μ ($\in [0,1]$) to a sample firm to indicate the strength of membership belonging to some class based on the similarity. We consider our four financial factors to be the features, since these factors are used to find the characteristics of the productivity in this study. The fuzzy C-means [2] and certain relevant approaches are performed, such as unsupervised fuzzy clustering analysis [12] and the validity function [12], then the 63 sample firms are satisfactorily grouped into four classes. In addition, the centroid of each class and the membership degree μ ($\in [0,1]$) of each firm belonging to each class are also determined by the algorithms. Here, we define a threshold value θ (=1/4) to determine whether a sample firm has a strong evidence of belonging to a particular class. Finally, classes 1, 2, 3 and 4 contain 23, 22, 15 and 11 firms, respectively. Note that the total of firms contained in the four classes exceed the number of sample firms, because eight firms have stronger evidence of belonging to more than one pattern, relative to the threshold value.

To further examine the characteristics of the resulting patterns, first we conduct regression analysis to find the relationship between productivity and the financial factors for each pattern. Then pattern analysis is also conducted to determine the firms' financial characteristics of productivity through the centers of the four patterns in terms of the four financial factors and weighted averaged TFPs of each pattern. Based on the consequences of the two kinds of analyses, some characteristics of each pattern are described as follows.

(1) Regression analysis

We perform regression analysis for each pattern by considering the weighted TFP as response, and the weighted factor scores of the four financial factors as decisive variables. Table 1 lists the statistical model of each pattern, and the associated p-value and coefficient of determinant. In the

table, F_i and Z_i, with i = 1, …, 4, denote the four weighted financial factors and the weighted *TFPs* of the four patterns, respectively. Particularly, the statistical model before fuzzy clustering is also determined by using the original data for purposes of comparison. The notations of Z_0 and $\dot{F}_i$, i = 1, …, 4, are used in this model. As seen from the table, all of the five statistical models are significant with a significance level of 0.05. Almost all the coefficients in each model are also significant based on the *t*-test with a significance level of 0.05. However, the coefficients of determinant (R^2) of the models for the four patterns are greater than that of Z_0. This indicates that the relationship between financial factors and productivity from distinct patterns can be further investigated. Using the four models, we can know the financial factors that are influential to the productivity of the firms of each pattern due to their pattern's characteristic, and we can understand their competitive status in comparison with the other patterns.

(2) Pattern analysis

a. Pattern 1:

There are 23 firms in this pattern, whose weighted averaged TFP is the best and whose performance in terms of profitability, assets turnover and inventory turnover is better than those of other patterns, as shown in Table 2. In the t-test of regression coefficients, these three financial factors also show dominance. Therefore, Pattern 1 is referred to as the "high profitability and high turnover" pattern. Most of the firms in this pattern are high-tech related companies, such as electronics, semiconductors, computers and components manufacturing companies, and in average have higher capital, sales, profit margin and return on total assets, as shown in Table 3. These firms conform to the official high-tech strategic industries of Taiwan in the past decade, so that a large amount of assets from the stocks markets have flowed into these companies. Based on financial factors, these firms surely have better conditions of internal and external financial management, thus distinguishing profitability and productivity. Currently, Taiwan is prepared to shrink the scope of tax incentives for its massive semiconductor industry, and it encourages firms to make investments in other leading global technologies instead of the chip industry. According to the characteristics of productivity and the associated financial factors, the firms of Pattern 1 should promote research and development abilities to upgrade product quality and processing skills so as to maintain global competitiveness, thereby expanding capital profitability and TFP.

Table 1 Statistical models for the sample firms and distinct patterns

	Statistical models	p-value of the model	Coefficient of determinant (R^2)
Before clustering	$Z0 = 0.22\dot{F}_1^* + 0.38\dot{F}_2^* + 0.29\dot{F}_3^* + 0.26\dot{F}_4^*$	0.00	0.59
After clustering			
Pattern 1	Z1= 0.25F1* + 0.08 F2*+ 0.56F3*+ 0.14F4	0.00	0.68
Pattern 2	Z2= -0.41F1*+ 0.16F2*+ 0.09F3+ 0.21F4	0.01	0.74
Pattern 3	Z3= 0.25F1*+ 0.39F2*+ 0.11 F3*+ 0.71F4*	0.00	0.87
Pattern 4	Z4= 0.20F1*+ 0.52F2* - 0.06F3 - 0.27F4*	0.00	0.65

Note: Fi*, i= 1, …, 4, where * means this financial factor is significant under t-test with a significance level α=0.05

Table 2 Centers of the four patterns and their weighted averaged TFP

Pattern / Factor	Pattern 1	Pattern 2	Pattern 3	Pattern 4
Profitability	0.3288	-0.5650	0.2911	0.0462
Assets turnover	0.3638	-0.1534	0.1203	0.2201
Inventory turnover	0.5986	-0.4812	-0.2921	0.0534
Effective tax ratio	-0.1755	0.0205	1.0850	-0.7942
Weighted averaged TFP	3.4023	1.9580	3.0303	2.1917
Pattern attributes	High profitability High turnover	Low profitability Low turnover	High profitability High effective tax	Low profitability Low effective tax

Fig. 1 explains the differences of the four patterns within financial aspects and WTFP. Additionally, these four types of firms obtained a significant difference in effective tax ratio. Furthermore, the policy of the government for rewarding, guiding, and assisting these firms shows a significant influence on their finance programs and tax
savings.

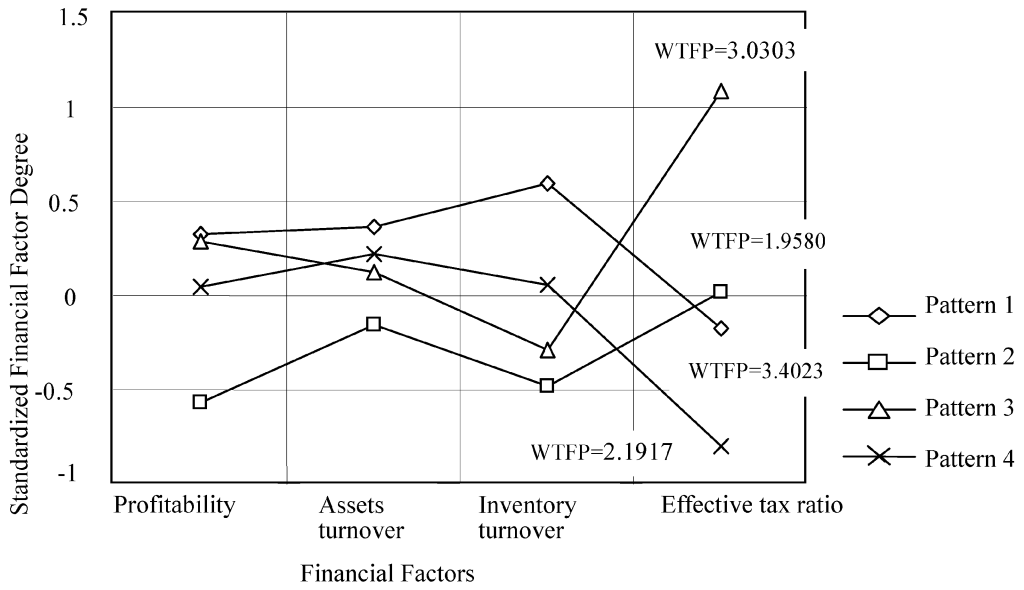


Figure 1 Centers of the four patterns and their weighted averaged TFP

b. Pattern 2:

This pattern contains 22 firms. It has a weighted averaged TFP of 1.96, and its factor scores for profitability, assets turnover and inventory turnover are -0.57, -0.15 and -0.48, respectively. The productivity and performance of these three financial factors are the worst among the four patterns. We refer to this pattern as “low profitability and low turnover” pattern, since profitability and assets turnover factors are significant based on significant level of 0.05. The firms in this pattern include traditional metal, cement, machinery and paper companies, and in average individual lower return on total assets of 1.31% and profit margin of 2.32%, as listed in Table 3. Although the firms of this pattern do not have many benefits from effective tax ratio, such as official tax breaks or incentives,

they could enhance their assets turnover and inventory turnover to improve profitability. By building up a sound financial management system, especially for the mechanism of capital turnover, the firms of Pattern 2 could successfully upgrade their productivity.

c. Pattern 3:

This pattern consists of 15 firms, with a weighted averaged TFP of 3.03 and moderate performance of financial turnover, but with a high effective tax ratio. The productivity achieved by this pattern is high. Although the high effective tax ratio indicates that official tax incentives and tax breaks are less, the profitability of firms in this pattern is sufficient, so that this pattern is referred to as "high profitability and high effective tax" pattern. The firms in this pattern are traditional manufacturing industries, such as plastics, steel, automobile and textile companies; however good profitability and productivity are achieved. On the average, firms in this pattern have $92 million of profit after tax, 5.10% return on total assets and 6.57% profit margin, as listed in Table 3. The four financial factors are all significant to explain the relationship with productivity. To further increase productivity, the firms of this pattern can strengthen their capabilities of financial turnover, especially in the aspect of inventory turnover related ratios. Meanwhile, multi-investments in leading technologies and strategic alliances with high-tech global enterprises would be helpful to upgrade the firms' future competitiveness.

d. Pattern 4:

This pattern consists of 11 firms, including network-software, medicine, chemical, food and feed companies, providing moderate return on total assets and profit margin compared to other patterns in Table 3. Most of firms in this pattern are now prepared to shift from traditional manufacturing industries to being official strategic industries of Taiwan, such as network, wireless communication, and biotechnology industries. The firms of this pattern have lower profitability and weighted averaged TFP; however the lower effective tax ratio benefits to the firms' profit after tax of 0.39. This directs the firms of this pattern towards accelerating their strategic transition to upgrade firms' productivity and leave aside official tax allowances to pursue profitability.

Based on the above descriptions, the relationship between financial factors and productivity has a highly degree of correlation. Referring to the magnitudes of profitability and the weighted averaged TFP of each pattern in Table 2, as well as those of return on total assets and profit margin of each pattern in Table 3, these factors appear in the same order among the four patterns, i.e., Pattern 1 > 3 > 4 > 2. This indicates that a firm's financial profitability can appropriately reflect the accomplishment of a firm's TFP in the distinct patterns. However, the order of magnitudes cannot be found in the relationship between the firms' average capital (or sales) and weighted averaged TFP. This indicates that the key feature affecting the achievement of TFP is the financial profitability related ratios instead of the quantity of capital.

Table 3. Some average performance measures for the firms of each pattern

	Pattern 1	Pattern 2	Pattern 3	Pattern 4
Return on total assets	7.63%	1.31%	5.10%	4.26%
Profit margin	10.56%	2.32%	6.57%	4.15%
Profit after tax ($ hundred millions)	1.38	0.04	0.92	0.39
Average capital ($ hundred millions	4.17	2.08	5.13	1.02
Average sales ($ hundred millions per yr.)	10.08	0.78	3.85	1.64

5. CONCLUSIONS

The purpose of this study is to investigate productivity in terms of financial factors from distinct financial patterns. By surveying 63 large-scale manufacturing firms in Taiwan, this study has extracted four financial factors, namely profitability factor, assets turnover factor, inventory turnover factor, and effective tax ratio factor. Based on these four financial factors, the sample firms are then grouped into four financial patterns using fuzzy clustering approaches. By building up the statistical models of the four patterns, the firms of each pattern can recognize the financial factors that are critical to productivity due to their pattern's characteristics, and understand their competitive status in comparison with the other patterns. The approach of fuzzy clustering can identify the degree to which a firm belongs to a specific pattern, and the membership degree is considered as the weight in determining the characteristics of pattern. Furthermore, through pattern analysis, the characteristics of productivity in terms of financial factors can be further examined. The productivity is highly correlated with the financial factors [1]. Thus, the firms with high performance in the four aspects of critical financial factors usually have high productivity. The advantage of the approaches in this study is that the firms' financial characteristics of productivity in each pattern can be examined simply and objectively according to their attributes of financial factors. Although the discussion of this study is confined to manufacturing firms in Taiwan, the methodology developed is applicable to the other countries.

References

Alessandra Bonfiglioli (2008) Financial integration, productivity and capital accumulation, Journal of International Economics, 76(2), 337-355.

Bezdek JC (1981) Pattern Recognition with Fuzzy Objective Function Algorithm, Plenum Press, New York.

Chia-Hung Sun(2004) Decomposing productivity growth in Taiwan's manufacturing, 1981–1999,Journal of Asian Economics, 15(4), 759-776.

Chia-Lin Chang, and Stéphane Robin(2008) Public policy, innovation and total factor productivity: An application to Taiwan's manufacturing industry, Mathematics and Computers in Simulation, 79(3), 352-367.

Craig CE and Harris RC (1973) Total productivity measurement at the firm level. Sloan Management Review, 14, 13-29.

Gath I and Geva AB (1989) Unsupervised optimal fuzzy clustering. IEEE Transaction on Pattern Analysis and Machine Intelligence, 11(7), 773-781.

Euripidis N. Loukis, Ioakim A. Sapounas, Alexandros E. Milionis(2008) The effect of hard and soft information and communication technologies investment on manufacturing business performance in Greece – A preliminary econometric study. Telematics and Informatics, 26(2), 193-210.

Simon K. Poon, Joseph G. Davis and Byounggu Choi (2009) Augmenting productivity analysis with data mining: An application on IT business value. Expert Systems with Applications, 36(2), 2213-2224.

Takashi Hasuike, Hiroaki Ishii (2008) On flexible product-mix decision problems under randomness and fuzziness. Omega, 37(4), 770-787.

Taylor, BWIII and Davis KR (1977) Corporate productivity-getting it all together. Industrial Engineering, 9(3), 32-36.

Weiss L (1999) State power and the Asian crisis. New Political Economy, 4(3), 317-342.

Xie XL and Beni G (1991) A validity measure for fuzzy clustering. IEEE Transaction on Pattern Analysis and Machine Intelligence, 13(8), 841-847.

The Expansion of Taiwanese Residential Construction in the 2000s: A Supply Led or Demand Pull Expansion

Henry H. Y. Hsieh

Assistant professor, Department of Business Administration
National Ping Tung University of Science and Technology, Taiwan, R.O.C
E-Mail: henry@npust.edu.tw

John Forster

Professor, Department of Accounting, Finance and Economic,
Griffith University, Brisbane, Australia.
E-Mail: j.forster@griffith.edu.au

ABSTRACT

Residential construction growth in the 2000s shows no significant evidence whether the boom is triggered by demand or supply side according to pooled cross-sectional time-series by 23 Cities and Counties in the period of 1999-2005 and Joint test of these two sides. This differs significantly from the supply led expansion in the 1990s. During the 2000s demand side plays more important role than before such as larger average residential unit size, housing price growth, and increasing housing loans. This can be seen from escalating approval, completion, number of developer and high vacancies. Transparent information by releasing market information can ameliorate group irrationality derived from rational individual decision. Although demand factors yield significant influence to residential construction in the 2000s, fast construction, subcontracting practices, fast expansion of residential construction are still similar to those in the 1990s.

Keywords: *Residential construction, Supply led expansion, Demand led expansion, Oversupply, Asymmetric market information*

1. INTRODUCTION

The factors precipitating the residential construction industry influence Taiwan significantly, especially while construction boom is supply-led always causing huge oversupply and vacancies. This argument leads to the question, which force precipitated the up and down of the construction during the 1990s and the 2000s? Hsieh (2005) argued that the residential construction boom in the 1990s is due to event trigger and supply led expansion in Taiwan. However few researches investigate the phenomenon of the 2000s' expansion.

An overall view of Taiwanese residential construction industry there was a significant peak in the 1990s, causing significant impact to Taiwan in the construction quality and housing stocks. From the earthquake damage in 1999 evidence shows substandard construction quality in the building constructed during 1990s (Hsieh & Forster, 2006). In addition huge oversupply caused large vacancies (Hsieh 2005). The peak largely precipitated by supply side under a stringent regulation change in 1992 and easy credit from financial deregulation in 1987. The regulation called Volume Control reducing allowed building space of land nearly 40 % was announced in 1992 but not until 1999 was it fully enforced (Hsieh 2002). This implies the boom is triggered mainly by policy factor not by market mechanism.

Again residential constructions increase in the 2000s. Residential building production increased from 2002 to 2004 (Figure 1), indicating a recovery of residential construction. This research investigates those factors precipitating the residential construction during the 2000s to prevent the fallout again as did in the 1990s.

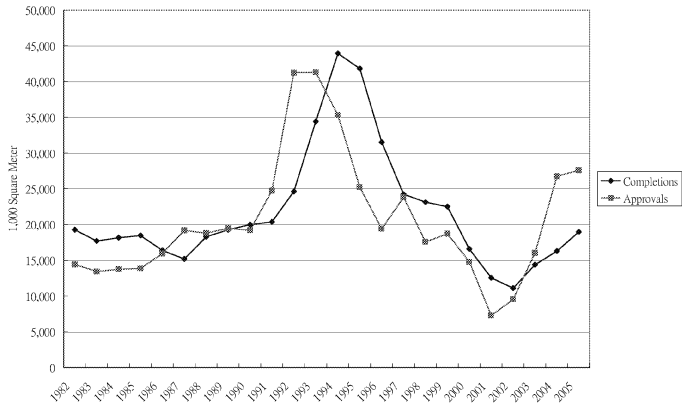


Figure 1 Residential Approvals and Completions by Floor Space

Source: CPA 1998,1999, 2000, 2001, 2004 ;DGBAS 2001

2. RESIDENTIAL CONSTRUCTION PRODUCTION ANALYSIS

Residential completion increased 46.5 percent in the period of 2002-2004 (Figure 1). Notably this increase occurred right after a sharp decline, indicating the flexibility of this industry. Through networking and subcontracting practices developer, contractor and subcontractor enter and exit this industry quite easily resulting in the quick rise and fall of the residential completions in the 1990s (Hsieh & Forster, 2004). Although government keep a lax interest rate under 2% in 2000 encouraged housing demand and caused housing market to grow, the expansion of completion even greater than demand, which can be seen from the increase of vacancies in 2004 and 2005. The completions are laggard indicator of approvals. Accordingly approvals are always considered as an important indicator to measure the reaction or impact of external events or factors imposing on residential construction industry. In particular event is an important factor to this industry such as volume control regulation announced in 1992 residential approvals increasing instantly to reflect the impact of this event (Hsieh & Forster, 2004). In addition approvals are always considered as an indicator to reflect the market demand. Developer will increase the approvals when demand is strong. Accordingly residential approval increased 266.2 percent during 2001-2004. Approvals always lead and are much greater than completions. This is due to the difference between planning and execution. It is certain that both residential approvals and completions were in strong growth in the early 2000s. What factors, supply side or demand side, precipitating this sharp growth is examined in this research.

3. SIMPLE DEMAND AND SUPPLY MODELS

There are two types of market theory of the construction industry, supply model or demand model. The supply model means demand did not change but supply increased largely. On the other hand demand model stands for the growth of demand without increase of the supply. Price depends on these two forces to decide up or down. Both supply and demand increase during the boom will cause the increase of completions but also price will increase depending on the strength of the degree of supply and demand expansion. When supply expand are greater than demand expansion the price will decline vice versa. However the price is raised to a higher degree will cause oversupply as indicated in the Figure 2.

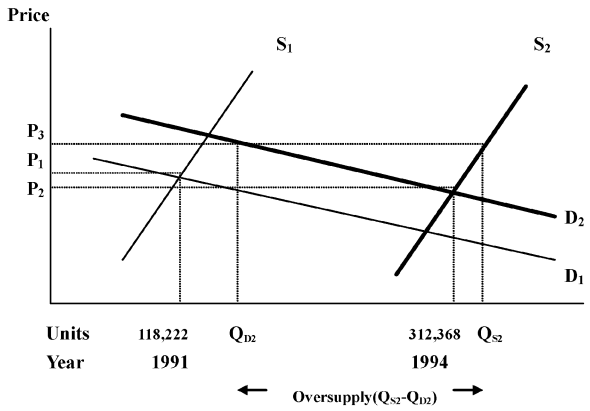


Figure 2 Both Supply Pull and Demand Push Model in Residential Construction

In fact the demand and supply is influenced by external factors such as event, macro factors, population growth and vacancies etc (Hsieh & Forster, 2007). Those factors can be categorized into demand and supply side in order to test which side influencing residential construction most. Developer represents supply side providing skill, capitals, and management to build residential units. Home buyer and investor represent demand side purchasing the housing units for residence or investment. The general model of residential construction including those factors is illustrated in Figure 3.

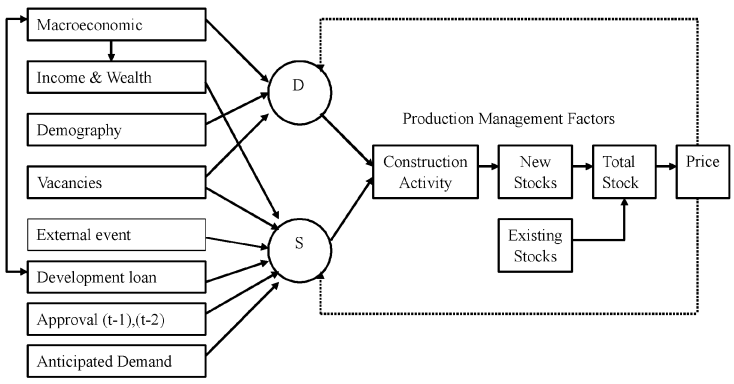


Figure 3 A Dynamic Demand and Supply Model of Construction Activity

4. REGRESSION RESULTS AND INTERPRETATION

The empirical relationships of factors related to the residential construction, pooled cross-section time-series regression analysis is used. The results provide evidence concerning determinants of the residential construction, especially the supply side or demand side arguments. The completions are the focus of an estimated single equation model. We pool the demand and supply variables in 23 cities and counties in Taiwan during 1999-2005, emphasizing the period of the 2000s.

4.1 The Model

Factors involved in both demand and supply sides of residential construction are used to establish the model. In equilibrium completions should equate demand and supply. However, the durability of the stocks involved, and the long production time, hinders this as the market price feedback loop is less able to operate effectively. Vacancies or shortages then occur (Chen and Chen 1998:105-106; Peng and Chang 2000:333). This version of the estimated completions is equation (1).

(1) $$Log(Completion) = Lnb_0 + b_1 Log(Population) + b_2 Log(Density) + b_3 Log(Development\ loan) + b_4 Log(Interest) + b_5 Log(Price) + b_6 Log(Approval(t-1)) + b_7 Log(Approval((t-2)) + b_8 Log(GDP\ per) + b_9 Log(Housing\ loan) + b_{10} Log(Vacancy\ unit) + b_{11} Log(Real\ Deposit\ per + b_{12} Log(Saving\ rate)$$

Where

$b_0>0$; b_1, b_2, b_3, b_5, b_6, b_7, b_8, b_9, b_{11}, $b_{12}>0$; b_4, $b_{10}<0$; b_5 is unknown.

The variables are summarized in Table 1.

Table 1 Summary of the variables

The Macroeconomic Variable:	*Coefficient*
Log(GDP per): GDP per capita.	B_8
Log(Interest): interest rate	B_4
The Supply Side Variables:	
Log(Completion): residential completion (floor space)	
Log(Population): population in each city and county	B_1
Log(Develop loan): development loan	B_3
Log(Price): The price level of housing market	B_5
Log(Approval(t-1)): lagged (t-1) approval (floor space)	B_6
Log(Approval(t-2)): lagged (t-2) approval (floor space)	B_7
The Demand Side Variables:	
Log(GDP per): GDP per capita	B_8
Log(Population): population in each city and county	B_1
Log(Density): population density	B_2
Log(Housing loan): housing loans	B_9
Log(Price): housing price	B_5
Log(Vacancy unit): vacancy rate	B_{10}
Log(Deposit per): real bank deposit per capita (1996=100)	B_{11}
Log(Saving rate): saving rate	B_{12}

Estimation with completions as dependent variable by ordinary least square (OLS) regression is first examined. Unexpectedly, the model shows high levels of multi-collinearity. The tolerance and VIF of variables in the model are used as a test of collinearity (Peng and Chang 1995:69). The VIF of development loan, interest, GDP per capita, deposit per and housing loan are greater than 10, and their tolerance are smaller than 0.1, which indicates collinearity. These variables are also individually highly correlated. We substitute high correlated variables, Log(Deposit per), Log(Housing loan), Log(GDP per), Log(Interest) and Log(Population) with Log(Density), Log(Saving rate) and Log(Development loan). The model in Table 2 is treated as the improved model through the absence of those five variables.

Table 2 Coefficients of the improved completion model

Coefficients [a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	1.527	3.971		.385	.701		
	Log(density)	2.509E-02	.031	.032	.816	.416	.681	1.468
	Log(price)	-.185	.156	-.044	-1.187	.237	.780	1.282
	Log(saving rate)	5.734	1.214	.157	4.722	.000	.949	1.054
	Log(vacancy unit)	.552	.083	.404	6.635	.000	.284	3.527
	Log(develop loan)	.372	.271	.050	1.376	.171	.786	1.272
	Log(approval t-1)	.413	.065	.387	6.363	.000	.285	3.510
	Log(approval t-2)	.200	.062	.184	3.204	.002	.319	3.135

a. Dependent Variable: Log(completion1000m2)

R^2= .839, F=113.847***, N=161, *** < .001

In order for the model to be valid, the requirements of regression are analysed and tested (Keller et al. 1990:676~677). The model is tested and complied with the requirement of normality, zero Mean of Residuals, heteroscedasticity, autocorrelation (Independent) (Keller et al 1990:769), and collinearity (Peng and Chang 1995:69).

4.2 Interpreting the Model

The model of Table 2 indicates a high level of statistical explanation of the completions behaviour of residential construction. Most importantly it has sufficient empirical validity to allow an examination of the relation of demand, supply and macroeconomic factors to this industry. The coefficient of density variable is positive but insignificant. Development loans (to developers and not customers) had a positive relationship to completions but insignificance. This may relate to comparatively short term of the research within five years in real estate industry. Normally real estate needs longer time in each cycle say five to six years in Taiwan. We can see from the cycle since 1992 to 1999 taking nearly seven to eight years of the last cycle. Hence the short period development loan is not enough time to yield significant influence. Density changed very small in the short period. Especially population growth became smaller every year that this factor did increase the housing demand but is insignificant.

Price as expected is insignificant to the completions since demand and supply forces making the influence vague. Higher price will encourage developer to build more houses but will discourage buyer to buy and vice versa. Saving rate has a positive and significant relationship with completion, indicating a growth of consumer's purchasing power after a long recession. This is true when residential industry declined from 1997 and exacerbated by the 1999 earthquake. Consumer may have more saving to buy better residential unit and larger and better buildings are emerge during this period. However vacancies are significant and positive to completions, indicating oversupply. Approval leading completion one and two year shows positive and significant relationship, consistent with our expectation. Interestingly approval of previous year has a higher coefficient than approval two year previous, implying that most buildings were lower building and constructed under a fast pace.

5. WERE RESIDENTIAL CONSTRUCTIONS IN THE 2000S DEMAND OR SUPPLY LED EXPANSION?

That the residential construction was supply or demand side oriented was further tested by the Joint Test of demand and supply factors affecting completions. Equation (2) shows the relevant calculated F for an F test.

(2) $$F_{q,N-k} = \{(R^2_{UR} - R^2_R)/q\} / \{(1-R^2_{UR})/N-k\}$$

Where

$R^2_{UR} = R^2$ of unrestricted model, $R^2_R = R^2$ of restricted model, q: number of coefficient assumed zero in null hypothesis, N: number of observation, k: number of coefficient of unrestricted model (Pindyck and Rubinfeld 1991:110-112).

The completion model shown in Table 2 was treated as unrestricted model. It included all possible demand, supply and other factors. This model's variables are classified into three categories: supply, demand, and both supply and demand as indicated in Table 1.

The first restricted model represents a demand only model (Table 3) by omitting all the supply side variables, the model in Table 3 being the unrestricted model.

Table 3 The restricted model (Demand side)

Coefficients [a]

Model		Unstandardized Coefficients		Standardized Coefficients			Collinearity Statistics	
		B	Std. Error	Beta	t	Sig.	Tolerance	VIF
1	(Constant)	2.170	2.209		.983	.327		
	Log(vacancy unit)	1.118	.068	.819	16.446	.000	.721	1.386
	Log(price)	-.381	.198	-.090	-1.926	.056	.821	1.218
	Log(saving rate)	4.176	1.541	.115	2.709	.007	.999	1.001
	Log(density)	7.840E-02	.039	.100	2.009	.046	.717	1.395

a. Dependent Variable: Log(completion1000m2)

R^2=0.721, F=100.894, ,N=161, ***<.001

The joint null hypothesis is then on the contribution of the supply side variables.

H_0: $B_i = 0$, i = 3, 6, 7 ;

H_1: $B_i \neq 0$, i = 3, 6, 7

The R^2 of this first restricted model (Table 3) is 0.721. Thus

$$F_{3,154} = \{(0.839-0.721)/3\}/\{(1-0.839)/(161-7)\}$$

$$=33.94 > F_{3,\infty} = 3.02, \alpha=1\%.$$

Hence, H_0 is rejected, implying that supply variables jointly add explanation. This provides evidence of the supply side interpretation of the residential construction in the 2000s.

The second restricted model is examined by omitting the demand variable (Table 4).

Table 4 The restricted model (Supply side)

Coefficients [a]

Model		Unstandardized Coefficients		Standardized Coefficients			Collinearity Statistics	
		B	Std. Error	Beta	t	Sig.	Tolerance	VIF
1	(Constant)	5.939	3.983		1.491	.138		
	Log(price)	.183	.172	.043	1.067	.288	.943	1.060
	Log(develop loan)	-.350	.307	-.047	-1.141	.256	.896	1.115
	Log(approval t-1)	.665	.068	.622	9.770	.000	.381	2.623
	Log(approval t-2)	.324	.067	.298	4.831	.000	.405	2.467

a. Dependent Variable: Log(completion1000m2)

R^2=0.759; F=122.694, N=161, *** <.001

The joint hypothesis is then

H_0: $B_i = 0$, i = 2, 10, 12 ;

H_1: $B_i \neq 0$, i = 2, 10, 12

The R^2 of this second restricted model (Table 4) is 0.759. Thus,

$$F_{3,154} = \{(0.839-0.759)/3\}/\{(1-0.839)/(161-7)\}$$

$$=22.324 > F_{3,\infty}=3.02, \alpha=1\%.$$

Hence, H_0 is also rejected, indicating that the demand variable is also a significant factor in the unrestricted model. The implication is that demand should be interpreted as playing some role in the 2000s residential construction.

Overall the test results do not conclusively indicate that residential construction in the 2000s was either supply or demand triggered. Of course, the completion necessarily contains elements of both. In addition, the comparatively short term time series can not yield significant influence to a longer residential cycle. Under a longer term completion model contains more completed cycle can yield a better explanation of those supply and demand variables. However, the F statistic of supply-side model (i.e. 33.94) is much greater than demand-side model (i.e. 22.324) more consistent with the supply side interpretation of this model. The implication of this is that both demand and supply influence completion model. Demand factors are also relevant to the model increasing residential completion. In addition supply factors also affect the model, implying that both factors should be considered. The difference is that supply factors are more significant to the completion than that of demand factors. However compared with two forces in 1980s and 1980s, the strength of supply side apparently declined and the demand increased in the 2000s (Table 5), implying more demand oriented construction in this industry.

Table 5 F statistic of supply and demand sides

Period	1980s & 1990s (1982-1999)	2000s (1999-2005)
Forces of supply side	79.12	33.94
Forces of demand side	15.95	22.32

Source: Hsieh 2005

6. CONCLUSION

We have presented the empirical results of the research and also support evidence to explain the phenomenon. Some conclusions are drawn from this research. Empirical results do not show strong evidence of residential construction being supply led expansion in the 2000s. However still other evidences support more supply led phenomenon such as higher vacancies. Vacancy is significant and positive to completions. Under a strong demand market this will not happen. Besides the completion growth is much greater than population growth. The number of developer increased rapidly indicating individual rationality however it turned out to be group irrationality resulting in oversupply and vacancies.

Demand factors caused some influences to the completions. Especially more large unit emerged representing better living quality is required. The increase of housing loan and housing price all indicate a growing residential demand. However the speed of this demand is less than supply as seen in the growth rate of development loan greater than that of housing loan.

The reasons of supply led are interacted and facilitate each other. A supply led expansion in residential construction should be facilitated by individual rationality, subcontracting and easy credit. Individual rationality of developer initiate the construction which can only be possible by the subcontracting mechanism to reduce the entry and exit barrier, and also supported by easy credit without a strong demand or sales.

This supply led and oversupply can be prevented by more transparent information provided. In the 2000s information is more transparent than that in the 1990s since government already releases more data such as completions and approvals so that developer can alert the threat of oversupply and high vacancy. However the information is still insufficient to comprehensively interpret this industry since its complex industrial structure. Although vacancy is released every five years, there is no official price in cities and counties released which sporadically provided by real state agents with vague and biased information. These all can be better monitored by a more transparent market information mechanism provided by government and industry collaboratively.

References

Chen, Y.C. and Chen, P.Y. (1998) 'The research on the effect of vacancy tax—an adjustment simulation of residential market pricing model', *Proceeding of the Chinese Society of Housing study 7th Conference,* Taipei, August, 93-113.

Chung Hua Credit Investigation Institute (CHCII) (1994), *Taiwan Industrial Yearbook-Real Estate Industry,* Chung Hua Credit Investigation Institute, Taipei

Construction Planning and Administration (1994, 1995, 1996, 1998, 1999) *Construction and Planning Statistical Yearbook of Taiwan and Fuchien Area, Republic of China 1993, 1994,1995,1997,1998,* CPA.

Construction and Planning Administration (CPA) (1999), 'Construction permit and occupancy permit of housing and store in Taiwan and Fuchien area'. 〔online〕. Available:http://www.cpami.gov.tw/yuann/ph/house/ph881130.htm

Construction and Planning Administration (CPA) (1999), *Housing Information Quarterly 1st Quarter 1999*, CPA,

Taipei, June.

Construction and Planning Administration (CPA) (2000) October 10. Monthly 'Residential approvals floor space and units'. 〔email〕to Hui-Yuan Hsieh 〔Monthly construction permit 1989-1996〕.

Construction and Planning Administration (CPA) (2001) *Monthly Report of Construction and Planning Affair Indicator, Taiwan and Fuchien Area, Republic of China July 2001,* 238, CPA, October.

Construction and Planning Administration (CPA) (1999,2004), *Residential information quarterly,* 1st Quarter, The Construction and Planning Administration, Taipei, June.

Directorate-General of Budget, Accounting and Statistics (DGBAS), Executive Yuan, Republic of China (2001) *Quarterly National Economic Trends, Taiwan Area, The Republic of China,* 94, Directorate-General of Budget, Accounting and Statistics, August.

Directorate-General of Budget, Accounting and Statistics, (DGABS) (1983, 1984,1985,1986,1987,1988,1989,1990,2001), *Monthly Statistics of the Republic of China,* DGBAS, Taipei, December.

The Central Bank of China (1985, 1986, 1987,1991,1994,1997,1998,2000), *Financial Statistics Monthly, Taiwan District, The Republic of China,* The Central Bank of China, December.

Hsieh, H.Y. (2002), The Taiwanese residential construction Peak in the 1990s: Interpreting industry and developer behaviour, *Unpublished PhD Dissertation*, Griffith University, Australia.

Hsieh, H.Y. & Forster J. (2004), 'Entry, Exit and Scale in Taiwanese Residential Construction', *The proceedings of The 6th Conference of Sustainable Development of Management,* National Pingtung University of Science and Technology, Taiwan.

Hsieh, H.Y. & Forster J. (2004), 'Impacts of the Taiwanese residential construction boom of the early 1990s', *The Proceedings of 16th Annual Conference of the Association for Chinese Economic studies*, University of Queensland, Brisbane. (http//www.uq.edu.au/economics/acesa2004/proceed.htm).

Hsieh, H.Y. (2005), "The 1990s Taiwan residential construction boom: a supply side interpretation", *Construction Management and Economics*, March 23, 265-284.

Hsieh, H.Y. & Forster J. (2006) "Residential construction quality and production levels in Taiwan", *Engineering, Construction and Architectural Management*, V13 No.5, 502-520, Emerald, UK

Hsieh, H.Y. & Forster, J. (2007). "Market external events as triggers of the 1991-1997 residential construction Peak in Taiwan", *Economic Analysis & Policy*, V37, No1, March 2007, 15-39, Brisbane.

Keller, D., Warrack, B. and Bartel, H. (1990) *Statistics for Management and Economics: A Systematic Approach,* 2nd ed, Wadsworth, Belmont.

Peng, C.W. and Chang, C.O. (1995) 'An analysis of housing vacancy rate phenomenon and reasons in Taiwan', *Journal of housing studies,* 3, January, 45-71.

Peng, C.W. and Chang, C.O. (2000) 'The influence of macroeconomic variables on real estate cycles in Taiwan', *Proceedings of the National Science Council, Republic of China,* 10 (3) Taipei, July, 330-343.

Pindyck, R.S. and Rubinfeld, D.L. (1991) *Econometric Models and Economic Forecasts, 3rd ed*, McGraw-Hill, New York.

The Competitiveness of Semiconductor Corporations in China from Institution Theory and Resource-Based Theory: Case Study of Smic and Tsmc

Mu Hua Chen
Xin-Min Tian
Ph D. student and Professor of Antai College of Economics and Management
Shanghai Jiao Tong University, China
E-Mail: kay@mail.goodnet.com.tw
Wan-Chiang Chen
Bih-Shiaw Jaw
Ph D. student and Professor of HRM Institute
National Sun Yat-Sen University, Taiwan
E-Mail: bsjaw510@mail.nsysu.edu.tw

ABSTRACT

Chinese government has actively issued many preferential policies to encourage the development of high-tech industry in China. The present case study visits two semiconductor corporations operating in China and discusses their competitiveness from institutional theory and resource-based view.

Keywords: *Institutional Theory, Resource-Based Theory, Chinese High-Tech Industry, HRM.*

1. Introduction

Chinese economic has been grown rapidly since the reforms. China now is the third largest trading country and has highest foreign exchange reserves in the world. Since the 1990s, Chinese government has greatly increased the budget for science and technology development. In 2004, the appropriation for science and technology reached 97.55 billion yuan, accounts for 1.35 percent of national GDP and the budget is expected to increase to 2 percent of national GDP by 2010. After the 16th Communist Party congress, the national strategy for developing science and technology has been shifted to focus on making independent innovations and technological strides, aiming at the international sci-tech heights. The 17th Communist Party congress continues to emphasis on the importance of this strategy. For instance, China has built up thousands of new and high-tech development zones and they have become important engines of national economic growth. However, Chinese high-tech industry is still at the beginning stage. At present, Chinese semiconductor industry has an annual market of 60 billions US dollars, and 90% rely on importing. How to increase independent innovation capability and increase competitiveness in the global market has become the priority task faced by Chinese government. The present case study has visited two semiconductor corporations operated in China. One is locally funded and the other is foreign corporation. A deep interview has been given between the senior managers of each company and the authors. This paper will first introduce the corporation profile of each corporation followed by discussing their strengths and competitiveness from institutional theory and resource-based view.

2. CORPORATION PROFILES

2.1 SMIC (Semiconductor Manufacturing international Corporation)

SMIC is a locally funded company established in 2000 and is now listed on the Hong Kong Exchange (KHEx) and on the New York Stock Exchange (NYSE). SMIC provides integrated circuit (IC) manufacturing service at 0.35 micron to 65 nanometer and finer line technologies. SMIC also engages in a broad range of operations including logic, mixed signal/RF CMOS, high voltage, SoC, DRAM, flash, EEPROM, CIS and LCoS micro-display technology. The top management team is composed of six experienced professionals from Taiwan, America, and Japan. SMIC has become the most advanced and leading semiconductor foundry in China. For instance, Richard Ru Gin Chang, the founder of SMIC and is currently President, Chief Executive Officer and Executive Director, has over 27 years of semiconductor experience in foundry operations, wafer fabrication and research and development.

The headquartered is located in Shanghai and the main customers are from North America, Europe, Asia and Japan. In order to meet the diverse needs of the global customer base, SMIC is actively looking for technology transfer and cooperation with advanced international technology corporations. For the full year of 2008, SMIC has managed to grow the non-DRAM revenue by 14.3% year-on-year despite a difficult fourth quarter. The sales to the domestic IC companies has also been increased by 28% in 2008 relative to 2007. In addition, Datang Holdings, a large high-tech state-owned enterprise administered by the State-owned Assets Supervision and Administration Commission of the State Council and is the leader in TD-SCDMA 3G development, invested US$172 million in SMIC in 2008. The alliance with Datang will enhance SMIC's International Competitiveness by Leveraging both companies' resources and will enable SMIC to capture the large market opportunity presented by China transitioning from 2G to 3G wireless communication.§

2.2 TSMC (Taiwan Semiconductor Manufacturing Corporation)

TSMC was established in 1987 and is the world's largest dedicated semiconductor foundry. TSMC's headquarters is located in Taiwan, with account management and engineering service offices in China, India, Japan, Korea, the Netherlands, Taiwan and the United States. TSMC operates two advanced 300mm wafer fabs, four 8-inch wafer fabs, and one 6-inch wafer fab. Those fabs are located worldwide including Taiwan, Camas, Washington (WaferTech), Singapore (SSMC, a joint venture with NXP Semiconductors), and Shanghai, China. The company's total managed capacity exceeds 8 million 8-inch equivalent wafers in 2007, while its revenues represent some 50% of the dedicated foundry segment in the semiconductor industry. In 2002, TSMC became the first semiconductor foundry to enter the ranks of the top 10 IC companies in terms of worldwide sales. It continues to move up and is ranked number sixth in 2007 according to the IC insight research report in March, 2008. TSMC is listed on the Taiwan Stock Exchange (TSE) and on the New York Stock Exchange (NYSE). However, TSMC's fabs investment in China has been limited by Taiwanese government. The relevant regulations were finally removed on conditions in 2002. For instance, investment involving the latest technology is still prohibited at the moment. In other words, TSMC are only allowed to engage in outdated technology in China.

Triggered by a deepening economic recession worldwide and customers' inventory adjustment, TSMC's fourth quarter results represent a 30.6% decrease in revenue, a decrease of 59.3% in net income, and a decrease of 59% in diluted EPS compared to third quarter of 2008. Nevertheless, TSMC still manages to make revenue between NT$32 billion and NT$35 billion and the gross profit margin is expected to be between 1% and 5%.

3. THE COMPETITIVENESS FROM INSTITUTIONAL THEORY

Institutional theory considers the processes by which structures, including schemas, rules, norms, and routines, become established as authoritative guidelines for social behavior. Scott (1995:33, 2001:48) asserts that, "Institutions are social structures that have attained a high degree of resilience. [They] are composed of cultural-cognitive, normative, and regulative elements that, together with associated activities and resources, provide stability and meaning to social life. Institutions are transmitted by various types of carriers, including symbolic systems, relational systems, routines, and artifacts. Institutions operate at different levels of jurisdiction, from the world system to localized interpersonal relationships. Institutions by definition connote stability but are subject to change processes, both incremental and discontinuous". The following paragraph explores the competitiveness of each company from institutional theory.

3.1 SMIC

Compare with foreign semiconductor corporation, SMIC faces smaller institutional impact in regulative pressure, normative pressure and cognitive pressure. SMIC actively contributes to building up a harmonious society and value family, humanity, cooperation and care. Therefore, it fits well with the local society and has no cultural conflict/problem. As a local company, SMIC also has institutional advantages. For instance, SMIC has established factories in Wuhan, Chengdu, and Shenzhen with the local governments support. Moreover, Chinese government has issued many tax policies forced foreign companies to shift their production order to China.

However, under Chinese social institutionalism, China is lack of international technology talent, and can only rely on recruiting experienced R&D and management talents from the world at the moment. In order to cope with this problem, Chinese government has actively adopted some strategies in local talents development. For instance, Dalian local government assisted Intel to establish semiconductor technology school in Dalian Technology University and Chinese government plans to spend RMB 100 millions each year in cultivating semiconductor talents. In addition, the possibility for local semiconductor companies to grow without competitors' stimulation is very limited. Therefore, Chinese government has broadly invited international semiconductor companies to enter China. For instance, Intel has decided to establish first Asian 12-inch wafer fabs in Dalian. This move has gained high attention and many relevant businesses have visited Dalian privately as a result. The industrial cluster effect is expected to be formed within the next five to ten years.

3.2 TSMC

Compare with the local semiconductor corporation, TSMC is facing higher institutional impact in regulative pressure, normative pressure and cognitive pressure. The largest problem faced by foreign semiconductor corporation is human capital. First, China is currently lack of highly skilled technology talent and

TSMC needs to rely on parent company for R&D and management talents. However, this will increase the operational cost and there will also be problem of knowledge transfer. Second, due to the Cultural Revolution, many Chinese managers are lack of global business operation knowledge and experience. Therefore, how to develop local technology talents and cultivate them global view, how to efficiently transfer parent company's corporation culture, technology and knowledge to Chinese employees become a long term goal for foreign semiconductor corporation. The new Chinese labor regulation does not have significant impact on foreign semiconductor corporation. This is because this industry requires highly skilled talent, therefore, how to recruit, train, and retain those talents are the priority concern to those foreign semiconductor corporations.

Chinese government has been actively issue variety of preferential policies to encourage semiconductor industry development in China. Capitals are no longer the target for China, China is now more eager for foreign company's management and technology knowledge. Nowadays, the Chinese economic policies focus on both quantity and quality, and from export oriented to a balance of export and import. Many preferential policies to foreign company are no longer available. Instead, a sequent of policies have increase foreign company's operational cost and decrease their competitiveness. For instance, decrease the tax refunds and new labor regulation. In order to seek for more preferential benefits, many foreign companies are forced to move to inner west of China or Vietnam. At the moment, Chinese government still provides many incentives to semiconductor industry since it is the targeting cultivating task. However, once Chinese semiconductor industry become mature, the benefit given by Chinese government will be removed (just like what happened to the manufacturing industry). Therefore, it would be better for foreign semiconductor company to prepare relevant strategy in order to response to possible external institutional incidents in the near future.

4. THE COMPETITIVENESS FROM RESOURCE-BASED VIEW

Resource-based view emphasizes a firm should have valuable resources to exploit opportunities and neutralize threats in a firm's environment (Barney, 1991). Rare resource is another key element to enhance the alliance performance. A firm enjoys competitive advantage when it is implementing a value-creating strategy that is not simultaneously implemented by large numbers of other firms (Barney, 1991). The following paragraph examines the competitiveness of each company from resource-based view.

4.1 SMIC

a. Organizational Capability

SMIC is lack of core technology and needs to rely on technology transfer or authorize from advanced high-tech corporation. Although the technology transfer with international corporation (such as IBM, Fujitsu, TI, Infineon, and Elpida…etc) has shorten SMIC's R&D time, SMIC still faces the challenge of integrating the variety sources of technology knowledge and know-how. In addition, SMIC has comparative low degree of internationalization. SMIC's internationalization stays at the stage of sales only. The sales office is located in Hong Kong and the production center is located in Shanghai. SMIC has not built up global manufacturing network and has comparative low global integrating ability. SMIC is also lack of worldwide learning channel

and needs to actively seek resource from outside.

b. Human Resource Management

About 10%of SMIC's employees are recruiting from oversea. SMIC prefers not to use head hunter and believes that employees' attitude is the most important thing. SMIC develops training program each season according to the employees' need. SMIC builds up internal lecture system and encourages internal knowledge share and transfer. SMIC has IT system to provide employees instant training program information. At the moment, the program is held in the face-to-face format and e-learning program will be promoted in the near future. SMIC also cooperates with local university to deliver in-house lecturing after work. The employees will receive formal diploma issued by government after complete the course.

4.2 TSMC

a. Organizational Capability

TSMC has 20 years R&D and management experience in the semiconductor industry. As a result, the subsidiary in China has technologic advantage by transferring the know-how from parent company. In addition, TSMC strive to build deep and enduring relationships with their customers. At TSMC, customers come first. TSMC strive to build deep and enduring relationships with their customers. TSMC believes that they are not only engaging in manufacturing activities, but also consider themselves as a service provider. Customer's need and success is their priority concern. TSMC works with their customers to develop new technologies and continuously enhance the quality and reliability of products. TSMC provides integral consulting service and share the production information to their key customers.

b. Global strategic Capability

TSMC serves the global semiconductor market through its network of worldwide manufacturing facilities and offices. All orders are taken by the parent company then assign the task to the subsidiary. This is to ensure production flexibility and efficiency and provide instance services to the customers. TSMC has annual global business meeting to integrate seasonal information and forecast short term and long term operation. In addition, TSMC has global learning network. Therefore, employees could easily learn the latest technology and skills through oversea assignment or business trip.

c. Human Resource Management

TSMC's recruiting strategy is to recruit employees who have similar values with the corporate culture. This strategy has been put into practice in both parent company and subsidiary. In order to develop well-rounded talents and increase the quality and competitiveness of employees, TSMC has an Individual Development Plan (IDP) that tailored to the individual based on his/her work experience, educational background, work needs, work performance, and career development needs. In addition, TSMC has global internal learning channel which provides employees a unique opportunity to learn latest technology and gain experience through their oversea assignment or business trip.

5. CONCLUSION

The operation of semiconductor business in China is like a basketball game. SMIC has local advantages and is familiar with the local environment. However, can SMIC, which adopted socialism for corporation culture, achieve same efficiency and innovation capability as the foreign company requires further observation. TSMC on the other hand, is like a strong competitor with great capability and experience .In order to accumulate competitiveness and sustainability, SMIC needs to develop organizational capability and TSMC needs to be able to response to external institutional impact. It is hard to tell at the moment as which team will win this game at the end. Perhaps the party who can provide products that satisfy customer needs is the final winner of this game.

References

Aral, S., & Weill, P., 2007, "IT assets, organizational capabilities, and firm performance: how resource allocations and organizational differences explain performance variation," *Organization Science*, Vol. 18, p.p. 763-780.

Argote, L., & Ingram, P., 2000, "Knowledge transfer: A basis for competitive advantage in firms," *Organizational Behavior and Human Decision Processes*, Vol. 82, p.p 150–169.

Barney, JB., 1991, "Firm resources and sustained competitive advantage," *Journal of Management*, Vol. 17, p.p. 99-120.

Barney, JB., 2002, *Gaining and Sustaining Competitive Advantage*, 2nd edn. New Jersey: Prentice Hall.

Baum, J., & Oliver, C, 1991, "Institutional linkages and organizational mortality," *Administrative Science Quarterly*, Vol. 36, p.p. 187–218.

Dunning, J.H., 1988, *Multinationals, Technology And Competitiveness*, London, Unwin Hymm, Chap 7.

Dunning, J.H., 1992, *Multinational Enterprises and The Global Economy*, Addison-Wesley Publishing Company Inc.

Grant, R. M., 1991 "The Resource-Based Theory of Competitive Advantage: Implications for Strategy Formulation," *California Management Review*, Vol. 33(3), p.p. 114-135.

Grand, S., von Krogh, G., Leonard, D. and Swap, W., 2004, "Resource Allocation Beyond Firm Boundaries: A Multi-level Model for Open Source Innovation," *Long Range Planning*, Vol. 37(6), p.p. 591-610.

Nohria, Nitin, and Sumantra Ghoshal, 1997, The Differentiated Network: Organizing Multinational Corporations for Value Creation. San Francisco: Jossey-Bass.

Oliver, Christine, 1991, "Strategic responses to institutional processes," *Academy of Management Review*, Vol. 16, p.p. 145-79.

Scott, W. R., 1995, *Institutions and Organizations*, Thousand Oaks, CA: Sage.

Wernerfelt, B., 1984, "A Resource-Based Theory of the Firm," *Strategic Management Journal*, Vol. 5, p.p. 171-180.

Wernerfilt, B., 1989, "Firm Critical Resource to Corporate Strategy," *Journal of General Management*, Vol. 14, p.p. 4-12.

Wright, Patrick M. & Gary C. McMahan, 1992, "Theoretical perspectives for strategic HMR," *Journal of Management*, Vol. 18, p.p 295-320.

Zucker, L., 1977, "The Role of Institutionalization in Cultural Persistence," *American Sociological Review*, Vol. 42, p.p. 726–43.

Zucker. L., 1987, "Institutional Theories of Organizations," *Annual Review of Sociology*, Vol. 13, p.p. 443–64.

Websites

http://www.tsmc.com/english/default.htm

http://www.smics.com/website/enVersion/Homepage/index_1024.jsp

http://english.gov.cn/about/sci.htm

Does the Leadership Style Influence Employee's Organizational Trust? – The Mediating Effect of Leader-Member Exchange

Yuan-Duen Lee

Prof. & Dean of the College of Management, Chang Jung Christian University, Taiwan, R.O.C

E-Mail: ydlee@mail.cjcu.edu.tw

Shih-Hao Chen

Wen-Yu Chiu

Doctoral Student of Graduate School of Business and Operations Management, Chang Jung Christian University

E-Mail: shihhao_chen@yahoo.com.tw christineandjane@hotmail.com

Pei-Wen Chao

Lecturer, General Education Center, Chang Jung Christian University

E-Mail: andyotello@gmail.com

ABSTRACT

According to the Directorate-General of Budget, Accounting and Statistics, the service industry is now the focus of economic and social development in Taiwan. Therefore, it is necessary to explore how the leaders and managers in service industry firms operate and seek to develop the competitive advantages of their companies. A review of the literature shows that few scholars have undertaken research on servant leadership, LMX and employee's organizational trust. Consequently, a localized measuring scale was well developed in this study in order to explore the relationship among these three variables in Taiwan.

This study developed the measuring scale of servant leadership through an analysis of the literature and expert consultations, and the fuzzy Delphi method, analytic hierarchy process (AHP) and confirmatory factor analysis (CFA) were adopted to construct and verify the validity of the measuring scale. A total of 2,000 questionnaires were distributed to employees of service industry firms in Taiwan, and 311 valid questionnaires were returned. Reliability, Pearson correlation, and SEM were conducted to test the hypotheses presented in this research. The results show that there are significant and positive correlations among dimensions of servant leadership, LMX and employee's organizational trust, and LMX has mediation effect on the relationship between servant leadership and employee's organizational trust. This study discusses the conclusions and implications and this research, and then offers some suggestions for management practitioners and directions for future research.

Keywords: *Servant leadership, LMX, Employee's Organizational Trust, Service Industry in Taiwan.*

1. INTRODUCTION

According to Directorate-General of Budget, Accounting and Statistics, the service industry accounted for 67.24% of GDP and 57.85% of all employment in Taiwan in 2007, and it is now the focus of economic and social development on the island. Some scholars (Reichers & Schneider, 1990; Hunt, 1999) argue that the study of leadership is already mature, and the most popular leadership theories currently being discussed by researchers include charismatic, transactional, and transformational leadership (Smith, Montagno, & Kuzmenko, 2004). And distinct from other forms of leadership, there are some researchers mentioned that a service-oriented philosophy of and approach to leadership is a manifestation of and an antecedent to enabling a wise organization

(Barbuto & Wheeler, 2006). Like many other leadership thinkers, Spears (1995) refers to a kind of emerging approach to leadership and service as servant-leadership (Washington, 2007). Many theorists and researchers espouse servant leadership as a valid model for modern organizational leadership (Russell & Stone, 2002), and one that still requires substantial empirical research (Bass, 2000). And the research on dyadic leadership represented most commonly as leader-member exchange (LMX), has also begun to receive considerable attention (Vecchio, 1998). LMX theory differs from other theories of leadership address generalized leader behaviors and traits to all followers (Brower, Schoorman, & Tan, 2000). Since servant leadership emphasize the behavior and attributes of the leaders, so one of the motives of this study is to demonstrate the relationship between servant leadership and LMX.

Trust is the most basic and essential element of both personal and business success (Boutros & Joseph, 2007). The central importance of interpersonal trust for sustaining team and organizational effectiveness is increasingly being recognized (Dirks & Ferrin, 2001). In the last several decades there has been a tremendous wave of interest in the relationship between servant leadership and employee's organizational trust. Based on this, it is extremely important to understand how managers lead their subordinates by their inspirative actions. Also of recent interest is the interplay of LMX, and employee's organizational trust; therefore, leaders should act behaviors that will have varying influences on followers' trust. However, servant leadership theory is somewhat undefined and few supported by sufficient empirical research (Russell, and Stone, 2002,), besides, no empirical study in Taiwan has ever been reported as to whether or not servant leadership promotes organizational trust through LMX. Our research addresses these under researched issues, so the purpose of this paper is to examine the situation of three constructs of firms of service industry in Taiwan. To this end, multivariate analyses were conducted.

This paper unfolds in four sections: introduction, theory, methodology, and conclusion. The next section, theory and hypotheses, will address the current state of servant leadership theory, and the mediation effect of LMX on relationship between servant leadership and employee's organizational trust.

2. LITERATURE REVIEW

2.1 Leadership style and Employee's organizational trust

Several theories of leadership can be identified including the "trait theory," "behavior theory," and "contingency theory." These leadership theories focus on leader's task and person-oriented behaviors (House & Aditya, 1997; Boal & Schultz, 2007). A subject of growing interest in the leadership literature is servant leadership theory, which is a phrase coined by Robert Greenleaf in the essay, The Servant as Leader (Hamilton, 2005). Unlike traditional leaders who are primarily motivated by aspirations to lead, servant leaders are motivated more by a desire to serve than to lead (Washington, 2007). From the literature, we know trust in management and the organization as a means of positively influencing not only quality of work life but efficiency and effectiveness of performance (Ronald, & Lawrence, 2007) Employees' trust in their leaders has been related not only to team performance (Dirks, 1999, 2000), but also to a range of productivity-related

processes and outcomes(Dirks and Ferrin, 2002). The recent literature demonstrates that the relationships among trust in the chief executive, trust in the organizational and employee work satisfaction represent three critical employee perspectives: their views of the top executive, their organization and their job (Ronald & Lawrence, 2007). Podsakoff, Mackenzie & Bommer (1996) highlight the need to examine how a wide range of leadership practices impact on followers' trust (Gillespie & Mann, 2004).

Just as Bennis (2002) stressed that leaders must generate trust (Dennis & Bocarnea, 2005). Leaders generate and sustain trust through the behavior of the leader (Joseph & Winston, 2005), such as supportive behaviors (Gimbel, 2001; Tschannen-Moran and Hoy, 1998). Behavior is thus the medium for assessing and acting on perceptions of overall trust in leaders (Sparks, 2000). When a leader has spirit, the drive behind the urge to serve takes one into an active role as servant, building trust not only between the leader and follower but also between followers (Spears, 1998). Since the development of the abilities and skills of followers (employees) is central in the thinking of adherents to the service leadership approach (Dennis & Winston 2003; Dannhauser & Boshoff, 2006), so servant leaders can assist followers achieving their potential through building self-confidence (Lord, Brown, & Freiberg, 1999), such as serving as a role model, inspiring trust, and providing information, feedback, and resources (Liden, Wayne, Zhao & Henderson, 2008). Just like Russell and Stone's (2002) model of servant leadership presented trust as one of the functional attributes of servant leadership. The selfless behavior of servant leaders can build trust between employees and supervisors (Dannhauser, 2007). Researchers (Pollard, 1996; Russell, 2001; Russell and Stone, 2002) proposed that leaders' values of their care for followers, integrity, and competence are all necessary to foster interpersonal trust (Washington, Sutton, & Field, 2006). So from Greenleaf's perspective, that is servant leaders build trust by selflessly serving others first (Greenleaf, 1977), servant leadership is both a product and an antecedent of leader and organizational trust (Joseph & Winston, 2005). From Reinke's (2004) conclusions we can also find evidence that servant leadership can create organizational trust. As mentioned above, we make the following hypothesis:

Hypothesis 1: *Servant Leadership of service industry in Taiwan is positively related to organizational trust.*

2.2 Mediating effect of LMX

LMX theory had its early roots in vertical dyad linkage theory (VDL) developed by Graen and his colleagues (Dansereau, Graen, & Haga, 1975; Graen, 1976; Graen & Cashman, 1975). Throughout the history of research on LMX, the operational definition of LMX has been in terms of leader behaviors directed at the subordinate, and the measurement of LMX has generally been from the subordinate's perspective (Brower, Schoorman, & Tan, 2000). The basic principle of leader–member exchange (LMX) is that leaders develop different types of exchange relationships with their followers and the quality of these relationships (Ilies, Nahrgang, & Morgeson, 2007). The quality of the relationships between leader and member affects their important attitudes and behaviors (Gerstner & Day, 1997; Liden, Sparrowe, & Wayne, 1997; Sparrowe & Liden, 1997), which will also influence a number of important organizational outcomes (Graen & Uhl-Bien, 1995).

From the literature, we know that trust develops in the relationship as a result of the subordinate finding the leader's judgments and actions to be thoughtful, dependable, and moral (Liden, Wayne, Zhao & Henderson,

2008). The supervisor's behavior, include those often used to delineate higher-quality exchanges, i.e. sharing appropriate information, allowing mutuality of influence, and not abusing the vulnerability of others (Zand, 1972), is fundamental in determining the level of interpersonal trust in a work unit (Likert & Willits, 1940). Such as the high-quality exchange, represented by the 'in-group', leaders develop trusting and mutually beneficial relationships with employees (Greenleaf, 1996; Dannhauser, 2007). Once an employee is classified as an in-group member by the leader, he will take more responsibility, trust the leader more (Chuang & Shen, 2008). Therefore by the dyadic perspective, Brower, Schoorman, & Tan (2000) asserted that the LMX theory is closely aligned with theories of interpersonal trust.

LMX has been shown to serve in mediator capacity with transformational leadership to enhance performance (Krishnan, 2005; Wang, Law, Hackett, Wang, & Chen, 2005; Mayfield & Mayfield, 2007). According to Barbuto and Wheeler's (2006) founding that servant leadership was a better predictor of LMX quality than transformational leadership, because the strong supportive relationship with all employees developed by servant leaders; their findings demonstrate the impact that servant leadership has on the LMX leadership (Dannhauser, 2007). Previous study had also mentioned that relationships built on trust and service from the basis of influence for servant leadership (Sarkus, 1996). As mention above, it may be reasonable to represent the LMX as an intermediate step in the relationship between the servant leadership and employee's trust. In order to test this mediation viewpoint, servant leadership was treated as exogenous influence, and employee's organizational trust served as endogenous variable (Baron & Kenny, 1986). LMX, in turn, was treated as mediating variable linking servant leadership and employee's organizational trust. These lead to our second hypothesis:

Hypothesis 2: *The relationships between servant leadership and organizational trust of service industry in Taiwan are mediated by LMX.*

3. METHODOLOGY

3.1 Research Framework

This study treated firms of service industry as the subjects to develop and verify the research framework according to the hypotheses, as presented in Figure 1.

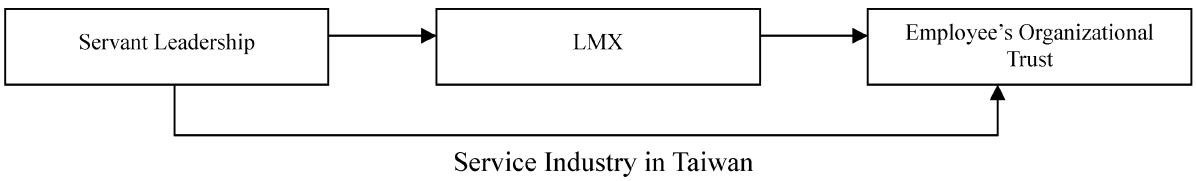


Figure 1 Research Framework

3.2 Variables Measurement

The questionnaires for each construct used in this research are described as follows.

3.2.1 Servant leadership

After referring to the previous scholars' assessment of servant leadership (Dennis & Winston, 2003; Dennis,

2004; Dennis & Bocarnea, 2005), this study developed the measuring scale on servant leadership through expert consultation. The content experts in this study were sourced from ten people who conduct research in leadership or have practical experience in Taiwanese enterprises, and they completed the qualitative components of the questionnaire. Half of the respondents were university academics (50 per cent); the rest held a Master's degree by research (50 per cent). And the fuzzy Delphi method was adapted to construct the measuring scales of servant leadership including love, humility, altruism, empowerment, and vision. This study also used analytic hierarchy process (AHP) method to find out the most important factor of servant leadership: "altruism". Besides, the items in the questionnaire were constructed for Likert-type scaling. The responses to the questions were rated on a seven-point Likert scale.

3.2.2 Employee's organizational Trust

This study assessed organizational trust using 17 items developed by Yu's (2006). The assessment scale measures the degree of employees' trust to colleagues, superiors and organizations. The responses to the questions were rated on a seven-point Likert scale.

3.2.3 Leader-member exchange

This study assessed organizational trust using 16 items developed by Wang, Niu and Law (2004). After referring Liden and Maslyn's (1998) scales, the authors used the back-translate technology to avoid the culture difference. The assessment scale measures the degree of employees' affect, loyalty, professional respect, contribution. The responses to the questions were rated on a seven-point Likert scale.

3.3 Sampling Design

The target population for this study consisted of the employees of firms of service industry in Taiwan. Employees were informed that participation was voluntary with confidentiality and anonymity assured. Employees completed the servant leadership, LMX, and organizational trust questionnaires. A total of 2000 questionnaires were sent by post to the employees of these companies. Of these, 311 questionnaires were returned. The usable returned rate was 15.55%.

3.4 Results

The SPSS 12.0 and AMOS 5.0 statistical software package were used. First, the confirmatory factor analysis was computed to verify the validity of measuring scales of three constructs. Next, reliability as a measure of internal consistency was calculated.

3.4.1 Analysis of Validity and Reliability

Leadership research, being a mature field, should focus on nomological validity (Cronbach & Meehl, 1955). This study invites ten experts and scholars of leadership to the content of the questionnaire in this research, so it has content validity.

(1) Assessment of model fit

The assessments of measurement model fit include two steps: over all model fit and the quality of the measurement model. Step two was to assess the quality of the measurements.

(1.1) Servant leadership.

In our data set, confirmatory factor analysis revealed that a higher-order servant leadership factor explained the common variance among the five leadership components (χ^2_{242} = 789.530, p < .01, RMR = .054, NFI = .902, IFI = .930, CFI = .930)

(1.2) Employee's organizational Trust.

A confirmatory factor analysis of the 17 items showed that three factors captured the variance among the items ($\chi 2_{116}$ = 524.74, p < .01, RMR = .069, NFI = .904, IFI = .923, CFI = .930).

(1.3) Leader-member exchange.

A confirmatory factor analysis of the 16 items showed that four factors captured the variance among the items. (χ^2_{98} = 326.61, p < .01, RMR = .05, NFI = .948, IFI = .963, CFI = .963).

(2) Convergent validity

All items loaded significantly on their respective factors (p < .01) and the coefficients of the average variance extracted were over .60 (Baggozzi & Yi, 1988). With the average variances extracted (AVE) of the dimensions are over 0.5 (Fornell & Larcker, 1981), the findings provided support for the convergent validity of the measures of servant leadership, LMX and employee's organizational trust.

(3) Discriminat Validity

For adequate discriminant validity, the diagonal elements should be significantly greater than the off-diagonal elements in the corresponding rows and columns (Fornell & Larcker, 1981; Hulland, 1999). This study report square root of the average variance extracted values and inter-construct correlations in the table of appendix, providing clear evidence of discriminant validity that all the square root of the average variance extracted is significantly greater than the correlations between different dimensions.

(4) Reliability

All questionnaires were examined in order to test the reliability of the constructs; See table in appendix for the Cronbach's α of the full samples. The Cronbach's α for these constructs was approximately .9. Dimensions of these two constructs were found to have good reliability.

3.4.2 Correlation

Table in Appendix contains the correlations among the dimensions of servant leadership, LMX, and employee's organizational trust. The dimensions of Servant leadership had significant positive correlation with LMX. The dimensions of LMX also had positive correlation with employee's organizational trust.

3.4.3 Structural Model

The structural relationship among the variables as proposed in literature review. Figure 2 depicts the structural model of this study, which is generally the same as the hypothesized model shown in Figure 1.

Maximum Likelihood (ML) estimation was used to estimate the parameters in the structural model. The hypothesized model yielded a chi-square value (χ^2) of 210.379, with 51 degrees of freedom. The indices of GFI, AGFI, NFI, and CFI were high and the error indices of RMR were low (see Table 1). All the goodness-of-fit indices were within the acceptable values.

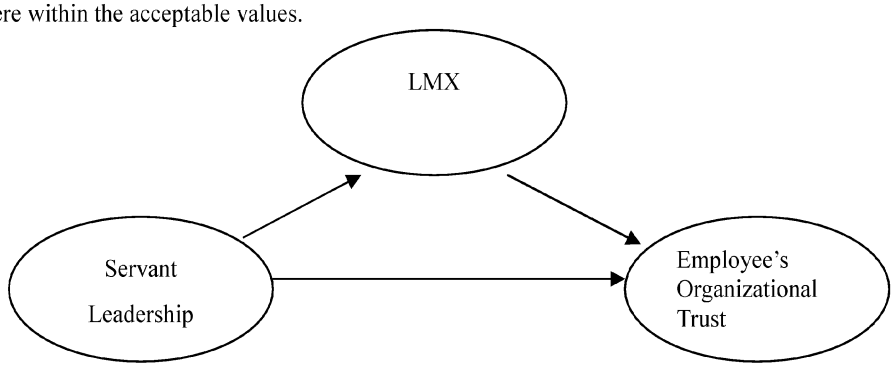


Figure 2 Structural Model

Table 1 Summary of the Overall Fit Indices of the Structural Model

Index	χ^2	*df*	GFI	AGFI	CFI	NFI	RMR
result	210.379	51	.896	.841	.957	.944	.043

A summary of the paths and standardized parameter estimates as well as the test statistics are provided in Table 2. The results indicate that servant leadership is related to leader-member exchange (β=.964, p<.05) but not to employee's organizational trust (β=.259, p>.05). Hypothesis 1 is not supported. Besides, leader-member exchange is related to employee's organizational trust (β=.719, p<.05).

Table 2 Summary of the Paths of the Final Model

Paths	Standardized Parameter Estimates	C.R.
Servant Leadership→Leader-Member Exchange	.964	18.172***
Servant Leadership→Employee's Organizational Trust	.259	1.552
Leader-Member Exchange→Employee's Organizational Trust	.719	4.279***

Note：*** Significant at p< .05

The results from the AMOS output as shown in Table 3 indicate that leader-member exchange (β=.719) was the direct determinants of the employee's organizational trust. And the servant leadership had significant indirect effects on employee's organizational trust (β=.693). These findings reflected the fact that leader-member exchange is a critical component in the structural model. It shows the mediation effect in the relationship between servant leadership and employee's organizational trust. Hypothesis 2 is supported.

Table 3 Direct, Indirect, and Total Effects between Endogenous and Exogenous Variables

		Standardized Coefficient		
Dependent Variable	Independent Variable	Direct	Indirect	Total
Employee's Organizational Trust	Servant Leadership	-	.693	.693
	Leader-Member exchange	.719	-	.719

4. CONCLUSIONS AND LIMITATIONS

4.1 Conclusions

This study has chosen firms of service industry as its subjects to go through a questionnaire survey on the dimensions of servant leadership, LMX, and employee's organizational trust. The results of this study demonstrate a mutually positive relationship among the three constructs of servant leadership, LMX, and employee's organizational trust. The outcomes of the study show that there are positive correlations between servant leadership and LMX. And the result is also consistent with Joseph and Winston (2005)'s research, that there was a positive correlation between servant leadership and employee's organizational trust. As to Barbuto and Wheeler's (2006) statement also pointed out that the strong supportive relationship with all employees developed by servant leaders. Besides, Just like Chuang & Shen's (2008) argument that when employees perceive high-quality exchange with their leaders, they will trust the leader more. The findings of this study show that LMX has been shown to serve in mediator capacity with servant leadership to employee's trust. According to the results we can say that the employee's perceptions of servant leadership resulted in high-LMX and higher levels of trust.

4.2 Contributions

4.2.1 Contribution to the Academics

By the results of AHP method we know that "altruism" is the most important factor, but according to the empirical results showed that most of the service industry firms' leaders lead their subordinates by empowerment. The difference between the expert opinion and the realistic situation of service business of Taiwan shows that leaders are willing to pay more attention to empower their subordinates. According to the literature, empowerment is thought to unleash employees' potential, enhance their motivation, allow them to be more adaptive and receptive to their environment, and minimize bureaucratic hurdles that slow responsiveness (Forrester, 2000; Ahearne, Mathieu & Rapp, 2005).

Besides, the relationships among servant leadership, LMX and employee's organizational trust have been confirmed by this study. This study has found that leadership styles and employee's organizational trust are dovetailed concepts, the results show that employees' trust to organization, superiors, and colleagues can be upgraded through servant leadership undertaken by managers. Besides, just as Russell (2000) posited that the attributes of servant leadership are necessary for leaders to have vision for intensifying organizational trust. Furthermore, servant leadership has significantly effects on LMX, and LMX also has significantly effects on employee's organizational trust. This result can serve as an effective reference for follow-up research.

The implications of the present study for the senior management of firms of service industry in Taiwan can be summarized as follows. First, servant leadership is not only reflected in research and development; it should also be regarded as an administrative issue. Next, about the senior management of service industry in Taiwan should recognize that the two constructs must co-exist. About the leaders' behavior, Braun (1997) mentioned that employees will make more contributions to the organization

when they have higher trust. And high trust has positive influence not only on quality of work life but also on efficiency and effectiveness of performance (Ronald, & Lawrence, 2007), so executive officials should play the role of a priest and parent. Like a priest, an executive official should listen to complaints from employees and put no blame on them. Like a parent, an executive official should love and foster the employees. When they go astray, an executive official should lead them back on the right track. Besides, just as Washington, Sutton, and Field (2006) said that when leaders can behave more altruism and provide their subordinates with professional supports, resources and assistances, leaders can receive better relationship with their followers to foster their followers' interpersonal trust and then employees' trust to superiors will also be intensified.

4.3 Limitations and Future Research

1. This study has focused on firms of service industry in Taiwan. However, these samples do not represent all types of organizations in Taiwan, like high-technology firms. Nevertheless, the conclusions and implications are of relevance to Taiwanese management in firms of service industry.
2. With globalization and cross-culture issues gaining increasing importance for the operating and management of business firms, these issues could be the subject of future study within transnational enterprises.
3. Even though this study has its limitations, the authors hope that it will serve as a basis for further study into managers' leadership styles.

References

Barbuto, J. E., & Wheeler, D. W. (2006). Scale Development and Construct Clarification of Servant Leadership. *Group & Organization Management*, 31(3), 300-326.

Baron, R. M., & Kenny, D. A. (1986). Moderator-Mediator variable distinction in social psychology research: Conceptual, strategic and statistical considerations. *Journal of Personality and Social Psychology*, 51, 1173-1182.

Bass, B. (2000). The future of leadership in learning organizations. *Journal of Leadership Studies*, 7(3), 18-40.

Bennis, W. (2002). Become a tomorrow leader. In Spears, L. (Ed.), *Focus on Leadership: Servant-leadership for the Twenty-First Century, Wile*y, New York, NY, 101-109.

Boal, K. B. and Schultz, P. L. (2007). Storytelling, time, and evolution: The role of strategic leadership in complex adaptive systems. *The Leadership Quarterly*, **18** (4), 411-428.

Boutros, A., & Joseph, C. B. (2007). Building, Maintaining and Recovering Trust: A Core Leadership Competency. *Physician Executive*, 33(1), 38-41.

Brower, H. H., Schoorman, F. D., & Tan, H. H. (2000). A model of relational leadership: The integration of trust and leader–member exchange. *Leadership Quarterly*, 11(2), 227–250.

Chuang, A., & Shen, C. T. (2008). Leader-member relationship: the mediation and moderation effects of person-enviorment fit in a Chinese culture. *Academy of Management Proceedings*, 1-6.

Dansereau, F., Graen, G., & Haga, W. (1975). A vertical dyad approach to leadership within formal organizations. *Organizational Behavior and Human Performance, 13*, 46–78.

Dannhauser, Z., & Boshoff, A. B., (2006). *The relationships between servant leadership, trust, team*

commitment and demographic variables. Servant Leadership Research Roundtable, August 2006.

Dannhauser, Z. (2007). The relationship between servant leadership, Follower trust, team commitment and unit effectiveness. Dissertation at the University of Stellenbosch.

Dennis, R.S. & Bocarnea, M., 2005, Development of the servant leadership assessment instrument, *Leadership & Organization Develop Journal*, 26(8), pp.600-615.

Dennis, R.S. & Winston, B.E., 2003, A factor analysis of Page and Wong's servant leadership instrument. Leadership *&Organization Development Journal*, 24, pp.455-459.

Dirks, K.T., & Ferrin, D. L. (2001). The role of trust in organizational settings. *Organization Science*, 12(4), 450-67.

Fornell, C. & Larcker, D. F. (1981). Evaluating Structural Equation Models with Unobservables and Measurement Error. *Journal of Marketing Research*, 18, 39-50.

Gerstner, C. R., & Day, D. V. (1997). Meta-analytic review of leader– member exchange theory: Correlates and construct issues. *Journal of Applied Psychology, 82,* 827–844.

Gillespie, N. A., & Mann, L. (2004). Transformational leadership and shared values: the building blocks of trust. *Journal of Managerial Psychology*, 19(6), 588-607.

Gimbel, P. A. (2001). Understanding principal trust-building behaviors: evidence from three middle schools. Dissertation Abstracts International, UMI No. 301832.

Graen, G. (1976). R*ole-making processes within complex organizations*. In M. D. Dunnette (Ed.), Handbook of industrial and organizational psychology (pp. 1201–1245). Chicago: Rand McNally.

Graen, G. B., & Cashman, J. (1975). *A role-making model of leadership in organizations: A development approach.* In J. G. Hunt & L. L. Larson (Eds.), Leadership frontiers (pp. 143–165). Kent, OH: Kent State University Press.

Graen, G. B., & Uhl-Bien, M. (1995). Relationship-based approach to leadership: Development of leader-member exchange (LMX) theory of leadership over 25 years: Applying a multi-level multi-domain perspective. *Leadership Quarterly, 6*, 219–247.

Greenleaf, R. K. (1977). Servant leadership: A journey into the nature of legitimate *power and greatness*. New York: Paulist Press.

Greenleaf, R. K. (1996). The crisis of leadership. In Frick, D. M. & Spears, L. C. (Eds.), On becoming a servant leader. San Francisco: Jossey-Bass.

Hamilton, F. (2005). Practicing Servant-Leadership: Succeeding Through Trust, Bravery, and Forgiveness. *Academy of Management Review*, 30(4), 875-877.

House R.J., Aditya R. (1997). The social scientific study of leadership: Quo vadis? *Journal of Management*, 23, 409-474.

Hulland, J. (1999). Use of partial least squares (PLS) in strategic management research : a review of four recent studies. *Strategic Management Journal*, 20, 195–204.

Hunt, J. G. (1999). Transformational/charismatic leadership's transformation of the field: An historical essay. *Leadership Quarterly*, 10, 129–144.

Ilies, R., Nahrgang, J. D., & Morgeson, F. P. (2007). Leader–Member Exchange and Citizenship Behaviors: A Meta-Analysis. *Journal of Applied Psychology*, 92(1), 269–277.

Joseph, E. E., & Winston, B. E. (2005). A correlation of servant leadership, leader trust, and organizational trust. *Leadership & Organization Development Journal*, 26(1), 6-22.

Krishnan, V. R. (2005). Leader-member exchange, transformational leadership, and value system. *Electronic Journal of Business Ethics and Organization Studies*, 10, 14–21.

Liden, R. C., & Maslyn, J. M. (1998). Multidimensionality of leadermember exchange: An empirical assessment through scale development. *Journal of Management, 24,* 43–72.

Liden, R. C., Sparrowe, R. T., & Wayne, S. J. (1997). Leader-member exchange theory: The past and potential for the future. *Research in Personnel and Human Resources Management*, 15, 47–119.

Liden, R. C., Wayne, S. J., Zhao, H., & Henderson, D. (2008). Servant leadership: Development of a multidimensional measure and multi-level assessment. The Leadership Quarterly, 19, 161 - 177.

Mayfield, J., & Mayfield, M. (2007). The Effects of Leader Communication on a worker's Intent to stay: an investigation using structural equation modeling. *Human Performance*, 20(2), 85–102

Podsakoff, P. M., Mackenzie, S. B., & Bommer, W. H. (1996). Transformational leader behaviors and substitutes for leadership at determinants of employee satisfaction, commitment, trust, and organizational citizenship behaviors. *Journal of Management*, 22(2), 259-299.

Pollard, C.W. (1996). The leader who serves. in Hesselbein, F., Goldsmith, M. and Beckhard, R. (Eds), The Leader of the Future: New Visions, Strategies, and Practices for the Next Era, Jossey-Bass, San Francisco, CA.

Reichers, A. E., & Schneider, B. (1990). Climate and culture: an evolution of constructs. In: Schneider, B., Editor, *Organizational climate and culture*, Jossey-Bass, San Francisco, 5–39.

Reinke, S. J. (2004). Service before self: towards a theory of servant-leadership. *Global Virtue Ethics Review*, 5, 30-58.

Ronald, P. W., & Lawrence, M. D. (2007). Organizational Trust, Trust in the Chief Executive and Work Satisfation. *Public Personnel Management*, 36(2), 165-179.

Russell, R.F. (2001). The role of values in servant leadership. *Leadership & Organization Development Journal*, 22(2), 76-85.

Russell, and Stone, (2002). A review of servant leadership attributes: developing a practical model. *Leadership & Organization Development Journal*, 23(3), 145-157.

Sarkus, D. J. (1996). Relationaships built on trust and service from the basis of influence for servant-leadership. *Professional Safety*, 41(6), pp.26-32.

Smith, B. N., Montagno, R. V., & Kuzmenko, T. N. (2004). Transformational and Servant Leadership: Content and Contextual Comparisons. *Journal of Leadership and Organizational Studies*, 10(4), 80-91.

Sparks, J. (2000). Exploring trust: a dynamic and multidimensional model of interpersonal trust development in a task setting. Dissertation Abstracts International, UMI No. 3059879.

Spears, L. C. (1995). Servant-Leadership and the Greenleaf Legacy. In L. C. Spears, ed. *Reflections on Leadership: How Robert K Greenleaf's Theory of Servant-Leadership Influenced Today's Top Management Thinkers*. New York, NY: John Wiley (1-16).

Spears, L. C. (1998). Tracing the growing impact of servant leadership. *In Spears, L. C. Insights on Leadership: Service, Stewardship, Spirit, and Servant-Leadership*, John Wiley and Sons, New York, NY.

Tschannen-Moran, M. and Hoy, W. (1998). Trust in schools: a conceptual and empirical analysis. *Journal of Educational Administration*, 36(4), 334-352.

Vecchio, R. P. (1998). Leader-member exchange, objective performance, employment duration, and superior ratings: testing for moderation and mediation. Journal of Business and Psychology, 12(3), 327-341.

Wang, H., Law, K. S., Hackett, R. D.,Wang, D., & Chen, Z. X. (2005). Leader-member exchange as a mediator of the relationship between transformational leadership and followers'performance and organizational citizenship behavior. *Academy of Management Journal*, 48, 420–432.

Wang, H., Niu, X. Y., and Law, K. S. (2004). Multi-dimensional Leader-member Exchange (LMX) and Its Impact on Task Performance and Contextual Performance of Employees. *Acta Psychology Sinica,* 36(2), 179-185.

Washington, R. R., (2007). Empirical relationships among servant, transformational, and transactional leadership: Similarities, differences, and correlations with job satisfaction and organizational commitment Ph.D., Department of Management, College of Business, Auburn University, 112 pages.

Washington, R. R., Sutton, C. D., & Field, H. S. (2006). Individual differences in servant leadership: the roles of values and personality Leadership & Organization Development Journal. Bradford: 2006. 27(8), 700-716.

Yu, M. C. (2006). Employee Uncertainty towards Organizational Change and Employee Working Attitude: The Mediating Effects of Organizational Communication and Employee Trust. *Journal of Human Resource Management (in Chinese),* 6(2), 89-11.

Zand, D. E. (1972). Trust and managerial problem solving. Administrative Science *Quarterly*, 17, 229–239.

戦略論におけるパラダイム対立と統合的モデル
STRATEGY PARADOX AND INTEGRATED MODEL OF STRATEGIC MANAGEMENT

Chan-Wei Tsai

Assistant Professor of Department of Business Administration
National Pingtung University of Science and Technology, Taiwan, R.O.C
E-Mail: tsaidaniel@mail.npust.edu.tw

ABSTRACT

This article propounds a framework for classifying Strategic Management according to two dimensions; Content vs. Process, and Environment vs. Organization. Strategic Management can be thus partitioned into four approaches—The Planning Approach, The Positioning Approach, The Emergent Approach, The Resource Approach.

First, we discuss the typical theories of each approach, and find their problems and characteristics. Secondly, we use an integrated model of organizational theory to explain the relationship between four approaches and find the strategy Paradox out. Finally, we propound an Integrated Model from two options-Strategy Selection and Strategic Change.

Keywords: *Strategy Paradox; Strategic Selection; Strategic Change*

本論文の目的はお互いに対立する戦略論の諸理論を整理し、戦略論の全体像を体系的に把握するための統合モデルを戦略選択と戦略変化という２つの視点から構築することである。組織論には、組織と環境との相互関係は構造統制（Organized）と組織生成（Organizing）から構成される（岸田，1985）が、この視点は現代組織論を理解するための重要な考え方であり、組織論におけるさまざまな理論をパラダイム対立として表現することでもある。もちろん、組織論のサブ理論である経営戦略論においても同様なパラダイム対立(Strategy Paradox)が戦略研究を主宰している。このパラダイム対立をうまく把握すると、戦略論の全貌を容易に解明することができる。

１ 戦略論におけるパラダイム対立

戦略とは、『成長と競争という２つの目的を実現するための手段である』。この定義からすると、戦略論には目的をめぐる対立と手段をめぐる対立との２つの大きなパラダイム対立が存在している。まず、戦略の目的を企業の成長にするか、あるいは各事業領域の競争にするかという対立は、企業は戦略の重心を全社戦略と事業戦略（競争戦略）のどちらに置くかという戦略選択を意味している。次に、手段の対立は、環境と組織の接点としての戦略のあり方を選択することを意味している。すなわち、環境と組織の接点としての戦略は、一方が戦略形成（Strategizing）によって環境への働きかけであり、他方が戦略統制（Strategized）による戦略行動の制限でもある。このような考え方に基づき戦略論の実態をまとめると、図１になる。

戦略論はそもそも事業部制組織の創始から発端した経営理論であり、図１は事業部制組織から見た戦

略論の全貌である。図1から見ると、戦略論には全社戦略と事業戦略の2つの分野に大別され、同じく戦略の目的を企業の成長に置いている全社戦略の議論には、Strategized としての全社戦略、及び Strategizing としての全社戦略との2つ相対立の議論があり、同じく戦略の目的を事業部の競争に据えている競争戦略の研究には、Strategized としての競争戦略、及びStrategizing としての競争戦略との2つお互いに対峙している戦略研究が存在している。

図1 事業部制組織から見た戦略論の全貌

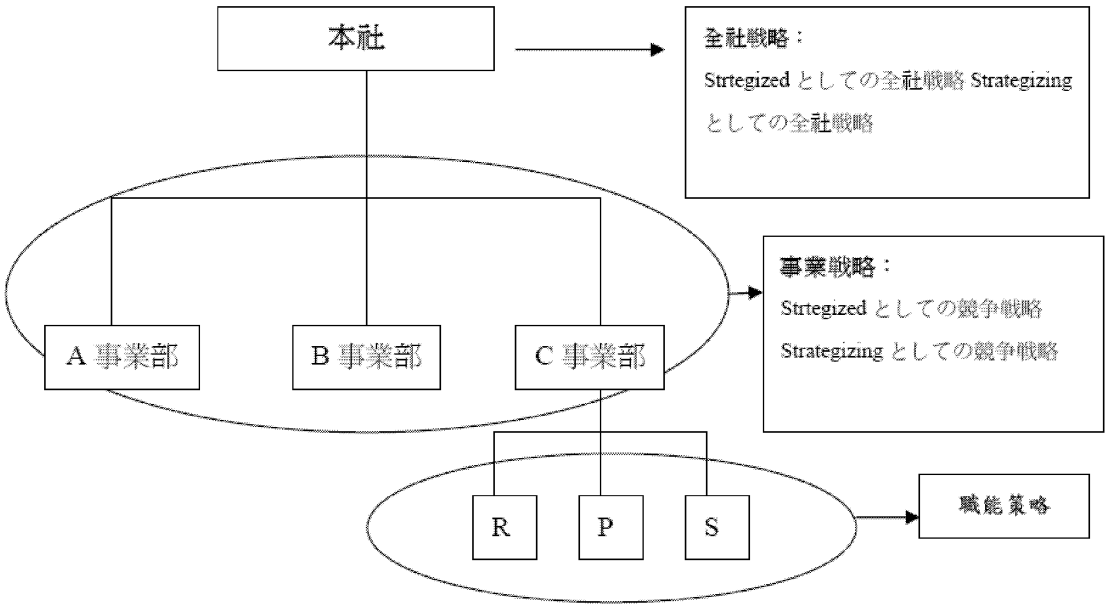
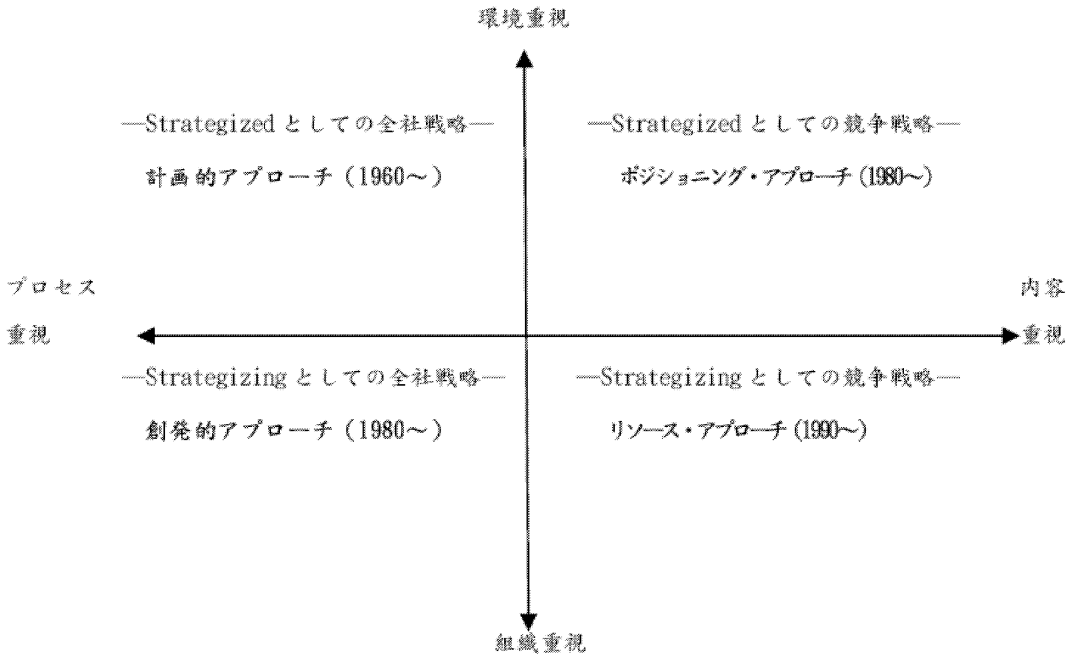


図１からもわかるように，確かに戦略論には，成長と競争との２つの異なる目的をめぐる２つのパラダイム対立が従来の戦略研究を支配している。もちろん、従来の戦略研究者もこのパラダイム対立を意識し、激しい論争や議論を発展してきた。すなわち，成長の手段のあり方に関する論議は，アンゾフ-ミンツバーグ論争が示したように「計画性と創発性のどちらが重要であるか」という問題であり、また競争の手段のあり方に関する議論はポーターとバー二ーの論争の「競争優位を獲得するための手段の源泉は外部にあるか，あるいは内部か」という対立点の問題である。

この２つのパラダイム対立をいっそう鮮明にし、そして対立の真相を解明するため、各戦略研究の中身と各戦略研究が注目している戦略の発生源を検討する必要がある。すなわち、従来の戦略研究がどのようになされてきたのかという戦略研究の中身，およびそれぞれの研究者がどこから戦略を考えるのかという戦略の発生源との２点は，戦略論を正確に把握するために必要不可欠である。第１に、内容重視とプロセス重視が戦略研究を把握するのに不可欠な視点である。戦略内容とは，何が意思決定されたかの中身であり，戦略内容の研究は競争上の企業戦略もしくは事業戦略に関連するものである。これに対して，戦略プロセスはこうした意思決定がどのように組織状況において達成されるのかに関連するものである。すなわち，戦略内容論は，主によい戦略とはどのようなものなのかに関する研究であり，それをよいポジションとよい資源との２つの側面から説明した２つのアプローチがある。戦略プロセス論は，主に組織における戦略の策定と実施の問題を扱う理論であり，策定プロセスを重視する戦略策定プロセス論と，戦略の実施過程に注目する戦略形成プロセス論という２つの異なる主張がある。第２に，戦略の発生源について，戦略を，企業目的を達成するための手段の出発点として考えるなら，環境重視と組織重視という２つの大きな流れがある。つまり戦略を考えるときに外部環境から考えるのか，あるいは組織内部から考えるのかという違いであ

したがって、以上のような分析視点に立つなら、戦略論の変遷を次の４つのアプローチ（図２）に分類することができる（蔡展維、2004；2005）。すなわち、全社戦略のパラダイム対立として、計画的アプローチと創発的アプローチとの２つの異なる戦略手法がある。また事業戦略のパラダイム対立として、ポジショニング・アプローチとリソース・アプローチとの２つの異なる戦略手段がある。

図２：戦略論の変遷



出所：（蔡展維，2004）より修正

２ 全社戦略論におけるパラダイム対立

2.1 Strategized としての全社戦略（計画的アプローチ）

戦略論の視点から見れば，計画的アプローチは環境重視とプロセス重視であり，Strategized としての全社戦略でもある。また、公式的な分析による戦略的意図に基づき，戦略の中身を計画的に策定していくプロセス，また手続きの開発に焦点を当てたアプローチである。特に，このアプローチは Chandler（1962）の『経営戦略と組織』に触発され，あるいは強い影響を受けた。このアプローチの根底には多角化戦略（全社戦略）と事業部制組織という大前提があり，次の２つの問題と関連して発展した。第１は，会社はどんな事業に手をつけるべきなのかに関する全社戦略レベル，あるいは多角化戦略の意思決定である。第２は，本社あるいは本社計画部門は，一連の事業単位あるいは現場をどのように管理し，コントロールするのかに関する問題である。

このアプローチを最初に展開したのは，第１の問題点に注目するAndrews(1971)とAnsoff(1965)である。Hoffer&schendel(1978)によれば，前者は，戦略を企業の目的とその達成のための基本政策と定義し，両者を組み合わせて考えることが有用であると主張している。また，SWOT 分析を用いて組織の強みと弱み，及び環境における機会と脅威を分析し，適合的な戦略を策定するのが彼の理論の中心である。後者のアンゾフは，戦略の概念を企業の目的を達成するための手段と定義し，企業における意思決定を戦略的意思決定，管理的意思決定，業務的意思決定の３種類に区別した。特に，戦略的意思決定とは，企業と環境との関係を確立する意思決定であり，すなわちどのような事業，あるいは製品・市場を選択すべきかに関する決定，つまり多角化戦略の決定である。また「部分的な無知」のもとで行わ

れるこのような戦略的意思決定の手続き，ルールとなるのが企業戦略であり，戦略計画の立案の手続きでもある。

第２の問題点，すなわち本社は一連の事業をどのように管理すべきかに注目したのが戦略計画論である。特に，1960 年代は戦略計画論の出発点でもある。50 年代後半の長期経営計画に代わって，60 年代から70 年代にかけて，企業戦略と結合した戦略計画の概念が急速に広まった。例えば P.Lorange や G.A.Steiner などの戦略計画論者は公式的な分析に基礎を置きながら，目標，予算といった戦略の計画策定の手続きの開発に注目しており，本社と本社の計画部門によるコントロールを重視する傾向がある。

要するに、このアプローチは戦略論の分野では最も古典的かつ重要な存在であり，計画性，分析による事前評価などの概念が，企業に一つの指針を与えてきたところが，このアプローチの最も大きな貢献であり、戦略によって企業の戦略行動を統制する戦略統制（Strategized）の意味が初期の戦略論研究を強く支配している。また，戦略経営やシナリオ・プランニングのような新しい理論は次々展開してきたが，Plan→Do→See というこのアプローチの大前提は変わらない。

2.2 Strategizing としての全社戦略（創発的アプローチ）

計画的アプローチとは異なり、創発的アプローチは組織とプロセスを重視する戦略研究であり、Strategizing としての全社戦略でもある。すなわち，戦略を考えるときには組織内部の行動から考慮し，しかも組織における戦略形成プロセスのあり方に注目したアプローチである。計画的アプローチが規範的な視点から戦略策定プロセスの開発を重視するものであるのに対して，創発的アプローチは主に組織の戦略形成プロセスを，記述的な手法から解明する研究である。これは主に「自律的な行動から戦略を生み出す」というもので，つまり実験を先に行うことで行動の中から帰納的に戦略を導き出すという方法に注目したアプローチである。また，このアプローチの研究は主に計画的アプローチに対する批判から成り立っていた。いうまでもなく，伝統的な戦略論を最も激しく批判したのはミンツバーグである。Mintzberg（1985）は，計画としての戦略概念と行動のパターンとして記述される戦略概念とは，必ずしも正確に一致していないことがあり，時には全く独立した２つのアプローチになる場合があると主張した。彼は戦略のタイプを，意図された戦略と実現された戦略に分け，トップによる当初の計画がすべて実現に向かう戦略の流れを計画的戦略（Deliberate strategy），当初意図されていない変化がなされ，実現された戦略に導く戦略行動の流れを創発的戦略（Emergent Strategy）と名づけた。その後，Mintzberg（1990a,1994）は計画的戦略，すなわち，アンゾフを代表とする伝統的戦略論に対する痛烈な批判を展開することによって，創発的戦略の優位性を強調している。さらに，Mintzberg（1989）は，創発的戦略の生成を促すような組織的な仕組みが必要であると主張し，戦略作成の「草の根モデル」を提示した。要するに，彼にとって，戦略とは，組織と環境ならびに組織内の相互作用のプロセスを通じて創発的に生み出されてくる行動のパターンである。したがって，戦略は，企業の環境変化に対処する意思決定の指針あるいは決定ルールではなく，むしろ企業内外の相互作用的な意思決定，あるいは組織学習の成果である。

ミンツバーグと同様に，現実の戦略には，２つの異なるルートを経て実現されるものがあると指摘したのはBurgelman(1983)である。彼の社内ベンチャーに対する実証研究によれば，戦略行動がデザイン

されるルートには，導出された戦略行動（Inducedstrategic behavior）と自律的戦略行動（Autonomous strategic behavior）との２つ異なるタイプのものがある。導出された戦略行動とは，公式的な計画プロセスを通じてデザインされる戦略である。すなわち，ミンツバーグの計画的戦略と同じように，Plan→Do→See という観点から発展したものである。これに対して，自律的戦略行動は，新しい事業を定義するために新しいカテゴリーを必要とするような戦略行動である。現場の組織メンバーは，新しい事業機会を認識し，その事業のために企業の余裕資源を獲得するための活動を展開する。社内ベンチャーはこの戦略行動の典型である。

要するに、このアプローチでは，戦略が組織の日常業務の行動に相当し，これらの行動はいずれも当初に意図したものではなく，行動の１つ１つが集積されるプロセスで戦略の一貫性やパターンが形成され、組織の創発的な行為や自律的な行動から戦略形成（Strategizing）を説明するのが研究の共通点である。また、このアプローチはPlan→Do→See という計画的アプローチの大前提に徹底的に反対し，組織における個人の行動（Do）から新しい戦略に導く可能性をも提示した。

３ 競争戦略論における手段対立

3.1 Strtegized としての競争戦略（ポジショニング･アプローチ）

このアプローチは，ハーバード学派の産業組織論から影響を受けて，焦点市場における戦略的なポジションの選択に注目したアプローチである。また、戦略論の視点から見ると、環境と内容を重視するアプローチであり、Strtegized としての競争戦略でもある。PPM やPIMS などの伝統的な理論もこのアプローチに含まれるが，代表的な研究としてはポーターの理論が上げられる。ポーターの研究を紹介する前に，まずこの学派の根底にある理論的なフレームワークを議論する。このフレームワークとは，「業界構造（Market Structure）―市場行動(Market Conduct)―市場パフォーマンス(Market Performance)･ モデル」，略して「SCP モデル」として知られるような産業組織論の概念である。その基本的な命題とは，市場パフォーマンスが売り手と買い手の市場行動に依存し，またその市場行動が市場の業界構造によって規定される，という概念である。すなわち，S→C→Pという因果関係である。Porter（1980）は，このような産業組織論のモデルを戦略論に持ち込んで，特定事業つまり事業部レベルの戦略策定，いわゆる競争戦略の議論を展開した。これは，産業構造分析（5 つの競争要因）を通じて企業にとってより望ましい投資利益をあげられる市場を捜し出し，そのための基本戦略のいずれかを選択し，追求しなければならないということである）。さらに，Porter（1985）は，持続的な競争優位を確保することを目的とし，そのための方法論についても論じている。これは価値連鎖という概念であり，主に事業部内の職能活動間の戦略的適合性を指している。すなわち，競争戦略によって獲得した競争優位を維持するために，組織内の整合性（内的適合）の支援がなければならないということである。２つの議論をまとめて見ると，次のようにSCP モデルと同じ因果関係を持つポーターのモデルがまとめられる。すなわち，５つの要因分析（市場構造）→基本戦略→Value Chain（組織）→持続的な競争優位（市場パフォーマンス）という因果関係である。

要するに、計画的アプローチと同様に，このアプローチも規範的な研究手法をとっており，Plan→Do→See という大前提を受け入れており、同じく戦略統制の側面を重視しているが，全社戦略ではなく事業戦略の視点から，市場（環境）でのポジションの確立のための戦略の重要性と戦略の内容に注目

したという特徴がある。

3.2 Strategizing としての競争戦略（リソース·アプローチ）

これは組織重視と内容重視のアプローチであり、Strategizing としての競争戦略でもある。ポジショニング· アプローチの概念とは正反対であり，競争優位の源泉を企業の内部資源に求める Resource-Based View はこのアプローチの中心であるが，「コア· コンピタンス）」や「知識創造」などの理論もこのアプローチに属している。RBV を最初に提起したのはWernerfelt(1984)である。彼は，なぜ企業が超過利潤を獲得できるのかについて，その企業が保有する資源をライバルが獲得，模倣できないような資源障壁（Resource Position Barrier）があるからであると主張した。また，Dierickx&Cool(1989)は，資源の取引可能性に着目した。ある戦略要素である経営資源は，本質的に市場で取引可能なものではなく，企業内で蓄積されるものである。すなわち，競争優位を決定するのは，競争戦略論がいう外部環境のポジショニングではなく，企業の内部資源である。しかし，ある企業が競争優位を獲得すれば，ライバル企業はやはり資源獲得活動を通じてその優位性を中立化しようとする。そこで，Rumelt（1984）は，ライバル企業の模倣を妨げる要因を隔離メカニズム（Isolating Mechanism）と呼び，このメカニズムが働くときに企業の競争優位が維持されると主張した。さらに，Barney（1991，2001）は模倣を困難にする要因として，①独自の歴史的条件，②因果関係のあいまい性，③社会的複雑性，④特許，の４つをあげている。以上の４つの要因のいずれか，あるいはそれらの組み合わせにより，他社による経営資源の模倣は困難となり，企業が持続的な競争優位を獲得し維持できる。

また，Grant（1991）は，「資源が組織の競争優位性を直接に規定する」というBarney などのRBV 論者の基本命題を、「資源はケーパビリティの源であり、ケーパビリティは競争優位の源泉である」と拡張した。

要するに，リソース· アプローチでは，個別企業が独自の戦略で利潤を最大化するために，最も影響力を持つのはポーターが提唱した産業環境の構造要因ではなく，各企業が保有する内部資源であると主張される。すなわち，ポーターが競争優位を決める要因として産業構造という外部環境を重視するのに対して，リソース· アプローチは個別企業レベルの組織内部をより重視する。

4 戦略論の統合モデル

以上、４つのアプローチ、もしくはお互いに対峙して来た二組の戦略研究を戦略論と組織論の視点を通じて概観したが、ここではもう一度パラダイム対立のポイントを整理する。まず、戦略の目的を企業全体の成長に置く全社戦略論には、成長の手段のあり方に関するパラダイム対立が存在している。Strategized としての全社戦略（計画的アプローチ）はその手段の計画性を重視し、Strategizing としての全社戦略（創発的アプローチ）は手段の創発性をより強調している。しかし、計画的アプローチの戦略はそれを実施する一定の組織が必要とし、創発的アプローチの戦略は一定の組織から生れる（蔡展維、2005）。「計画性と創発性」とパラダイム対立は戦略を実施する組織の違いに関係しており，戦略論が扱うべき課題というより，むしろ戦略論の枠組みを超えて組織論の問題となる。また、競争の手段のあり方に関するパラダイム対立は主に競争戦略研究を支配し、Strategized としての競争戦略(ポジショニング・アプローチ)はその手段の源泉が外部環境にあると主張し Strategizing と

しての競争戦略(リソース・アプローチ)が手段の源泉が組織内部にあると想定している。もちろん、戦略論における両者の出発点は180 度異なるが，戦略策定を考慮するときには外部環境と内部資源は共に重要であり，両者が交わるところに戦略，またトップの戦略選択はある。その意味では両者がお互いに対立するのではなく，戦略策定に対して両者は補完的である（蔡展維、2005）。

要するに、計画性と創発性、および外部と内部との２つのパラダイム対立は従来の戦略研究を完全に支配してきたが、戦略研究をひとつの閉鎖状態に陥入させる根源でもある。この閉鎖状態から脱出し、戦略論の更なる発展を求めるために、この２つのパラダイム対立を体系的に把握する統合的な枠組みが重要である。

戦略論の４つのアプローチの統合モデルを検討する前に，まず戦略論の統合的モデルの条件としてこれから本章で扱おうとする「統合」の概念を簡単に整理する。まず統合とは，2 つ以上のものを一つに統べ合わせることである。すなわち，相互に対立する戦略論の４つのアプローチを統合するためには，４つのアプローチのいずれか一方に重点を置くのではなく，４つのアプローチを同時に射程内に収めた枠組を構築しなければならない。実際に，岸田（2001）によれば，複数の正反対のパラダイムやアプローチを統合するためには，次の２つの方法がある。第1 に，共時的統合である。すなわち，メタ・パラダイムを設定し，包括的モデルを作ることによって，一つの時点で対立するパラダイムやアプローチを統合する方法である。言い換えれば，同じレベル，同じ階層では対立するものを一次元上あるいは一階層上で統合することである。第2 に，経時的統合である。すなわち，時間の経過に沿ってパラダイムやアプローチの対立を統合する方法である。言い換えれば，対立するパラダイムやアプローチの因果関係を分析し，その因果関係に基づいて対立するパラダイムやアプローチを順に並べてその相互関係を説明する方法である。

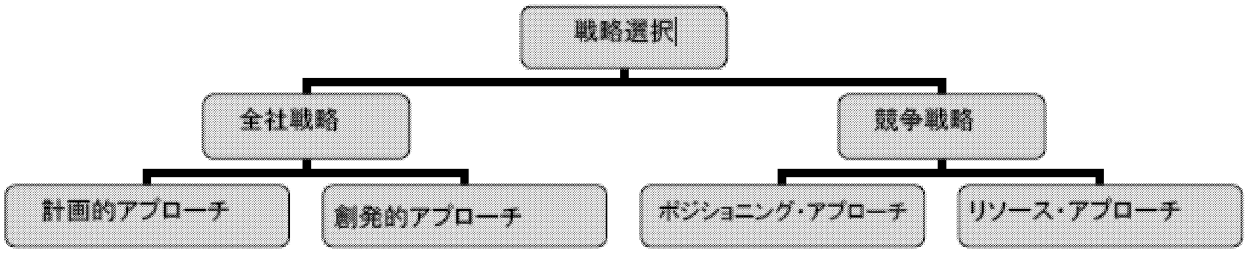
4.1 戦略選択–共時的統合–

戦略論全体を共時性に基づいて統合することは，戦略論の４つのアプローチを同時に一つの枠組みに存在させる，あるいは戦略を策定・実施する組織では，戦略というものをどうやって包括的に考えるのかということを意味する。

図３は戦略論の共時的統合モデルであり、戦略論の４つのアプローチは戦略選択（Strategic Selection）という上位概念に共時的に統合される。また，計画的アプローチ（Strategized）と創発的アプローチ（Strategizing）は全社戦略という上位概念によって統合され，ポジショニング・アプローチ（Strategized）とリソース・アプローチ（Strategizing）は競争戦略という上位概念によって統合される。ここでは、共時的統合モデルは次の２つの意味を有している。第1 に、Strategized と Strategizing との２つの概念を統合することは、組織が戦略的課題に対する関心とともに，組織の日常業務にも同等の注意を払わなければならないということを意味している。特に，今日の環境状況は，日常業務面と戦略的課題面での対応の間における競争関係を示している。一方では，多くの企業が需要の飽和，グロバール化の急展開，急速な技術の陳腐化のようないくつかの激しい環境変化に翻弄されており，リスクを賭けた戦略的な判断や環境変化への迅速な反応のようなトップ・マネジメントの戦略性が重要となる。他方では，日常業務における戦略行動について，トップ・マネジメントが積極的に追求しない限り，それはいつまでも日常業務的な課題の背後に隠れたままである。第2 に、激し

い競争環境に直面している現代企業はしばしば資源が極めて限られており、複数のアプローチではなく、ときには一つのアプローチを選択し専念する必要がある。すなわち、企業が直面する経営課題に応じて適切な戦略手段を選べる必要があり、そのとき共時的統合モデルを企業の戦略選択を意味している。ここで問題となるのは、企業がどうやって、もしくはどんな概念のもとで戦略を選択し続けるのか、経時的統合モデルは一つの示唆を提示する。

図３ 戦略論の共時的統合モデル

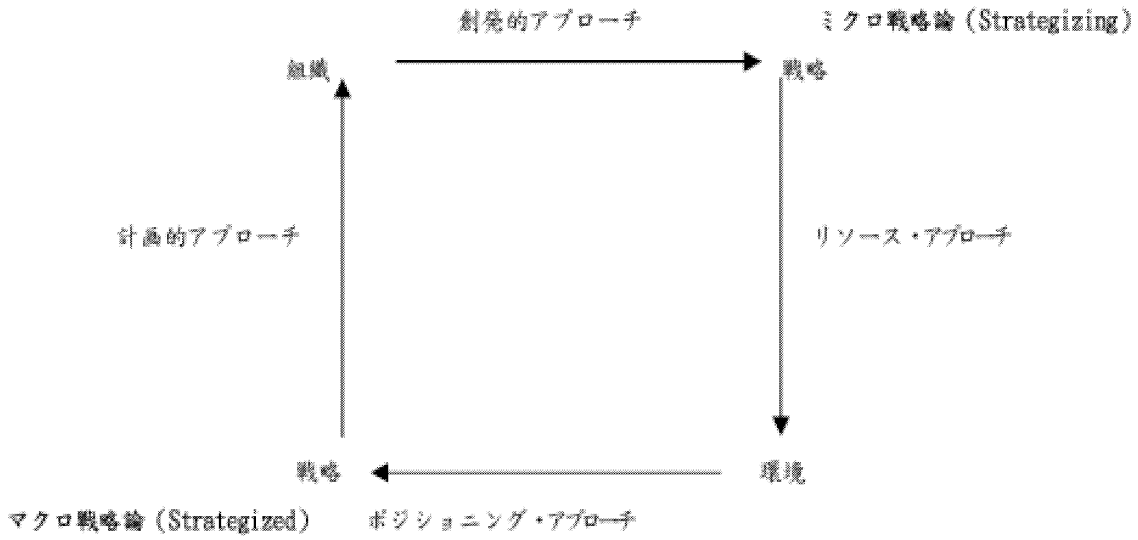


4.2 戦略変化–経時的統合–

急激な環境変化につれて，戦略選択が頻繁に行われるようになり，戦略を再策定する重要性も増えてきた。チャンドラーの命題である「組織構造が戦略に従う」が示唆するように，日常業務に対する戦略の優位性という前提で組織から戦略を独立させて論じるだけではもはや不充分である。したがって，戦略論と組織論の両方の視点から，また戦略を環境と環境の接点として捉え、既存の戦略論を体系的に理解することがいっそう重要となる。ここでは，岸田（1985）の組織分析枠組を用いて戦略論のアプローチを検討することによって，戦略論の統合モデルを構築する。岸田によれば，組織には組織構造（Organized）と組織過程（Organizing）との２つの側面がある。ここでは，計画的，創発的，ポジショニング，およびリソース・アプローチの構成要素を加えて，図４のように組織論の視点から戦略論の４つのアプローチの因果関係を示し、４つのアプローチを経時的に統合してみる。

まず、ポジショニング・アプローチは環境分析から始まり戦略である位置づけへと至り，環境が戦略を制約する側面に該当する。これに対して，計画的アプローチの研究も環境分析に言及したが，計画によるコントロールにより焦点を当てているため，戦略が組織の行動を統制する側面と考えられる。つまり，両者を合わせて考えると，環境→戦略→組織という因果関係を持つマクロ戦略論（Open&合理的モデル）である。また，環境→戦略→組織という因果関係は，組織のマクロの戦略がミクロの行動を決定するというマクロ戦略論の前提を持っており，組織のトップが策定した戦略を実現するために戦略を実施する人間の行動を規制してゆくプロセスであり，戦略統制（Strategized）と呼ぶことができ，トップによる戦略経営の側面に当たっている。

図４：戦略論の統合モデル



出所：蔡展雄（2005）

これに対して，創発的アプローチの研究では，実現された戦略が組織の下位レベル，特に現場の人間の行動からボトムアップで創発されるので，組織が戦略をもたらす側面に該当する。リソース・アプローチは，こうした創発された知識や能力を組織の資源としてまとめており，環境に対して戦略がどのような影響力を持つのかに注目しているので，戦略から環境を変えていく側面と考えられる。すなわち，両者を合わせて考えると，組織における個人行動の相互作用が新しい戦略を形成し，そして環境変化を引き起こすというミクロ戦略論（Open な自然体系モデル）である。また，組織→戦略→環境という因果関係は組織のミクロの行動がマクロの戦略を決定するというミクロ戦略論の前提を持っており，戦略が組織の戦略行動から生成され，環境に働きかけるプロセスを示している。ここでは，この因果関係を戦略形成（Strategizing）の側面と呼ぶ。これは，戦略を実施する組織の日常業務における戦略行動と深く関連している

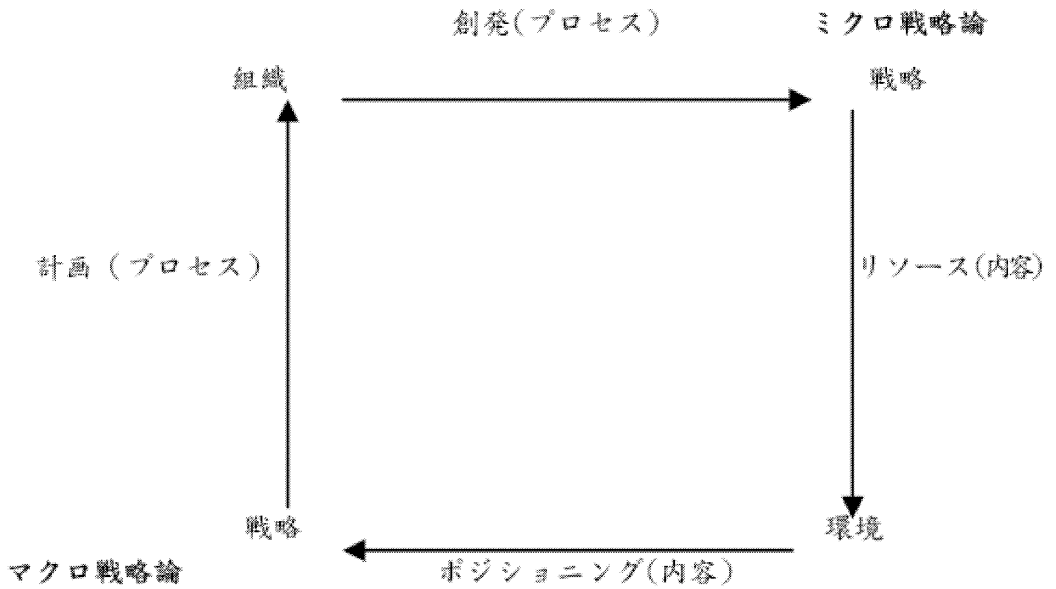
要するに、以上の因果関係は、創発的アプローチ→資源アプローチの組織→戦略→環境というミクロ戦略論と、ポジショニング・アプローチ→計画的アプローチの環境→戦略→組織のマクロ戦略論に大別に区分し、戦略論の４つのアプローチを経時的に統合することができる。この経時的モデルは次のことを意味している。

第1 に，この統合モデルは，マクロ戦略論とミクロ戦略論という環境適応の異なる２つの方向性を表現し、戦略を通して環境と組織の２つの相互関係を示唆している。すなわち，組織は単に戦略を通して環境変化に適合するだけではなく，戦略行動を通じて環境を創造していく，あるいは環境を操作していくこともある。また，組織はこうした戦略変化のプロセスを通じて，環境との相互作用を行いながら，継続的に成長していく。

第2に、前述した内容重視・プロセス重視という戦略研究の重要な区別視点とこの統合モデルの関係について図5のように考えることもできる。

図5では，まず戦略とそれを実行する組織の関係を扱う戦略プロセス論は，「戦略の策定プロセス」に注目する計画的アプローチと，「戦略の形成プロセス」に注目する創発的アプローチからなる。戦略の策定プロセスは，策定された戦略が組織の実行プロセスを規定する意味を持ち，戦略→組織という計画的アプローチの因果関係に当たる。戦略の形成プロセスは，組織の実行プロセスから戦略が形成されることを意味し，組織→戦略という創発的アプローチの因果関係に相当する。次に，環境と戦略の関係を扱う戦略内容論は，「良い資源」に注目するリソース・アプローチと，「良いポジション」に注目するポジショニング・アプローチから構成される。よいポジションは普通公式的な環境分析を通じて得られるので，環境→戦略というポジショニング・アプローチの因果関係に相当する。また，良い資源は，組織が戦略を通じて環境に働きかけることを意味し，戦略→環境というリソース・アプローチの因果関係に当たっている。したがって，5に基づいて，以下のようなことが言える。まず，Open&自然体系モデルの因果関係を持つミクロ戦略論（組織→戦略→環境）では，創発的アプローチからリソース・アプローチへ移行し，すなわちプロセス→内容という因果関係を持ち，組織の実行プロセス，あるいは組織の現場の学習プロセスを通じてよい資源，あるいはよい戦略が生成し，環境に働きかけるということを意味している。次に，Open&合理的モデルの因果関係を持つマクロ戦略論（環境→戦略→組織）は，ポジショニング・アプローチから計画的アプローチへと移行し，すなわち内容→プロセスという因果関係を持ち，経営トップが環境分析を通じて「よいポジション」と具体的な行動内容といった戦略の内容を作り出し，またそれに基づいて組織の実行プロセスをコントロールすることを意味している。最後に，なぜ以上の2つの戦略変化が発生するのかについては，Pettigrew（1985；1987）によれば，組織の戦略変化を考慮するときに，コンテクスト（内外の），内容（例：製品と市場の選択），プロセス（例：実施プロセス）の3つの次元から考えなければならない。特に，ここでいうコンテクストは，内部的コンテクストと外部的コンテクストからなる。前者の内部的コンテクストが本論文の注目した環境，戦略，組織という3つの変数の中の組織という変数に相当し，後者の外部的コンテクストが環境という変数に当たっている。したがって，環境（外部的コンテクスト）が変化すると，トップ・マネジメントがこうした外部環境の変化を分析し，それに対応できる戦略を策定し実施するように，内容→プロセスというマクロ・レベルの変化が起きる。これに対して組織内部で変化が起きると，プロセス→内容というミクロ・レベルの変化が発動される。以上のように，戦略内容論と戦略プロセス論を統合的モデルと関連付けることによって，戦略変化をマクロ・レベルとミクロ・レベルの2つの視点から説明することができる。

図５ 統合的モデルにおける内容とプロセスの関係



出所：蔡晨维（2005）

第3 に、共時的統合が組織の静態的な戦略選択（Strategic Selection）を意味することに対して、経時的統合は組織の動態的なプロセスである戦略変化（Strategic Change）を意味している。また、経時的統合モデルは、ダイナミクスな環境変化および複雑な戦略行動が織り成す複雑な状況を単純化したものであり、組織が環境、戦略自身および組織との間の相互関係を的確に認識し、ある時点に適切な戦略を選択し、またその相互関係が変化する際に戦略変化や戦略変更を管理することが戦略家にとってもっとも重要な課題である。

５．結論

本論文は，環境と組織の接点として戦略を捉え、多様なアプローチが林立している戦略論の現状を整理するための統合モデルを提示し、また組織と環境の相互関係を戦略論の議論を通じて検討した。要するに、戦略（Strategy）は、戦略統制（Strategized)と戦略形成(Strategizing)からなり、組織がいつもこの２つの概念から派生したパラダイム対立に直面し戦略選択を行い、また組織がこの2つのプロセスの繰り返しを通じて戦略変化が行われる。したがって、戦略論の全体像は、戦略統制の理論、戦略形成の理論、戦略選択及び戦略変化についての理論、の４つの重要な課題からなる。特に、戦略選択と戦略変化からなる戦略論の統合モデルによって、異なる組織階層、戦略に対する内外の異なるパワーの影響にいる戦略行動から生じたパラダイム対立、理論の対立関係を体系的に説明できる。また、このモデルには、戦略論の４つのアプローチが同時に組織内部に存在するのみならず、逐次的な関係をも示している。戦略論の４つのアプローチを共時的かつ経時的に、また静態的かつ動態的に統合することが、戦略統制と戦略形成の同時性を求めると同時に、戦略統制と戦略形成との間の戦略変化のプロセスをうまく管理するの重要性を意味している。

References

岸田民樹, 1985,『経営組織と環境適応』三嶺書房。

岸田民樹,2001,「組織論と統合的解釈モデル」『大阪大学経済学』第51 巻第２号，102-115 頁。

蔡展維, 2004,『戦略論の構図と統合的解釈』，『経済科学』，第52 巻，第3 号，pp.59-66.

蔡展維,2005,『戦略論の展開とその理論的構図』，日本国立名古屋大学大学院経済学研究科博士学位論文.

Andrews, K.R., 1987, "*The Concept of Corporate*," *Strategy* ,Irwin,（中村元一訳『経営幹部の全社戦略−全社最適像の構築・実現を求めて−』産能大学出版社，1991 年）.

Ansoff,I,1965, "*Corporate Strategy*," McGraw-Hill（広田壽亮訳『企業戦略論』産業能率大学出版部，1969 年）.

Ansoff,I. ,1990 , " *Implanting Strategic Management*,"Prentice-Hall（中村元一監訳『戦略経営の実践原理』ダイヤモンド社，1994 年）

Barney,J.B. ,2001 , "*Gaining and Sustaining Competitive Advantage*," Prentice Hall.

Burgelman,R.A,1983, "A Model of the Interaction of Strategic Behavior, Corporate Context, and the Concept of Strategy," *Academy of Management Review,* Vol.8,No.1,pp21-36.

Chandler,A.D,1962, "*Strategy and Structure: Chapters in the History of the American Industrial Enterprises*,"MIT Press（有賀裕子訳『組織は戦略に従う』ダイヤモンド社，2004 年）.

Dierickx,I.&K.Cool,1989, "Asset Stock Accumulation and Sustainability of Competitive Advantage," *Management Science*,Vol.35,pp.1504-1514.

Grant,R.M. ,1991, "The Resource-Based Theory of Competitive Advantage: Implications for Strategy Formulation," *California Management Review*, Vol.33,No.3, pp.114-135.

Hofer,C.W.&D.Schendel,1978, "*Strategy Formulation: Analytical Concepts*,"West Publishing（野中郁次郎・奥村昭博・榊原清則訳『戦略策定―その理論と手法―』千倉書房，1981 年）.

Mintzberg,H,2007, "*Tracking Strategies-Toward A General Theory*,"Oxford.

Porter,M.E. ,1980, " *Competitive Strategy*,"Free Press（土岐坤・中辻萬冶・服部照夫訳『競争の戦略』ダイヤモンド社，1982年）.

Porter,M.E. ,1985, "*Competitive Advantage*," Free Press（土岐坤・中辻萬冶・小野寺武夫訳『競争優位の戦略－いかに高業績を持続させるか－』ダイヤモンド社，1985 年）.

Rumelt,R.P. ,1984, "Towards a Strategic Theory of the Firm," in R.Lamb,(ed.) *Competitive Strategic*

Management,pp.556-570,Prentice-Hall.

Wernerfelt,B. ,1984, “A Resource-Based View of The Firm,” *Strategic Management Journal*,Vol.5,No.2,pp.171-180.

A Study of Grey Theory on Improving the Investment Performance of Technical Analysis Index —An Example of the Shenzhen Index's Component Stocks

Alex Kung-Hsiung Chang

Professor Dep. Of Business Administration, National Pingtung University of Science and Technology
1 Hsefu Rd. Neipu Pingtung, Taiwan 912
E-Mail: bear419@mail.npust.edu.tw

Kuei-Yi Lin

Director of Accounting, Neipu Junior High School, Pingtung Taiwan 912

ABSTRACT

Using the daily, weekly and monthly data of the Shenzhen Index's Component Stocks from January 2000 to May 2007 as examples, this paper try to improve the investment performance of technical analysis indices in China stocks market. First of all, this paper whitens original data through a grey model GM (1,1), and grey technical analysis indices are obtained. We use traditional technical analysis indices like RSI, BIAS, KD, and WMS%R as agency indices; compare the investment performance between original and grey technical analysis indices. Based on the empirical results, we find:

Eight of twelve technical analysis indexes can improve the performance of investment over 50% than original ones. Especially daily-KD and daily-RSI can improve the performance of investment over 60%. Obviously the results find that the performance of investment of post-GM(1,1) treatment were better than those of pre-GM(1,1) treatment. And the investors can use the grey technical analysis indexes to obtain higher investment returns in Shenzhen Stocks Market. But due to the pre and post-GM(1,1) treatment of technical analysis can't obtain extra profit than buy and hold strategy(BHS) , the weak-form market hypothesis in Shenzhen stocks market could not be rejected

Key Words: *GM (1, 1), Shenzhen Stocks Market, Technical Analysis, RSI, BIAS, KD, WMS%R.*

1. INTRODUCTION

Investing on stocks market is the main way of investment in China after 1978. Based on trading data, 85% of investors in the China Stocks Market are individual investors. Individual investors have over-confidence and less-risk control disorder under asymmetrical and uncompleted information. Under the physical distortion, likes fear and greed, investors have irrational behavior usually. (Chang and Chang, 2007)

According to Efficiency Market Hypothesis (EMH; Fama, 1970), investor will not have abnormal return using technical analysis indices under weak-form efficiency market. Under this opinion, if China stocks market were identical to weak-form efficiency market hypothesis, technical analysis indices would be useless. But, in fact most of individual investors in China stocks market use technical analysis as an important instrument in investment.

Academics and practitioners have discussed EMF and technical analysis useful over the past years. Researchers concluded EMH didn't exist in China stocks market before 1993.（Likes Yu, 1994, Kao, 1996）. But A lot of research showed that China stocks market is seemly identical to EMH, and technical analysis is not useful. (Likes Wei, 1998; Chow, 1998; Hu and Fang, 2000; Zhang and Chou, 2001; Chen, 2003; Lee, 2003; Liu, 2004; Xen, 2005)

Recently, a lot of academics try to improve the investment performance by modify technical analysis indices. Most of them focus on the artificial wisdom network. (Likes Tsai, 2001; Liu, 2001; Jen, 2001; Liu, 2003; Huang, 2004) But it's not customarily to individual investors.

This study intends to eliminate noise, increase accuracy of forecasting effectiveness using a grey forecasting model. The Grey forecasting model was used in the VAR model modify first in finance study.（Chang, 1997; Chang and Wu, 1998; Chang, Wu, and Lin, 2000; Chang, 2004; 2005） The results show that the Grey forecasting model could capture the securities price impulse, made the prices discovering process more stable. And the out-of-the-period forecasting accuracy had been increased.

The Grey Theorem founded by Deng (1983) has been applied in research in agriculture, engineering（likes Deng, Kao, Wen, Chang, and Chang, 1999; Wen, 2004）, but scarcely in business, especially finance.

Chang (1997) applied GM (1, 1) firstly in the study of transmission mechanism between security market, monetary market, and foreign exchange market in a VAR model. The result showed that GVAR could eliminate noise of markets, increase the accuracy of forecasting stock prices in the out-of-the-period.

Chang and Wu (1998) discussed seasonality about the Chinese Festival in China's Security Market using the Grey Forecasting Model. The results showed that the forecasting accuracy was better than that of a Moving Average Model.

Chang and Lu(2007) applied GM (1, 1) in the study of the investment performance by modify technical analysis indices. Using the Morgan Stanley Taiwan Index' Component Stocks from January 1998 to June 2004 as samples, the author found that the forecasting effectiveness and efficiency from the Grey

Forecasting Model on the investment performance are clearly excellent. The Grey Forecasting Model on the investment performance is a suited and good forecasting model.

This study wants to modify the original technical analysis indices to Grey ones, increase the ex-post investment performance effectively. Nest, sector 2 presents the methodology, sector 3 describes the data, sector 4 presents the results of study, and sector 5 presents conclusion.

2. METHODOLOGY

Let $X^{(0)}$ be a discrete function at t=1, 2, ... , n, such as,

$$x^{(0)} = (x^{(0)}(1), x^{(0)}(2), x^{(0)}(3), ..., x^{(0)}(n)) = (x^{(0)}(k); k = 1,2,3,....,n) \quad (1)$$

Let $X^{(1)}$ be an accumulated generating operation (AGO) of $X^{(0)}$, and $Z^{(0)}$ be mean of $X^{(1)}$, such as,

$$Z^{(1)}(k) = 0.5X^{(1)}(k) + 0.5X^{(1)}(k-1), \forall k \in \{2,3,...,n\} \quad (2)$$

AGO: $X^{(0)} \rightarrow X^{(1)}$, that is

$$AGO\{x^{(0)}(k)\} = x^{(1)}(k) = \left(\sum_{k=1}^{1} x^{(0)}(k), \sum_{k=1}^{2} x^{(0)}(k), .., .., \sum_{k=1}^{n} x^{(0)}(k) \right) \quad (3)$$

Suppose that GM is a modeling

GM: $X^{(1)} \rightarrow \hat{X}^{(1)}$.

And denotes the result of GM modeling by GM ($X^{(0)}(1)$; a, b), where a is the development coefficient of GM, b is the grey input, $X^{(0)}(1)$ is an initial value, if

$$\hat{a} = \begin{bmatrix} a \\ b \end{bmatrix} = (B^T B)^{-1} B^T Y_N \quad (4.1)$$

$$B = \begin{bmatrix} -z^{(1)}(2) & 1 \\ -z^{(1)}(3) & 1 \\ -z^{(1)}(4) & 1 \\ .... & \\ -z^{(1)}(n) & 1 \end{bmatrix}. \quad , \quad (4.2)$$

$$Y_N = \begin{bmatrix} x^{(0)}(2) \\ x^{(0)}(3) \\ x^{(0)}(4) \\ .... \\ x^{(0)}(n) \end{bmatrix} \tag{4.3}$$

$$\hat{x}(k+1) = \left(x^{(0)}(1) - \frac{b}{a} \right) e^{-ak} + \frac{b}{a} \quad \Leftrightarrow \quad \text{GM} \ (\text{X}^{(0)}(1);\ \text{a},\ \text{b}) \tag{5}$$

It's said to be a sequence defined in set k {1, 2, ….., n}.

Using inverse accumulated generating operation (IAGO), we could have a forecasting sequence.

$$\begin{aligned} & x^{(1)}(k) = x^{(1)}(k-1) + x^{(0)}(k) \Rightarrow \hat{x}^{(0)}(k) = \hat{x}^{(1)}(k) - \hat{x}^{(1)}(k-1), \\ & \hat{x}^{(r-1)}(k) = \hat{x}^{(r)}(k) - \hat{x}^{(r)}(k-1) \ , \\ & \hat{x}^{(0)}(k) = \hat{x}^{(1)}(\text{k}) - \hat{\text{x}}^{(1)}(k-1) . \end{aligned} \tag{6}$$

The sequences after GM (1, 1) above is called whiten sequences. And whiten sequences are used in the computation of technical analysis indices.

3. DATA

This study samples from the Shenzhen Index's component stocks from J January 2000 to May 2007. The component stocks of Shenzhen Index were listed on the Shenzhen Stocks Exchange Co. on 1 January 2006. After taking away samples which had not public offered before January 2003, we get 33 samples.

First of all, the raw trading data of samples are whitened using a GM (1, 1). Four technical analysis indices RSI, Bias, WMS%R, and K-D are constructed using raw and whitened trading data separately. According to the buy-sell rulers, we compare the investment performance among grey technical analysis indices strategy, original technical analysis indices strategy, and buy-and-hold strategy (BHS) separately. Three hypotheses are set as follow.

Hypothesis I: The investment performance using original technical analysis indices is better than the average return of the market.

Hypothesis II: The investment performance using grey technical analysis indices is better than the buy-and-hold strategy.

Hypothesis III: The investment performance using grey technical analysis indices is better than those using original technical analysis indices.

4. RESULTS

4.1 The investment performance of original technical strategy v.s. market index

According to table 1, we compare the investment performance using original technical analysis indices with market index (Shenzhen stocks market weighted index). The results show that,

（1） The investment performance of using original daily BIAS index strategy is better than market index by 6%, weekly KD index strategy is better than market index by 61%. The performance of using original daily RSI index strategy is better than market index by 70%. The performances of using original daily and weekly WMS%R index strategy are better than market index by 91% and 55% separately.

（2） The performances of using grey daily and monthly RSI index strategy are better than market index by 85% both separately. The performance of using grey daily WMS%R index strategy is better than market index by 91%.

Based on the empirical results, a lot of original and grey technical analysis indices' performances are better than the return of market index. The strategy using original or grey technical analysis indices could beat the market, investors can get risk premium on investment.

4.2 The investment portfolio performance using original and grey technical analysis indices v.s. buy-and-hold strategy

We compare the investment performance using original and grey technical analysis indices separately with buy-and-hold strategy (BHS). According to table 2, we find all of investment performances using original and grey technical analysis indices are not better than the buy-and-hold strategy. The weak-form market hypothesis in China stocks market could not be rejected.

4.3 The investment performance of grey technical strategy v.s. original technical strategy.

This study modifies the original technical analysis indices to grey ones, tries to increase the ex-post investment performance effectively. According to table 3, we compare the investment performance using grey technical analysis indices with that of original technical analysis indices. The results show that,

（1） The investment performance of using grey monthly KD index strategy better than the original index by 100%.

（2） The performances of using grey weekly RSI index strategy is better than the original index by 58%.

（3） The performance of using grey weekly WMS%R index strategy is better than the original index by 79%.

Based on above results, the investment performance of analysis indices strategy could be increased effectively using grey forecasting model.

Table 1 The investment performance of grey technical strategy and original technical strategy than market

	Daily BIAS	Weekly BIAS	Monthly BIAS	Daily KD	Weekly KD	Monthly KD	Daily RSI	Weekly RSI	Monthly RSI	Daily WMS%R	Weekly WMS%R	Monthly WMS%R
No. of examples	33	33	33	33	33	33	33	33	33	33	33	33
No. of better than market using original technical indices	25	0	15	7	20	8	23	9	11	30	23	3
Percentage of better than market using original technical indices	76%	0%	45%	21%	61%	24%	70%	27%	33%	91%	70%	9%
No. of better than market using grey technical indices	0	6	10	6	10	0	28	4	28	30	16	16
Percentage of better than market using grey technical indices	0%	18%	30%	18%	30%	0%	85%	12%	85%	91%	48%	48%

Table 2 The investment performance of grey technical strategy and original technical strategy than Buy and Hold Strategy

	Daily BIAS	Weekly BIAS	Monthly BIAS	Daily KD	Weekly KD	Monthly KD	Daily RSI	Weekly RSI	Monthly RSI	Daily WMS%R	Weekly WMS%R	Monthly WMS%R
No. of examples	33	33	33	33	33	33	33	33	33	33	33	33
No. of better than BHS using original technical indices	8	10	7	2	5	9	1	2	9	4	4	9
Percentage of better than BHS using original technical indices	24%	30%	21%	6%	15%	27%	3%	6%	27%	12%	12%	27%
No. of better than BHS using grey technical indices	8	8	8	3	7	6	1	3	9	6	3	10
Percentage of better than BHS using grey technical indices	24%	24%	24%	9%	21%	18%	3%	9%	27%	18%	9%	30%

Table 3 The investment performance of grey technical strategy v.s. original technical strategy

	Daily BIAS	Weekly BIAS	Monthly BIAS	Daily KD	Weekly KD	Monthly KD	Daily RSI	Weekly RSI	Monthly RSI	Daily WMS%R	Weekly WMS%R	Monthly WMS%R
No. of examples	33	33	33	33	33	33	33	33	33	33	33	33
No. of better	19	17	16	21	18	0	21	14	18	18	7	19
Percentage of better	58%	52%	48%	64%	55%	0%	64%	42%	55%	55%	21%	58%
No. of worse	14	16	17	12	15	33	12	19	15	15	26	14
Percentage of worse	42%	48%	52%	36%	45%	100%	36%	58%	45%	45%	79%	42%

5. CONCLUDING REMARK

This paper use traditional technical analysis indices like RSI, BIAS, KD and WMS%R as agency indices, try to improve the investment performance of technical analysis indices through a grey model GM (1,1). We compare the investment performance between original and grey technical analysis indices using the daily, weekly and monthly data of the Shenzhen Index's Component Stocks from January 2000 to May 2007 as examples. Based on the empirical result we find:

1. The investment performance using the original and grey technical indices are better than that of the Shenzhen stocks market weighed average index.
2. The investment performance using original and grey technical analysis indices are not better than that of buy-and-hold strategy separately. Based on the above results, the weak-form market hypothesis in Shenzhen stocks market could not be rejected.
3. The investment performance of technical indices can be increased more effectively through a grey forecasting model GM (1,1).

The investment performance of original technical analysis indices strategy increases significantly after using the grey technical analysis indices. Especially daily-KD and daily-RSI can improve the performance of investment over 60%. The results indicate that the performance of investment of post-GM(1,1) treatment were better than those of pre-GM(1,1) treatment. And the investors can use the technical analysis indexes of post-GM(1,1) treatment to obtain higher investment returns in Shenzhen Stocks Market.

References

Chang, K.H., 1997, A Grey VAR Model on Information Mechanism of Monetary Markets in Taiwan, *Doctor Dissertation, National Sun Yat-Sen University.*

Chang, K.H., 2004, Applying Grey Forecasting Model on the Systematic Risk Estimation: A Study of the MSCI World Index' Component Securities, *Journal of Grey System and Uncertainty* **7(2):** 113-120.

Chang, K.H., 2005, Applying Grey Forecasting Model on the Systematic Risk Estimation: A Case of the MSCI World' Component Securities Markets, *Journal of Grey System and Uncertainty* **8(1)**: 1-13.

Chang, K.H, and Y.F. Chang, 2007, An Empirical Study on Disposition Effect of Individual Investors in Taiwan, Money Watching and Credit Rating 64: 19-42.

Chang, K.H. and C.S. Wu, 1998, A Grey Time Series Model on Forecasting the Chinese New Year Effect in the Taiwan Stock Market, *Journal of The Chinese Grey System Association* **1**: 55-63.

Chang, K.H., and K. L. Lu, 2007, A Study of Grey Theory on Improving the Investment Performance of Technical Analysis Index —An Example of Morgan Stanley Taiwan Index' Component Stocks, 2007 IEEE International Conference on Grey System and Intelligent Services.

Chang, K.H., C.S. Wu, and T.Y. Lin, 2000, A Grey VAR Forecasting Model on the Long-term Information Transmission Mechanism intra the Taiwan Stock Market, *Journal of Management* **17(4)**: 591-623.

Chen, Chun-Chi, 2003, The Weak Form Efficiency Of B-Stock Market In China, *Master Dissertation, National Taipei University.*

Chou, Y.L., 1998, The Information Implication of Accounting Earning Discovery, Economic Research 7.

Deng, J., 1983, Grey Fuzzy forecast and control of grain, *Journal of Huazhong University of Science and Technology*, **11:** 1-9.

Deng, Kao, Wen, Chang, and Chang, 1999, *Grey Forecasting Methods and Applications*, Kao-Lih Press co, Taipei, Taiwan.

Hong, Z.H., 1999, An Empirical Study on the Investment Performance of KD, MACD, RSI, and WMS%R, *Master Dissertation, National Taiwan University.*

Huang Y.F., 2001, An Empirical Study on the Investment Performance of Dow Theory, Filter Ruler, and Buy-and-Hold Strategy, *Master Dissertation, National Cheng-Kung University.*

Hu, W. and L.J. Fang, 2004, The Weak Form Efficiency of Stocks Market In Shanghai Stocks Market, Fudan University.

Jen, S.S., 2001, An Empirical Study of Stocks Price Forecasting using MACD and Artificial Neural Model on the Taiwan Stocks Market, *Master Dissertation, Jin-Ih University.*

Kao, H. J., 1996, The Weak Form Efficiency of Stocks Market In China, The Academy of Xiaman University.

Lee, L.J., 2003, A Study on the Effectiveness of Technical Analysis, *Master Dissertation, She-Jen University.*

Liou, S.W., 2004, The Weak Form Efficiency of Stocks Market In China, *Master Dissertation, National Donhua University.*

Liu, W.S., 2001, An Empirical Study of Stocks Price Forecasting using Artificial Neural Model on the Taiwan Stocks Market, *Master Dissertation, National Kaohsiung First University of Science and Technology.*

Tsai, J.F., 2001, An Empirical Study of Stocks Price Forecasting using Artificial Neural Model on the Taiwan Stocks Market, *Master Dissertation, National Kaohsiung First University of Science and Technology.*

Wen, K.L., *Grey Systems: Modeling and Prediction* (Yang's Scientific Research Institute, LLC, 2004).

Wei, K., 1998, An Empirical Study on Public Corporate in China, Economic Research 6.

Xen, D.D., 2005, The Dynamic Efficiency of Stocks Market In China, Financial Class 21.

Yu, C., 1994, Market Efficiency, Seasonality, and Stocks Price Variance, Economic Research 5.

Zhang I.C., and I. Chou, 2001, A Study on the Weak Form Efficiency of Stocks Market In China, Modern Financial Economic 201.

A Study of Grey Theory on Improving the Investment Performance of Technical Analysis Index —An Example of the Dow Jones Industry Index's Component Stocks

Alex Kung-Hsiung Chang

Professor Dep. Of Business Administration, National Pingtung University of Science and Technology
1 Hsefu Rd. Neipu Pingtung, Taiwan 912
E-Mail: bear419@mail.npust.edu.tw

Jui-Lin Hsu

Testing Manufacturing Dept.,Walton Advanced Engineering Inc., Kaohsiung Taiwan 806

ABSTRACT

Using the daily, weekly and monthly data of the Dow Jones Industry Index's Component Stocks from January 1997 to September 2007 as examples, this paper try to improve the investment performance of technical analysis indices in New York Stocks Exchange Market. First of all, this paper whitens original data through a grey model GM (1,1), and grey technical analysis indices are obtained. We use traditional technical analysis indices like RSI, BIAS, KD, and WMS%R as agency indices; compare the investment performance between original and grey technical analysis indices. Based on the empirical results, we find:

Nine of twelve technical analysis indexes can improve the performance of investment over 60% than original ones. Especially daily-KD, daily-RSI, and daily-WMS%R can improve the performance of investment over 70%. Obviously the results find that the performance of investment of post-GM(1,1) treatment were better than those of pre-GM(1,1) treatment. And investors can use the grey technical analysis indexes to obtain higher investment returns in New York Stocks Exchange Market. But due to the pre and post-GM(1,1) treatment of technical analysis can't obtain extra profit than buy and hold strategy(BHS) , the weak-form market hypothesis in New York Stocks Exchange Market could not be rejected

***Key Words**: GM (1, 1), Dow Jones Industry Index, Technical Analysis, KD, RSI, BIAS, WMS%R.*

1. INTRODUCTION

Investing on stocks market is the main way of investment in USA after 1900. Based on trading data, fewer than 10% of investors in the America's Stocks Market are individual investors. Individual investors have over-confidence and less-risk control disorder under asymmetrical and uncompleted information. Under the physical distortion, likes fear and greed, investors have irrational behavior usually. (Chang and Chang, 2007)

According to Efficiency Market Hypothesis (EMH; Fama, 1965, 1970), investor will not have abnormal return using technical analysis indices under weak-form efficiency market. Under this opinion, if American stocks market were identical to weak-form efficiency market hypothesis, technical analysis indices would be useless. But, in fact some of investors in American stocks market use technical analysis as an important instrument in investment.

A lots of paper discussed EMH in United States of American, found Efficiency Market Hypothesis could be challenged, and some technical analysis indices could obtain abnormal returns. (Likes Bohan, 1981; Pruitt and Richard, 1988; Brock, William, Lakonishok and LeBaron, 1992; Levich and Thomas, 1993; Szakmary, Davidson, and Schwartz, 1999)

Recently, a lot of academics try to improve the investment performance by modify technical analysis indices. Most of them focus on the artificial wisdom network. (Likes Tsai, 2001; Liu, 2001; Jen, 2001; Liu, 2003; Huang, 2004) But it's not customarily to individual investors.

This study intends to eliminate noise, increase accuracy of forecasting effectiveness using a grey forecasting model. The Grey forecasting model was used in the VAR model modify first in finance study. （Chang, 1997; Chang and Wu, 1998; Chang, Wu, and Lin, 2000; Chang, 2004; 2005） The results show that the Grey forecasting model could capture the securities price impulse, made the prices discovering process more stable. And the out-of-the-period forecasting accuracy had been increased.

The Grey Theorem founded by Deng (1983) has been applied in research in agriculture, engineering (likes Deng, Kao, Wen, Chang, and Chang, 1999; Wen, 2004）, but scarcely in business, especially finance.

Chang (1997) applied GM (1, 1) firstly in the study of transmission mechanism between security market, monetary market, and foreign exchange market in a VAR model. The result showed that GVAR could eliminate noise of markets, increase the accuracy of forecasting stock prices in the out-of-the-period.

Chang and Lu (2007) applied GM (1, 1) in the study of the investment performance by modify technical analysis indices. Using the Morgan Stanley Taiwan Index' Component Stocks from January 1998 to June 2004 as samples, the author found that the forecasting effectiveness and efficiency from the Grey Forecasting Model on the investment performance are clearly excellent. The Grey Forecasting Model on the investment performance is a suited and good forecasting model.

This study wants to modify the original technical analysis indices to Grey ones, increase the ex-post investment performance effectively. Next, sector 2 presents the methodology, sector 3 describes the data, sector

4 presents the results of study, and sector 5 presents conclusion.

2. METHODOLOGY

Let $X^{(0)}$ be a discrete function at t=1, 2, ... , n, such as,

$$x^{(0)} = (x^{(0)}(1), x^{(0)}(2), x^{(0)}(3), ..., x^{(0)}(n)) = (x^{(0)}(k); k = 1,2,3,....,n) \quad (1)$$

Let $X^{(1)}$ be an accumulated generating operation (AGO) of $X^{(0)}$, and $Z^{(0)}$ be mean of $X^{(1)}$, such as,

$$Z^{(1)}(k) = 0.5X^{(1)}(k) + 0.5X^{(1)}(k-1), \forall k \in \{2,3,...,n\} \quad (2)$$

AGO: $X^{(0)} \rightarrow X^{(1)}$, that is

$$AGO\{x^{(0)}(k)\} = x^{(1)}(k) = \left(\sum_{k=1}^{1} x^{(0)}(k), \sum_{k=1}^{2} x^{(0)}(k), .., .., \sum_{k=1}^{n} x^{(0)}(k) \right) \quad (3)$$

Suppose that GM is a modeling

GM: $X^{(1)} \rightarrow \hat{X}^{(1)}$.

And denotes the result of GM modeling by GM ($X^{(0)}(1)$; a, b), where a is the development coefficient of GM, b is the grey input, $X^{(0)}(1)$ is an initial value, if

$$\hat{a} = \begin{bmatrix} a \\ b \end{bmatrix} = (B^T B)^{-1} B^T Y_N \quad (4.1)$$

$$B = \begin{bmatrix} -z^{(1)}(2) & 1 \\ -z^{(1)}(3) & 1 \\ -z^{(1)}(4) & 1 \\ .... & \\ -z^{(1)}(n) & 1 \end{bmatrix}., \quad (4.2)$$

$$Y_N = \begin{bmatrix} x^{(0)}(2) \\ x^{(0)}(3) \\ x^{(0)}(4) \\ .... \\ x^{(0)}(n) \end{bmatrix} \quad (4.3)$$

$$\hat{x}(k+1) = \left(x^{(0)}(1) - \frac{b}{a} \right) e^{-ak} + \frac{b}{a} \Leftrightarrow \text{GM } (X^{(0)}(1);\ a,\ b) \quad (5)$$

It's said to be a sequence defined in set k {1, 2, ….., n}.

Using inverse accumulated generating operation (IAGO), we could have a forecasting sequence.

$$x^{(1)}(k) = x^{(1)}(k-1) + x^{(0)}(k) \Rightarrow \hat{x}^{(0)}(k) = \hat{x}^{(1)}(k) - \hat{x}^{(1)}(k-1),$$

$$\hat{x}^{(r-1)}(k) = \hat{x}^{(r)}(k) - \hat{x}^{(r)}(k-1) \quad , \qquad (6)$$

$$\hat{x}^{(0)}(k) = \hat{x}^{(1)}(\mathrm{k}) - \hat{\mathrm{x}}^{(1)}(k-1).$$

The sequences after GM (1, 1) above is called whiten sequences. And whiten sequences are used in the computation of technical analysis indices.

3. DATA

This study samples from the Dow Jones Industry Index's component stocks from January 1997 to September 2007. The 30 component stocks sample of Dow Jones Industry Index were listed on the New York Stocks Exchange Co. (NYSE) at 1 January 2007.

First of all, the raw trading data of samples are whitened using a GM (1, 1). Four technical analysis indices RSI, Bias, WMS%R, and KD are constructed using raw and whitened trading data separately. According to the buy-sell rulers, we compare the investment performance among grey technical analysis indices strategy, original technical analysis indices strategy, and buy-and-hold strategy (BHS) separately. Three hypotheses are set as follow.

Hypothesis I: The investment performance using original technical analysis indices is better than the average return of the market.

Hypothesis II: The investment performance using grey technical analysis indices is better than the buy-and-hold strategy.

Hypothesis III: The investment performance using grey technical analysis indices is better than those using original technical analysis indices.

4. RESULTS

4.1 The investment performance of original technical strategy v.s. market index

According to table 1, we compare the investment performance using original technical analysis indices with market index (Dow Jones Industry Index). The results show that,

（1） The investment performance of using original daily and weekly and monthly BIAS index strategy are better than market index by 70% and 73.3% and 73.3% separately, original weekly and monthly KD index strategy are better than market index by 50%. The performance of using original daily and weekly RSI index strategy are better than market index by 76.7% and 76.7% . The performances of using original daily and weekly WMS%R index strategy are better than market index by 50% and 53.3% separately.

（2） The performances of using grey daily and weekly RSI index strategy are better than market index by 70% and 66.7% separately. The performance of using grey daily and monthly WMS%R index strategy are better than market index by 73.3% and 66.7%. The performance of using grey daily and weekly and monthly BIAS index strategy are better than market index by 76.7% and 73.3% and 83.3%separately.

Based on the empirical results, a lot of original and grey technical analysis indices' performances are better than the return of market index. The strategy using original or grey technical analysis indices could beat the market, investors can get risk premium on investment.

4.2 The investment performance using original and grey technical analysis indices v.s. buy-and-hold strategy

We compare the investment performance using original and grey technical analysis indices separately with buy-and-hold strategy (BHS). According to table 2, we find all of investment performances using original and grey technical analysis indices are not better than the buy-and-hold strategy. The weak-form market hypothesis in New York Stocks Exchange Market could not be rejected.

4.3 The investment performance of grey technical strategy v.s. original technical strategy.

This study modifies the original technical analysis indices to grey ones, tries to increase the ex-post investment performance effectively. According to table 3, we compare the investment performance using grey technical analysis indices with that of original technical analysis indices. The results show that,

（1） The performance of using grey daily and monthly BIAS index strategy are better than the original index by 66.7% and 66.7% separately.

（2） The investment performance of using grey daily KD index strategy is better than the original index by 76.7%.

（3） The performances of using grey daily and weekly RSI index strategy are better than the original index by 80% and 70% separately.

（4） The performance of using grey daily WMS%R index strategy is better than the original index by 70%.

Table 1 The investment performance of grey technical strategy and original technical strategy compared to market

	Daily BIAS	Weekly BIAS	Monthly BIAS	Daily KD	Weekly KD	Monthly KD	Daily RSI	Weekly RSI	Monthly RSI	Daily WMS%R	Weekly WMS%R	Monthly WMS%R
No. of examples	30	30	30	30	30	30	30	30	30	30	30	30
No. of better than market using original technical indices	21	22	22	13	15	15	23	23	14	15	16	12
Percentage of better than market using original technical indices	70%	73.3%	73.3%	43.3%	50%	50%	76.7%	76.7%	46.7%	50%	53.3%	40%
No. of better than market using grey technical indices	23	22	25	16	15	19	21	20	14	22	12	20
Percentage of better than market using grey technical indices	76.7%	73.3%	83.3%	53.3%	50%	63.3%	70%	66.7%	46.7%	73.3%	40%	66.7%

Table 2 The investment performance of grey technical strategy and original technical strategy compared to Buy and Hold Strategy

	Daily BIAS	Weekly BIAS	Monthly BIAS	Daily KD	Weekly KD	Monthly KD	Daily RSI	Weekly RSI	Monthly RSI	Daily WMS%R	Weekly WMS%R	Monthly WMS%R
No. of examples	30	30	30	30	30	30	30	30	30	30	30	30
No. of better than BHS using original technical indices	8	4	4	1	7	5	11	8	4	2	4	6
Percentage of better than BHS using original technical indices	26.7%	13.3%	13.3%	3.3%	23.3%	16.7%	36.7%	26.7%	13.3%	6.7%	13.3%	20%
No. of better than BHS using grey technical indices	9	8	6	6	6	7	12	9	5	3	4	6
Percentage of better than BHS using grey technical indices	30%	26.7%	20%	20%	20%	23.3%	40%	30%	16.7%	10%	13.3%	20%

Based on above results, the investment performance of analysis indices strategy could be increased effectively using grey forecasting model.

Table 3 The investment performance of grey technical strategy v.s. original technical strategy

	Daily BIAS	Weekly BIAS	Monthly BIAS	Daily KD	Weekly KD	Monthly KD	Daily RSI	Weekly RSI	Monthly RSI	Daily WMS%R	Weekly WMS%R	Monthly WMS%R
No. of examples	30	30	30	30	30	30	30	30	30	30	30	30
No. of better	20	19	20	23	18	16	24	21	17	21	18	16
Percentage of better	66.7%	63.3%	66.7%	76.7%	60%	53.3%	80%	70%	56.7%	70%	60%	53.3%
No. of worse	10	11	10	7	12	14	6	9	13	9	12	14
Percentage of worse	33.3%	36.7%	33.3%	23.3%	40%	46.7%	20%	30%	43.3%	30%	40%	46.7%

5. CONCLUDING REMARK

This paper use traditional technical analysis indices like RSI, BIAS, KD and WMS%R as agency indices, try to improve the investment performance of technical analysis indices through a grey forecasting model GM (1,1). We compare the investment performance between original and grey technical analysis indices using the daily, weekly and monthly data of the Dow Jones Industry Index's Component Stocks from January 1997 to September 2007 as examples. Based on the empirical result we find:

4. The investment performance using the original and grey technical indices is better than that of the Dow Jones Industry Index.
5. The investment performance using original and grey technical analysis indices are not better than that of buy-and-hold strategy separately. The weak-form market hypothesis in New York Stocks Exchange Market could not be rejected.
6. The investment performance of technical indices can be increased more effectively through a grey forecasting model GM (1,1).

The investment performance of original technical analysis indices strategy increases significantly after using the grey technical analysis indices. Especially daily-KD, daily-RSI, weekly-RSI, and daily-WMS%R can improve the performance of investment over 70%. The results indicate that the performance of investment of post-GM(1,1) treatment are better than those of pre-GM(1,1) treatment. And investors can use the technical analysis indexes of post-GM(1,1) treatment to obtain higher investment returns in New York Stocks Exchange Market.

References

Bohan and James, 1981, "Relative Strength: Further Positive Evidence." *Journal of Portfolio Management*, 7: 39~46.

Brock, William, Lakonishok, Josef and LeBaron Blake,1992, "Simple Technical Trading Rules and the Stochastic Properties of Stock Returns", *Journal of Finance*, 47: 1731-1764

Chang, K.H., 1997, A Grey VAR Model on Information Mechanism of Monetary Markets in Taiwan, *Doctor Dissertation, National Sun Yat-Sen University.*

Chang, K.H., 2004, Applying Grey Forecasting Model on the Systematic Risk Estimation: A Study of the MSCI World Index' Component Securities, *Journal of Grey System and Uncertainty* **7(2):** 113-120.

Chang, K.H., 2005, Applying Grey Forecasting Model on the Systematic Risk Estimation: A Case of the MSCI World' Component Securities Markets, *Journal of Grey System and Uncertainty* **8(1)**: 1-13.

Chang, K.H, and Y.F. Chang, 2007, An Empirical Study on Disposition Effect of Individual Investors in Taiwan, Money Watching and Credit Rating 64: 19-42.

Chang, K.H. and C.S. Wu, 1998, A Grey Time Series Model on Forecasting the Chinese New Year Effect in the Taiwan Stock Market, *Journal of The Chinese Grey System Association* **1**: 55-63.

Chang, K.H., and K. L. Lu, 2007, A Study of Grey Theory on Improving the Investment Performance of Technical Analysis Index —An Example of Morgan Stanley Taiwan Index' Component Stocks, 2007 IEEE International Conference on Grey System and Intelligent Services.

Chang, K.H., C.S. Wu, and T.Y. Lin, 2000, A Grey VAR Forecasting Model on the Long-term Information Transmission Mechanism intra the Taiwan Stock Market, *Journal of Management* **17(4)**: 591-623.

Deng, J., 1983, Grey Fuzzy forecast and control of grain, *Journal of Huazhong University of Science and Technology*, **11:** 1-9.

Deng, Kao, Wen, Chang, and Chang, 1999, *Grey Forecasting Methods and Applications*, Kao-Lih Press co, Taipei, Taiwan.

Fama, Eugene F., 1965, "The Behavior of Stock Market Prices", Journal of Business, 20: 34-105.

Fama, E. F., 1970, "Efficient Capital markets：A review of theory and empirical work", *Journal of Finance* 25.

Fama, Eugene F. and Marshall E. Blume, 1966, "Filter Rules and Stock Market Trading", *Journal of Business* 39: 226-241.

Fama, E. F., 1991, "Efficient Capital Markets：A Review of Theory and Empirical Work II", *Journal of Finance*, 46(5): 1575-1617.

Hong, Z.H., 1999, An Empirical Study on the Investment Performance of KD, MACD, RSI, and WMS%R, *Master Dissertation, National Taiwan University.*

Huang Y.F., 2001, An Empirical Study on the Investment Performance of Dow Theory, Filter Ruler, and Buy-and-Hold Strategy, *Master Dissertation, National Cheng-Kung University.*

Jen, S.S., 2001, An Empirical Study of Stocks Price Forecasting using MACD and Artificial Neural Model on the Taiwan Stocks Market, *Master Dissertation, Jin-Ih University.*

Levich, Richard M. and Lee R. Thomas, 1993, The Significance of Technical Trading-rule Profits in the Foreign Exchange Markets: A Bootstrap Approach, *Journal of International Money and Finance*, 12: 451-474.

Pruitt, S.W. & E.W. Richard, 1988, "The CRISMA Trading System: Who Says Technical Analysis Can't Beat the Market?" *Journal of Portfolio Management*, pp 55 ~ 58.

Liu, W.S., 2001, An Empirical Study of Stocks Price Forecasting using Artificial Neural Model on the Taiwan Stocks Market, *Master Dissertation, National Kaohsiung First University of Science and Technology.*

Szakmary, A., W.N. Davidson, and T.V. Schwartz, 1999, "Filter Tests in NASDAQ Stocks Market", *The Financial Review* 34: 45-70.

Tsai, J.F., 2001, An Empirical Study of Stocks Price Forecasting using Artificial Neural Model on the Taiwan Stocks Market, *Master Dissertation, National Kaohsiung First University of Science and Technology.*

Wen, K.L., *Grey Systems: Modeling and Prediction* (Yang's Scientific Research Institute, LLC, 2004).

Implementing Option Pricing Models when Asset Returns Follow an Autoregressive Moving Average Process

Chou-Wen Wang
Associate Professor, Department of Risk Management and Insurance,
National Kaohsiung First University of Science and Technology, Taiwan
E-Mail: chouwen1@ccms.nkfust.edu.tw

Chin-Wen Wu
Assistant Professor, Department of Finance & Institute of Financial Management,
Nanhua University, Taiwan
E-Mail: chinwenwu813@gmail.com

ABSTRACT

Motivated by the empirical findings that asset returns or volatilities are predictable, this paper studies the pricing of European options on stock or volatility, the instantaneous changes of which depend upon an autoregressive moving average (ARMA) process. An ARMA process transforms to an MA process with new MA orders which depends on the observed time span under a risk-neutral probability measure. The pricing formula of an ARMA-type option is similar to that of Black and Scholes, except that the total volatility input depends upon the AR and MA parameters. Based on the results of numerical analyses, the option values are increasing functions of the levels of AR or MA parameters for all moneyness levels. Specifically, the AR effect is more significant than the MA effect.

1. INTRODUCTION

The pricing, hedging and risk management of derivatives is important because derivatives are now widely used to transfer risk in financial markets. At first, these options were priced and hedged using the classic Black–Scholes assumptions. In particular, it was assumed that stock price returns follow a geometric Brownian motion; however, it has been well-documented using empirical data that stock dynamics under the physical measure follow a more complicated process than the standard geometric Brownian motion. Hence, various extensions of the standard model have been proposed.

As pointed out by Lo and Wang (1995), there is now a substantial body of evidence that documents the predictability of financial asset returns. In addition to the mean-reverting model, the autoregressive moving average process (ARMA process) is one of the most popular models used to describe predictable financial asset returns. For example, Fama (1965) finds that the first-order autocorrelations of daily returns are positive for 23 of 30 Dow Jones Industrials. Fisher (1966) suggests that the autocorrelations of monthly returns on diversified portfolios are positive and larger than those for individual stocks. Gençay (1996) uses the daily Dow Jones Industrial Average Index from 1963 to 1988 to examine predictability of stock returns with buy-sell signals generated from the moving average rules. Lo and MacKinlay (1988) find that weekly returns on portfolios of NYSE stocks grouped according to size show positive autocorrelation. Similarly, Conrad and Kaul (1988) also present positive autocorrelations of Wednesday-to-Wednesday returns for size-grouped portfolios of stocks. Lo and MacKinlay (1990) report positive serial correlations in weekly returns for indices and portfolios and negative serial correlations for individual stocks. Chopra, Lakonishok and Ritter (1992), De Bondt and Thaler

(1985), Fama and French (1988), French and Roll (1986), Jegadeesh (1990), and Lehmann (1990) all find negatively serial correlations in returns of individual stocks or various portfolios.

It is also well known that the value of an option may depend on the log-price dynamics of underlying. The stock price process under Black–Scholes assumptions is a geometric Brownian motion, which implies an independently incremental property in stock returns. Distinguishing between the risk-neutral and true distributions of an option's underlying asset return process, Grundy (1991) shows that the Black-Scholes formula still holds, even though the underlying asset returns follow an Ornstein-Uhlenbeck (O-U) process. Along this line of research, Lo and Wang (1995) followed price options on an asset with a trending O-U process by using the Black-Scholes formula with an adjustment for predictability. They showed that as long as an Ito process with a constant diffusion coefficient describes the underlying asset's log-price dynamics, the Black-Scholes formula yields the correct option price regardless of the specification and arguments of the drift. Liao and Chen (2006) derive the closed-form formula for a European option on an asset, the returns of which follow a continuous-time type of first-order moving average process. The pricing formula of these options is similar to that of Black and Scholes, except for the volatility input. The first-order MA parameter is significant to option values even if the autocorrelation between asset returns is weak. However, there exist no studies concerning the extent to whether the Black-Scholes formula still holds when asset returns follow a generalized ARMA process. From the numerical analysis introduced later, the impact of AR parameters on the option value is more significant than is the MA effect, which shows that it is important to derive the pricing formula of European options with the instantaneous return of underlying assets following an ARMA process. Thus, the main goal herein is to fill-in this gap by introducing a continuous-time type of ARMA process, which is consistent with the findings in empirical studies, and to price European stock options by using the martingale pricing method.

The underlying asset's log-price dynamics in this study are similar to the discrete-time model used by Jokivuolle (1998) and the continuous-time one used by Liao and Chen (2006). Specifically, Jokivuolle (1998) values a European option on observed stock index returns which are specified as an infinite-order moving average process which is assumed to be different from true index returns. However, unlike Jokivuolle (1998), the process of asset returns in this study is a continuous-time type of ARMA process and the observed and true returns are identical, which is a common assumption in the martingale pricing methods. Furthermore, the MA(1) process used by Liao and Chen (2006) is the special case of the ARMA process, in which the AR order is zero and the MA order equals one. The MA order in Liao and Chen (2006) model is unchanged, but the ARMA process transforms to an MA process in which the new MA orders depend on the observed time span under risk-neutral probability measure.

2. DISCRIPTION OF THE MODEL

In this section, an ARMA process, which is composed of the AR effect on the drift term and the MA effect on the diffusion term of the instantaneous stock return, is first described; consequently, MA(1) process used by Liao and Chen (2006) is the special case of the ARMA process, in which the AR order is zero and the MA order equals one. The martingale measure, which makes the discounted stock price into a martingale, is also defined.

The ARMA process under physical measure becomes a MA process under martingale measure, the MA order of which depends upon the time span.

2.1 An ARMA Process of Instantaneous Asset Returns

Without loss of generality, this paper represents the underlying assets including dividends as *S*. The current time is t_0 and the expiration date of the options considered here is *T*. Since the stock returns of an autoregressive moving average process are a common finding in empirical studies, and as one actually observes a (negative) autocorrelation at very short lags in high-frequency return series, this paper introduces an ARMA process and assumes the dynamics of the instantaneous asset return as follows:

$$d\ln S_t = \mu\, dt + \sum_{i=1}^{p} \alpha_i\, d\ln S_{t-ih} + \sum_{j=0}^{q} \sigma \beta_j\, dW^P_{t-jh} \tag{1}$$

where *p* and *q,* respectively, denote the AR and MA orders, α_i and β_j are the AR and MA coefficients and $\beta_0 = 1$. μ is an arbitrary constant, $\sigma > 0$ is a constant volatility coefficient, $dt > 0$ is an infinitesimal time interval and $h > 0$ is a fixed, but arbitrary, small constant. In addition, W_t^P is a one-dimension standard Brownian motion defined in a naturally filtered probability space $\left(\Omega, \Im, P, (\Im_t)_{t\in[0,T]}\right)$ and dW^P_{t-ih}, $i = 1,\ldots,N$, are the instantaneous increments of the standard Brownian motion at time $t-ih$. For empirical work, *h* is restricted by the frequency of historical data. It is convenient to assume that $T \in [t_N, t_{N+1})$, where $t_n = t_0 + nh$, $n = 0,\ldots,N$. It is worth noting that Equation (1) reduces to the continuous-time MA(1) process in Liao and Chen (2006) when the AR and MA coefficients are all zero except for $\beta_0 = 1$ and $\beta_1 = \beta$.

To show the iterating procedure for an ARMA process, it follows from Equation (1) that

$$d\ln S_{t-\eta h} = \mu\, dt + \sum_{i=1}^{p} \alpha_i\, d\ln S_{t-(\eta+i)h} + \sum_{j=0}^{q} \sigma \beta_j\, dW^P_{t-(\eta+j)h}, \eta = 0,\ldots,N \tag{2}$$

By substituting the right hand side of Equation (2) for $d\ln S_{t-ih}$ in Equation (1) step-by-step for $i = 1,\ldots,n$, the dynamics of the stock price can be represented in the following Lemma.

Lemma 1. *Assume that the underlying stock price process S satisfies Equation (1). Given that* $y_1(-1) = 1$, $y_i(0) = \alpha_i$ *and* $\theta_j(0) = \beta_j$ *where* $i = 1,\ldots,p$ *and* $j = 0,\ldots,q$, *repeated substitution in Equation (1) n times yields*

$$d\ln S_t = \mu\left(\sum_{j=0}^{n} y_1(j-1)\right)dt + \sum_{j=1}^{p} y_j(n)\, d\ln S_{t-(n+j)h} + \sigma\sum_{j=0}^{n+q} \theta_j(n)\, dW^P_{t-jh} \tag{3}$$

where

$$y_j(k) = \alpha_j\, y_1(k-1) + 1_{(j<p)}\, y_{j+1}(k-1), \qquad for\ \ j = 1,\ldots,p \tag{4}$$

$$\theta_j(k) = \begin{cases} \beta_{j-k}\, y_1(k-1) + 1_{(j<k+q)}\, \theta_j(k-1) & if \quad j \geq k \\ \theta_j(j) & if \quad j < k \end{cases} \tag{5}$$

Two important modeling issues concerning Equation (1) should be discussed. First, is the price process specified in Equation (1) used plausibly to represent security price fluctuations? Second, does the price process specified in Equation (1) rule out arbitrage opportunities? For the first issue, Harrison and Pliska (1981) demonstrate that as long as the discounted price process is a martingale under risk neutral probability measure *Q* equivalent to *P*, then the price process can be used to represent security price fluctuations. As for the second issue, it is well known that there are no arbitrage opportunities if and only if risk neutral probability measure *Q*

exists. For expository purposes, the preceding condition will be checked in the next section.

2.2 Martingale Property of an ARMA Process

To price the financial derivatives written on a stock *S*, it is more convenient to have a risk-free security. Suppose the risk-free interest rate *r* is constant over the trading interval [0, *T*] and the saving account, denoted by *B*, is assumed to continuously compound in value at rate r; that is,

$$dB_u = r\,B_u\,du \quad ,\forall u \in [0,T]. \tag{6}$$

where equivalently, $B_t = e^{rt}$ with the usual convention that $B_0 = 1$. For $t \in [t_n, t_{n+1})$, the dynamics of the stock prices in (3) are equivalent to the following Itô integral equation:

$$\ln(S_t/S_{t_0}) = r(t-t_0) + Y_n(t_0,t) + Z_n^P(t_0,t), \quad \forall t \in [t_n, t_{n+1}),\ n=0,\ldots,N \tag{7}$$

where

$$Y_n(t_0,t) = \left[\mu\sum_{i=0}^{n} y_1(i-1) - r\right](t-t_0) + \sum_{i=1}^{p} y_i(n)\int_{t_0}^{t} d\ln s_{u-(n+i)h}$$
$$+ \sigma\sum_{i=n+1}^{n+q}\theta_i(n)\int_{t_0}^{t} dw^P_{u-ih} + \sigma\sum_{i=0}^{n}\theta_i(i)\int_{t_0}^{t_i} dw^P_{u-ih} \tag{8}$$

$$Z_n^x(t_0,t) = \sigma\sum_{i=0}^{n}\theta_i(i)\int_{t_i}^{t} dW^x_{u-ih}\ , \quad x = P, Q,\ R \tag{9}$$

Conditioning on $\Im_{t_0}$, $d\ln s_{u-(n+i)h}$ and dw^P_{u-ih} in Equation (8) are the realized past increments of the log-price and Brownian motion, respectively. As the paths of stock price and the Brownian motion prior to the time t_0 are known, $Y_n(t_0,t)$ is $\Im_{t_0}$-measurable. In addition, rearranging $Z_n^P(t_0,t)$ as the sum of independent increments of Brownian motion, Equation (11) can be rewritten as follows:

$$Z_n^P(t_0,t) = \sigma\sum_{i=0}^{n}\theta_i(i)\int_{t_0}^{t-ih} dW_u^P = \sigma\left[\theta_0(0)\int_{t_0}^{t} dW_u^P + \theta_1(1)\int_{t_0}^{t-h} dW_u^P + \ldots + \theta_n(n)\int_{t_0}^{t-nh} dW_u^P\right]$$
$$= 1_{(n>0)}\left(\sigma\sum_{j=0}^{n-1}\left[\sum_{i=0}^{j}\theta_i(i)\right]\int_{t-(j+1)h}^{t-jh} dW_u^P\right) + \sigma\left[\sum_{i=0}^{n}\theta_i(i)\right]\int_{t_0}^{t-nh} dW_u^P \tag{10}$$

where 1_D is the indicator function, the value of which is 1 if *D* occurs and 0 otherwise. Therefore, the mean of geometric stock return at time *t* conditional on $\Im_{t_0}$ is

$$E_P\left(\ln(S_t/S_{t_0})\,\middle|\,\Im_{t_0}\right) = r(t-t_0) + Y_n(t_0,t) \tag{11}$$

and the conditional variance obtained by using the independently incremental property of Brownian motion is given by

$$V_n(t_0,t) \equiv Var_P\left(\ln(S_t/S_{t_0})\,\middle|\,\Im_{t_0}\right) = \sigma^2\left(1_{(n>0)}\sum_{j=0}^{n-1}\left(\sum_{i=0}^{j}\theta_i(i)\right)^2 h + \left(\sum_{i=0}^{n}\theta_i(i)\right)^2(t-t_n)\right) \tag{12}$$

Based on the risk-neutral pricing theory, pricing the ARMA-type contingent claims is done under the martingale probability measure *Q* which makes the discounted stock price $\widetilde{S}_t = S_t/B_t$ into a Q-martingale, which can be represented as

$$E_Q\left(\widetilde{S}_u\,\middle|\,\Im_{t_0}\right) = \widetilde{S}_{t_0} \quad ,\forall u \in [t_0,T] \tag{13}$$

Based on both the dynamics of the stock price in Equation (9) and the definition of martingale measure *Q*, the transformation from probability measure *P* to *Q* is shown in the following Lemma.

Lemma 2. *Assume that the dynamics of underlying stock price S satisfies Equation (1). The predictable process H defined as*

$$H_n(x,y)=\int_x^y \varphi(z)dz \text{, if } t_n \le x \le y \le t_{n+1}, n=0,\ldots,N \tag{14}$$

satisfies

$$H_n(t_n,t)=\frac{-\left(Y_n(t_0,t)+G_n(t_0,t)+\frac{1}{2}V_n(t_0,t)\right)}{\sigma},\ \forall t\in[t_n,t_{n+1}), \tag{15}$$

where

$$G_n(t_0,t)=\begin{cases} 1_{(n>1)}\,\sigma\sum_{j=0}^{n-1}\left(\sum_{i=0}^{j}\theta_i(i)\right)\left[H_{n-j-1}\left(t-(j+1)h,t_{n-j}\right)+H_{n-j}\left(t_{n-j},t-jh\right)\right] \\ +\sigma\left[H_{n-1}\left(t-h,t_n\right)+\left(\sum_{i=0}^{n}\theta_i(i)\right)H_0\left(t_0,t-nh\right)\right] & \text{if } t\in[t_n,t_{n+1}),\ n\ge 1 \\ 0 & \text{if } t\in[t_0,t_1) \end{cases} \tag{16}$$

and φ *is an real- valued process. Then the process* W_t^Q*, which is given by the formula*

$$dW_t^Q=dW_t^P-\varphi(t)\,dt,\ \forall t\in[t_0,T], \tag{17}$$

follows a one-dimensional Brownian motion on the probability space $(\Omega,\Im,Q)$.

In view of Lemma 2, the dynamics of the stock price defined in Equation (9) under martingale measure *Q* becomes

$$\ln(\widetilde{S}_t/\widetilde{S}_{t_0})=Z_n^Q(t_0,t)-\frac{1}{2}V_n(t_0,t),\ \forall t\in[t_n,t_{n+1}), n=0,\ldots,N \tag{18}$$

Since the quadratic variation of $Z_n^Q(t_0,t)$ over $[t_0,t]$ equals $V_n(t_0,t)$, as proved by Klebaner (1998, p.111), Equation (18) is the unique solution of the stochastic differential equation $dU_t=U_t\,dZ_n^Q(t_0,t)$, where $U_t=\widetilde{S}_t/\widetilde{S}_{t_0}$ and $U_{t_0}=1$. Or equivalently, the dynamics of the stock price conditional on $\Im_{t_0}$ is as follows:

$$\frac{dS_t}{S_t}=r\,dt+\sum_{i=0}^{n}\theta_t(i)\,dW_{t-ih}^Q,\ \forall t\in[t_n,t_{n+1}) \tag{19}$$

By virtue of (19), it suggests that the instantaneous stock returns, an ARMA process under physical measure P, follows a MA process under martingale measure *Q*, the MA order of which depends upon the integer part of time span $t-t_0$ divided by *h*. Besides, the new MA parameters $\theta_t(i)$ are affected by the original AR and MA parameters.

2.3 ARMA OPTION PRICING MODEL

Taking plain vanilla European call and put options as examples, the payoffs at the expiry date *T* are correspondingly $Max(S_T-K,0)$ and $Max(K-S_T,0)$, where *K* is the strike price. The time-t_0 values of European call options C_{t_0} and European put options P_{t_0} are given by

$$C_{t_0}=e^{-r(T-t_0)}E_Q\left[Max(S_T-K,0)\,\middle|\,\Im_{t_0}\right],\quad P_{t_0}=e^{-r(T-t_0)}E_Q\left[Max(K-S_T,0)\,\middle|\,\Im_{t_0}\right] \tag{20}$$

The pricing formulas of them are provided in the following Theorem.

Theorem 1. Assuming that the dynamics of the underlying stock prices are given by Equation (1), the

closed-form solutions for the ARMA(p, q)-type European options are as follows:

$$C_{t_0} = S_{t_0}\,\Phi\left(d_{1N}(t_0,T)\right) - K e^{-r(T-t_0)}\,\Phi\left(d_{2N}(t_0,T)\right) \tag{21}$$

$$P_{t_0} = K e^{-r(T-t_0)}\,\Phi\left(-d_{2N}(t_0,T)\right) - S_{t_0}\,\Phi\left(-d_{1N}(t_0,T)\right) \tag{22}$$

where

$$d_{1z}(t,s) = \frac{\ln\frac{S_t}{K} + \left(r + \frac{1}{2}\sigma_z^2(t,s)\right)(s-t)}{\sigma_z(t,s)\sqrt{s-t}},\quad d_{2z}(t,s) = d_{1z}(t,s) - \sigma_z(t,s)\sqrt{s-t}, \tag{23}$$

$$\sigma_z^2(t,s) = \frac{V_z(t,s)}{s-t}, \tag{24}$$

z is the integer part of $(s-t)/h$ *for* $s \geq t$ *and* $\Phi(\cdot)$ *is the cumulative probability of an standard normal distribution.* The proof of Theorem 1 is in Appendix C.

2.4 NUMERICAL ANALYSES OF ARMA-TYPE OPTIONS

To gauge the ARMA effect of stock return on the option's value, a one-month maturity European call option on stock is considered here, the instantaneous return of which follows ARMA(1,1) process. The initial stock price and volatility are set to 40 and 30%, respectively. The risk-free interest rate is 5%. Moreover, the ARMA effect on option price may depend on the strike price of the European call option. Hence, regarding the strike price, three target options are considered: an in-the-money (ITM), an at-the-money (ATM), and out-of-the-money (OTM) call option (K=90, 100, and 110, respectively).

[Insert Table 1 here]

Table 1 shows the ratio of one-month maturity ARMA(1,1)-type option prices in terms of BSM prices across different combinations of AR and MA parameters and various moneyness levels of the target option. Obviously, the option values increase as the level of AR or MA parameters increases for all moneyness levels. In particular, the AR effect on ARMA(1,1)-type option prices is more significant than the MA effect. To illustrate, in the case of $\alpha_1 = 0$, the absolute ratio increments for ITM, ATM, and OTM options are, respectively, 12.09% (108.55%-96.46%), 90.36% (145.68%-55.32%) and 273.79% (279.46%-5.67%) as β_1 changes from -0.5 to 0.5. In the case of $\beta_1 = 0$, however, the absolute ratio increments for ITM, ATM, and OTM options are, respectively, 22% (118.96%-96.96%), 118.94%(188.65%-69.71%), and 458.41%(481.51%-23.1%), as α_1 changes from -0.5 to 0.5. Thus, the AR effects dominate the MA effects for all moneyness levels.

In the case of $\alpha_1 + \beta_1 = 0$ (in the main diagonal for each Panel), the ARMA(1,1)- type option prices are equal to the BSM prices, which indicates that ignoring the impacts of an autocorrelation induced by AMRA-type process may not lead to a mispricing problem. However, in view of (14"), if $\alpha_1 + \beta_1 > 0$ $(\alpha_1 + \beta_1 < 0)$ resulting in $\sigma_n^2(t_0,t) > \sigma^2$ $(\sigma_n^2(t_0,t) < \sigma^2)$, the BSM prices undervalues (overprices) the ARMA(1,1)-type option prices. In particular, it is also observed that the impact of $\alpha_1 + \beta_1$ is asymmetric for all moneyness levels. For example, in the case of the ITM option, the ARMA(1,1)-type option price is higher than the BSM price by 43.67% when $\alpha_1 = \beta_1 = 0.5$ and is lower than the BSM price by 3.64% as $\alpha_1 = \beta_1 = -0.5$. Accordingly, in the case of lower values of the AR and MA parameters and the smaller strike prices, it is obvious that the difference between the ARMA(1,1)-type call prices and BSM prices is insignificant.

Given the AR or MA parameters, the absolute percentage differences between the BSM prices and the ARMA(1,1)-type option prices depend on the moneyness level. The absolute difference is maximized for ITM options and it is minimized for the OTM options. For example, the percentage absolute differences, which are correspondingly 3.64% (100%-96.36%), 58.65%(100%-41.35%) and 99.64%(100%-0.36%) for ITM, ATM and OTM options in the case of $\alpha_1 = \beta_1 = -0.5$, are likewise 1.4367, 2.7771 and 9.4161 times the BSM price for the ITM, ATM and OTM options when $\alpha_1 = \beta_1 = 0.5$, which indicates that the ARMA effects on option values depend not only on the level of AR and MA parameters but also the moneyness of the target option.

3. CONCLUSIONS

The evidence shows that daily, weekly and monthly returns are predictable from past returns. Motivated by the empirical findings that asset returns or volatilities are predictable, this paper studies the pricing of European options on the stock or volatility, the instantaneous logarithm increments of which depend upon an autoregressive moving average (ARMA) process. The dynamic for instantaneous stock return, an ARMA process under physical measure, transforms into an MA process with new MA orders depending on the observed time span under a risk-neutral probability measure. The pricing formula of an ARMA-type option is similar to BSM formula, except for the total volatility input depending upon the AR and MA parameters. Consequently, the implied volatility estimated from the BSM formula can be successfully interpreted as one calculated from an ARMA-type option formula. Specifically, this finding demonstrates that the BSM implied volatility is also valid even if the instantaneous stock returns follow an ARMA process.

In the absence of ARMA effects, the ARMA option pricing formula, indeed, reduces to the BSM pricing formula. When the AR and MA parameters are equal to zero (except for the first order MA coefficient), the ARMA option pricing formula reduces to the MA(1)-type option formula of Liao and Chen (2006). Furthermore, the ARMA-type option prices eventually converge to the BSM price when the time-to-maturity is approaching to zero. This result is in agreement with the assumption of Roll (1977), Duan (1995), Heston and Nandi (2000) and Liao and Chen (2006), where the option value with one period to expiration obeys the BSM formula. Based on the result of numerical analyses, the option values are increasing functions of the level of AR or MA parameters for all moneyness levels. Specifically, the AR effect is more significant than the MA effect.

APPENDIX A

The Proof of Lemma 1

Equation (1) can be proved by using mathematical induction. First, for the case of $n = 1$, by eliminating $d \ln S_{t-h}$ in Equation (1), the dynamics of the stock price can be represented as follows:

$$\begin{aligned} d \ln S_t &= \mu(1+\alpha_1)dt + \sum_{i=1}^{p-1}(\alpha_i \alpha_1 + \alpha_{i+1}) d \ln S_{t-(i+1)h} + \alpha_p \alpha_1 d \ln S_{t-(p+1)h} \\ &\quad + \sigma\, dW_t^P + \sum_{j=1}^{q}(\beta_{j-1}\alpha_1 + \beta_j) dW_{t-jh}^P + \beta_q \alpha_1 dW_{t-(q+1)h}^P \\ &= \mu\left(\sum_{i=0}^{1} y_1(i-1)\right)dt + \sum_{i=1}^{1} y_i(1)\, d \ln S_{t-(i+1)h} + \sigma \sum_{i=0}^{q+1} \theta_i(1) dW_{t-ih}^P \end{aligned} \tag{A.1}$$

Consequently, Equation (3) holds for the case of $n = 1$. Assume that Equation (3) is valid for $n = k$, i.e.,

$$\begin{aligned} d \ln S_t &= \mu\left(\sum_{i=0}^{k} y_1(i-1)\right)dt + \sum_{i=1}^{p} y_i(k)\, d \ln S_{t-(k+i)h} + \sigma \sum_{i=0}^{k+q} \theta_i(k) dW_{t-ih}^P \\ &= \mu\left(\sum_{i=0}^{k} y_1(i-1)\right)dt + y_1(k)\, d \ln S_{t-(k+1)h} + \sum_{i=1}^{p-1} y_{i+1}(k)\, d \ln S_{t-(k+i+1)h} \\ &\quad + \sigma \sum_{i=0}^{k} \theta_i(i) dW_{t-ih}^P + \sigma \sum_{i=k+1}^{k+q} \theta_i(k) dW_{t-ih}^P \end{aligned} \tag{A.2}$$

Eliminating $d \ln S_{t-(k+1)h}$ in Equation (A.2), the dynamics of the stock price satisfies:

$$\begin{aligned} d \ln S_t &= \mu\left(\sum_{i=0}^{k} y_1(i-1)\right)dt + y_1(k)\left(\mu\, dt + \sum_{i=1}^{p} \alpha_i\, d \ln S_{t-(k+i+1)h} + \sum_{j=0}^{q} \sigma \beta_j\, dW_{t-(k+j+1)h}^P\right) \\ &\quad + \sum_{i=1}^{p-1} y_{i+1}(k)\, d \ln S_{t-(k+i+1)h} + \sigma \sum_{i=0}^{k} \theta_i(i) dW_{t-ih}^P + \sigma \sum_{i=k+1}^{k+q} \theta_i(k) dW_{t-ih}^P \\ &= \mu\left(\sum_{i=0}^{k+1} y_1(i-1)\right)dt + \sum_{i=1}^{p-1}\left[\alpha_i\, y_1(k) + y_{i+1}(k)\right] d \ln S_{t-(k+i+1)h} + \alpha_p y_1(k)\, d \ln S_{t-(k+p+1)h} \\ &\quad + \sigma \sum_{i=0}^{k} \theta_i(i) dW_{t-ih}^P + \sigma \sum_{j=k+1}^{k+q}\left[\beta_{j-(k+1)} y_1(k) + \theta_j(k)\right] dW_{t-jh}^P + \sigma \beta_q y_1(k)\, dW_{t-(k+q+1)h}^P \\ &= \mu\left(\sum_{i=0}^{k+1} y_1(i-1)\right)dt + \sum_{i=1}^{p} y_i(k+1)\, d \ln S_{t-(k+i+1)h} + \sigma \sum_{j=0}^{k} \theta_j(j) dW_{t-jh}^P + \sigma \sum_{j=k+1}^{k+q+1} \theta_j(k+1)\, dW_{t-jh}^P \\ &= \mu\left(\sum_{i=0}^{k+1} y_1(i-1)\right)dt + \sum_{i=1}^{p} y_i(k+1)\, d \ln S_{t-(k+i+1)h} + \sigma \sum_{j=0}^{(k+1)+q} \theta_j(k+1)\, dW_{t-jh}^P \end{aligned} \tag{A.3}$$

where $\theta_j(j) = \theta_j(k+1)$, for $j \le k$, is used in the last equation of Equation (A.3). Consequently, Equation (3) is also valid for the case of $n = k+1$. This completes the proof of the Lemma.

APPENDIX B

The Proof of Lemma 2

By virtue of Equation (9), the dynamics of discounted stock prices satisfies:

$$\ln(\widetilde{S}_t/\widetilde{S}_{t_0}) = Y_n(t_0,t) + Z_n^P(t_0,t), \quad \forall t \in [t_n,\ t_{n+1}) \tag{B.1}$$

Since $t - jh \in \left[t_{n-j}, t_{n-j+1}\right)$, it can be verified that

$$\int_{t_0}^{t-nh} dW_u^P = \int_{t_0}^{t-nh} dW_u^Q + \int_{t_0}^{t-nh} \varphi(z)\, dz = \int_{t_0}^{t-nh} dW_u^Q + H_0(t_0, t-nh) \tag{B.2}$$

$$\int_{t-(j+1)h}^{t-jh} dW_u^P = \int_{t-(j+1)h}^{t_{n-j}} dW_u^Q + \int_{t_{n-j}}^{t-jh} dW_u^Q + H_{n-j-1}\left(t-(j+1)h, t_{n-j}\right) + H_{n-j}\left(t_{n-j}, t-jh\right) \tag{B.3}$$

Substituting (B.2) and (B.3) into Equation (9), the dynamics of the discounted stock prices under the risk neutral measure Q are

$$\begin{aligned}\ln(\widetilde{S}_t/\widetilde{S}_{t_0}) &= Y_n(t_0,t) + Z_n^Q(t_0,t) + G_n(t_0,t) + \sigma H_n(t_0+nh,t) \\ &= \left[Y_n(t_0,t) + G_n(t_0,t) + \sigma H_n(t_0+nh,t) + \frac{1}{2}V_n(t_0,t)\right] + \left[Z_n^Q(t_0,t) - \frac{1}{2}V_n(t_0,t)\right]\end{aligned} \tag{B.4}$$

APPENDIX C

The Proof of Theorem 1

To carry out the proof of Theorem 1, Equation (22) is divided into two parts:

$$C_{t_0} = e^{-r(T-t_0)} E_Q\left[Max(S_T - K, 0) \,\middle|\, \Im_{t_0}\right] = A - B \tag{C.1}$$

where

$$A = e^{-r(T-t_0)} E_Q\left[S_T\ I_{(S_T>K)} \,\middle|\, \Im_{t_0}\right] \tag{C.2}$$

and

$$B = K e^{-r(T-t_0)} E_Q\left[I_{(S_T>K)} \,\middle|\, \Im_{t_0}\right] \tag{C.3}$$

Under the risk neutral martingale measure Q, the stock price at time T equals

$$S_T = S_{t_0} \exp\left(r(T-t) + Z_N^Q(t_0,T) - \frac{1}{2}V_n(t_0,T)\right) \tag{C.4}$$

It is convenient to introduce an auxiliary probability measure Q_R on (Ω, F) by setting its Radon-Nikodym derivative as follows:

$$\xi_T^R = \frac{dQ_R}{dQ} = \exp\left(Z_N^Q(t_0,T) - \frac{1}{2}V_n(t_0,T)\right) \tag{C.5}$$

By virtue of Equation (12), $Z_N^Q(t_0,T)$ satisfies

$$Z_N^Q(t_0,T) = 1_{(N>0)}\left(\sigma\sum_{j=0}^{N-1}\left(\sum_{i=0}^{j}\theta_i(i)\right)\left(W_{t-jh}^Q - W_{t-(j+1)h}^Q\right)\right) + \sigma\left(\sum_{i=0}^{N}\theta_i(i)\right)\left(W_{t-Nh}^Q - W_{t_0}^Q\right) \tag{12'}$$

It follows from the Girsanov's theorem that the process W^R given by

$$W_v^R = W_v^Q - \sigma v \sum_{i=1}^{N} \theta_i(i), \quad v \in [t_0, t - Nh) \tag{C.6}$$

$$W_v^R = W_v^Q - \sigma v \sum_{i=0}^{j} \theta_i(i), \quad v \in [t-(j+1)h, t-jh), \quad j = 0,...,N-1 \tag{C.7}$$

is a standard Brownian motion under the probability measure Q_R. Therefore, $Z_n^Q(t_0,t)$ is equal to $Z_n^R(t_0,t) + V_n(t_0,T)$ and the dynamics of the stock price under the probability measure Q_R are

$$S_T = S_{t_0} \exp\left(r(T-t_0) + Z_N^R(t_0,T) + \frac{1}{2} V_n(t_0,T) \right) \tag{C.8}$$

Therefore, (C.2) can be rewritten as follows:

$$\begin{aligned} A &= S_{t_0} E_{Q_R}\left(I_{(S_T>K)} \middle| \Im_{t_0} \right) = S_{t_0} P_{rob}^{Q_R}\left(S_T > K \middle| \Im_{t_0} \right) \\ &= S_{t_0} P_{rob}^{Q_R}\left(\ln S_{t_0} + r(T-t_0) + Z_N^R(t_0,T) + \frac{1}{2} V_N(t_0,T) > \ln K \middle| \Im_{t_0} \right) \\ &= S_{t_0} P_{rob}^{Q_R}\left(\frac{\ln \frac{S_{t_0}}{K} + r(T-t_0) + \frac{1}{2} V_N(t_0,T)}{\sqrt{V_N(t_0,T)}} \geq \frac{-Z_N^R(t_0,T)}{\sqrt{V_N(t_0,T)}} \right) \\ &= S_{t_0} \Phi\left(d_{1N}(t_0,T) \right) \end{aligned} \tag{C.9}$$

Equation (C.3) can be proved along the similar pricing procedure. For the proof of (24), since the discounted stock price and the ARMA(*p*, *q*)-type European options are Q-martingale, (24) is derived by using the well-known put call parity $P_{t_0} = C_{t_0} + Ke^{-r(T-t_0)} - S_{t_0}$. This ends the derivation of the pricing formulas for ARMA-type European options.

References

Alizadeh, S., Brandt, M. W., & Diebold, F. X. (2002). Range-Based Estimation of Stochastic Volatility Models. Journal of Finance, 57(3), 1047.

Black, F. (1976). The Pricing of Commodity Contracts. Journal of Financial Economics, 3(1-2), 167-179.

Bollerslev, T. (1987). A Conditionally Heteroskedastic Time Series Model for Speculative Prices and Rates of Return. Review of Economics & Statistics, 69(3), 542.

Brenner, M., & Galai, D. (1989). New Financial Instruments for Hedging Changes in Volatility. Financial Analysts Journal, 45(4), 61.

Brenner, M., & Galai, D. (1993). Hedging Volatility in Foreign Currencies. The Journal of Derivatives, 1(1), 53-59.

Chopra, N., Lakonishok, J., & Ritter, J. R. (1992). Measuring Abnormal Performance: Do Stocks Overreact? Journal of Financial Economics, 31(2), 235-268.

Conrad, J., & Kaul, G. (1988). Time-Variation in Expected Returns. Journal of Business, 61(4), 409-425.

De Bondt, W. F. M., & Thaler, R. (1985). Does the Stock Market Overreact? Journal of Finance, 40(3), 793.

Detemple, J., & Osakwe, C. (2000). The Valuation of Volatility Options. European Finance Review, 4(1), 21-50.

Duan, J. C. (1995). The GARCH Option Pricing Model. Mathematical Finance, 5(1), 13-32.

Fama, E. F. (1965). The Behavior of Stock-Market Prices. Journal of Business, 38(1), 34-105.

Fama, E. F., & French, K. R. (1988). Permanent and Temporary Components of Stock Prices. Journal of Political Economy, 96(2), 246.

Ferland, R., & Lalancette, S. (2006). Dynamics of Realized Volatilities and Correlations: An Empirical Study. Journal of Banking & Finance, 30(7), 2109-2130.

Fisher, L. (1966). Some New Stock-Market Indexes. Journal of Business, 39(1), 191.

French, K. R., & Roll, R. (1986). Stock Return Variances: The Arrival of Information and the Reaction of Traders. Journal of Financial Economics, 17(1), 5-26.

French, K. R., Schwert, G. W., & Stambaugh, R. F. (1987). Expected Stock Returns and Volatility. Journal of Financial Economics, 19(1), 3-29.

Gallant, A. R., Hsu, C. T., & Tauchen, G. (1999). Using Daily Range Data to Calibrate Volatility Diffusions and Extract the Forward Integrated Variance. Review of Economics & Statistics, 81(4), 617.

Gençay, R. (1996). Non-Linear Prediction of Security Returns with Moving Average Rules. Journal of Forecasting, 15(3), 165-174.

Grünbichler, A., & Longstaff, F. A. (1996). Valuing Futures and Options on Volatility. Journal of Banking & Finance, 20(6), 985-1001.

Granger, C. W. J., & Newbold, P. (1976). Forecasting Transformed Series. Journal of the Royal Statistical Society. Series B (Methodological), 38(2), 189-203.

Grundy, B. D. (1991). Option Prices and the Underlying Asset's Return Distribution. Journal of Finance, 46(3), 1045-1069.

Hamao, Y., Masulis, R. W., & Ng, V. (1990). Correlations in Price Changes and Volatility across International Stock Markets. The Review of Financial Studies, 3(2), 281-307.

Harrison, J. M., & Pliska, S. R. (1981). Martingales and Stochastic Integrals in the Theory of Continuous

Trading. Stochastic Processes and their Applications, 11(3), 215-260.

Heston, S. L. (1993). A Closed-Form Solution for Options with Stochastic Volatility with Applications to Bond and Currency Options. Review of Financial Studies, 6(2), 327.

Heston, S. L., & Nandi, S. (2000). A Closed-Form GARCH Option Valuation Model. The Review of Financial Studies, 13(3), 585-625.

Jegadeesh, N. (1990). Evidence of Predictable Behavior of Security Returns. Journal of Finance, 45(3), 881.

Jokivuolle, E. (1998). Pricing European Options on Autocorrelated Indexes. The Journal of Derivatives, 6(2), 39-52.

Klebaner, F. (1998). Introduction to Stochastic Calculus with Applications: Imperial.

Lehmann, B. N. (1990). Fads, Martingales, and Market Efficiency. Quarterly Journal of Economics, 105(1), 1-28.

Liao, S. L., & Chen, C. C. (2006). The Valuation of European Options When Asset Returns Are Autocorrelated. Journal of Futures Markets, 26(1), 85-102.

Lo, A. W., & MacKinlay, A. C. (1988). Stock Market Prices Do Not Follow Random Walks: Evidence from a Simple Specification Test. The Review of Financial Studies, 1(1), 41-66.

Lo, A. W., & MacKinlay, A. C. (1990). When Are Contrarian Profits Due to Stock Market Overreaction? The Review of Financial Studies, 3(2), 175-205.

Lo, A. W., & Wang, J. (1995). Implementing Option Pricing Models When Asset Returns Are Predictable. Journal of Finance, 50(1), 87.

Pong, S., Shackleton, M. B., Taylor, S. J., & Xu, X. (2004). Forecasting Currency Volatility: A Comparison of Implied Volatilities and AR(FI)MA Models. Journal of Banking & Finance, 28(10), 2541-2563.

Psychoyios, D., & Skiadopoulos, G. (2006). Volatility Options: Hedging Effectiveness, Pricing, and Model Error. Journal of Futures Markets, 26(1), 1-31.

Roll, R. (1977). An Analytic Valuation Formula for Unprotected American Call Options on Stocks with Known Dividends. Journal of Financial Economics, 5(2), 251-258.

Whaley, R. E. (1993). Derivatives on Market Volatility: Hedging Tools Long Overdue. The Journal of Derivatives, 1(1), 71-84.

Are World Socially Responsible Investment Markets Integrated?

Eduardo D. Roca

Associate Professor in Department of Accounting, Finance and Economics

Victor S.H. Wong

PhD Scholar in Department of Accounting, Finance and Economics
E-Mail: V.Wong@griffith.edu.au

Gurudeo A. Tularam

Lecturer in Faculty of Science, Environment, Engineering and Technology
Griffith University, 170 Kessels Road, Nathan, QLD 4111, Australia

ABSTRACT

A growing number of SRI funds invest across different SRI markets worldwide. Are SRI markets worldwide therefore becoming integrated? This issue is highly important since greater integration between SRI markets implies lower benefits from international diversification and higher contagion risks between SRI markets. This paper examines the extent of price interdependence between the SRI markets of Australia, Canada, Japan, UK and US over the period 1994-2007. Based on a vector autoregression context and allowing for structural break arising from the September 11 crisis, it conducts variance decomposition and impulse response analyses.

Keywords: *Socially responsible investment, integration, vector autoregression, international diversification*

1 INTRODUCTION

Socially responsible investment (SRI) is a booming market around the world. SRI volume is greatest in the United States, with a total value of $2.71 trillion (Social Investment Forum: United States, 2007). Europe's commitment to socially responsible investing is rising rapidly and the major contributing country is UK with its asset valued at $1.17 trillion (European Social Investment Forum, 2006). Australia, Canada, and Japan have smaller but fast growing SRI markets (Gardner, 2007). Essentially SRI is continuing to emerge as a response to the increasing globalisation of finance and the changing expectations from corporations and their visible environmental and social impact. Additionally, as social and environmental performance is becoming an area of differentiation among organisations, and consumers and investors are increasingly going "green", SRI may end up being integrated into mainstream financial markets (CopperWiki, 2008). Since SRI markets may be integrating with the mainstream financial markets and globalisation causes markets to integrate with each other, the issue of market integration is certainly one that is important to investigate.

Integration entails the equality of price or risk-adjusted returns[2]. It also implies co-movements in prices. Investigating integration based on the former requires the use of asset pricing models. The use of asset pricing models creates difficulty in examining financial integration, e.g. if no integration is found, this can mean either that there is indeed no integration at all or that the asset-pricing model used is not valid. To avoid this problem,

[2] As argued by Kenen (1976): "… integration refers to the degree to which participants in any market are enabled and obliged to take notice of events occurring in other markets. They are enabled to do so when information about those events is supplied into the decision making processes of recipients. They are obliged to do so when it is supplied in ways that invite them to use it in order to achieve their own objectives…". This definition therefore, implies information spill-over.

this paper examines integration based on co-movement of prices. The higher the co-movement of prices and the faster the response of prices in one market to the other market, the greater the degree of integration.

Major investment models in academia such as portfolio diversification depend on market integration. Based on portfolio diversification theory, it is important for investors to know the extent of financial integration between markets. The less integrated markets are, the more benefits can be obtained from diversification. This knowledge is also important from a policy perspective. If the markets are found to be closely-linked, there is a danger that shocks in one market may spill-over to other markets (the so-called "contagion effect"). Hence, this may require closer cooperation between the prudential and monetary regulators of these markets if this spill-over or contagion effect is to be avoided or minimised.

There are now a number of studies on SRI which have investigated the following aspects of SRI - performance (Luther *et al.*, 1992; Hamilton *et al.*, 1993; Gregory *et al.*, 1997; Russo and Fouts, 1997; Dibartolomeo and Kurtz, 1999; Statman, 2000; Orlitzky *et al.*, 2003; Bauer et al., 2005; Kreander *et al.*, 2005; Hong and Kacperczyk, 2006; Bauer *et al.*, 2007; Edmans, 2007), ratings (Angel and Rivoli, 1997; Lee and Ng, 2002; Guenster *et al.*, 2005) and screenings (Guerard, 1997). None of these studies, however, have focused on the linkages or spill-over between SRI markets. Considering the importance of the issue of integration between markets, this paper therefore addresses this gap in the literature. This paper analyses the extent of integration between the SRI markets in Australia, Canada, Japan, UK and US.

The remaining parts of this paper are organised as follows. The next section provides an institutional background of SRI. Section three presents a brief discussion of the data and methodologies used in the study. Section four presents the empirical results followed by the conclusion in section five.

2 INSTITUTIONAL BACKGROUND

Socially responsible investment (SRI) is an umbrella term to describe an investment process which takes environmental, social, ethical and/or governance considerations into account. This process stands in addition to or is incorporated into the usual fundamental investment selection and management process. Since the late 1960's the focus and support for SRI have expanded, the expansion was driven by a number of factors such as the rise of the civil rights movement, environmentalism and concerns about globalisation (Kinder *et al.*, 1993). In recent years, supra-national bodies have been formed such as the Global Reporting Initiative, United Nations Environment Programme, and United Nations Principles for Responsible Investment, among others. This development, jointly with the progress of corporate initiatives towards environmental and social impact information disclosure eventually created fertile ground for the SRI markets (SIF-J, 2007).

SRI continues to be an area of diversity and ever increasing scope. There are signs of robust SRI strategies, increased mandates from institutional players and the growing involvement of more traditional financial services providers. Over the past three decades, SRI has continued to grow and expand throughout the world. The SRI assets in North America market are worth US$2.71 trillion for the US and C$503 billion (US$471 billion) for Canada (Social Investment Forum: United States, 2007 and Canada's Social Investment Organisation, 2006). The largest SRI market in Europe is the UK market valued at €781 billion (US$1.17 trillion) (European Social Investment Forum, 2006). In Asia, Japan is the leading market with up to ¥840 billion (US$7.3 billion) worth of

SRI assets (Social Investment Forum: Japan, 2007). Finally, Australia is the fastest growing SRI market, with total assets of A$19.4 million (US$17.3 million) (Responsible Investment Association Australasia, 2007). The interest and support for SRI has also generated the creation of specific share indexes such as the Dow Jones Sustainable Index (DJSI) and FTSE4GOOD as well as specialised research houses such, among others, Morningstar and Sustainable Investment Research Institute (SIRIS) to support the growth of the industry.

SRI funds differ from conventional mutual funds in several ways. First, SRI funds invest only in companies that adhere to the social, environmental and corporate governance requirements as determined by these funds. Hence, the exclusion of companies that fail these screens may reduce the diversification possibilities and negatively influence the performance of the SRI funds in comparison to conventional funds. Alternatively, the use of investment screens can also be regarded as an active selection strategy of firms with characteristics that are believed to yield superior performance (Bollen, 2007). This involves one or more of the following practices being included in the research, selection and monitoring of an investment security or portfolio. There are three dominant SRI screening practices employed today, i.e. (1) Negative, (2) Positive, and (3) Best of sector screens. Each of these has been described by Lee (2006).

Investors in SRI funds may also derive non-financial utility by investing in companies that adopt specific social, environmental or ethical policies, which correspond to these investors' concerns. For example, investors who are committed in protecting the environment may decide not to invest in companies emitting high pollution, even though such companies may provide high investment returns and opportunities, in terms of risk-return trade-off. As a result of non-financial utility, SRI funds may attract specific types of investors. Beal and Goyen (1998) report that SRI investors in Australia are more likely to be older, female and highly educated than the investors investing in the whole universe of stocks listed on the Australian Stock Exchange. Bollen (forthcoming) found similar findings for SRI investors in the US market. Hence, the types of SRI investors are different from those investing in mainstream funds, and the determinants of the money-flows into and out of SRI funds as compared with mainstream funds may also differ (Renneboog *et al*, 2006).

3 DATA AND EMPIRICAL SPECIFICATIONS

3.1 Data Description

This study investigates the international integration among the socially responsible investment (SRI) markets of Australia, Canada, Japan, UK and US. These markets are the world's leading and fast growing SRI markets (DJSI, 2007; Gardner, 2007). Data are collected from Dow Jones Sustainable Index (DJSI) via DataStream. A major strength of DJSI is that it is one of the only SRI indexes that is fully and regularly audited and verified by independent auditors (Beloe *et al*, 2004).

The study period is from January 7, 1994 to December 28, 2007. Since September 11, 2001 is an important event that would have altered integration between markets – the period is divided into two sub-periods: (1) Pre-crisis period from January 7, 1994 to September 7, 2001; and (2) Post-crisis period from September 21, 2001 to December 28, 2007. This study utilises weekly data to avoid noise, non-synchronous trading and the day of the week effects associated with daily data. All SRI indices are expressed in USD and returns on the price indexes calculated by the following formula: $R_t = \ln(\text{price}_t/\text{price}_{t-1}) \times 100$.

Figure 1 illustrates the movement of the SRI indices. The Canadian SRI index peaked in 2000 and fell greatly in 2001, which could be explained by the September 11, 2001 crisis. Similar behaviour seems to apply to the US and Japan markets. Conversely, the Australian and UK markets exhibited sustained growth over the years.

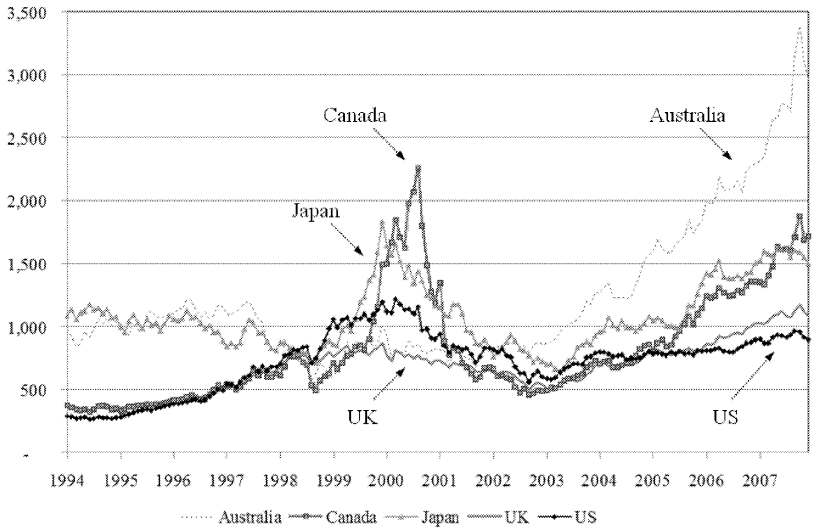


Figure 1 Movement of SRI Indices from 1994 to 2007

3.2 Vector Autoregression (VAR) analysis

The structure of dynamic linkages among the five SRI markets is examined using the Vector Autoregression (VAR) analysis (Sims, 1980) which is applied into an unrestricted reduced form equation system. The estimated five markets VAR systems are showed as follows:

$$R_t = \alpha + \sum_{k=1}^{L} \beta_k R_{t-k} + \varepsilon_t \tag{1}$$

where R_t is a 5 × 1 column vector of weekly SRI market returns, α and β_i are respectively, 5 × 1 and 5 × 5 matrices of coefficients, L is the lag length and ε_t is a 5 × 1 column vector of serially uncorrelated error terms, The i, jth component of β_k measure the direct effect on the ith market of a change in the return to the jth market in the k periods. In effect, the ith component of ε_t is the innovation of the ith market which cannot be predicted from past returns of other markets in the system.

A VAR analysis supports the purpose of this study by providing two aspects of the structure of dynamic interactions among the SRI markets: (1) the variance decomposition (see, Eun and Shim, 1989) of the n-step ahead forecast errors captures the percentage of unexpected variation in one SRI market's return account for by shocks from other markets in the system; and, (2) the impulse response captures the speed of adjustment of each market to a shock of another market. If the responses subside towards zero quickly then the transmissions between these markets are relatively efficient. The generalised impulse response analysis by Pesaran and Shin (1998) are used to avoid variations in results due to Cholesky ordering. To conserve space, more detailed information on the methodologies are explained in the authors' papers. Hence, this paper provides a more comprehensive investigation of SRI market linkages as it tackles the issue of SRI market integration that have

not been addressed by other studies.

4 EMPIRICAL RESULTS

4.1 Data preliminaries

The statistical properties of return series presented in Panel A (Table 1, which is not shown here due to page limit, the authors will provide these tables upon request) reveal that the US and UK market had the highest returns (0.25% and 0.14% respectively) while maintaining a low risk. Canada had the highest risk while generating an average return of 0.13%. Australia and Japan had lower performance during the pre-crisis period. For the post-crisis period, (Panel B of Table 1 shows that US market had the worst performance. Other markets showed improved performance generating returns of 0.41% for Australia, 0.32% for Canada and 0.14% for Japan. The UK market was generated similar returns before and after the crisis. The Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests confirm that all returns series are stationary at levels.

The results of the correlation analysis are displayed in Table 2 (not shown due to page limit). During the pre-crisis period, the highest correlations among the markets are those pertaining to the US-Canada (0.5746) and US-UK (0.4306,) while correlations among the other markets during this period seem low. After the crisis, however, the correlations between the markets seem to have increased. For example, the Australia market is fairly highly correlated with Canada, Japan, UK and US markets. The correlation analysis shows that markets seem to be more integrated after the crisis.

Test results for the optimum lags are presented in Table 3 (not shown due to page limit). The results show that a lag of 2 was significant in the pre-crisis period while a lag of 1 was significant in the post-crisis period. This shows that the markets react quicker after the crisis. Hence, the VAR analysis will use the lags based on this result.

4.2 Vector Autoregression (VAR) coefficients

The estimated VAR system in Equation (1) produces analysis of channels of influence in the 5 market dynamic system in two forms, variance decomposition of forecast errors and generalised impulse response analysis. The output for the VAR analysis is presented in Table 4. The table shows the effect of one market on another market. The table shows that all markets have a significant coefficient – either as influencing another market or as a market that is being influenced. Thus, the markets, in general, are interdependent. The only coefficients that are not significant are those corresponding to the effect of the UK and the US on Canada during the pre-crisis period and of the UK on Canada in the post-crisis period. However, these two markets have significant coefficients as markets being influenced by other markets. In other words, although these markets are not influential on other markets, other markets significantly influence them. Hence, all markets are linked among themselves. This supports the results from the correlation analysis. This can be taken as an indication of the existence of integration among the SRI markets.

Table 4 Vector Autoregression Estimated Coefficients

	Australia	Canada	Japan	UK	US
Panel A – Pre-crisis period: 1994-2001					
Australia_1	- 0.0568 (0.0541)*	0.0495 (0.0749)*	0.0357 (0.0510)*	0.0225 (0.0350)**	0.0655 (0.0416)**
Australia_2	- 0.0560 (0.0536)*	- 0.0195 (0.0743)*	0.0783 (0.0505)*	- 0.0284 (0.0346)**	- 0.0262 (0.0412)**
Canada_1	- 0.0532 (0.0447)**	- 0.0706 (0.0620)*	0.0209 (0.0422)**	- 0.0175 (0.0289)**	- 0.0240 (0.0344)**
Canada_2	- 0.0658 (0.0446)**	0.1508 (0.0618)*	- 0.0245 (0.0420)**	- 0.0133 (0.0288)**	0.1043 (0.0343)**
Japan_1	0.1027 (0.0563)*	0.1295 (0.0781)*	- 0.2163 (0.0531)*	- 0.0220 (0.0364)**	0.0262 (0.0433)**
Japan_2	0.1887 (0.0567)*	- 0.0049 (0.0785)*	0.0933 (0.0534)*	0.0388 (0.0366)**	0.0183 (0.0436)**
UK_1	0.1841 (0.0928)*	0.1902 (0.1287)	0.0768 (0.0875)*	- 0.1238 (0.0600)*	0.2008 (0.0714)*
UK_2	0.1312 (0.0933)*	0.0029 (0.1293)	- 0.0949 (0.0880)*	- 0.0601 (0.0603)*	0.0508 (0.0718)*
US_1	- 0.0021 (0.0856)*	- 0.0839 (0.1187)	0.0651 (0.0807)*	0.0823 (0.0554)*	- 0.1903 (0.0659)*
US_2	0.0852 (0.0847)*	- 0.1273 (0.1174)	0.1613 (0.0798)*	0.0856 (0.0548)*	- 0.0706 (0.0651)*
Panel B – Post-crisis period: 2001-2007					
Australia_1	- 0.1695 (0.0732)*	- 0.0537 (0.0693)*	- 0.0886 (0.0780)*	- 0.0802 (0.0587)*	- 0.0842 (0.0594)*
Canada_1	0.1932 (0.0786)*	- 0.0128 (0.0744)*	0.0719 (0.0837)*	0.0201 (0.0631)*	0.0290 (0.0638)*
Japan_1	- 0.1356 (0.0628)*	- 0.0918 (0.0595)*	- 0.1208 (0.0669)*	- 0.0933 (0.0504)*	- 0.0834 (0.0510)*
UK_1	0.3055 (0.1090)	- 0.0196 (0.1031)	0.1335 (0.1160)	0.1472 (0.0874)*	0.2331 (0.0884)*
US_1	- 0.0214 (0.0961)*	0.2416 (0.0909)*	0.1675 (0.1023)*	- 0.1338 (0.0771)*	- 0.1220 (0.0780)*

Note: *, **, *** significant at 10%, 5% and 1%. Standard errors are in parentheses.

Figure 2 provides a summary of the linkages between the SRI markets. This figure shows that all markets are affecting each other, some mutually and some just one way. The linkages differ in terms of strength - some linkages are significant at 10% level of significance (thin lines) and others are significant at the 5% level (dotted lines). Therefore, there is significant interdependence among SRI markets, which could be taken as an indication of integration following our definition and concept of integration as discussed earlier.

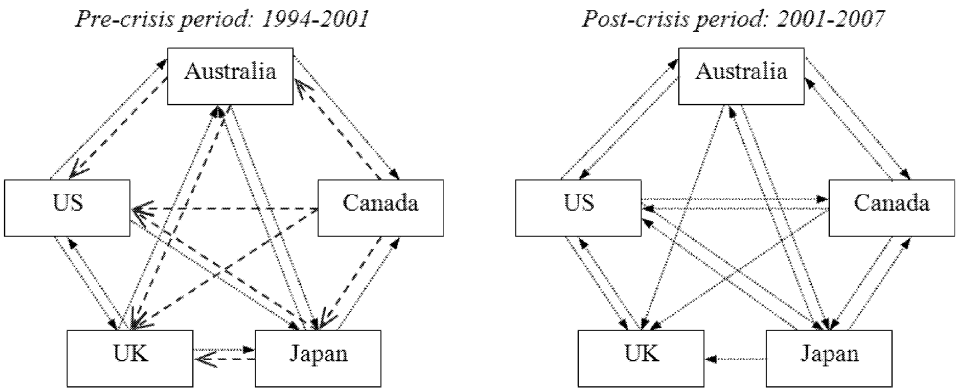


Figure 2 Linkages between SRI markets

4.2.1 Variance Decomposition

The results for the pre-crisis period (Panel A of Table 6) indicate that Australia and Canada have a very high percentage of error variance that is accounted for by its own market - about 94.32% and 93.00% respectively. Similar results are obtained for Japan and the UK (88.74% and 81.37%, respectively). Comparing across the markets reveals that the US is the market that is most affected by other markets since about 44.80% of its error variance is explained by innovations in other markets, particularly by the Canadian market.

Results for the period after the crisis (Panel B of Table 6) reveal that the two most interactive markets are the UK and US, as only about 49.46% and 46.78%, respectively, of their error variance are accounted for by their own market. Most of the UK variance is explained by Australia (32.18%), and most of the US variance is due to the UK (20.47%). During the period after the crisis, Canada and Japan have a lower proportion of their error variance that is due to their own market (65.32% and 66.70% respectively), when compared to the period before the crisis (93.00% and 88.74%, respectively). Most of their variance (post-crisis) is accounted for by Australia (28.33%, in the case of Canada and 26.22%, in the case of Japan). The variance decomposition results for the Australian market in the period after the crisis are similar to those in the pre-crisis period.

In summary, the results of the variance decomposition analyses for both periods reveal that the Australian market is the most influential market as it has the most effect on other markets. At the same time, it is the least influenced by any market. On the other hand, the US market is the most affected by other markets and surprisingly, the least influential. Canada, Japan and the UK are more influenced by other markets during the post-crisis period than in the pre-crisis period.

Table 6 Variance Decomposition Analyses Results

Dependent variable	***Independent variable***				
	Australia	**Canada**	**Japan**	**UK**	**US**
Panel A – Pre-crisis period: 1994-2001					
Australia	94.3199	0.0899	3.3756	1.7533	0.4613
Canada	5.1192	93.0049	1.0793	0.4949	0.3017
Japan	6.8860	2.8264	88.7425	0.5700	0.9751
UK	10.4404	4.9902	2.3234	81.3656	0.8805
US	3.8019	30.1807	1.0571	9.7609	55.1994
Panel B – Post-crisis period: 2001-2007					
Australia	90.8885	3.2789	1.0854	3.3241	1.4232
Canada	28.3357	65.3236	0.5922	3.5351	2.2135
Japan	26.2213	3.2869	66.7031	2.8381	0.9506
UK	32.1835	14.8840	2.1788	49.4620	1.2917
US	13.2924	16.5342	2.9429	20.4748	46.7557

4.2.2 Impulse Response Analysis

The VAR system also produces the estimated impulse response as an additional insight on the response of a market to innovation in another market. Impulse response provides evidence on how much and quick movement of one market is transmitted to the others. Only the significant coefficients in the VAR analysis are plotted in the impulse responses. A quick inspection of Figure 3 reveals that all responses were immediate for pre- and post-crisis periods. The duration of responses to shocks was longer during the pre-crisis period (average of 7 weeks), than in the post-crisis periods (average of 4 weeks).

The responses in the pre-crisis period vary greatly for all the markets. The largest movements in the responses are those from the US and Australian markets, followed by Canada and Japan, and then the UK. The markets generally reacted immediately in Week 1 and then fall in week fading off in week 7. The responses in the post-crisis period are very similar to those in the pre-crisis period - immediate in week 1, then falls in week 2. However, the responses in the post-crisis are much larger as compared to those in the pre-crisis period. Thus, it seems that the markets became more responsive and quicker to responding to shocks in the post-crisis period.

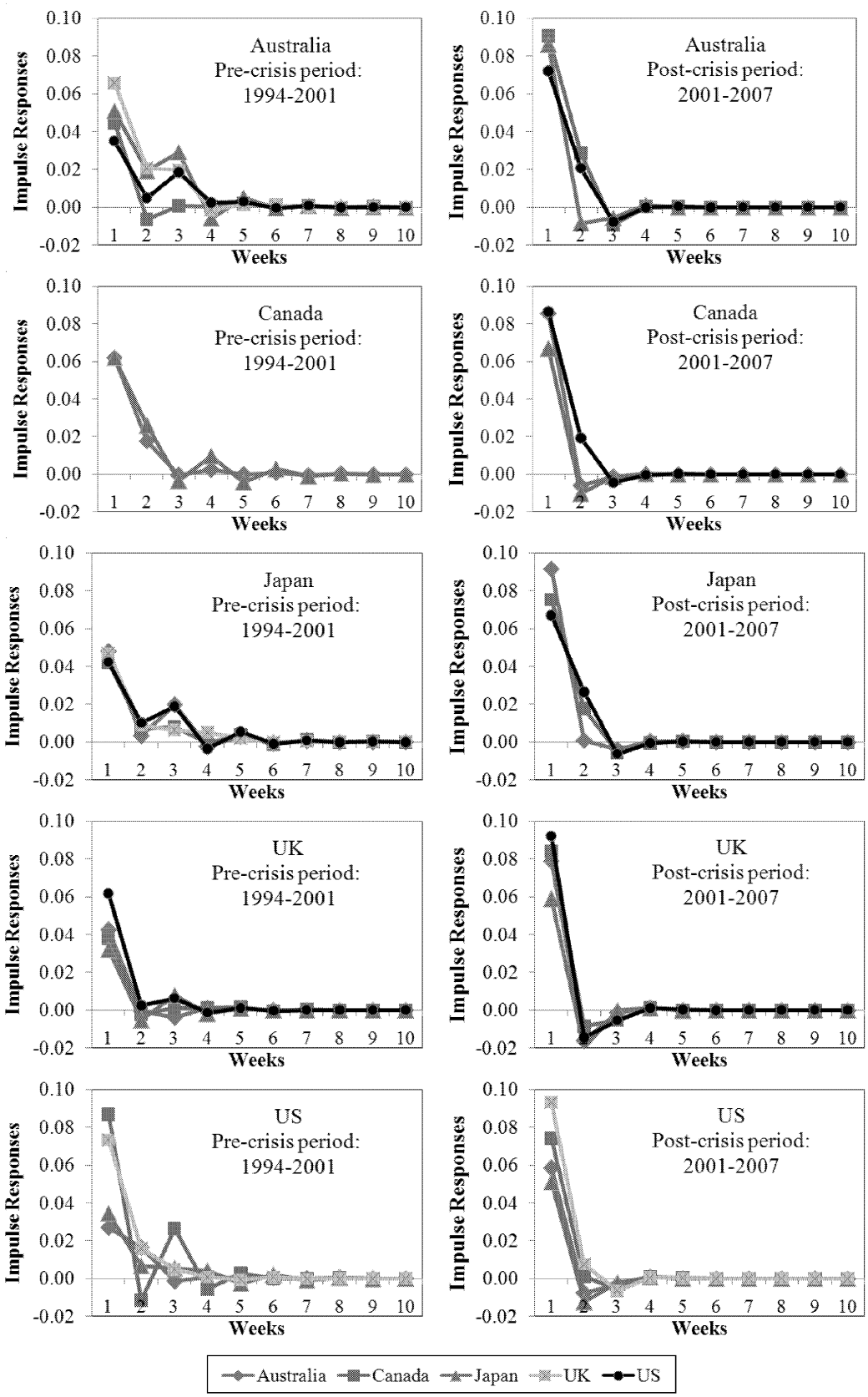


Figure 3 Impulse responses for the SRI markets

5 CONCLUSION

This paper investigates the extent of integration between the socially responsible investment (SRI) markets of Australia, Canada, Japan, UK and US using weekly DJSI data covering the period 1994–2007. The period is divided into two sub-periods to allow for the structural break arising from the September 11, 2001 crisis. This study employs variance decomposition and impulse response analysis based on the Vector Autoregression (VAR) systems to analyse the data. The results show that all markets are significantly affecting each other. This could be taken as indicative of integration between the SRI markets. The Australian SRI market is the most influential while the US is the least. The US market was the most internationalised market is it was the most influenced by other markets. The markets respond to each other immediately during week 1. During the period before the crisis, the interaction continues up to 7 weeks. However, during the period after the crisis, the markets complete their interaction in a shorter time period – 4 weeks, and also, the interactions are stronger.

Thus, SRI markets seem to be interdependent and integrated. Thus, for investors who want to simply focus on SRI, it appears that there is not much scope for international diversification within SRI assets. This also implies that there is significant contagion risk between SRI markets. Thus, policymakers in different SRI markets would need to coordinate with each other as policies implemented in one SRI market could also impact on other SRI markets.

References

Angel, J. and P. Rivoli, (1997) "Does Ethical Investing Impose a Cost Upon the Firm? A Theoretical Examination", *Journal of Investing*, 6, 57-61.

Bauer, R., J. Derwall, and R. Otten, (2007) "The Ethical Mutual Fund Performance Debate: New Evidence from Canada", *Journal of Business Ethics*, 70, 111-124.

Bauer, R., K. Koedik, and R. Otten, (2005) "International Evidence on Ethical Mutual Funds Performance and Investment Style", *Journal of Banking and Finance*, 29, 1751-1767.

Beal, D. and M. Goyen, (1998) "Putting Your Money Where Your Mouth Is: A Profile of Ethical Investors", *Financial Services Review*, 7, 129-143.

Beechey, M., D. Gruen, and J. Vickery, (2000) "*The Efficient Market Hypothesis: A Survey*", Research Discussion Paper 2000-01, Reserve Bank of Australia.

Beloe, S., J. Scherer, and I. Knoepfel, (2004) "*Values for Money: Reviewing the Quality of SRI Research*", http://www.sustainability.com/insight/sri-article.asp?id=136 (last accessed July 20, 2008).

Bollen, N.P., (2007) "Mutual Fund Attributes and Investor Behavior", *Journal of Financial and Quantitative Analysis,* 42, 682-708.

Bracker, K., D.S. Docking, and P.D. Koch, (1999) "Economic Determinants of Evolution in International Stock Market Integration", *Journal of Empirical Finance*, 6, 1-27.

Canada's Social Investment Organisation, (2006) "*Canadian Socially Responsible Investment Review 2006*" http://www.socialinvestment.ca/documents/SRIReview.pdf (last accessed July 18, 2008).

CopperWiki, (2008) "*Socially Responsible Investing*" http://www.copperwiki.org/index.php/

Socially_Responsible_Investing (last accessed August 3, 2008).

DiBartolomeo, D. and L. Kurtz., (1999) "*Managing Risk Exposures of Socially Screened Accounts*", Northfield Working Paper, 1999.

DJSI, (2007) "*World's Leading Countries in Socially Responsible Investments*" http://www.sustainability-indexes.com/htmle/data/components_djsiworld.html (last accessed July 11, 2008)

Edmans, A., (2007) "*Does the Stock Market Fully Value Intangibles? Employee Satisfaction and Equity Prices*", MIT Working Paper, 2007.

Eun, C. S. and S. Shim, (1989) "International Transmission of Stock Market Movements", *Journal of Financial and Quantitative Analysis*, 24, 241-256.

European Social Investment Forum, (2006) "*European SRI Study 2006*" http://www.eurosif.org/content/download/580/3548/version/1/file/Eurosif_SRIStudy_2006_complete.pdf (last accessed July 18, 2008).

Gardner, G., (2007) "*Socially Responsible Investments Grows Rapidly*" http://www.worldwatch.org/node/5481 (last accessed July 21, 2008).

Gregory, A., J. Matatko, and R. Luther, (1997) "Ethical Unit Trust Financial Performance: Small Company Effects and Fund Size Effects", *Journal of Business Finance and Accounting*, 24, 705-725.

Guenster, N., J. Derwall, R. Bauer, and K. Koedijk, (2005) "*The Economic Value of Corporate Eco-Efficiency*", Working Paper, Erasmus University, July 25, 2005.

Guerard, J., (1997) "Is There a Cost to Being Socially Responsible in Investing?", *Journal of Investing*, Summer, 6, 11-18.

Hamilton, S., H. Jo, and M. Statman, (1993) "Doing Well While Doing Good? The Investment Performance of Socially Responsible Mutual Funds", *Financial Analysts Journal*, 49, 62-66.

Hong, H. and M. Kacperczyk, (2006) "*The Price of Sin: The Effects on Social Norms on Markets*", Working Paper, Princeton University, April 2006.

Kenen, P.B. (1976) "*Capital Mobility and Financial Integration: A Survey*", Princeton Studies in International Finance, No. 39, Princeton University.

Kinder, P., A.L. Domini, and S.D. Lydenberg, (1993) "*Investing for Good: Making Money While Being Socially Responsible"*, Harper Business, New York.

Kreander, N., R.H. Gray, D.M. Power, and C.D. Sinclair, (2005) "Evaluating the Performance of Ethical and Non-ethical Funds: A Matched Pair Analysis", *Journal of Business Finance and Accounting*, 32, 1465-1493

Lee, C. and D. Ng, (2002) "*Corruption and International Valuation: Does Virtue Pay?*", Cornell University, Working Paper, November 2002.

Lee, D., (2006) "An Analysis of the Sustainability Investment Strategy Employing the Dow Jones World Sustainability Index", PhD Thesis submitted on July 2006 in Monash University.

Luther, R.G., J. Matatko, and D.C. Corner, (1992) "The Investment Performance of UK "Ethical" Unit Trusts", *Accounting Auditing & Accountability Journal*, 5, 57-70.

Orlitzky, M., F.L. Schmidt, and S.L. Rynes, (2003) "Corporate social and financial performance: A meta-analysis", *Organization Studies*, 24, 2003.

Pesaran, M.H. and Y. Shin, (1998) "Generalized impulse response analysis in linear multivariate models", *Economics Letters*, 58, 17–29.

Renneboog, L, J. ter Horst, and C. Zhang, (2006) "*Is Ethical Money Financially Smart?*", Finance Working Paper No. 117/2006. European Corporate Governance Institute.

Responsible Investment Association Australasia, (2007) "*Responsible Investment 2007*" http://www.responsibleinvestment.org/files/78RUBP9VVA/RIAA%20Benchmark%20Report%202007%20FINAL.pdf (last accessed July 18, 2008).

Roca, E.D., (1999) "Short-term and Long-term Price Linkages between the Equity Markets of Australia and its Major Trading Partners", *Applied Financial Economics*, 9, 501-511.

Russo, M. and P. Fouts, (1997) "A Resource-Based Perspective on Corporate Environmental Performance and Profitability." *Academy of Management Journal*, June 1997.

SIF-J, (2007) "*Socially Responsible Investments in Japan*" http://www.sifjapan.org/sri/sri.html (last accessed July 18, 2008).

Sims, C.A., (1980) "Macroeconomics and Reality", *Econometrica*, 48, 1-48.

Social Investment Forum: Japan, (2007) "*2007 Review of Socially Responsible Investment Japan*" http://www.sifjapan.org/document/sri2007_english.pdf (last accessed July 18, 2008).

Social Investment Forum: United States, (2007) "*Report on Responsible Investing Trends in the U.S. 2007*" http://www.socialinvest.org/pdf/SRI_Trends_ExecSummary_2007.pdf (last accessed July 18, 2008)

Statman, M., (2000) "Socially Responsible Mutual Funds", *Financial Analysts Journal*, 56, 30-39.

Market Mechanism and Traders' Behavior at the Close

Yu Chuan Huang
Professor Department of Risk Management and Insurance
National Kaohsiung First University of Science and Technology, Kaohsiung, Taiwan, ROC
E-Mail:ychuang@ccms.nkfust.edu.tw
Shu Hui Chan
Assistant professor, Banking and Finance at Cheng Shiu University, Kaohsiung, Taiwan. R.O.C
Doctoral student, Risk management and insurance at National Kaohsiung First University of Science and Technology, Kaohsiung, Taiwan. R.O.C

ABSTRACT

This paper examines the trader's behavior at the close before and after a new closing mechanism. On July 1 2002, the Taiwan Stock Exchange (TSEC) changed its closing price procedure to a five-minute call auction. It is found that after the new mechanism, individuals shift their trades away from the closing interval to the pre-closing interval, whereas foreign investors trade more aggressively and attempt to influence the closing prices on index futures' expiry days. Overall, the new auction mechanism makes traders attempt to influence the stock price more difficult and expensive.

Keywords: *Market mechanism, traders' behavior, manipulation*

1. INTRODUCTION

The closing price serves as a benchmark for an array of interested parties, particularly on the expiration days of derivative contracts or the end of quarters (when mutual funds and other portfolios generate reports). Fund managers (Carhart, et al., 2002) or brokers (Hillion and Suominen, 2004) temporarily and artificially inflate their performance numbers to give their customers a better impression of their trading abilities, and the expiration day effect for arbitragers or speculators, especially institutions such as index funds (Stoll and Whaley, 1991, 1997; Chow, et al., 2003). Therefore, anomalies at the daily close of exchange trading have received much attention from both academics and regulators.

Concern over observed anomalies at the close of trading has prompted several regulatory changes in stock exchanges around the world in an effort to reduce the volatility typically observed near the close of trading and to enhance the fairness of closing prices. Closing call auctions allow investors to execute trades at the closing price; simultaneously, they can reduce the possibility of manipulation by consolidating liquidity. Empirical evidence suggests that call auctions generate more efficient prices than continuous auctions (Amihud, et al., 1990; Madhavan, 1992; Pagano and Schwartz, 2003).

The Taiwan Stock Exchange Corporation (TSEC) previously used call auctions throughout the day at 60-90 second intervals, depending on a stock's liquidity. A stock's closing price was simply its last transaction price of a trading day for TSEC. On July 1, 2002, the TSEC changed its closing price procedure to a five-minute call auction. We use the natural experiment offered by the TSEC's

introduction of five-minute closing call auctions to examine the impact of the new mechanism on traders' behavior at the close and whether the new mechanism affects the trader's closing manipulation on futures expiration days.

The remainder of this paper is organized as follows: Section II describes the data. Section III examines anomalies at the close of trading on the TSEC. Section IV attempts to discern the trader's behavior on critical days. And Section V offers conclusions.

2. DATA DESCRIPTION

To examine the impact of the TSEC's new auction mechanism on trader's behavior at trading close, we collect intraday transactions and order flows for the period from July 1, 2001, to June 30, 2003. The component stocks of the Taiwan 50 index not only contain the TSEC's most liquid stocks, but also include roughly 70% of the exchange's total market value; they are therefore quite representative of the TSEC. We utilize this dataset to examine the impact of the TSEC's new call auction mechanism. We restrict attention to component stocks that were continuously in the Taiwan 50 index during the sample period and for which all study data was available. This generates a sample of 30 stocks.

For each stock, the dataset includes every order submitted to the TSEC and all transaction data. Each order record includes details of the quoted price, quoted size and trader type, and is time-stamped to the nearest second. The sample period was divided into two smaller periods to evaluate the effect of regulatory changes in the closing trading mechanism. The period before introducing the five-minute closing call auction on July 1, 2002, is referred to as the *pre period* and the subsequent period is referred to as the *post period.*

Table 1 presents the brief descriptive statistics on the stocks in the sample during our sample period. A wide range of trading activity is presented, with daily trading volume ranging from NT$ 1.88 million to NT$ 14,700 million. The daily trade size ranges from 68,000 to 344,686,000 shares. There is also a large variation in price, return[3] and turnover rate. We find most quoted orders (63.99%) are fewer than 5000 shares. Our available data classify traders into five groups: mutual funds, foreign institutions, individuals, dealers, and other corporations. Table 1 shows individuals have the highest daily order submission rates, 72.77%. This indicates that individuals generate most of the trading activity on the TSEC. Foreign institutions have the highest daily order submission rates (14.94%) among institutional investors (including mutual funds, foreign institutions, dealers, and other corporations).

[3] Because the daily price limit of stocks on the TSEC is set at 7% of the closing price of the preceding business day; the maximum (minimum) return is 7% (-7%).

Table 1
Descriptive Statistics (July 1, 2001 ~ June 30, 2003)

	Mean	Min.	Max.
Market Size (in million NT$)	134,276.80	5,542.00	1,641,174.00
Price (in NT$)	30.23	5.47	143.02
Daily Return (%)	0.04	-7.00	7.00
Turnover Rate (%)	0.97	0	20.2
Daily Number of Trades	5,217.62	42	51,929
Daily Trading Volume (in million)	889.11	1.88	14,700
Daily Trade Size (in 1000 shares)	24,333.14	68	344,686
Frequency of Quoted Size			
~ 5,000 shares	63.99%		
5,001 ~ 10,000	14.74%		
10,001 ~ 15,000	10.65%		
15,001 ~	10.61%		
Daily Order Submission Rate by Trader Types			
Mutual Funds	3.78%		
Foreign Institutions	14.94%		
Individuals	72.77%		
Dealers	1.92%		
Other Corporations	6.57%		

Market Size, Price, Return Volatility, Turnover Rate, Number of Trades and Trading Volume are the mean cross-sectional average daily values. Frequency of Quoted Size was tabulated separately for "5,000 shares or less," "5,001 to 10,000", "10,001 to 15,000", and "more than 15,000", and was measured by the numbers in each interval divided by the total daily numbers. Daily Order Submission Rate was tabulated separately for mutual funds, foreign institutions, individuals, dealers and other corporation, and was measured by the daily order size for each trader type divided by the total daily order size.

3. ANOMALIES AT THE CLOSE OF THE TSEC

A large body of research has documented various anomalies in intraday returns, volumes, and volatility throughout the world (Harris, 1986, 1989, Jain and Joh, 1988, Cushing and Madhavan, 2000). Recent empirical studies have chiefly focused on exploring possible changes in volatility, trading activity, order aggressiveness, and spread at the close. For example, Hillion and Suominen (2004) found before introducing a closing call auction on the CAC40 stocks of the Paris Bourse, there was a striking jump in price volatility, order submission rate, trading volume, and frequency of large and aggressive orders during the last minute of trading, despite an increase in the bid-ask spread. They suggest these phenomena are related to the manipulation of closing prices. Moreover, Comerton-Forde and Rydge (2006) studied cases of call auction price manipulation and found traders display similar behavior across markets by submitting large and unrepresentative orders at the closing call auction. This type of manipulation is commonly referred to in the literature as trade based manipulation (e.g. Allen and Gale, 1992).

In accord with previous literature, stock return volatility (as reflected by Parkinson's measure of

volatility), trading activity (including trading volume and order submission rate), order aggressiveness[4] (including frequency of aggressive (large) orders, aggressive (large) order rate) and effective spread are applied as proxies for manipulation. Using these variables, this paper systematically examines effects on trading behavior from the TSEC's introduction of five-minute closing call auctions.

Using the sample of component stocks of the Taiwan 50 index, Table 2 examines the impact of trading activity from the consolidation of liquidity. Trading is examined in five-minute intervals over the 10 minutes before the closing call auction (13:20~13:30). We compare the difference in order submission rates between 13:20~13:25 and 13:25~13:30 for both the pre and post period, and then compares the difference for the pre-period difference and post-period difference across trader types.

Table 2
The Order Submission Rate across Trader Types

Trading interval	Pre Period		Post Period		Change Difference	
	Rate (%)	Change	Rate (%)	Change		
Panel A: Mutual Fund						
13:20~13:25	0.030	0.006*** (-3.89)	0.024	0.003*** (7.03)	-0.003	(-1.49)
13:25~13:30	0.036		0.027			
Panel B: Foreign Institutions						
13:20~13:25	0.271	0.209*** (5.50)	0.333	0.460*** (10.22)	0.251***	(3.44)
13:25~13:30	0.480		0.793			
Panel C : Individuals						
13:20~13:25	1.450	1.510*** (63.42)	1.731	0.550*** (34.79)	-0.960***	(-38.38)
13:25~13:30	2.960		2.281			
Panel D: Dealers						
13:20~13:25	0.038	0.043*** (20.51)	0.064	0.032*** (12.42)	-0.011***	(-4.41)
13:25~13:30	0.081		0.096			
Panel E: Other Corporations						
13:20~13:25	0.099	0.156*** (20.71)	0.142	0.107*** (13.10)	-0.049***	(-2.34)
13:25~13:30	0.255		0.249			

The sample period is from July 1, 2001, to June 30, 2003. The period prior to the introduction of a five-minute closing call auction on July 1, 2002, is referred to as the *pre* period and the subsequent period is referred to as the *post* period. The Order Submission Rate (%) is measured by the order size in each interval divided by the total daily order size. Change is measured as the difference in order submission rates between 13:20~13:25 and 13:25~13:30. Change Difference is measured as the difference for the pre-period change and post-period change. The Wilcoxon signed-rank test is applied to test the difference and Z values are reported in parentheses.
*, **, *** indicate significance levels of 10%, 5%, 1%, respectively.

The results show individuals, dealers and other corporations significantly shifted their trades away

[4] Because Table 1 shows about 20 percent of submissions for stocks traded in the Taiwan 50 Index were more than 10,000 shares, an order is regarded as *large order* when the quoted size is greater than 10,000 shares. Due to the daily price limit of stocks on the TSEC is set at 7% of the closing price of the preceding business day, an order is regarded as *aggressive* when the quoted price is higher (lower) than the closing price of the preceding business day by 5–7%.

from the closing interval to the pre-closing intervals (13:20~13:25) after the five-minute closing call was introduced, and individuals are the main cause of the decline, -0.96%, in trading activity during the closing interval. The results support our previous conjecture that the opacity of the limit order book at the end of the trading day for the post period, traders may advance their trades toward the pre-closing intervals to avoid execution uncertainty.

While most trader types shifted their trades away from the closing interval to the pre-closing intervals, participation by foreign institutions during the closing interval significantly increased 0.251%. It is worth analyzing further whether trader's closing behavior is associated with particular types of traders on particular days especially on expiration days.

4. TRADING BEHAVIOR AT THE CLOSE ACROSS TRADER TYPES

This section identifies whether introducing the five-minute closing call auction changes the trader's closing behavior on expiration days, and impedes the incidence of anomalies in the Taiwan stock market.

We use MSCI-TW futures to analyze whether the new closing mechanism change trader's closing behavior on expiration day and reduce the anomalies. Trading of MSCI-TW futures ceases and the final settlement price is determined by the closing price on the penultimate business day of the expiration month. Attempts to manipulate closing prices would normally occur on this day. For comparison, we also examine one trading day prior (T-1) and two trading days after (T+2) the expiration day[5].

Table 3 shows the differences in the various variables between expiration day (T) and comparison days (non-expiration days, T-1). If there were discernible price pressure on the index futures' expiration day due to the activities of arbitragers or manipulators, unusually large order flow, trading volume and volatility would be observed on the expiration days (Stoll and Whaley, 1991). Table 3 shows all variables are significantly higher during the closing interval on expiration days than on comparison days for both the pre and post periods. This indicates the expiration day effect is still evident, even after the TSEC implemented five-minute closing call auctions.

We further examine whether introducing the new mechanism significantly reduces the magnitude of the anomalies between expiration days and non-expiration days for the pre and post period (as shown in the last column of Table 3). Market quality has been improved, as indicated by the significant decline in abnormal volatility (from 0.207 to 0.169) during the closing interval. On the other hand, there seems to be no lessening in the incidence of manipulation; the abnormal trading activity and order aggressiveness during the closing interval does not decrease significantly. Attempts by specific traders to influence the closing price would be more difficult and costly, however, because the abnormal trading activity and order aggressiveness significantly increase during the closing interval. For example,

[5] One trading day after the expiration day is also the end of the month. To avoid any potential month-end effect or quarter-end effect, this study uses for comparison two trading days after the expiration day (T+2), which is also the first day of a month. Because the results are similar to T-1, we do not show the results to save the space.

the abnormal aggressive order rate significantly increases from 0.617% to 1.492%, and 2.447% to 5.277% for abnormal large order rate. The results indicate the temporal consolidation of liquidity may require an investor who attempts to influence the closing price to place more numerous aggressive and larger orders for the post period.

Table 4 attempts to discern who has more incentives to influence the closing price on the expiration day. Because MSCI-TW futures are traded in Singapore, these index futures provide foreign institutions with an opportunity to hedge their Taiwan stock positions or to arbitrage their index futures positions. We conjecture that foreign institutions have more incentive to influence the index's component stocks, and have more change in trading behaviors at the close after introducing the five-minute closing call auction.

Overall, the difference of order submission rates during the closing interval between expiration day and comparison days is numerically small for individuals, mutual funds, dealers and other corporations during both the pre and post periods. Nevertheless, unusual order submissions by foreign institutions on expiration days are noted. The order submission rate by foreign institutions during the closing interval increases about seven times (from 0.30% to 2.37%) for the pre-period, and about 14 times for the post period (from 0.41% to 5.7%). In particular, the order submission by foreign institutions is greater than individuals (who generate most of the trading activity) for the post period. This result implies the anomalies on expiration days are primarily caused by foreign institutions for the pre and post period.

Table 4 further shows abnormal order submissions by foreign institutions during the closing interval increases from 2.064% in the pre period to 5.289% in the post period. These results are consistent with the idea that after introducing call auctions, an investor attempting to manipulate the closing price would need to place an order that matches a significant percentage of the order volume present on the other side of the limit order book (Kehr, et al., 2001).

5. CONCLUSIONS

On July 1, 2002, the TSEC changed its closing price procedure to a five-minute call auction. This paper examines the trader's behavior at the close before and after the new mechanism. The results show that return volatility at the close significantly reduced. However, the expiration day effect did not disappear. Foreign institutions seem to attempt to push up the stock prices at the close on the expiration days. However, the patterns of trading behavior have changed after introducing the new mechanism. The temporal consolidation of liquidity may cause traders who are attempting to influence stock prices at the close to submit more numerous large and aggressive orders. The new mechanism thus makes influencing the closing price more difficult and costly.

These results suggest that the introduction of the five-minute closing call auctions of TSEC has effectively reduced return volatility and made manipulation more costly at the close.

Table 3
Test for expiration day effect before and after the introduction of five-minute closing call auctions

Trading interval	Pre Period			Post Period			Difference in Difference
	Exp. Day	Non Exp. Day	Difference	Exp. Day	Non Exp. Day	Difference	
Panel A: Parkinson's Measure of Volatility							
13:20~13:25	0.282	0.332	-0.050 (-0.11)	0.215	0.191	0.024 (1.30)	0.074 (0.50)
13:25~13:30	0.627	0.420	0.207*** (5.31)	0.265	0.096	0.169*** (5.68)	-0.038*** (-2.05)
Panel B: Trading Activity							
Trading Volume (%)							
13:20~13:25	2.932	3.074	-0.142 (-0.42)	4.267	3.540	0.727*** (5.34)	0.869 (0.50)
13:25~13:30	9.234	5.672	3.562*** (8.76)	11.553	4.231	7.322*** (14.17)	3.760*** (-2.05)
Order Submission Rate (%)							
13:20~13:25	2.014	2.063	-0.049 (-0.91)	2.755	2.298	0.457*** (5.19)	0.506*** (3.08)
13:25~13:30	6.041	3.457	2.584*** (8.45)	8.329	3.038	5.291*** (14.18)	2.707*** (7.90)
Panel C: Order Aggressiveness							
Frequency of Aggressive Orders							
13:20~13:25	0.265	0.238	0.027 (0.94)	0.333	0.262	0.071** (2.59)	0.044 (1.42)
13:25~13:30	0.618	0.483	0.135* (1.93)	0.577	0.383	0.194*** (4.40)	0.059 (1.33)
Aggressive Order Rate (%)							
13:20~13:25	0.255	0.200	0.055* (1.93)	0.340	0.253	0.087*** (2.66)	0.032 (0.82)
13:25~13:30	1.127	0.510	0.617*** (4.93)	2.040	0.548	1.492*** (7.61)	0.875*** (4.50)
Frequency of Large Orders (%)							
13:20~13:25	0.475	0.489	-0.014 (1.16)	0.655	0.534	0.121*** (5.90)	0.135*** (4.48)
13:25~13:30	0.990	0.719	0.271*** (7.48)	0.980	0.629	0.351*** (12.51)	0.080** (2.45)
Large Order Rate (%)							
13:20~13:25	1.426	1.457	-0.031 (1.08)	2.130	1.658	0.472*** (5.45)	0.503*** (2.96)
13:25~13:30	4.959	2.512	2.447*** (8.16)	7.603	2.326	5.277*** (14.26)	2.830*** (9.15)
Panel D: Effective Spread							
13:20~13:25	0.0049	0.0049	0.0000 (0.44)	0.0049	0.0049	0.0000** (2.445)	0.0000 (0.42)
13:25~13:30	0.0052	0.0050	0.0002*** (2.73)	0.0057	0.0050	0.0007*** (2.824)	0.0005 (0.46)

The table presents the estimates of volatility, trading activity, order aggressiveness, and spread for expiration days and comparison days. Index future expiration days are reported as *Exp. Day*, and one trading day before (*T-1*) expiration days for comparison are reported as *Non-Exp. Day*. *Parkinson's Measure of Volatility* generates return volatility. *Trading Volume* is measured by the volume traded in each interval divided by the total daily trading volume. *Order Submission Rate* is measured by the order size in each interval divided by the total daily order size. *Frequency of Larger Orders* is measured by the number of larger orders (more than 10,000 shares) submitted in each interval divided by the total daily number of orders. *Frequency of Aggressive Orders* is measured by the number of aggressive orders (the quoted price is higher (lower) than the previous day's closing price by 5%~7%) submitted in each interval divided by the total daily number of orders. *Large* (aggressive) *Order Rate* is measured by the size of large (aggressive) orders submitted in each interval divided by the total daily sizes. *Effective spread* measures the difference between the actual trade price and the midpoints of the best quote bid and ask prices. *Difference* presents the change in values between *Exp. Day* and *Non-Exp. Day*. *Difference in Difference* presents the difference for the pre-period difference and post-period difference. The Wilcoxon Signed-Rank Test is applied to test the difference and Z values are reported in parentheses.

*, **, *** indicate significance levels of 10%, 5%, 1%, respectively.

Table 4

The order submission rates (%) across trader types on expiration days and non-expiration days

Trading interval	Pre Period			Post Period		
	Exp. Day	Non- Exp. Day	Difference	Exp. Day	Non- Exp. Day	Difference
Panel A: Mutual Funds						
13:20~13:25	0.054	0.029	0.025 (1.11)	0.022	0.022	0.000 (1.38)
13:25~13:30	0.041	0.047	-0.006 (-1.22)	0.039	0.020	0.019*** (2.65)
Panel B: Foreign Institutions						
13:20~13:25	0.381	0.200	0.181*** (6.32)	0.831	0.278	0.553*** (9.53)
13:25~13:30	2.366	0.302	2.064*** (10.17)	5.698	0.409	5.289*** (15.43)
Panel C: Individuals						
13:20~13:25	1.449	1.648	-0.199 (-0.96)	1.691	1.786	-0.095 (-0.05)
13:25~13:30	3.229	2.746	0.483*** (3.41)	2.249	2.260	-0.011 (-0.15)
Panel D: Dealers						
13:20~13:25	0.033	0.062	-0.029 (-0.99)	0.050	0.051	-0.001 (-1.64)
13:25~13:30	0.080	0.114	-0.034 (-0.36)	0.074	0.100	-0.026 (-0.04)
Panel E: Other Corporations						
13:20~13:25	0.096	0.124	-0.028 (-1.07)	0.160	0.161	-0.001 (-0.91)
13:25~13:30	0.324	0.248	0.076 (1.24)	0.269	0.249	0.020 (0.24)

The index future expiration day is reported as *Exp. Day*, and for comparison one trading days before the expiration day (T-1) is also reported as *Non-Exp. Day*. *Order Submission Rate (%)* is measured by the order size (quoted size) in each interval divided by the total daily order sizes. *Difference* presents the change in values between *Exp. Day* and *Non-Exp. Day*. The Wilcoxon Signed-Rank Test is applied to test the difference and Z values are reported in parentheses.

*, **, *** indicate significance levels of 10%, 5%, 1%, respectively.

References

Allen, F., Gale, D., 1992. Stock price manipulation. Review of Financial Studies 5, 503-529.

Amihud, Y.; Mendelson; H., Murgia, M., 1990. Stock market microstructure and return volatility, evidence from Italy. Journal of Banking and Finance 14, 423-440.

Carhart, M. M., Musto, R. D. K., Reed, A. V., 2002. Leaning for the tape: evidence of gaming behavior in equity mutual funds. The Journal of Finance 52, 661-693.

Chow, Y. F., Yung, H. H. M., Zhang, H., 2003. Expiration day effects: the case of Hong Kong. The Journal of Futures Markets 23, 67-86.

Comerton-Forde, C., Rydge, J., 2006. Call auction algorithm design and market manipulation. Journal of Multinational Financial Management 16, 184-198.

Cushing, D., Madhavan, A., 2000. Stock returns and trading at the close. Journal of Financial Markets 3, 45-67.

Harris, L., 1986. A day-end transaction price anomaly. Journal of Financial and Quantitative Analysis 24, 29-45.

Harris, L., 1989. A transaction data study of weekly and intradaily patterns in stock returns. Journal of Financial Economics 16, 99-117.

Hillion, P., Suominen M., 2004. The manipulation of closing price. Journal of Financial Markets 7, 351-375.

Jain, P., Joh G., 1988. The dependence between hourly prices and trading volume. Journal of Financial and Quantitative Analysis 23, 269-283.

Madhavan, A., 1992. Trading mechanisms in securities markets. The Journal of Finance 47, 607-641.

Pagano, M., Schwartz, R., 2003. A closing call's impact on market quality at Euronext Paris." Journal of Financial Economics 68, 439-484.

Stoll, H., Whaley, R., 1997. Expiration-day effects of the all ordinaries shares prices index futures: empirical evidence and alternative settlement procedures. Australian Journal of Management 22, 139-174.

Stoll, H., Whaley, R., 1991. "Expiration-day effects: What has changed? Financial analysis Journal 47, 58-72.

Achieving a Higher Accuracy for Hull and White's Method for Estimating Value-at-Risk

Chu-Hsiung Lin

Hsien-Chueh Peter Yang

Professor and associate professor of Department of Risk Management & Insurance
National Kaohsiung First University of Science and Technology, Taiwan, R.O.C
E-Mail: chusiung@ccms.nkfust.edu.tw

Chang-Cheng Changchien

Assistant professor of Department of Finance
Chang Jung Christian University, Taiwan, R.O.C

ABSTRACT

We propose a method in which the Garman-Klass estimator is followed by the historical simulation (HS) such that the Hull and White's method of estimating the value-at-risk of a portifolio can achieve a higher accuracy. Our proposed method does not require the estimation of the parameters for forecasting the variance in the GARCH/EWMA model and is meanwhile featured with the easy use of the HS approach. We use six international stock price indices and three hypothetical portfolios formed by these indices. The sample was observed daily from January 1, 1996 through December 31, 2006. Confirmed with the failure rates and back-testing, which are developed by Kupiec (1995) and Christoffersen (1998), the empirical results show that our method can considerably improve the estimation accuracy of Value-at-Risk. Thus the study establishes an effective alternative model for risk prediction and hence also provides a reliable tool for the management of portfolios.

Keywords: *Value-at-Risk, Historical simulation, Volatility, Garman-Klass estimator.*

1. INTRODUCTION

The goal of this paper is to improve the accuracy of the estimation of Value-at-Risk (VaR). It is of particular importance for risk management tools such as VaR models, which have received considerable attentions in recent years. VaR summarizes the worst expected loss over a target period with a given level of confidence (Jorin, 2000). Three major approaches, referred to as historical simulation (HS), variance-covariance, and Monte Carlo simulation, have been employed in practice for its precise estimation. The HS has been highly praised due to its unique feature of being free of distribution assumption for returns (Alexander and Leigh, 1997). Therefore, the HS is characterized with two major advantages. First, the HS can accommodate various forms of leptokurtosis and skewness since it does not assume a specific distribution for the returns of assets and portfolio. Secondly, it focuses on portfolio returns as a whole, ignoring the complicated processing of component assets returns and hence does not involve tremendous time-consuming for the estimation of variance components.

Although the HS is preferred for the reasons mentioned above, it requires massive amounts of historical

data to assure the accuracy of its risk measurement and therefore the historical sampling period has to be long enough to reflect a comprehensive risk profile. Hendricks (1996) and Vlaar (2000) have shown that the accuracy of the HS estimation can be improved by increasing the sample size. To increase the sample size, it would be desirable to trace back to the distant past to cover enough data of returns. However, market information from the distant past would inevitably dilute the significance of more recent information. For example, Jorin (2000) emphasizes that the HS method usually miss the situations with temporarily elevated volatility. Consequently, this dilution effect on the estimation accuracy of portfolio VaR could be so significant that the attractiveness of HS may fade away completely.

Hull and White (1998) present a volatility updating procedure, based on the normality assumption of returns, such that the advantages of HS can be preserved. Hull and White (1998) present a volatility updating procedure based on the normality assumption of returns. However, with the HS, there is no need to assume specific distribution shapes for assets and portfolios returns; hence, Hull and White's (1998) method does not have the HS's advantage. In Hull and White's (1998) method the daily variances are updated with an exponentially weighted moving average (EWMA) model with the decay factor of 0.94. The decay factor determines the rate at which the weights on past observations are decaying as they become older. The decay factors may vary across the series and over time and thus would lose consistency over different periods. Thus the selection of an optimal decay factor becomes troublesome. Moreover, Guermat and Harris (2002) use the same procedure to fit the returns data by the Generalized Error Distribution and show that this volatility updating procedure with the assumption of non-normality is more efficient and flexible than the conventional HS method, since it accommodates both normality and non-normality situations in one model and it also captures various fat-tailed distributions.

We would like to further improve Hull and White's (1998) method and conduct Hull and White's (1998) volatility updating procedures and fit the volatility by the Garman-Klass estimator. Our method possesses two major advantages for portfolio VaR estimation. That is, we preserve the HS's advantages of distribution-free estimation and avoid an erroneous estimate of the decay factor by using Hull and White's (1998) volatility updating procedures and the Garman-Klass estimator.

The remainder of the paper is organized as follows. Section 2 describes our research method. Section 3 analyzes the empirical evidence of the accuracy of our proposed method. We compare our method's performance with that of the HS and Hull and White's (1998) method by the Kupiec (1995) test, Christoffersen (1998) test and failure ratios. The results show that our method is much more stable than the HS and Hull and White's (1998) methods, which are updated with simple moving average (SMA) model, exponentially weighted moving average (EWMA) model, and GARCH model. Section 4 concludes our study.

2. METHODOLOGY

The following subsections discuss in details the definition of VaR, the HS approach, and our proposed method.

2.1 The definition of Value at Risk

The VaR of an investment portfolio is defined as the maximum value of expected loss at the confidence level of (1-c)% in a specific period *T*. In other words, the VaR is the confidence of (1-*c*)% we have and it is anticipated that the value of monetary loss will not exceed that VaR within a period of *T* days in the future. In general, the VaR can be mapped from the probability distribution *f (w)* of the future value of a specific investment portfolio. If we use the random variable W_t to represent the distribution of the losses of the investment portfolio in the future *t* days at the 1-*c*% level of confidence, the VaR can be expressed as equation (1):

$$P(w_t \le -VaR) = c = \int_{-\infty}^{-VaR} f(w)dw \tag{1}$$

In assessing the VaR by the HS method, the distribution of returns formed by the historical rates of return is used to simulate the VaR of a specific investment portfolio. Given an investment portfolio *P*, its historical rates of return is denoted as

$$R_{p,t} = \sum_{i=1}^{N} w_{i,t} R_{i,t} \quad , \quad t=1,2,...,T \tag{2}$$

where $R_{p,t}$ is the rate of return for the *t*th day of the portifolio; $R_{i,t}$ is the rate of return on the *i*th asset for the *t*th day, and the weights $w_{i,t}$ are indexed by time to identify the dynamic nature of trading portfolios. In assessing the VaR by the HS method, equation (2) is first used to find the portfolio return $R_{P,t}$ at each time point, and then the return of the investment portfolio at each time point is moved from a low value to a high one in order to obtain the probability distribution of the portfolio returns. Then this probability distribution of ratios is used to determine the decimal places at a particular level of confidence, and the VaR can be obtained.

2.2 Combining the Garman-Klass estimator with the HS

The classical volatility-estimation procedure employs the squared return as an unbiased estimator of σ^2. Although it gains simplicity, some readily available information for estimator efficiency is ignored. Garman and Klass (1980) use volatility estimators, which is denoted as $\hat{\sigma}^2_{i,t+1}$ in expression (3), that are based upon the historical opening price, the closing one, the highest one and the lowest one.

$$\hat{\sigma}^2_{i,t+1} = (1/2)\left[\ln(H_{i,t}) - \ln(L_{i,t})\right]^2 - \left[2\ln(2) - 1\right] \times \left[\ln(Q_{i,t}) - \ln(C_{i,t})\right]^2, \tag{3}$$

where $H_{i,t}$ is the highest price on the *i*th asset on the *t*th day; $L_{i,t}$ is the lowest price on the *i*th asset on the *t*th day; $Q_{i,t}$ is the opening price on the *i*th asset on the *t*th day; $C_{i,t}$ is the closing price on the *i*th asset on the *t*th day.

Hull and White (1998) proposed that a volatility-updating scheme can be used in conjunction with the HS for calculating the VaR. Their method performs better than Boudoukh, Richardson and Whitelaw's (1998) hybrid approach and the HS. Our study also uses Hull and White's (1998) volatility updating procedure. Hull and White (1998) propose equation (4) to revise the historical data for return on investment ($R_{i,t}$) by using information about fluctuation in recent times ($\sigma_{i,N} / \sigma_{i,t}$), and to obtain a new set of historical data ($R^*_{i,t}$). They use this new set of data for the HS and derive the probability distribution to assess the VaR.

$$R^*_{i,t} = \sigma_{i,N} \frac{R_{i,t}}{\sigma_{i,t}} \quad , \tag{4}$$

where $R_{i,t}$ is the rate of return on the *i*th asset on the *t*th day; $\sigma_{i,t}$ is the standard deviation of the *i*th asset on the *t*th day; $\sigma_{i,N}$ is the standard deviation for the most recent period.

In contrast to Hull and White's (1998) estimation of $\sigma_{i,N}$ and $\sigma_{i,t}$ with the normality assumption, in this study we use Garman and Klass's (1980) method to estimate the $\sigma_{i,N}$ and $\sigma_{i,t}$.

2.3 Model evaluation

We evaluate the accuracy of the proposed models by the Kupiec (1995) test, Christofferson (1998) test and the failure ratios of binary loss function (BLF). When comparing the different models' performance, one day is used as the specific period for assessing the VaR at 99.5%, 99%, 95%, and 90% levels of confidence respectively. The rationales of these three tests can be summarized as follows.

(1) The unconditional coverage test of Kupiec (1995)

The unconditional coverage of the Kupiec (1995) test, based on a binomial distribution, is a likelihood statistic, denoted as LR_{PF}, shown in equation (5), and it is used to determine whether the failure ratio is compatible with the expected level of confidence. The sample size is T and the frequency x of failures has the binomial probability of $\binom{T}{x}(1-c)^{T-x}c^{x}$. Under the binomial assumption, the assessed value of risk would satisfy the unconditional coverage ratio *c,* which is the expected level of c_0; the statistic LR_{PF} has the χ^2 distribution with 1 degree of freedom under the null hypothesis $H_0 : c = c_0$.

$$LR_{PF} = -2\ln\left[(1-c_0)^{T-x}c_0^{x}\right] + 2\ln\left[(1-(x/T))^{T-x}(x/T)^{x}\right] \tag{5}$$

(2) The conditional coverage test of Christofferson (1998)

In this study we use the conditional coverage test of Christofferson (1998). This test is to simultaneously test whether the signals of VaRs are independent and the average number of signals is correct. Namely, $H_0 : \pi_{01} = \pi_{11} = q^*$. The likelihood statistic is

$$LR_{cc} = -2\ln(L_A - L_I) \sim \chi^2(2) \tag{6}$$

$$L_A = (1-q^*)^{T-N}(q^*)^{N}$$

$$L_I = (1-\pi_{01})^{T_{00}}(\pi_{01})^{T_{01}}(1-\pi_{11})^{T_{10}}(\pi_{11})^{T_{11}}$$

$$\pi_{ij} = T_{ij}/(T_{i0}+T_{i1}),$$

where T_{ij}, *i, j* = 0, 1 is the number of times that state *j* follows state *I*; state 0 denotes an actual return less than the forecasted VaR; state 1 denotes an actual return that exceeds the forecasted VaR. The LR_{cc} test statistic

has the χ^2 distribution with two degrees of freedom.

(3) Binary Loss Function (BLF)

We also used the BLF as an indicator for the accuracy of the models. The BLF is based on the concept of failure ratios, where a failure is counted and the number of one is assigned for it if the actual loss were greater than VaR value; a constant of zero is assigned otherwise. If a VaR model provides the level of coverage defined by its confidence level, the average BLF over the full sample achieves 0.05 for the 95th percentile VaR and 0.01 for the 99th percentile VaR. Therefore, the closer the BLF value is to the confidence level from the model, the greater the accuracy is.

$$BLF_{i,t+1} = \begin{cases} 1 & \text{if } \Delta P_{i,t+1} < VaR_{i,t} \\ 0 & \text{if } \Delta P_{i,t+1} \geq VaR_{i,t} \end{cases} \quad (7)$$

where $\Delta P_{i,t+1}$ is the rate of return on the ith asset on the $t+1$th day

3. RESULTS

3.1 Sources and analysis of data

We use daily data of six international indices (CAC 40, FTSE 100, S&P 500, Hang Seng, Nikkei 225, and TAIEX) from January 1, 1996 through December 31, 2006 to test our model. We also use daily returns data of three hypothetical portfolios formed by these indices. These three portfolios are respectively constructed the following: (1) CAC 40, FTSE 100 and S&P 500, (2) Hang Seng, Nikkei 225, and TAIEX, and (3) CAC 40, FTSE 100, S&P 500, Hang Seng, Nikkei 225, and TAIEX. Although a stock index represents a market portfolio intrinsically, we still create these hypothetical portfolios to evaluate the robustness of our method in the context of portfolios heterogeneity. Continuously compounded returns are then calculated as the first difference of the natural logarithm of each series, $R_t = \ln(P_t / P_{t-1})$, where R_t is the return index value for day t.

The tests of the assumption that each return index series is normally distributed are presented in Table 1. The statistical values in Table 1 show the average daily returns are about 0. These results are consistent with those of previous studies about the long-term average daily return rate of stock market. Table 1 also shows the extreme values of the entire sample pool, which are respectively the mean plus and minus three standard deviations, we can observe that significant discrepancy exists between the lowest (highest) extreme values and the mean minus (plus) three standard deviation. The similar phenomenon holds between the lowest (highest) value of the sample and the 1% (99%) percentile. This implies that the tail of the actual distribution would be thicker than that of a normal distribution. In addition, the skewness and kurtosis coefficients are different from those of a normal distribution. In summary, the distribution of the returns on stock markets is not normally distributed and leptokurtic; thus a volatility-updating scheme used in conjunction with the HS would be meaningful.

3.2 The empirical findings and analysis

(1) The results of unconditional and conditional coverage testing

At the confidence levels of 99.5%, 99%, 95%, and 90%, our proposed approach is compared with the conventional HS and Hull and White's (1998) method for forecasting capability of one-day VaRs of six international indices and three hypothetical portfolios. In Hull and White's (1998) method, the daily variances are updated with the Garman-Klass estimator, simple moving average (SMA) model, exponentially weighted moving average (EWMA) model, and GARCH. To demonstrate that the proposed approach is reasonably accurate for estimating VaR, we also check its validity systematically by backtesting, according to the procedures proposed by Kupiec (1995) and Christoffersen (1998). The null hypothesis is that the risk model is correct. Thus, the proposed risk model is not adequate if the test statistics rejects the null hypothesis. Our major conclusions are presented in Tables 2 and 3.

First, in Table 2, we present the findings of the test for the unconditional coverage for the indices (CAC 40, FTSE 100, S&P 500, Hang Seng, Nikkei 225, and TAIEX) and the hypothetical portfolios. For the conventional HS, twenty-six out of thirty-six tests, the null hypotheses are rejected at the significance level of 5%; for the HW-SMA, thirteen out of thirty-six tests, the null hypotheses are rejected at the significance level of 5%; for the HW-EWMA, sixteen out of thirty-six tests, the null hypotheses are rejected at the significance level of 5%;for the HW-GARCH, twenty-three out of thirty-six tests, the null hypotheses are rejected at the significance level of 5%. However our proposed approach could not reject the null hypothesis at the significance levels of 5% and 1% respectively.

Secondly, in Table 3, we present the findings of the test for the conditional coverage. For the conventional HS, eight out of thirty-six tests, the null hypotheses are rejected at the significance level of 5%; for the HW-SMA, five out of thirty-six tests, the null hypotheses are rejected at the significance level of 5%; for the HW-EWMA, two out of thirty-six tests, the null hypotheses are rejected at the significance level of 5%; for the HW-GARCH, three out of thirty-six tests, the null hypotheses are rejected at the significance level of 5%. However, our proposed approach could not reject the null hypothesis at the significance levels of 5% and 1% respectively.

The VaR estimates produced by the conventional HS and Hull and White's (1998) method was updated with the SMA, EWMA, and GARCH model reject the null hypothesis at most levels of significance as Table 2 and 3 reveal. The results demonstrate that the conventional HS, HW-SMA, HW-EWMA, and HW-GARCH cannot provide sufficiently accurate VaR estimates for the six international indices and three hypothetical portfolios. Hence, most of the test results for the conventional HS, HW-SMA, HW-EWMA, and HW-GARCH show that these methods cannot maintain stable accuracy for forecasting. By contrast, in most cases, our proposed approaches achieve better results with respect to forecasting accuracy for any confidence level.

(2) The results of BLF tests

Since the BLF is based on the concept of failure ratio, it can be used as an indicator for the accuracy of estimation models. Therefore, the closer the BLF value is to the specified confidence level, the more accurate the model is. Table 4 indicates that the BLF values of our proposed models are usually closer to the specified significance levels than those of the conventional HS, HW-SMA, HW-EWMA, and HW-GARCH. The significant performance of our approach in failure ratio tests also demonstrates its strong capacity to capture the

tail behavior of returns. Therefore, combining the Garman-Klass estimator with the HS VaR forecasts not only offers an estimation method that is easy to use, but also effectively improves the performance of the conventional HS and Hull and White's (1998) method with respect to accuracy.

TABLE 1

The Descriptive Statistics of Returns of the Five Stock Indices and the Three Hypothetical Portfolios

	CAC 40	FTSE 100	S&P 500	Hang Seng	Nikkei 225	TAIEX	Portfolio 1	Portfolio 2	Portfolio 3
Mean (A)	0.00024	0.00022	0.00032	0.00046	-0.00019	-0.00005	0.00028	0.00009	0.00013
Standard Deviation (B)	0.01316	0.01015	0.00995	0.01574	0.01475	0.01812	0.01131	0.01218	0.01100
Kurtosis	5.88383	6.17709	6.91833	13.20913	6.10566	5.58278	5.96549	6.48013	6.79961
Skewness	-0.10881	-0.11555	-0.10195	-0.04548	0.16343	-0.22227	-0.14205	-0.12269	-0.10379
Lowest	-0.07678	-0.05885	-0.07113	-0.14735	-0.07234	-0.09710	-0.05761	-0.07724	-0.07197
A-3B	-0.03923	-0.03023	-0.02952	-0.04676	-0.04445	-0.05441	-0.03366	-0.03645	-0.03286
1% quartile	-0.03692	-0.02907	-0.02620	-0.04224	-0.03834	-0.05949	-0.03308	-0.03254	-0.02905
99% quartile	0.03451	0.02746	0.02692	0.04222	0.03708	0.05170	0.03053	0.03169	0.02826
A+3B	0.03970	0.03067	0.03016	0.04769	0.04406	0.05432	0.03422	0.03662	0.03312
Highest	0.07002	0.05904	0.05573	0.17247	0.12430	0.07581	0.05676	0.06904	0.06740
Sum	2789	2779	2770	2716	2708	2870	2686	2481	2374

TABLE 2

Backtesting results: unconditional coverage test statistics

CAC 40	C=0.005	C=0.01	C=0.05	C=0.1
HS	12.92**	18.78**	20.94**	35.27**
HW-SMA	4.22*	0.09	0.33	1.05
HW-EWMA	4.22*	8.48**	0.70	3.22
HW-GARCH	7.19**	11.11**	2.70	6.67*
GK	1.08	0.00	0.03	0.13
FTSE 100	**C=0.005**	**C=0.01**	**C=0.05**	**C=0.1**
HS	7.10**	4.53*	20.42**	38.33**
HW-SMA	3.92*	0.00	1.72	5.73*
HW-EWMA	1.04	3.17	1.08	5.73*
HW-GARCH	4.16*	3.17	4.57*	12.29**
GK	0.06	0.11	0.41	1.27
S&P 500	**C=0.005**	**C=0.01**	**C=0.05**	**C=0.1**
HS	7.03**	18.43**	44.77**	65.86**
HW-SMA	1.01	1.21	11.47**	20.00**
HW-EWMA	4.09*	1.21	9.54**	10.38**
HW-GARCH	7.03**	8.22**	18.57**	20.97**
GK	1.01	0.63	0.97	1.09
Hang Seng	**C=0.005**	**C=0.01**	**C=0.05**	**C=0.1**
HS	0.00	1.63	10.33**	28.28**
HW-SMA	0.13	0.12	3.05	4.09*
HW-EWMA	0.81	2.61	3.05	4.95*
HW-GARCH	3.73	3.87*	11.33**	10.61**
GK	0.21	0.91	0.83	1.50
Nikkei 225	**C=0.005**	**C=0.01**	**C=0.05**	**C=0.1**
HS	0.79	0.10	3.92*	16.29**
HW-SMA	0.79	0.07	0.10	4.20*
HW-EWMA	0.19	1.58	3.38	4.20*
HW-GARCH	0.19	2.54	3.38	6.04*
GK	0.19	0.10	3.38	1.56
TAIEX	**C=0.005**	**C=0.01**	**C=0.05**	**C=0.1**
HS	4.79*	1.85	28.59**	45.03**
HW-SMA	0.55	0.58	7.18**	16.67**
HW-EWMA	0.11	0.58	6.46*	4.52*
HW-GARCH	0.11	0.58	7.94**	12.84**
GK	1.40	0.04	2.15	3.75

Note: C=0.005 stands for the confident level of 99.5%. C=0.01 stands for the confident level of 99%. C=0.05 stands for the confident level of 95%. C=0.1 stands for the confident level of 90%. **HS** stands for Historical Simulation. **HW-SMA** stands for the daily variance was updated using simple moving average model. **HW-EWMA** stands for the daily variance was updated using EWMA model with decay factor λ=0.94. **HW-GARCH** stands for the daily variance was updated using GARCH model. **GK** stands for the daily variance was updated using Garman-Klass estimator. *, ** denote significance at the 5%, and 1% levels.

TABLE 2

Backtesting results: unconditional coverage test statistics (continued)

Portfolio 1	C=0.005	C=0.01	C=0.05	C=0.1
HS	6.32*	3.57	18.47**	31.67**
HW-SMA	0.00	0.06	0.51	6.06*
HW-EWMA	3.53	5.12*	2.00	6.06*
HW-GARCH	3.53	7.08**	5.19*	6.58*
GK	0.15	0.06	0.24	0.06
Portfolio 2	**C=0.005**	**C=0.01**	**C=0.05**	**C=0.1**
HS	0.86	2.90	4.01*	17.77**
HW-SMA	0.18	0.07	1.87	6.52*
HW-EWMA	2.23	1.74	4.69*	4.40*
HW-GARCH	2.23	1.74	6.22*	5.95*
GK	0.00	0.00	1.87	2.03
Portfolio 3	**C=0.005**	**C=0.01**	**C=0.05**	**C=0.1**
HS	0.49	3.25	6.77**	21.93**
HW-SMA	0.03	0.07	5.06*	16.20**
HW-EWMA	3.80	1.91	7.73**	13.23**
HW-GARCH	3.80	1.91	8.77**	23.21**
GK	0.09	0.18	2.45	3.19

Note: C=0.005 stands for the confident level of 99.5%. C=0.01 stands for the confident level of 99%. C=0.05 stands for the confident level of 95%. C=0.1 stands for the confident level of 90%. **HS** stands for Historical Simulation. **HW-SMA** stands for the daily variance was updated using simple moving average model. **HW-EWMA** stands for the daily variance was updated using EWMA model with decay factor λ=0.94. **HW-GARCH** stands for the daily variance was updated using GARCH model. **GK** stands for the daily variance was updated using Garman-Klass estimator. *, ** denote significance at the 5%, and 1% levels.

TABLE 3

Backtesting results: conditional coverage test statistics

CAC 40	C=0.005	C=0.01	C=0.05	C=0.1
HS	0.00	0.12	1.64	0.01
HW-SMA	0.06	0.21	5.52*	0.25
HW-EWMA	0.11	0.78	5.22*	0.17
HW-GARCH	0.23	1.18	4.33*	0.10
GK	0.51	0.02	3.05	0.32
FTSE 100	**C=0.005**	**C=0.01**	**C=0.05**	**C=0.1**
HS	2.55	0.12	2.15	3.23
HW-SMA	0.12	0.19	5.66*	2.43
HW-EWMA	0.45	0.11	2.97	2.43
HW-GARCH	0.02	0.11	4.65*	2.64
GK	0.04	0.14	3.47	2.22
S&P 500	**C=0.005**	**C=0.01**	**C=0.05**	**C=0.1**
HS	0.00	4.03*	0.51	0.03
HW-SMA	0.27	0.00	1.45	4.95*
HW-EWMA	1.09	1.54	0.00	0.30
HW-GARCH	0.21	0.27	0.06	0.14
GK	0.38	1.38	0.01	0.01
Hang Seng	**C=0.005**	**C=0.01**	**C=0.05**	**C=0.1**
HS	4.36*	6.43*	19.81**	7.75**
HW-SMA	1.12	0.00	4.17*	10.48**
HW-EWMA	0.13	1.12	4.04*	1.38
HW-GARCH	0.11	0.72	1.74	7.90**
GK	0.38	2.02	2.46	0.57
Nikkei 225	**C=0.005**	**C=0.01**	**C=0.05**	**C=0.1**
HS	0.50	3.94*	2.51	0.28
HW-SMA	0.13	0.00	0.02	0.05
HW-EWMA	0.31	0.18	0.85	0.08
HW-GARCH	0.31	0.98	0.85	0.11
GK	0.39	0.20	0.85	0.05
TAIEX	**C=0.005**	**C=0.01**	**C=0.05**	**C=0.1**
HS	0.00	3.92*	0.04	1.56
HW-SMA	1.13	0.52	0.29	0.01
HW-EWMA	1.76	0.52	0.48	0.43
HW-GARCH	1.76	0.52	0.53	0.00
GK	0.05	0.35	0.33	0.01

Note: C=0.005 stands for the confident level of 99.5%. C=0.01 stands for the confident level of 99%. C=0.05 stands for the confident level of 95%. C=0.1 stands for the confident level of 90%. **HS** stands for Historical Simulation. **HW-SMA** stands for the daily variance was updated using simple moving average model. **HW-EWMA** stands for the daily variance was updated using EWMA model with decay factor λ=0.94. **HW-GARCH** stands for the daily variance was updated using GARCH model. **GK** stands for the daily variance was updated using Garman-Klass estimator. *, ** denote significance at the 5%, and 1% levels.

TABLE 3

Backtesting results: conditional coverage test statistic (continued)

Portfolio 1	C=0.005	C=0.01	C=0.05	C=0.1
HS	2.85	0.59	0.12	0.02
HW-SMA	0.59	0.08	1.22	0.33
HW-EWMA	0.19	1.40	0.02	0.33
HW-GARCH	0.37	1.75	0.07	0.32
GK	0.85	0.37	1.77	0.73
Portfolio 2	**C=0.005**	**C=0.01**	**C=0.05**	**C=0.1**
HS	1.31	0.52	4.06*	0.00
HW-SMA	0.00	0.01	0.13	1.12
HW-EWMA	0.35	0.23	2.39	1.04
HW-GARCH	0.35	0.23	2.49	1.10
GK	0.20	0.05	0.13	0.94
Portfolio 3	**C=0.005**	**C=0.01**	**C=0.05**	**C=0.1**
HS	1.18	0.08	0.10	1.04
HW-SMA	0.06	0.69	0.13	0.59
HW-EWMA	0.89	1.35	1.59	0.53
HW-GARCH	0.37	1.35	1.65	0.74
GK	1.35	0.43	1.23	0.34

Note: C=0.005 stands for the confident level of 99.5%. C=0.01 stands for the confident level of 99%. C=0.05 stands for the confident level of 95%. C=0.1 stands for the confident level of 90%. **HS** stands for Historical Simulation. **HW-SMA** stands for the daily variance was updated using simple moving average model. **HW-EWMA** stands for the daily variance was updated using EWMA model with decay factor λ=0.94. **HW-GARCH** stands for the daily variance was updated using GARCH model. **GK** stands for the daily variance was updated using Garman-Klass estimator. *, ** denote significance at the 5%, and 1% levels.

TABLE 4

The Failure Ratios of Competing Models

Country	Method	C=0.005 (Theoretic NF: 6)		C=0.01 (Theoretic NF: 13)		C=0.05 (Theoretic NF: 64)		C=0.1 (Theoretic NF: 129)	
		Total NF	FR	Total NF	FR	Total NF	FR	Total NF	FR
CAC 40	HS	0	0.000	1	0.001	32	0.025	70	0.054
	HW-SMA	2	0.002	14	0.011	60	0.047	118	0.092
	HW-EWMA	2	0.002	4	0.003	58	0.045	110	0.085
	HW-GARCH	1	0.001	3	0.002	52	0.040	102	0.079
	GK	4	0.003	13	0.010	63	0.049	125	0.097
Country	Method	C=0.005 (Theoretic NF: 6)		C=0.01 (Theoretic NF: 13)		C=0.05 (Theoretic NF: 64)		C=0.1 (Theoretic NF: 128)	
		Total NF	FR	Total NF	FR	Total NF	FR	Total NF	FR
FTSE 100	HS	1	0.001	6	0.005	32	0.025	67	0.052
	HW-SMA	12	0.009	14	0.011	54	0.042	103	0.081
	HW-EWMA	4	0.003	7	0.005	56	0.044	103	0.081
	HW-GARCH	2	0.002	7	0.005	48	0.038	92	0.072
	GK	7	0.005	14	0.011	59	0.046	116	0.091
Country	Method	C=0.005 (Theoretic NF: 6)		C=0.01 (Theoretic NF: 13)		C=0.05 (Theoretic NF: 64)		C=0.1 (Theoretic NF: 127)	
		Total NF	FR	Total NF	FR	Total NF	FR	Total NF	FR
S&P 500	HS	0	0.000	1	0.001	19	0.015	50	0.039
	HW-SMA	4	0.003	9	0.007	39	0.031	82	0.065
	HW-EWMA	2	0.002	9	0.007	41	0.032	94	0.074
	HW-GARCH	1	0.001	4	0.003	33	0.026	81	0.064
	GK	4	0.003	10	0.008	56	0.044	116	0.091
Country	Method	C=0.005 (Theoretic NF: 6)		C=0.01 (Theoretic NF: 12)		C=0.05 (Theoretic NF: 61)		C=0.1 (Theoretic NF: 122)	
		Total NF	FR	Total NF	FR	Total NF	FR	Total NF	FR
Hang Seng	HS	6	0.005	8	0.007	38	0.031	70	0.058
	HW-SMA	7	0.006	11	0.009	48	0.039	101	0.083
	HW-EWMA	4	0.003	7	0.006	48	0.039	99	0.081
	HW-GARCH	2	0.002	6	0.005	37	0.030	89	0.073
	GK	5	0.004	9	0.007	54	0.044	109	0.090

Note: C=0.005 stands for the confident level of 99.5%. C=0.01 stands for the confident level of 99%. C=0.05 stands for the confident level of 95%. C=0.1 stands for the confident level of 90%. **HS** stands for Historical Simulation. **HW-SMA** stands for the daily variance was updated using simple moving average model. **HW-EWMA** stands for the daily variance was updated using EWMA model with decay factor λ=0.94. **HW-GARCH** stands for the daily variance was updated using GARCH model. **GK** stands for the daily variance was updated using Garman-Klass estimator. NF denotes number of failure. FR denotes failure ratio.

TABLE 4

The Failure Ratios of Competing Models (continued)

Country	Method	C=0.005 (Theoretic NF: 6)		C=0.01 (Theoretic NF: 12)		C=0.05 (Theoretic NF: 60)		C=0.1 (Theoretic NF: 121)	
		Total NF	FR	Total NF	FR	Total NF	FR	Total NF	FR
Nikkei 225	HS	4	0.003	11	0.009	46	0.038	81	0.067
	HW-SMA	4	0.003	13	0.011	58	0.048	100	0.083
	HW-EWMA	5	0.004	8	0.007	47	0.039	100	0.083
	HW-GARCH	5	0.004	7	0.006	47	0.039	96	0.079
	GK	5	0.004	11	0.009	47	0.039	108	0.089
Country	Method	C=0.005 (Theoretic NF: 7)		C=0.01 (Theoretic NF: 14)		C=0.05 (Theoretic NF: 69)		C=0.1 (Theoretic NF: 137)	
		Total NF	FR	Total NF	FR	Total NF	FR	Total NF	FR
TAIEX	HS	2	0.001	9	0.007	30	0.022	69	0.050
	HW-SMA	5	0.004	11	0.008	48	0.035	94	0.069
	HW-EWMA	6	0.004	11	0.008	49	0.036	114	0.083
	HW-GARCH	6	0.004	11	0.008	47	0.034	99	0.072
	GK	4	0.003	13	0.009	57	0.042	116	0.085
Country	Method	C=0.005 (Theoretic NF: 6)		C=0.01 (Theoretic NF: 12)		C=0.05 (Theoretic NF: 59)		C=0.1 (Theoretic NF: 119)	
		Total NF	FR	Total NF	FR	Total NF	FR	Total NF	FR
Portfolio 1	HS	1	0.001	6	0.005	30	0.025	65	0.055
	HW-SMA	6	0.005	11	0.009	54	0.046	94	0.079
	HW-EWMA	2	0.002	5	0.004	49	0.041	94	0.079
	HW-GARCH	2	0.002	4	0.003	43	0.036	93	0.078
	GK	5	0.004	11	0.009	63	0.053	116	0.098
Country	Method	C=0.005 (Theoretic NF: 5)		C=0.01 (Theoretic NF: 10)		C=0.05 (Theoretic NF: 49)		C=0.1 (Theoretic NF: 98)	
		Total NF	FR	Total NF	FR	Total NF	FR	Total NF	FR
Portfolio 2	HS	3	0.003	5	0.005	36	0.037	61	0.062
	HW-SMA	4	0.004	9	0.009	40	0.041	75	0.076
	HW-EWMA	2	0.002	6	0.006	35	0.036	79	0.081
	HW-GARCH	2	0.002	6	0.006	33	0.034	76	0.077
	GK	5	0.005	10	0.010	40	0.041	85	0.087
Country	Method	C=0.005 (Theoretic NF: 4)		C=0.01 (Theoretic NF: 9)		C=0.05 (Theoretic NF: 44)		C=0.1 (Theoretic NF: 87)	
		Total NF	FR	Total NF	FR	Total NF	FR	Total NF	FR
Portfolio 3	HS	3	0.003	4	0.005	28	0.032	49	0.056
	HW-SMA	4	0.005	8	0.009	30	0.034	54	0.062
	HW-EWMA	1	0.001	5	0.006	27	0.031	57	0.065
	HW-GARCH	1	0.001	5	0.006	26	0.030	48	0.055
	GK	5	0.006	10	0.011	34	0.039	72	0.082

Note: C=0.005 stands for the confident level of 99.5%. C=0.01 stands for the confident level of 99%. C=0.05 stands for the confident level of 95%. C=0.1 stands for the confident level of 90%. **HS** stands for Historical Simulation. **HW-SMA** stands for the daily variance was updated using simple moving average model. **HW-EWMA** stands for the daily variance was updated using EWMA model with decay factor λ=0.94. **HW-GARCH** stands for the daily variance was updated using GARCH model. **GK** stands for the daily variance was updated using Garman-Klass estimator. NF denotes number of failure.

4. CONCLUSION

To solve the problem that Hull and White's (1998) method may not have the HS advantage and it requires the solution of an optimal decay factor, we suggest that the Garman-Klass estimator be used in conjunction with the HS. Our method is featured with two major advantages: (1) the HS's advantage of non-parametric estimation is preserved, because there is no need to assume specific distribution shapes for assets and portfolios returns; (2) the choice of selecting the optimal decay factor is not required.

The empirical evidence in our study shows that our proposed method would provide much more accurate forecasts for portfolio VaR than the conventional HS and Hull and White's (1998) method, updated with the SMA, EWMA, and GARCH model.

References

Alexander, C.O., and C.T. Leigh, 1997, "On the Covariance Matrices Used in Value at Risk Models," *Journal of Derivatives*, Vol.4, No.3, p.p.50-62.

Boudoukh, J., M. Richardson and R. Whilelaw, 1998, "The Best of Both Worlds: A Hybrid Approach to Calculating Value at Risk," *Risk*, Vol.11, p.p.64-67.

Garman, M.B., and M.J. Klass, 1980, "On the Estimation of Security Price Volatility from Historical Data," *The Journal of Business*, Vol.53, No.1, p.p.67-78.

Guermat, C. and R.D.F. Harris, 2002, "Robust Conditional Variance Estimation and Value-at-Risk," *The Journal of Risk*, Vol.4, No.2, p.p.25-41.

Harris, R.D. F. and J. Shen, 2003, "Robust Estimation of the Optimal Hedge Ratio," *The Journal of Futures Markets*, Vol.23, No.8, p.p.799-816.

Hendricks, D., 1996, "Evaluation of Value-at-Risk Models Using Historical Data," *Economic Policy Review*, Vol.2, p.p.39-69.

Hull, J. and A. White, 1998, "Incorporating Volatility Updating into the Historical Simulation Method for Value-at-Risk," *Journal of Risk*, Vol.1, p.p.5-19.

Jorion, P., 2000, *Value at Risk*, McGraw Hill.

Kupiec, P., 1995, "Technique for Verifying the Accuracy of Risk Measurement Models," *Journal of Derivatives*, Vol.3, p.p.73-84.

Vlaar, Peter J.G., 2000, "Value at Risk Models for Dutch Bond Portfolios," *Journal of Banking and Finance*, Vol.24, No.7, p.p.1131-1154.

Relationship between Term Structure Information and Hedge Ratio of Treasury Futures Contracts

Jian-Hsin Chou
Professor, Department of Risk Management and Insurance,
National Kaohsiung First University of Science and Technology, Kaohsiung, Taiwan.
E-Mail: jian@ccms.nkfust.edu.tw

Wei-Ming Wu
Associate Professor, Instituteof Business Management,
National Kaohsiung First University of Science and Technology, Kaohsiung, Taiwan.

Chien-Yun Chang
Assistant Professor, Department Finance Management
Hsiuping Institute of Technology, Taichung, Taiwan.

ABSTRACT

This paper employs the Kalman filter to explore the impact of term structure variables in the hedging of Japanese Government Bonds (JGBs) with treasury futures. The term structure factors (level parameter, β_0; slope parameter, β_1; and curvature parameter, β_2) are based on Nelson and Siegel (1987) model. The out-of-sample hedging performance is also provided by moving window technology. The empirical results show the existence of significant relationships among the term structure factors, the earlier hedge ratio, and the optimal hedge ratio. However, the time-varying hedge ratio (which includes the term structure variables from the information set) did not provide good out-of-sample hedging effectiveness. Nevertheless, the out-of-sample results did demonstrate that the performance of the time-varying hedge ratio with term structure variables is better than a hedge ratio with a naive hedge or OLS model in the 7–10-year Japanese Government Bond index.

Keywords: *Kalman Filter, Term Structure of Interest Rates, Hedge Ratio*

1. INTRODUCTION

The so-called 'term structure of interest rates' (TSIR), which is also known as the yield curve, shows the expected yield from zero-coupon government bonds under a given default risk. For many large financial institutions, information derived from the TSIR has played an important role in the valuation and hedging of interest-rate-dependent instruments. Moreover, the shape of the TSIR provides a good predictive indicator of future economic activity, with consequent implications for estimations of GDP and inflation rates (Estrella and Mishkin, 1998; Estrella and Hardouvelis, 1991) Investors can therefore make judgments on the future impact of financial and economic activities by observing changes in the TSIR, and can thus adjust their investment and hedging strategies.

Because the spot price of bonds is a function of interest rates and the movement of the yield curve is not parallel within different maturities, Litterman and Scheinkman (1991) decomposed the curve of the TSIR into three phases: level, slope, and curvature. Diebold and Li (2006) used β_0, β_1, and β_2 in the Nelson and Siegel (1987) model to designate these three phases, which they interpreted as the long-term, short-term, and middle-term phases in the interest rate. In addition, apart from these three phases, the factor τ from the Nelson and Siegel (1987) model governs the exponential decay rate. When the value of τ is small, slow decay is

produced and there is a better fit with the yield curve at long maturities; conversely, when the value of τ is large, rapid decay is produced and there is a better fit with the yield curve at short maturities. Moreover, as Dolan (1999) and Diebold et al. (2006) have pointed out, the Nelson and Siegel (2006) model is well suited to describing the dynamic process of the TSIR and providing good forecasts.

To promote bond portfolio performance, bond investment managers obviously wish to manage interest rate risks efficiently, and they therefore need to understand the dynamic process of the TSIR. In this regard, Markowitz (1991) decomposed portfolio risk into: (i) system risk; and (ii) non-system risk. According to this view, bond investment managers can eliminate non-system risk by diversification of investment; however, diversification of system risk in the bond portfolio can only be achieved by the hedge function of futures contracts or other derivatives. Management of the interest risk with futures contracts therefore becomes an important issue in bond portfolio management.

The Tokyo Stock Exchange (TSE) has offered trading on 10-year Japanese Government Bond (JGB) Futures contracts since October 1985. The trading volume of these contracts has boomed, and the JGB Futures market is now regarded as one of the most active in the Asian financial system. These futures bonds are popular because they can be used to transfer risk and thus provide bond investors with a hedge against interest rate risks. In these circumstances, the determination of the optimal hedge ratio becomes a crucial issue in the hedge strategy of investors; however, their ability to do this effectively has been inhibited by the fact that most empirical studies of these issues have focused only on the question of stock portfolio hedge. The present paper addresses this gap in the literature by analysing the hedge function of interest rate futures in the JGB market.

Traditionally, hedge ratios have been estimated by regression analysis. However, Myers (1991) has argued that this method of estimating hedge ratios encounters two problems: (i) the estimated value of hedge ratios using this methodology does not involve all relevant information; and (ii) the hedge ratio derived by this method is not time-dependent because the covariance matrix of spot and futures prices will not change with time. As a result, the assumption of a fixed covariance matrix could induce investors to take unacceptable risks with futures. To resolve these difficulties in the traditional model, Engle (1982) provided the autoregressive conditional heteroscedasticity (ARCH) model, which predicts the conditional variance by taking a weighted average of past errors. In this model, recent information has more influence on the error term than information from the distant past. This ARCH model was extended in the Generalized ARCH model (known as the GARCH model), which was developed by Bollerslev (1986). The GARCH model assumes that variance is a weighted average between previous variance and error terms. An even more generalized model has been proposed by Engle et al. (1988), who took into consideration the feedback relationship between spots and futures. All of these ARCH-type models represent a significant advance on previously used methods because they all assume that hedge ratios are time-variant, and many studies have used them to estimate time-varying hedge ratios (Baillie and Myers, 1991; Kroner and Sultan, 1993; Koutmos, 2001; Rossi and Zucca, 2002)

Because the duration of a bond portfolio is fundamentally a function of interest rates, it is reasonable to assume that the returns of a bond portfolio will fluctuate with movements in the yield curve. As noted above, the traditional assumption that hedge ratios are time-invariant is not sustainable; rather, it is necessary to describe the dynamic relationship between yield-curve factors and hedge ratios. To incorporate information on the level, slope, and curvature of the yield curve into the estimation of a time-varying optimal hedge ratio, the present study utilises the Kalman filter, which avoids the difficulty of deciding the initial value of the GARCH model.

In accordance with the approach adopted by Fink et al. (2005), the present study investigates the performance of an optimal hedge ratio using moving window technology based on the Kalman filter; however, the approach of Fink et al. (2005) is extended here by a more accurate estimation of the yield curve factors. In this regard, Dolan (1999) pointed out that the parameters of the yield curve, estimated using the Nelson and Siegel (1987) model, can be predicted; indeed, Dolan (1999) presented forecasts of how the level, slope, and curve could have significant effects on bond portfolio performance. The main contribution of the present work is, therefore, to combine the yield curve factors of the JGB, using the Nelson and Siegel (1987) model, with the Kalman filter to generate the optimal hedge ratio.

The remainder of this paper is organised as follows. The next section introduces the estimation of yield curve factors, and the calculation of the time-varying optimal hedge ratio, using the Kalman filter. The third section proceeds to an empirical analysis - describing: (i) the detailed data; (ii) the estimation of the model of yield curve and the Kalman filter; and (iii) the in-sample and out-of-sample performance of a number of hedges. In the last section, the conclusions are presented.

2. METHODOLOGY

The parsimonious model of the yield curve used in this paper is that built by Nelson and Siegel (1987). Willner (1996) contended that this model is a useful method for approximating the sensitivity of a bond portfolio to yield-curve level, slope, and curvature. In a similar vein, Diebold and Li (2006) and Diebold et al. (2006) argued that the well-known Nelson-Siegel (1987) model is well suited to approximating yield-curve dynamics and providing good predictions. The model is used in the present study to estimate the level, slope, and curvature of the yield curve with Japanese government coupon bonds.

The theoretical price of a coupon bond is equal to the sum of the present value of the future coupon and the principal payments according to the following relationship:

$$\hat{B}_i = \sum_{j=1}^{M_i} C(t_{i,j}) exp\{-t_{i,j} R(t_{i,j})\},$$

(1) where:

$\hat{B}_i$ is the i_{th} theoretical price of coupon bond;

M_i is the maturity of the i_{th} bond;

$C(t_{i,j})$ is the cash flow of the i_{th} bond at time t_j; and

$R(t_{i,j})$ is the spot rate at time t_j in the i_{th} bond.

Nelson and Siegel (1987) chose a function for the forward rate curve that can be transferred by integrating process to spot rate curve as follows:

$$R(t_{i,j}) = \beta_0 + \beta_1 \left(\frac{\tau}{t_{i,j}}\right)\left[1 - \exp\left(\frac{-t_{i,j}}{\tau}\right)\right] + \beta_2 \left(\frac{\tau}{t_{i,j}}\right)\left[1 - \exp\left(\frac{-t_{i,j}}{\tau}\right)\left(\frac{t_{i,j}}{\tau} + 1\right)\right] \quad (2)$$

where:

β_0, β_1, β_2, and τ are the parameters for a maturity of t years.

The Nelson and Siegel (1987) model implies an intuitive explanation of the parameters: (i) the value of β_0, which is regarded as a long-term interest rate, is represented by the level of the curve; (ii) the value of β_1, which is regarded as a short-term interest rate, is represented by the slope of the curve; (iii) the value of β_2, which is regarded as a medium-term interest rate, is represented by the curvature of the curve; and (iv) the parameter τ, which governs the exponential decay rate at which the short-term and medium-term factors decay to zero.

To generate these parameters of the yield curve, the function of spot rate is added to the theoretical price of the coupon bond function (1) as follows:

$$\begin{aligned}\hat{B}_i &= \sum_{j=1}^{z_i} C(t_{i,j})\exp((-t)(R(t))) \\ &= \sum_{j=1}^{z_i} C(t_{i,j})\exp\left(\left(-t_{i,j}\right)\times\left(\beta_0+\beta_1(\frac{\tau}{t_{i,j}})\left[1-\exp(\frac{-t_{i,j}}{\tau})\right]+\beta_2(\frac{\tau}{t_{i,j}})\left[1-\exp(\frac{-t_{i,j}}{\tau})(\frac{t_{i,j}}{\tau}+1)\right]\right)\right)\end{aligned} \tag{3}$$

The parameters can then be estimated by minimising the difference between the actual and theoretical bond price. Because the objective function is nonlinear, the Newton method can be used to approximate the parameters of the Nelson and Siegel (1987) model. One advantage of this method is that τ cannot be assumed to be a constant; rather, it varies with other parameters. In this regard it should be noted that Diebold and Li (2006) estimated the Nelson and Siegel (1987) model with a constant τ, but Hurn et al. (2005) argued that the curve from the Nelson and Siegel (1987) model is sensitive to the scale parameter τ, which cannot be fixed. Applying the Newton method to the Nelson and Siegel (1987) model for each day generates a time series of estimates of parameters, which can then be placed as yield-curve factors in the Kalman filter model to estimate the optimal hedge ratio.

The GARCH-based estimation method for time-varying hedge ratios requires the imposition of inequality restrictions on model parameters and the use of a wide range of starting values (Fackler and McNew, 1994; Harris and Shen, 2003). To overcome these negative features of the GARCH method, the present study utilised a Kalman filter to construct a state space specification to estimate the optimal hedge ratio. A state space representation of the relationship between spot and futures return is given by the following system of equations:

$$\begin{aligned}\Delta S_t &= \Delta f_t \nu_t + \mu_t \\ \nu_t &= \alpha + \lambda \nu_{t\text{-}1} + \gamma_1\beta_0 + \gamma_2\beta_1 + \gamma_3\beta_2 + \zeta_t \\ \mu_t &\sim N(0,\sigma_\mu^2) \\ \zeta_t &\sim N(0,\sigma_\zeta^2)\end{aligned} \tag{4}$$

where:

ΔS_t is the log return of the bond index at time t;

Δf_t is the log return of the 10-year JGB futures contracts employed in the hedge portfolio at time t; and

ν_t, the optimal hedge ratio at time t, determines the value of futures contracts purchased or sold to the underlying security.

In the state equation, λ measures the persistence of the optimal hedge ratio. Other coefficients that interpret the effect of the yield-curve shape are:

γ_1, which represents the level effect of the yield curve;

γ_2, which represents the slope effect of the yield curve; and

γ_3, which represnts the curvature effect of the yield curve.

The error terms μ_t and ζ_t are assumed to follow a normal distribution and are independent of each other.

The Kalman filter procedure takes into account the serially correlated and heteroscedastic disturbance in the relationship between changes in the spot return and changes in the futures return. In addition, the Kalman filter is a recursive algorithm for sequentially updating the time-varying hedge ratios (given new information during the time series). For instance, consider a dataset that includes T observations with the former state vector $\lambda_{1|0}$ defined as the optimal hedge ratio at time one (which is estimated at time zero). In these circumstances, the later state variable $P_{1|0}$ represents the covariance matrix of the conditional distribution of the state vector $\lambda_{1|0}$ (given information available at time zero). Given that the information parameters λ、γ_1、γ_2、γ_3、σ_μ^2, and σ_ζ^2 are assumed to be known, the one-step ahead predictor of state terms $\lambda_{t|0}$ and $P_{1|0}$ can be expressed as:

$$\hat{\nu}_{t|t} = \hat{\nu}_{t|t-1} + \left(P_{t|t-1}\right)^2 \left(\Delta f_t\right)^2 F_t^{-1} \left(\Delta S_t - \lambda \hat{\nu}_{t|t-1}\right) \tag{5}$$

$$P_{t|t} = P_{t|t-1} - \left(P_{t|t-1}\right)^2 \left(\Delta f_t\right)^2 F_t^{-1} \tag{6}$$

$$F_t = \left(\Delta f_t\right)^2 P_{t|t-1} + \sigma_\mu^2 \tag{7}$$

Therefore, the optimal hedge ratio λ is predicted one step ahead in the following way:

$$\hat{\nu}_{t+1|t} = \left(\lambda - K_t \Delta f_t\right)\hat{\nu}_{t|t-1} + K_t \Delta S_t + \left(\alpha + \gamma_1\beta_0 + \gamma_2\beta_1 + \gamma_3\beta_2\right) \tag{8}$$

$$K_t = \lambda P_{t|t-1} \Delta f_t F_t^{-1} \tag{9}$$

$$P_{t+1} = \lambda^2 \left\{P_{t|t-1} - \left(P_{t|t-1}\right)^2 \lambda^2 F_t^{-1}\right\} + \sigma_\zeta^2 \tag{10}$$

To complete the Kalman filter, the unknown elements of the system matrices must be replaced by their estimates. Given the assumption of the normality of μ_t and ζ_t, the parameters of the system equations can be estimated by formulating the log likelihood function as follows:

$$\log L = -\frac{T}{2}\log(2\pi) - \frac{1}{2}\sum_{t=1}^{T}\log\left|F_t\right| - \frac{1}{2}\sum_{t=1}^{T}\frac{\theta_t^2}{F_t} \quad , \theta_t = \Delta S_t - \Delta f_t \hat{\nu}_{t|t-1} \tag{11}$$

3. EMPIRICAL RESULTS

3.1 Data and Estimation

The data used in the empirical study referred to daily 10-year JGB nearby Futures contracts traded on the Tokyo Security Exchange (TSE). The 10-year JGB nearby Futures contracts settlement prices were obtained from Datastream. The daily JGB price index was calculated by JP Morgan and collected from Datastream. The data transferred to the daily log return covered the period from 30 May 2002 to 18 April 2007. The total number of time-series observations in the data set was therefore 1275.For the purpose of estimating the

JGB yield curve, the daily JGB price was plotted. This consisted of 179 observations (on average) per day from 30 May 2002 to 18 April 2007. A Newton method was used to extract these yield-curve factors embedded in the Nelson and Siegel (1987) model.

From these data, it was possible to derive the parameters and variables as described in the previous section. Table 1 provides some descriptive statistics of these time-series parameters and variables. The left column of the table shows the means, mediums, maximums, minimums, and standard deviations. Among the yield-curve factors:

- the mean of daily β_0 was 0.0327, which shows that the long-term interest rate level tended to 3.27%;
- the mean of daily β_1 was -0.0336, which represents the positive slope of the yield curve on average;
- the mean of daily β_2 was 0.0036, which shows that the slope of the yield curve was not only positive, but also had a hump in the JGB market.

In addition, the maximum β_2 and the minimum β_2 were not all larger than zero, which shows that the shapes of the yield curves in the JGB market involved different patterns. The risk of yield-curve change should therefore be taken into account in interest risk management.

Table 1 also shows the statistics of the JGB spot and futures log return. The average log return of the JGB spot (–0.0017%) was less than that of the JGB futures (–0.0032%). Similarly, the standard deviation of spot log return (0.1453%) was also lower than that of the futures log return(0.2414%), which implies that the volatility of the futures market was greater than that of the spot market.

[Take in Table 1 about here]
Table 1: Descriptive Statistics for Yield-Curve Factors, Spot and Futures Returns

Pearson correlation analysis was used to investigate the yield-fitting ability of the Nelson and Siegel (1987) model and the degree of relationship between the JGB spot and futures returns (as shown in Table 2). The correlation coefficient between the 10-year JGB price index and 10-year JGB futures settlement price was quite high (98.189%), which implies that the 10-year JGB price index return was more strongly correlated to the 10-year JGB futures return.

[Take in Table 2 about here]
Table 2: Correlation of JGB Spot and Futures Price with JGB Yield and NS Yield

This relationship is also clear from Figure 1. The strong correlation between these factors indicates that the JGB 10-year futures could provide a good hedge function for the JGB 10-year price index.

[Take in Figure 1 about here]
Figure 1: Price of 10-Year JGB vs Settlement Price of 10-Year JGB Futures

As shown in Table 2, the correlation coefficient between the 10-year JGB yield and the 10-year JGB price index was negative (–92.197%). Table 2 also presents the correlation between the 10-year JGB yield and the 10-year JGB futures settlement price (–89.346%). The negative relationship between the JGB yield and price is in accordance with the intuitive perception of bond pricing.

Finally, both Table 2 and Figure 2 show that the 10-year JGB yield estimated by Nelson and Siegel (1987) had a correlation of 95.757% with the actual 10-year JGB yield, which suggests that the Nelson and Siegel (1987) model could fit the 10-year JGB yield well. For this reason, the parameters of the model should involve some information to explain the variety of the 10-year JGB yield.

[Take in Figure 2 about here]

Figure 2: Yield of 10-Year JGB vs NS_Yield of 10-Year JGB

3.2 Effect of TSIR Factors on the Hedge Ratio

To compare the influence of different parameters on the determination of hedge ratio, a number of constrained alternatives are specified. Table 3 shows results of a Kalman filter for unrestricted and restricted models. The following observations can be made.

First, it is apparent that the persistence parameter λ was significantly positive in all models, which implies that the movement of the hedge ratio displayed persistency. Secondly, the level coefficient γ_1 (2.1324) in model 1 was significantly positive with respect to the hedge ratio. This phenomenon might be due to investors increasing their hedge position as the level of interest rate increases. Thirdly, the slope coefficient γ_2 (2.3873) in model 1 was significantly positive with respect to the hedge ratio, which implies that the difference between the short-term and long-term interest rates pushed investors to increase their hedge position. Finally, the curvature coefficient γ_3 (0.0499) was not significant. These findings demonstrate that the early hedge ratio and the level and slope of the yield curve affect the next optimal hedge ratio.

[Take in Table 3 about here]

Table 3: Results of Kalman Filter for Unrestricted and Restricted Models

To gain a better understanding of the distribution of each parameter from the empirical model, different constraints of the parameters are shown as models 2 to 8 in Table 3. The following observations can be made.

Model 2 was estimated with a constraint of γ_3=0. The persistent coefficient λ (0.1316) of model 2 remained significantly positive. The yield-curve coefficients γ_1 (2.0956) and γ_2 (2.3896) also had a significant influence on the optimal hedge ratio.

Model 3 shows an alternative restriction, in which γ_2=0. The coefficients λ and γ_1 were significantly positive.

Model 4 imposed a constraint of γ_1=0. The coefficient λ remained significantly positive.

Two constraints were imposed to compare the contribution of each parameter in models 5 to 7. The coefficient λ was still significantly positive in these three models, but only γ_1 was significantly positive in model 5. These models returned similar results to those of previous models. As shown in models 1 to 7, it is apparent that the coefficients λ and γ_1 were important parameters for explaining the hedge ratio.

Finally, model 8 had a constraint of λ=0 (which enabled consideration of the effect of the yield-curve factor without the coefficient λ). The coefficients γ_1 and γ_2 were still significantly positive with respect to the

hedge ratio, which implies that the level and slope factors provide additional information of importance in explaining the determination of the optimal hedge ratio.

4. CONCLUSION

The present study has incorporated factors from Nelson and Siegel (1987) with a Kalman filter approach to investigate hedge effectiveness between Japanese Government Bond (JGB) spot and futures. The study has demonstrated statistically significant effects from the persistent, level, and slope factors from an in-sample test. An analysis of out-of-sample predicted performance has demonstrated that the use of yield-curve information (such as persistence, level and slope factors) in determining the optimal hedge ratio can improve the effectiveness of the hedge. The findings also contribute to the literature by revealing that the term structure information need to be accounted for directly in the hedging of the government bonds with interest rates futures contracts.

References

Baillie, R., and R. Myers, 1991, "Bivariate GARCH Estimation of the Optimal Commodity Futures Hedge," *Journal of Applied Econometrics*, 6, pp.109-124.

Bollerslev, T., 1986, "Generalized Autoregressive Conditional Heteroscedasticity," *Journal of Econometrics,* 31, pp.307-327.

Bollerslev, T., R.F. Engle, and J. M. Wooldridge, 1988, "A Capital Asset Pricing Model with Time-Varying Covariances," *Journal of Political Economy*, 96(1), pp.116-31.

Dolan, C., 1999, "Forecasting the Yield Curve Shape: Evidence from Global Markets," *Journal of Fixed Income*, 10(1), pp.92-99.

Diebold, F.X., G.D. Rudebusch, and S.B. Aruoba, 2006, "The Macroeconomy and the Yield Curve: A Dynamic Latent Factor Approach," *Journal of Econometrics*, 131, pp.309-338.

Diebold, F.X., and C. Li, 2006, "Forecasting the Term Structure of Government Bond Yields," *Journal of Econometrics*, 130, pp.337-364.

Ederington, L., 1979,"The Hedging Performance of the New Hedging Markets", *The Journal of Finance*, 34(1), pp. 157-170.

Estrella, A., and G. Hardouvelis, 1991, "The Term Structure as A Predictor of Real Economic Activity," *Journal of Finance*, 46(2), pp.555-576.

Estrella, A., and F. S. Mishkin, 1998, "Predicting U.S. Recessions: Financial Variables as Leading Indicators," *Review of Economics and Statistics*, 80(1), pp.45-61.

Engle, R. F., 1982, "Autoregressive Conditional Heteroscedasticity with Estimates of the Variance of United Kingdom Inflation," *Econometrica*, 55(2), pp.391-407.

Fink, J., Fink, K. E., and Lange, S., 2005, "The Use of Term Structure Information in the Hedging of Mortgage-Backed Securities," *Journal of Futures Markets*, 25(7), pp.661-678.

Fackler, P. L., and McNew, P. K., 1994, "Nonconstant Optimal Hedge Ratio Estimation and Nested Hypotheses Tests," *Journal of Futures Markets*, 14(5), pp.619-635.

Hurn, A.S., K.A. Lindsay, and V. Pavlov, 2005, "Smooth Estimation of Yield Curves by Laguerre Functions," Proceedings of Advances and Applications for Management and Decision Making on International Congress on Modelling and Simulation (MODSIM05), Australia.

Harris, R., and J. Shen, 2003, "Robust Estimation of the Optimal Hedge Ration," *Journal of Futures Markets*, 23, pp.799-816.

Kroner, K., and J. Sultan, 1993, "Time-Varying Distributions and Dynamic Hedging with Foreign Currency Futures," *Journal of Financial and Quantitative Analysis*, 28, pp.535-551.

Koutmos, G., 2001, "Common Volatility in MBS Return: A Factor GARCH Approach," *Journal of Fixed Income*, 10, pp.59-65.

Litterman, R., and J. Scheinkman, 1991, "Common Factors Affecting Bond Returns," *Journal of Fixed Income*, 1(1), pp.54-61.

Markowitz, H., 1991, "Foundation of Portfolio Theory," *Journal of Finance*, 46, pp.469-477

Nelson, C.R., and A.F. Siegel, 1987, "Parsimonious Modeling of Yield Curves," *Journal of Business*, 60(4), pp.473-489.

Myers R. J., 1991, "Estimating Time-Varying Optimal Hedge Ratios on Futures Markets," *Journal of Futures Markets*, 11, pp.39-53.

Rossi, E., and C. Zucca, 2002, "Hedging Interest Rate Risk with Multivariate GARCH," *Applied Financial Economics*, 12, pp.241-251.

Willner, R., 1996, "A New Tool for Portfolio Managers: Level, Slope, and Curvature Durations," *Journal of Fixed Income*, June, pp.48-59.

Table 1 Descriptive Statistics for Yield Curve Factors, Spot and Futures Returns

	β_0	β_1	β_2	JGB_Spot	JGB_Futures
Mean	0.0327	(0.0336)	0.0036	-0.0017%	-0.0032%
Median	0.0296	(0.0320)	0.0038	0.0000%	0.0000%
Maximum	0.0671	(0.0141)	2.1192	0.7086%	1.0525%
Minimum	0.0034	(0.0526)	(0.1376)	-0.8620%	-1.7891%
Std. Dev.	0.0123	0.0079	0.0866	0.1453%	0.2414%

Table 2 Correlation of JGB Spot and Futures Price with JGB Yield and NS Yield

	10yr JGB_Spot Index price	10yr JGB_Futures Settlement Price	10yr JGB_Yield	10yr JGB_NS_Yield
10yr JGB_Spot Index price	1	0.98189	-0.92197	-0.90868
10yr JGB_Futures Settlement Price	0.98189	1	-0.89346	-0.89210
10yr JGB_Yield	-0.92197	-0.89346	1	0.95757
10yr JGB_NS_Yield	-0.90868	-0.89210	0.95757	1

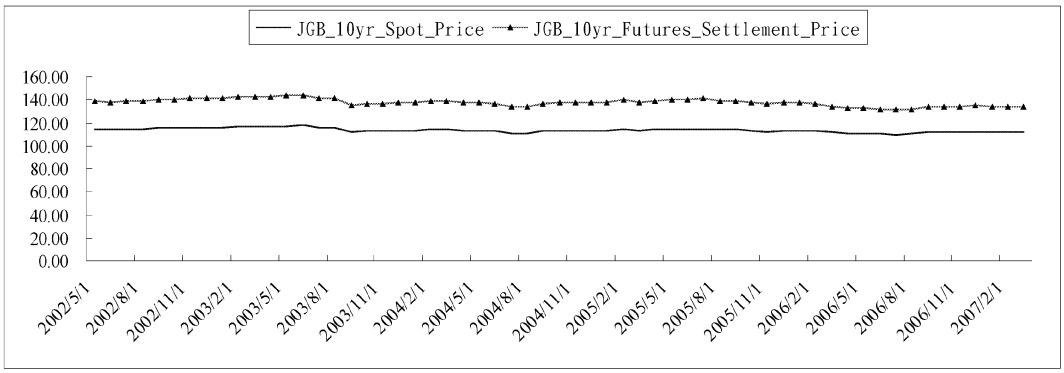


Figure 1 The Price of 10 Year JGB Versus the Settlement Price of 10 Year JGB Futures

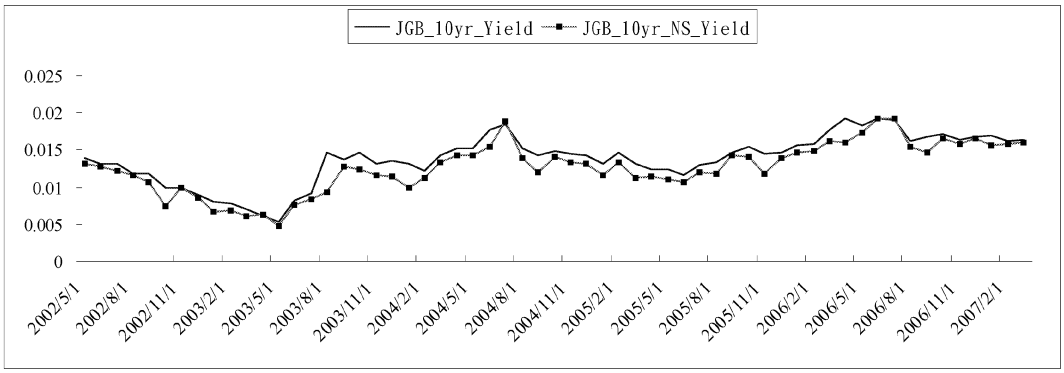


Figure 2 The Yield of 10 Year JGB Versus the NS Yield of 10 Year JGB

Table 3 Results of Kalman Filter for Unrestricted and Restricted Model

	Model 1 (not restricted)	Model 2 (γ_3=0)	Model 3 (γ_2=0)	Model 4 (γ_1=0)	Model 5 (γ_3=0) (γ_2=0)	Model 6 (γ_3=0) (γ_1=0)	Model 7 (γ_2=0) (γ_1=0)	Model 8 (λ=0)
λ	0.1312***	0.1316***	0.1383***	0.1380***	0.1340***	0.1394***	0.1398***	
	(0.0006)	(0.0006)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	
γ_1	2.1324**	2.0956**	1.1054*		1.0506***			2.4291***
	(0.0110)	(0.0126)	(0.0572)		(0.0701)			(0.0065)
γ_2	2.3873**	2.3896**		0.3173		0.3422		2.8098**
	(0.0384)	(0.0379)		(0.6920)		(0.6672)		(0.0215)
γ_3	0.0499		0.0407	0.0233			0.0245	0.0624
	(0.4338)		(0.5709)	(0.7745)			(0.7624)	(0.3153)
σ_μ	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002
σ_ζ	0.1622	0.1624	0.1634	0.1645	0.1633	0.1644	0.1643	0.1670
Log likelihood	8286.847	8286.549	8284.355	8282.401	8284.158	8282.336	8282.316	8284.74

Note1: This table provides parameter estimates in the following model:

$$\Delta S_t = \Delta f_t \nu_t + \mu_t$$
$$\nu_t = \alpha + \lambda \nu_{t-1} + \gamma_1 \beta_0 + \gamma_2 \beta_1 + \gamma_3 \beta_2 + \zeta_t$$
$$\mu_t \sim N(0, \sigma_\mu^2)$$
$$\zeta_t \sim N(0, \sigma_\zeta^2)$$

The ΔS_t is log returns of the JGB price index at time t. The variable Δf_t is the log returns of the JGB futures settlement price, that it can structure the hedge portfolio. The term structure factor β_0、β_1 and β_2, form Nelson and Siegel model, show level movement, slope change, and curvature shift separately. The ν_t presents the appropriate hedge ratio at time t, and the coefficient λ is parameter of persistence to determine the appropriate hedge ratio. Finally, the coefficients γ_1、γ_2, and 、γ_3 demonstrate the effect of term structure factor on hedge ratio.

Note 2: The sample period is daily between May 30, 2002 and April 18, 2007 with 1275 empirical data.

Note3: Model1 through model8 exhibit various restrictions of parameters.

To Establish Robust Portfolio Insurance Strategy by Artificial Intelligence Method

Pai-Lung Chou
Associate professor, Department of Risk Management and Insurance,
National Kaohsiung First University of Science and Technology,,Taiwan, R. O. C.
E-mail: plchou@ccms.nkfust.edu.tw

Jen-Wen Sheu
Ph. D. candidate , Institute of Management
National Kaohsiung First University of Science and Technology,Taiwan, R. O. C.

Chen-Hua Yao
Doctoral Student, Institute of Management
National Kaohsiung First University of Science and Technology,Taiwan, R. O. C.

ABSTRACT

The aims of this study can be integrated the various adjustment procedures by artificial intelligence method so that the problem of high cost caused by the simple adjustment procedures can be solved, and to present a new dynamic adjustment strategy based on the portfolio insurance strategy. In view of the proof from the experiment, based on the strategy of Time Invariant Portfolio Protection (TIPP), this study utilizes respectively three traditional rebalance disciplines and three technical analyses for adjustment strategies. Together with the search technique of optimization by genetic algorithm, we aim to find out the most appropriate portfolio insurance strategy. By the figures of the experiment, it is found that with this adjustment strategy, a better profit-making ability is achieved and the risk of portfolio insurance is reduced

Keywords: *Portfolio insurance strategy, Artificial intelligence method, Time invariant portfolio protection (TIPP)*

1. INTRODUCTION

In 2008, an unprecedented business-running crisis occurred to investment banks in the US. The main reason for the quake in Wall Street is the loose policy on house loan in the past ten years. After the price of the house fall down, many house owners or investors can not pay the monthly principal and the interest to the banks. As the price of the real estate soars, the buyers, buying houses for their own uses or for investment, will apply for a loan at the bank, paying only very little or even nothing for the first month. Once the slump range outnumbers the first-month loan payment, the buyers can't pay the loan, and the banks will take over their real estate for an auction, which may still be unable to fix the loss. Therefore, the investors turn to consider the principal guaranteed products. This kind of products will become the mainstream in the market.

Portfolio insurance is one of the principal guaranteed products. The strategy of the asset distribution is to pay a specific amount of insurance fare. By means of sacrificing some of the upper profit on the price rise, the price fall risk that it may encounter will be targeted, limiting the risk within a certain range without losing totally profit on the price rise. Such a characteristic indeed attracts the investors who seek to avoid risks.

Within the operation framework of portfolio insurance, investors have to continuously adjust the proportion of the asset so as to reach the goal of obtaining the profit and keep the principal, since the market price keeps changing. In the case of the actual operation, however, this continuous adjustment will lead to an unlimited

increase on the trading cost. Therefore, we have to find out the appropriate timing and ratio of the adjustment so as to enhance the effect of the portfolio insurance strategy.

Based on the past related literature, the framework of the portfolio insurance strategy, the related adjustment procedures and approaches are studied thoroughly. This paper adopts genetic algorithm and aims to find out the appropriate timing and ratio of the adjustment so as to enhance the profit-making of portfolio insurance and to reduce the risk.

Portfolio insurance strategy including two major patterns: Constant Proportion Portfolio Insurance (CPPI) and Time Invariant Portfolio Protection (TIPP).This study is based on the Time Invariant Portfolio Protection (TIPP).

Therefore, primary objective of this article is to explore entire framework of portfolio insurance strategy and relative adjustment discipline. This paper adopts genetic algorithm to find out outstanding timing and ratio of adjustment, and to evaluate the overall profitability and risk reduction. The remaining parts of this paper are organized as follows. The next section presents a brief background of TIPP and genetic algorithm. Section 3 lays out the methodology of optimal portfolio insurance procedure. Subsequently, section 4 provides analyses of empirical results. The final section concludes this study.

2. LITERATURE REVIEW

2.1 Portfolio insurance

Portfolio insurance is a prevalence strategy of assets allocation. Portfolio insurance not only escapes the downside risk but also keeps the upside profit for the portfolio (see Abken,1987). In the past, there are two types of portfolio insurance have been proposed, static portfolio insurance and dynamic portfolio insurance. Static portfolio insurance usually hedges by stock index futures and stock index option and holds them from start until maturity. Dynamic portfolio insurance distributes capital into two types of assets, risk assets and non-risk assets. Dynamic portfolio insurance varies the risk asset position and non-risk asset position dynamically and continuously to hedge. The common dynamic portfolio insurance strategies are as follows: constant proportion portfolio insurance (CPPI) strategy (see Black and Jones,1987), time invariant portfolio insurance (TIPP) strategy and option based portfolio insurance (OBPI) strategy. Due to CPPI has already been discussed extensively. This research only discusses with TIPP.

2.1.1 Time invariant portfolio protection

The time invariant portfolio insurance (TIPP) strategy was proposed by Estep and Kritzman(1988). TIPP strategy is a modified version of CPPI. They have simple formula which is easily understood by investors to calculation. However, the difference between CPPI and TIPP is that TIPP choose the bigger one between the previous floor and current floor. Therefore, when the market value rises, the total asset of the portfolio will rise and the floor will also rise. However, when the market values drops, the value of the portfolio will drop, but the floor will constant. The TIPP strategy can be expressed by the following formula:

$$E_{t+1} = M \times \left(A_t - F_{t+1} \right)$$

$$F_{t+1} = \max \left(F_t, A_t \times \lambda \right)$$

$$\lambda = F_0 / A_0$$

where λ is the ratio of floor. Others are the same with CPPI.

Estep and Kritzman(1988) indicated that investors except keep the initial asset, they request to protect the increased asset during the insurance. Therefore, when the total asset varies, TIPP choose the bigger one to be new floor between previous floor and current floor.

2.1.2 Rebalance disciplines

This study applies traditional rebalance disciplines and three technical analyses to adjust TIPP strategy. Firstly, traditional rebalance disciplines were proposed by Etzioni (1986). These disciplines included time discipline, market move discipline and lag discipline. Time discipline is a fixed time based triggers, market move discipline is market move triggers off threshold changes in the value of the portfolio insurance and Lag discipline is lag adjustment triggers when the actual mix of futures in the portfolio insurance lags the required mix by threshold. Secondly, this study applies Williams index, AR index and BR index to trigger off threshold changes in the value of the portfolio insurance.

2.2 Genetic algorithm

Holland proposed genetic algorithms (GA) that expanded from Darwin's evolution theory: survival of the fittest (see Holland,1975). Genetic algorithms use an evolutionary process that consists of replacement/selection, crossover and mutation to find a fitness solution. The evolutionary process retains good chromosomes, eliminates worse and searches a solution space using a population of individuals to make fitness not get stuck in local optimal solution and find global optimal solution (likes Mitchell,1996); Srinivas and Patnaik,1994;Tsai , Liu and Chou ,2004).

Genetic algorithms are stochastic search technique of optimization and computationally simple and powerful. Genetic algorithms are good tool for optimization problems since they contain immeasurable solution space. Genetic algorithms are achieved with longer computational time. However, the longer run time of GAs can be shortened by terminating the evolution earlier to get a satisfactory solution.

2.3 Portfolio insurance in the general literature

In the past, the researches of portfolio insurance have been plenty.(likes Lin, 1992;Hsu and Hsu, 2001;Hsu and Lai, 2000;Lee,Chiang and Hsu, 2008),However, among the researches of portfolio insurance with optimization approaches were deficient.(likes Chen et al., 2008; Chen and Lin ,2007;Chen and Liao, 2007;Huang , 2002) In addition, there were not any researches of portfolio insurance applied optimization approaches and various rebalance disciplines to experiment. Therefore, primary objective of this article is to explore entire framework of portfolio insurance strategy and relative rebalance discipline.

3. GA – TIPP OBJECTIVE FUNCTION

In the operation structure of the portfolio insurance, adjusting frequently will induce the transaction cost is too high. Therefore, this study proposes GA - TIPP to solve this problem and applies this approach to reach optimal adjustment timing and ratio to increase profit and reduce risk.

The fitness measure of our GA is

$$f = \frac{(r - nr)}{\sigma}$$

where r rate of monthly returns, nr is the risk-free interest rate and σ is the standard deviation. The exposure is readjusted when the difference between the current exposure and the exposure calculated by the GA - TIPP formula is greater than 0.6.

The GA – TIPP Objective Function is :

$$Maximum(f)$$

$$s.t.$$

$$P = (F_a - B_a) / B_a$$

$$f = (AvgP - nRisk) / Sd$$

$$AvgP = \sum(P) / t$$

$$Sd = \sqrt{\sum (P - AvgP)^2 / t}$$

where

B_a is initial of asset .

F_a is final of asset.

$nRisk$ is the risk-free interest rate.

P is return on assets.

t is transaction times.

Sd is standard deviation of return on assets.

4. EXPERIMENTAL RESULTS

To show the effectiveness of our GA – TIPP, we compare it with the weighted price index of the Taiwan Stock Exchange. Their performances are then evaluated by fitness value. This section presents the experimental process and the experimental results of return and standard deviation.

4.1 Data

This analysis uses adjusted return and standard deviation on Taiwan stock weighted index listed in the Taiwan Economic Journal (TEJ) between January 2006 and June 2008. There are 30 periods used for our experiments.

4.2 Parameters

The parameters of our genetic algorithm for GA - TIPP are described in Table 1.

Table 1: Parameters of our genetic algorithm runs

Parameter	Value
Population size	200
Termination condition	20000 generations
Selection method	Roulette wheel
Crossover method	Interpolating
Mutation method	Interpolating
Crossover rate	95%
Mutation rate	5%

Resource: this research

4.3 Results and analysis

In this research, we use mixed three traditional rebalance disciplines and three technical analyses and genetic algorithm based on time invariant portfolio protection to find optimal portfolio insurance strategies. Table2 shows that performances of GA - TIPP and Stock Indexes. The fitness value, return and standard deviation of GA - TIPP is 9.178, 21.414% and 2.333% respectively. Furthermore, the fitness value, return and standard deviation of Stock Indexes is 2.361, 14.89% and 5.21% respectively. According to the foregoing, the result of GA – TIPP is really better than Stock Indexes.

Table2: Performances of GA - TIPP and Stock Indexes on empirical periods

	GA - TIPP	Stock Indexes
Return	21.414%	14.89%
S.D	2.333%	5.21%
Fitness	9.178	2.361

Resource: this research

5. CONCLUSION

When carrying out the portfolio insurance strategy, we have to make appropriate adjustments according to the changes of the market price. Consequently, under a good adjustment procedure, the selection timing and the adjustment ratio will influence the effect of the portfolio insurance strategy. The adjustment strategy framework presented in this study includes traditional rebalance disciplines and technical analyses, which helped solve the problem that the adjustments of portfolio insurance in the past were too simple. In view of the proof from the experiment, based on the strategy of Time Invariant Portfolio Protection (TIPP), this study utilizes respectively three traditional rebalance disciplines and three technical analyses for adjustment strategies. Together with the search technique of optimization by genetic algorithm, we aim to find out the most appropriate portfolio insurance strategy. By the figures of the experiment, it is found that with this adjustment strategy, a better profit-making ability is achieved and the risk of portfolio insurance is reduced.

References

P. A. Abken, "An introduction to portfolio insurance," *Economic Review*, Federal Reserve Bank of Atlanta, Nov, pp. 2-25, 1987.

F. Black, and R. Jones, "Simplifying portfolio insurance," *Journal of Portfolio Management*, vol. 14, no. 1, pp. 48-51, 1987.

T. Estep and M. Kritzman, "TIPP: Insurance Without Complexity," *Journal of Portfolio Management*, vol. 14, pp. 38-42, 1988.

S. E. Etzioni, "Rebalance disciplines for portfolio insurance," *Journal of Portfolio Management*, vol. 13, pp. 59-62 1986.

J. H. Holland, Adaptation in natural and artificial systems: An introductory analysis with applications to biology, control, and artificial intelligence, University of Michigan Press, 1975.

M. Mitchell, An introduction to genetic algorithms, MIT Press, 1996.

M. Srinivas and L. Patnaik, "Genetic algorithms: A survey," *Computer*, vol. 27, pp. 17-26, 1994.

J. T. Tsai, T. K. Liu and J. H. Chou, "Hybrid Taguchi Genetic Algorithm for Global Numerical Optimization", IEEE Transactions on Evolutionary Computation, vol. 8, pp. 365–377, 2004.

Y. Lin, "Portfolio insurance and rebalance disciplines: weight and selection," *National Taiwan University Management Review*, vol 3, pp. 1-31, 1992.

H. Hsu and C. Hsu, "The cost of implementing portfolio insurance in the Taiwan stock market," *Commerce & Management Quarterly*, vol. 2, no. 4, pp. 359-376, 2001.

H. Hsu and M. H. Lai, "The application of contingent portfolio insurance in the Taiwan stock market," *Journal of Risk Management*, vol. 2, no. 2, pp. 89-118, 2000.

H. Lee, M. H. Chiang and H. Hsu, "A new choice of dynamic asset management: the variable proportion portfolio insurance," *Applied Economics*, vol. 40, pp. 2135-2146, 2008.

J. S. Chen, C. L. Chang, J. L. Hou, and Y. T. Lin, "Dynamic Proportion Portfolio Insurance Using Genetic Programming with Principal Component Analysis," *Expert Systems with Applications*, vol. 35, pp. 273-278, 2008.

J. S. Chen and P. C. Lin, "A genetic-based hybrid approach to corporate failure prediction," *International Journal of Electronic Finance*, Accepted in May 2007.

J. S. Chen and P. Y. Liao, "Piecewise nonlinear goal-directed CPPI strategy," *Expert Systems with Applications*, vol. 33, no. 4, pp. 857-869, 2007.

C. K. Huang, "Apply genetic model to strategy operation of dynamic portfolio insurance," National Chiao Tung University Press, Taiwan, R.O.C., 2002.

Assessing the Default Risk for the Residential Mortgage Loans: As the Perspective of the Decision Cost

Hsien-Chueh Peter Yang

Associate Professor of Department of Risk Management and Insurance,
National Kaohsiung First University of Science and Technology, Kaohsiung 811, Taiwan.

Tsoyu Calvin Lin

Professor of Department of Land Economics,
National ChengChi University, 116, Taiwan

Alex Kung-Hsiung Chang

Professor of Department of Business Administration,
National Pingtung University of Science and Technology, Ping-Tung,Taiwan

Tsung-Hao Chen

Assistant Professor of Department of Business Administration,
Shu-Te University, Yen Chau, Kaohsiung, 82445, Taiwan
E-Mail: thchen@mail.stu.edu.tw

ABSTRACT

Wall Street faced the financial crisis over mortgage-related securities in August 2008. Therefore USA government launched a plan to rescue the largest two mortgage companies, Fannie Mae and Freddie Mac. The worst economic pain for the people around the world is yet to come, as many economists predict a long global recession with higher rates of unemployment. Thus the International Monetary Fund has warned that the world would be facing its most dangerous economic crisis since the nineteen thirties. In this study we intend to examine the criterion of the optimal threshold at the minimum total cost. Principal findings in this study suggest that (1) in practice, the ratio of the cost of false positive to that of false negative can be used to assess the behavior of the total cost; (2) the empirical ROC, in conjunction with the cost, can be an alternative measure of the model accuracy of a credit risk model; (3) assessing a credit risk model for underwriting an individual financial contract involved misclassification costs, whereas a credit risk model used for capital estimation would emphasize the probability of default only.

Key words: *threshold, residential mortgage loans, false positive, false negative, credit risk model.*

1. INTRODUCTION

Wall Street faced the financial crisis over mortgage-related securities in August 2008. The age of large investment banks has ended with this crisis. Goldman Sachs and Morgan Stanley have become commercial banks due to the crisis. Therefore USA government launched a plan to rescue the largest two mortgage companies, Fannie Mae and Freddie Mac. The worst economic pain for the people around the world is yet to come, as many economists predict a long global recession with higher rates of unemployment. Thus the International Monetary Fund has warned that the world would be facing its most dangerous economic crisis since the nineteen thirties.

The residential mortgage loans carry a significant weight in the national economy; As of October 2008, Financial Supervisory Commission, Executive Yuan account for 86.7% of the balance in the consumer loans and

29.6% of the balance in the loans. The consequences of the global recession on residential mortgage loans are tremendous and can not be ignored.

The financial industry generally collateralizes the borrower's house and maintain low loan-to-value (LTV) to reduce the default risk. Diagnostic tests play a critical role in determining the default of residential mortgages. Numerous studies have attempted to screen the factors associated with the default of a residential mortgage.

Lawrence et al. (1992) showed that credit history and age of borrowers, contract maturity, loan to value (LTV) ratio and the ratio of mortgage payments to family income are the crucial factors associated with default. Archer et al. (1996) also concluded that the residential mortgage terminations were affected by household income and collateral value. Deng et al. (1996, 1997, and 2000) showed that the present value of mortgage payments, the characteristic of family, LTV ratio, home equity, unemployment rates, and divorce rates are the significant factors associated with default. Kau and Keenan (1999) indicated that LTV and market housing price are the significant factors affecting the default probability. Ciochetti et al. (2001) concluded that LTV and debt coverage ratio (DCR) are positively associated with default. Marrison (2002) introduced the score model for default determination, which extracts credit-bureau information on a retail customer, such as age, income, total number of credit cards, and number of delinquencies in the past three years. In Taiwan, Lin and Liu (2003) concluded that the significant factors associated with default are education, marital status, income, credit history, and collateral's location.

As for the recovery rate, Lambrecht et al. (2003) used the microeconomic data from the UK to examine the timing decision for a borrower to default. They suggested that income and interest rate affected the default behavior more than the LTV, and that lenders would accelerate the resolution of delinquent mortgages as the economy deteriorated. Using the option-based approach in a research of mortgage termination, Hartarska and Gonzalez-Vega (2005, 2006) studied the counseling effects on default, and concluded that counseled borrowers were less likely to default than non-counseled borrowers, and that the optimal exercise was also affected.

The most commonly used threshold value, denoted as $\pi_{0,}$ is 0.5(Hosmer and Lemeshow, 2000; Agrestic, 2002). If the estimated default probability for a loan exceeds 0.5, then the predicted result is default, denoted as 1; otherwise it is predicted as a non-default, denoted as 0. This approach is reasonable as the probability of default and the non-default are equal in the population, and the false positive cost and the false negative one are equal. However, the default probability is small and the cost of a false negative is much greater than that of a false positive. Therefore the threshold of 0.5 may cause a biased prediction.

In spite of some previous studies on residential mortgage default behaviors, no research was found to especially focus on the enhancement of the diagnostic accuracy by minimizing the total cost of correct and incorrect decisions. In the context of the significant factors associated with the default, this study attempts to search for an appropriate threshold in the binary logistic regression model to minimize the costs of decision-making. The remainder of this paper is organized as follows. Section 2 introduces research framework. Section 3 shows the empirical analysis. Section 4 concludes this study.

2. RESEARCH FRAMEWORK

2.1 The accuracy of a general screening test

We assume that the true status is one of two mutually exclusive states which are called positive, denoted as 1, and negative, denoted as 0. The ability for a test to correctly detect a status when it is actually present is measured by comparing the detected outcome to the true status of a predicted observation. This type of ability is called intrinsic accuracy or internal accuracy in the literature. Two basic measures of accuracy in tests are sensitivity and specificity for examining the effectiveness of the procedures (Zhou, et al., 2002; Pepe, 2003).

Le (1998) proposed the sample of sensitivity and specificity in the context of epidemiology：

$$\text{Sensitivity} = \frac{\text{number of diseased individuals who screen diseased}}{\text{total number of diseased individuals}} = \Pr(\text{Test}=+|\text{Diseased}=+) \quad (1)$$

whereas

$$\text{Specificity} = \frac{\text{number of healthy individuals who screen healthy}}{\text{total number of healthy individuals}} = \Pr(\text{Test}=-|\text{Disease}=-) \quad (2)$$

Sensitivity is the proportion of the predicted positive observations in the group of true positive ones. Specificity is the proportion of predicted negative observations in the group of true negative ones. They are illustrated by a contingency table with a 2 by 2 decision matrix in Table 1.

Table 1 The Classification Framework of 2 by 2 Decision Matrix

Prediction (classification)	observed		
	default(positive)	non-default(negative)	total
default(positive)	n_{11}(TP)	n_{12}(FP)	n_{1+}
Non-default(negative)	n_{21}(FN)	n_{22}(TN)	n_{2+}
total	n_{+1}	n_{+2}	n

There are n_{11} loans when a default is predicted and a default is observed, and there are n_{22} when a non-default is predicted and a non-default is observed. A general terminology for the cell of n_{11} is true positive (TP), and for the cell of n_{22} is true negative (TN).

Prediction errors are shown in the cells of n_{12} and n_{21}. There are n_{12} loans when a default is predicted and none is observed; there are n_{21} loans when no default is predicted, but default is observed. We can extend the terminology to define the cell of n_{12} as false positive (FP) and the cell of n_{21} as false negative (FN).

The sensitivity, that is, the true-positive rate (TPR), is n_{11}/n_{+1}; The specificity, that is, the true-negative rate

(TNR), is n_{22}/n_{+2} ; Obviously, we have TPR (n_{11}/n_{+1}) + FNR (n_{21}/n_{+1}) = 1 and TNR (n_{22}/n_{+2}) + FPR (n_{12}/n_{+2}) = 1.

Figure 1 shows the Receiver Operating Characteristic (ROC) curve of a test's sensitivity (plotted on the y axis) versus its 1-specificity (plotted on the x axis). Each point on the graph is generated by a different decision threshold. In Figure 3, a plot of sensitivity versus FPR (1-specificity) on the ROC curve represents a point (sensitivity, FPR) corresponding to a different decision threshold.

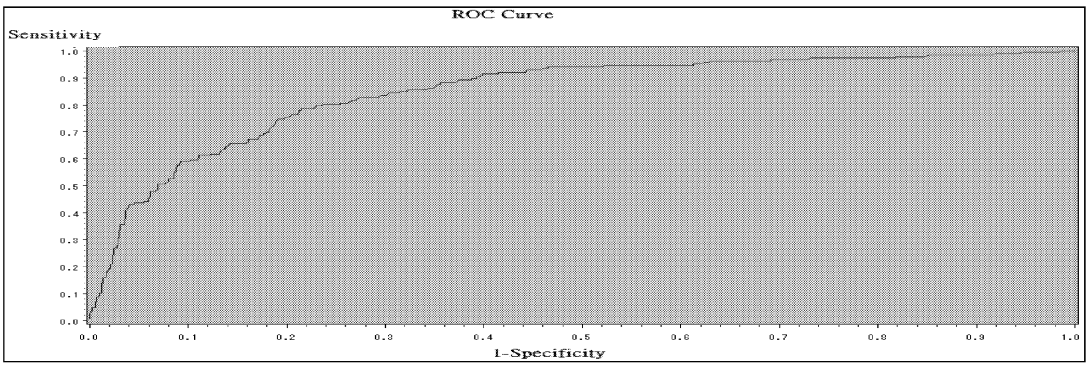


Figure 1 Plot of the ROC Curve for All Possible Thresholds.

The classification results of both sensitivity and specificity relies merely on a single threshold for determination. We thus need to enhance the predicting power and reduce the prediction error through the selection of an appropriate threshold. An accurate model of binary classification relies upon the selection of an optimal threshold.

2.2 An optimal threshold in the context of minimum total cost

Zhou et al. (2002) proposed an optimal threshold as the one minimizing the total cost of both correct and incorrect decisions.

The total cost of a decision, denoted as C, can be formulated as

$$C = C_0 + \Pr(TP) \times C_{TP} + \Pr(FP) \times C_{FP} + \Pr(TN) \times C_{TN} + \Pr(FN) \times C_{FN.} \quad (3)$$

Pr(TP) is the probability of true positive; *Pr(FP)* is the probability of false positive; Pr(TN) is the probability of true negative; and Pr(FP) is the probability of false negative.

It can be rewritten as equation (2) in terms of the prevalence rate, which is the proportion of true positive observation in the population.

$$\begin{aligned} C = {} & TPR \times p \times (C_{TP} - C_{FN}) + FPR \times (1-p) \times (C_{FP} - C_{TN}) \\ & + C_0 + p \times C_{FN} + (1-p) \times C_{TN}, \end{aligned} \quad (4)$$

$$\text{where } \Pr(TP) = TPR \times p;\ \Pr(FP) = FPR \times (1-p);\ \Pr(TN) = (1-FPR) \times (1-p);$$
$$\Pr(FN) = (1-TPR) \times p.$$

To find the minimum cost, we would differentiate C with respect to FPR and set the derivative equal to zero, and obtain the optimal point on the receiver operating characteristic curve (ROC curve) with the slope η

$$\frac{\partial\ sensituvity}{\partial(1-specificity)} = \eta = \frac{(1-p)}{p} \times \frac{(C_{FP} - C_{TN})}{(C_{FN} - C_{TP})}, \quad (5)$$

where $\frac{(C_{FP} - C_{TN})}{(C_{FN} - C_{TP})}$ is the ratio of the costs.

Corollary 1: Under the assumptions of $C_{FN} = C_{FP}$ and $C_{TN}=C_{TP}=0$,

the total cost is

$$C = TPR \times p \times (C_{TP} - C_{FN}) + FPR \times (1-p) \times (C_{FP} - C_{TN}) + C_0 + p \times C_{FN} + (1-p) \times C_{TN} \quad (6)$$

Equation (4) can be rewritten as

$$C = C_0 + [(1-specificity) \times (1-p) - sensitivity \times p + p] C_{FP} \quad (7)$$

Corollary 2: under the assumptions of $C_{FN} = k * C_{FP}$ and $C_{TN}=C_{TP}=0$,

The total cost is reduced as

$$C = C_0 + [(1-specificity) \times (1-p) - sensitivity \times pk + pk] C_{FP} \quad (8)$$

3. ANALYTICAL RESULTS

3.1 A Logit model as an example

For a binary logistic regression model, the dependent variables are classified into two groups, paid off and default. The original mortgage data collected in this study are all individual residential loans originated in 1985 with maturity of 20 years. The frequencies of the paid off and default records are 277 and 2381, respectively. Data are collected from a local bank in Taiwan during the observance period. The censoring time is the end of 2005, with all mortgages terminated (either paid off or default).

3.2 Definition of exploratory variables

The variables of this study are shown in Table 2 including one dependent variable and twelve independent variables. When a delinquency of a mortgage account has continued for over three months, default (dependent variable) is considered. There are many factors influencing the default of residential mortgages, age (X_1), education (X_2), the balance of credit loans (X_3), the number of cash cards (X_4), guarantor (X_5), loan to value ratio (X_6), mortgage term (X_7), grace period (X_8), category of collateral (X_9), regional variation (X_{10}) , flexible mortgage contract rate (X_{11}), and the economic growth rate (X_{12}) are considered in the Logit regression model according to the aforementioned literature conclusions and practical experiences.

Table 2 Variables and Explanations

variables	explanations
dependent	
Y-default	Delinquency over three months = 1, pay off = 0
independent	
X_1-age	Age of borrower
X_2-education	Dummy variables; University and above = 1, otherwise = 0
X_3-the balance of credit loans	Monetary amount of credit loans
X_4-the number of cash cards	Number of cash cards
X_5-guarantor	Dummy variables; with guarantee = 1, otherwise = 0
X_6-loan to value ratio	The ratio of original loan size to original housing price (individual data)
X_7- mortgage term	The mortgage loan term
X_8- grace period	The grace period (years) of housing loan
X_9- category of collateral #	Dummy variables; business office of large building = 1, otherwise = 0(including single house, apartment building)
X_{10}- regional variation	Dummy variables; house located in urban areas = 1, otherwise = 0
X_{11}- flexible mortgage contract rate	Adjustable-rate mortgage at the censoring time
X_{12}-the economic growth rate	Macro data; the economic growth rate

3.3 Fitted Logit model

There are many factors influencing the default of residential mortgages. **Table 3** presents the analytical results of maximum likelihood estimates. Most of them are consistent with expected influence on default. The age, the balance of credit loans, guarantor, loan to value, grace period and flexible mortgage contract rate have significant positive effects on default. The education and the economic growth rate have significantly negative related to default. The impacts on default of the number of cash cards, mortgage term, regional variation and

category of collateral are not significant. The fitted reduced logistic regression equation is listed as follows.

$$\begin{aligned}\text{logit}(\hat{p}) &= \ln\left[\frac{\hat{p}}{1-\hat{p}}\right] = \alpha + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_5 x_5 + \beta_6 x_6 + \beta_8 x_8 + \beta_{11} x_{11} + \beta_{12} x_{11} \\ &= -13.5966 + 0.0435 x_1 - 0.9547 x_2 + 0.0157 x_3 + 1.2587 x_5 + 0.0647 x_6 + 0.2784 x_8 + 1.8161 x_{11} - 8.6808 x_{12}\end{aligned} \quad (9)$$

Table 3 Results of Maximum Likelihood Estimates

	original model		optimal model	
Intercept	-13.2003	<.0001***	-13.5966	<.0001***
X1- age	0.0444	0.0022***	0.0435	0.0016***
X2- education	-0.9543	<.0001***	-0.9547	<.0001***
X3- the balance of fiduciary loans	0.0136	0.0023***	0.00415	0.0002***
X4- the numbers of cash card	0.0573	0.0921	deleted	
X5- guarantor	1.1877	0.0002***	1.2587	<.0001***
X6- loan to value	0.0622	0.0003***	0.0167	0.0001***
X7- mortgage term	-0.0288	0.6726	deleted	
X8- grace period	0.2847	0.0019***	0.2784	0.0020***
X9- category of collateral	0.5393	0.4124	deleted	
X10- regional variation	0.0521	0.8371	deleted	
X11- flexible mortgage contract rate	1.8471	<.0001***	1.8161	<.0001***
X12-the economic growth rate	-8.7179	<.0001***	-8.6808	<.0001***

Note: *p<0.l; **P<0.05; ***P<.001.

3.4 Considering the total cost of a decision (C)

The classification results above indicate that both sensitivity and specificity rely on a single threshold for determination. Total cost is not considered in these three methods, and it may be misleading simply by assuming that the misclassification costs are equal. In reality, the cost for a false negative prediction is much greater than that for a false positive prediction. It is therefore desirable to assume $C_{FN} = kC_{FP}$. An accurate model of binary classification thus relies upon the selection of an optimal threshold in order to minimize the total cost of decision-making.

When the observed frequency is substituted in the Corollary 2, we can obtain the following figures: $\eta = \frac{(1-p)}{p} == \frac{1-9.49\%}{9.49\% * k} = \frac{9.54}{k}$.

As shown in Table 4 and Figure 2, the optimal threshold, sensitivity and specificity depend on the ratio k, where k is the ratio of the cost of the false-negative prediction to that of the false-positive. The sensitivity increases with the ratio k. We thus can choose an optimal threshold to minimizing the total cost of decision-making.

Table 4 The Prediction Accuracy Rates under Each *k*

k	*k=1*	*k=2*	*k=4*	*k=6*	*k=8*	*k=10*
the slope (η)	9.54	4.77	2.39	1.59	1.19	0.95
threshold	**0.365**	**0.325**	**0.210**	**0.130**	**0.090**	**0.085**
sensitivity	74.3%	75.9%	79.5%	83.5%	86.7%	87.1%
specificity	98.8%	98.4%	97.1%	94.7%	92.0%	91.7%

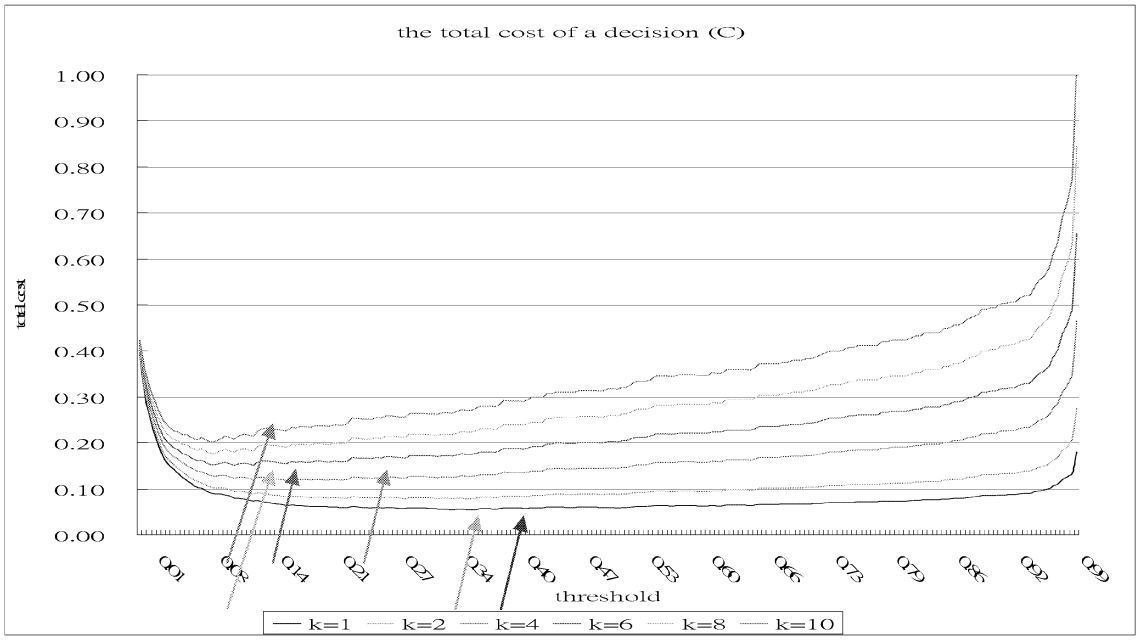


Figure 2 Plot of the Total Costs under *k*

Figure 2 also illustrates that the optimal threshold decreases with *k*; for *k*=1, it is 0.345; for *k*=2, it is 0.325; for *k*=4, it is 0.210; for *k*=6, it is 0.13; for *k*=8, it is 0.09; for *k*=10, it is .85. Thus, the optimal threshold is varies with the ratio of misclassification costs. However, the optimal threshold given by Zhou et al. (2002) is achieved at single point on ROC curve.

4. CONCLUSIONS

Residential mortgage loans differ from other types of loans in several respects. As discussed in previous literature, the default probability is significantly affected by many factors, such as LTV, education level, economic growth rate and unemployment rate. We then intend to assess an optimal threshold in a logistic regression model for minimizing the total costs of classification. Our principal findings are summarized as follows.

(1) While analyzing these factors on default risk, age, the balance of credit loans, guarantor, loan to value, grace period and flexible mortgage contract rate have significant positive effects on default. The education and the economic growth rate have a significant negative relationship to default. The effects of numbers of cash card, mortgage term, regional variation and category of collateral are not significant.

(2) While taking into accounts of total costs, we can choose the threshold to minimize the total cost decision-making. Unlike previous threshold of 0.5, sensitivity and specificity depend on the ratio of the costs of the false-negative to the false-positive.

(3) Assuming the continuity of an ROC curve, Zhou et al. (2002) provided the slope and the threshold to minimize the total cost. However, an empirical ROC curve is discrete so that their argument may encounter difficulty in practice. This difficulty can be resolved by assuming a ratio of misclassification costs as we have shown in Corollary 2.

References

Agresti, A. (2002). *Categorical date analysis* (2nd ed.). New York: John Wiley.

Ciochetti, B. A., Lee, G., Shilling, J., & Yao, R. (2001). *A proportional hazards model of commercial mortgage default with originator bias*. Umpublished working paper.

Deng, Y. H., Quigley, J. M., & Van Order, R. (1996). Mortgage default and low downpayment loans: The costs of public subsidy. *Regional Science and Urban Economics, 26*, 263-285.

Deng, Y. H. (1997). Mortgage Termination: An empirical harzard model with stochastic term structure. *Journal of Real Estate Finance and Economics, 14*, 309-331.

Deng, Y. H., Quigley, J. M., & Van Order, R. (2000). Mortgage terminations, heterogeneity and the exercise of mortgage options. *Econometrica, 68*(2), 275-307.

Hartarska, V. & Gonzalez-Vega, C. (2005). Credit Counseling and Mortgage Termination by Low-Income Households. *The Journal of Real Estate Finance and Economics, 30*(3), 227-243.

Hartarska, V. & Gonzalez-Vega, C. (2006). Evidence on the effect of credit counseling on mortgage loan default by low-income households. Journal of Housing Economics, *15*(1), 63-79.

Hosmer, D. W., & Lemeshow, S. (2000). *Applied logistic regression* (2nd ed.). New York: John Wiley.

Kau, J. B., & Keenan, D. C. (1999). Patterns of rational default. *Regional Science and Urban Economics, 29*, 765-785.

Lambrecht, B. M., Perraudin, W R.M., & Satchell, S. (2003). Mortgage Default and Possession under Recourse: A Competing Hazards Approach. *Journal of Money, Credit and Banking, 35*(3), 425-442.

Lawrence, E. C., Smith, L. D., & Rhoades, R. (1992). An analysis of default risk in mobile home credit. *Journal of Banking and Finance, 16*, 299-312.

Le, C. T., *Applied Categorical Data Analysis*. John Wiley & Sons, Inc., 1998.

Lin, T. C. & Liu, C. K. (2003). The application of logit model on the default behavior of consumers' loans in Taiwan. *The 2003 conference of Chinese society of housing study* (in Chinese), National Taichung Institute of Technology, Taiwan, R.O.C.

Marrison, C. (2002). *The fundamentals of Risk measurement.* New York: McGraw-Hill.

Pepe, M. S. (2003). *The statistical evaluation of medical tests for classification and prediction*. New York: Oxford University Press.

Zhou, X. H., Obuchowski, N. A., & McClish, D. K. (2002). *Statistical methods in diagnostic medicine*. New York: John Wiley.

Authors Index

Chou, Jian-Hsin 175

Professor, Dep. of Risk Management and Insurance, National Kaohsiung First University of Science & Technology, Taiwan. R.O.C.

Chou, Pai-Lung 43 187

Associate professor, Dep. of Risk Management and Insurance, National Kaohsiung First University of Science & Technology, Taiwan, R.O.C.

Forster, John 63

Professor, Dep. of Accounting, Finance and Economic, Griffith University, Australia.

Hsieh, Henry H. Y. 63

Assistant professor, Dep. of Business Administration, National Ping Tung University of Science & Technology, Taiwan, R.O.C.

Hsu, Jui-Lin 117

Testing Manufacturing Dept.,Walton Advanced Engineering Inc., Kaohsiung Taiwan R.O.C.

Huang, Yu Chuan 151

Professor, Dep. of Risk Management and Insurance National Kaohsiung First University of Science & Technology, Kaohsiung, Taiwan, ROC.

Jaw, Bih-Shiaw 73

Professor, HRM Institute Institute National Sun Yat-Sen University, Taiwan. R.O.C.

Lee, Yuan-Duen 81

Prof. & Dean of the College of Management, Chang Jung Christian University, Taiwan, R.O.C.

Liaw, Shu-Yi 53

Associate Professor, Dep. of Business Administration, National Ping Tung University of Science & Technology, Taiwan, R.O.C.

Lin, Chu-Hsiung 161

Professor, Dep. of Risk Management & Insurance National Kaohsiung First University of Science & Technology, Taiwan, R.O.C

Lin, Grier 1

Professor and President, International Leadership Institute Australia.

Lin, Kuei-Yi 107

Director of Accounting, Neipu Junior High School, Pingtung Taiwan, R.O.C.

Lin, Tsoyu Calvin 193

Professor, Dep. of Land Economics, National Cheng Chi University, Taiwan R.O.C.

Natoli, Riccardo 13

PhD, Victoria University, Australia.

Roca, Eduardo D. 139

Associate Professor, Dep. of Accounting, Finance and Economics, Griffith University, Australia.

Sheu, Jen-Wen 43 187

Ph. D. candidate , Institute of Management, National Kaohsiung First University of Science & Technology, Taiwan, R. O. C.

Tai, Chih-Ying 53

Graduate Student, Dep. of Business Administration, National Ping Tung University of Science & Technology, Taiwan, R. O. C.

Tian, Xin-Min 73

Professor, Antai College of Economics and Management Shanghai Jiao Tong University, China.

Tsai, Chan-Wei 93

Assistant Professor, Dep. of Business Administration, National Pingtung University of Science & Technology, Taiwan, R.O.C.

Tularam, Gurudeo A. 139

Lecturer, Faculty of Science, Environment, Engineering and Technology Griffith University Australia.

Wang, Chou-Wen 127

Associate Professor, Dep. of Risk Management & Insurance, National Kaohsiung First University of Science & Technology, Taiwan. , R.O.C.

Wong, Victor S.H. 139

PhD Scholar , Dep. of Accounting, Finance and Economics. Griffith University, Australia.

Wu, Chin-Wen 127

Assistant Professor, Dep. of Finance & Institute of Financial Management, Nanhua University, Taiwan, R.O.C.

Wu, Wei-Ming 175

Associate Professor, Institute of Business Management, National Kaohsiung First University of Science & Technology, Kaohsiung, Taiwan. R.O.C.

Yang, Peter Hsien-Chueh 161 193

Associate professor, Dep. of Risk Management & Insurance National Kaohsiung First University of Science & Technology, Taiwan, R.O.C.

Yao, Chen-Hua 43 187

Doctoral Student, Institute of Management ,National Kaohsiung First University of Science & Technology,Taiwan, R. O. C.

Yeh, Chao-Hui 3

Associate Professor, Dep. of Business Administration, I-Shou University, Taiwan, R.O.C.

Yeh, Hsien-Hung 23

Lecturer, Dep. of Business Administration, National Pingtung University of Science and Technology, Taiwan, R.O.C.

青年企業管理評論
Ymc Management Review

發 行 人：張宮熊
總 編 輯：張宮熊
執行編輯：陳宗豪

出 版 者：中華民國青年企業研究社　The Young Men Business Club of R.O.C.
發 行 所：912屏東縣內埔鄉學府路一號　國立屏東科技大學企業管理系
　　青年企業管理評論編輯委員會
電　　話：886-8-7740374
E - Mail：ymcmr@yahoo.com.tw
網　　址：www.ymc.org.tw
匯款帳號：中華民國青年企業研究社李柏熙　高雄銀行北高雄分行 241-102-315879

印刷裝訂：弘冠數位印刷
　　886-7-5315351　　htt://www.pod.com.tw
ISSN
書　　號：YMCMR002
出版日期：西元2009年4月1日（第二卷特刊）發行1000本
定　　價：新台幣300元

Printed in Taiwan