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THE INFLUENCE OF SHANGHAI-HONG KONG STOCK CONNECT ON THE MAINLAND CHINA AND HONG KONG STOCK MARKETS

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ABSTRACT

China has been intensively launching opening-up policies since November 2014. Among these policies, the Shanghai-Hong Kong Stock Connect offers international investors an approach to investing directly in Mainland China stock markets. At the same time, Mainland China capital can gain access to overseas markets via Hong Kong. This study investigates the influence of the policy by using the Vector Autoregressive and Generalized Autoregressive Conditional Heteroscedastic framework. The results show that the new policy has different impacts on the Shanghai, Shenzhen, and Hong Kong stock markets due to their distinct market features and policy restrictions. The three markets also transmit the policy effects to one another due to their close linkages. It not only indicates that Mainland China financial centers (Shanghai and Shenzhen) integrate with one of international financial centers (Hong Kong), but also symbolizes the gradually increasing strength of Chinese policy effects on global capital markets.

JEL: G00, G10, G18

KEYWORDS: Chinese Stock Market, Policy and Regulation, Shanghai-Hong Kong Stock Connect, VAR, GARCH

INTRODUCTION

The Shanghai-Hong Kong Stock Connect program was officially implemented on November 17, 2014, after being formally announced on April 10, 2014. It permits hundreds of Shanghai-listed companies to be traded in Hong Kong and vice versa. In addition, since March 2015, investors have been allowed to short sell stocks using the program. Further, the limited daily quota for Mainland investors buying Hong Kong stocks ran out for the first time on April 8, 2015. With China's economic development, not only Mainland investors are eager to enter Hong Kong or even foreign stock markets, but also foreign investors are enthusiastic about exploring new access to Mainland China stock markets. The stock connect program plays a role in bridging the gap. Due to the close relationships in economy and trade between Mainland China and Hong Kong, the Shanghai, Shenzhen, and Hong Kong stock markets are highly integrated. Investors are able to take advantage of better investment and diversification opportunities. For example, Li *et al.* (2014) show that cointegration and error-correction mechanisms exist between A-share and H-share. They also propose a trading strategy of which the returns beat the market. Arouri *et al.* (2010) suggest that cross-border portfolio diversification seems greatly possible despite considerable interdependencies among markets. Hence, it is important to know whether and how the stock connect program will influence the coactions of the Mainland China stock markets and the Hong Kong stock market. In addition, the program facilitates reforms of the Chinese stock market, which is consistent with the argument of Shen *et al.* (2007). They argue that openness policies enhance the market efficiency. The program is also considered as a milestone of the Chinese government to relax its capital controls. Furthermore, it bulks the Hong Kong CNH market and attracts more foreign capital flowing into the Chinese stock market, improving the liquidity of the stock markets. Therefore, how the stock markets of Mainland China and Hong Kong respond to the stock connect policy is a matter of importance.

In this study, we investigate how the Shanghai, Shenzhen, and Hong Kong stock markets respond to the implementation of the new stock connect program. We employ the Vector Autoregressive and Generalized Autoregressive Conditional heteroscedastic (VAR-GARCH) framework to evaluate the policy effects on the three markets in different stages. Markedly, it is found that the Shanghai-Hong Kong Stock Connect has effects on both market returns and volatility, and the power of the policy spreads through the comovements of the markets. The remainder of this paper is organized as follows. The next section presents the literature review, while the following section reports the data description along with the econometric methodology. Then, the next section presents the empirical findings and interprets the policy implications behind the structural changes in returns and volatility in the Shanghai, Shenzhen, and Hong Kong stock markets. The last section concludes the paper.

LITERATURE REVIEW

It is considered that government policies have significant effects on China's stock markets (Chen *et al.*, 2014; Tsai *et al.*, 2015). Policy uncertainty also makes the stock market fluctuates (Pastor and Veronesi, 2012; Antonakakis *et al.*, 2013; Liu and Zhang, 2015). In addition, investor sentiment embodies significant predictive power to stock returns (Dergiades, 2012). In other words, investor sentiment, affected by related policies and significant events, has tremendous impact on Mainland China stock markets (Chi *et al.*, 2012; Shan and Gong, 2012; Tsai *et al.*, 2016). Furthermore, China is opening up its financial market, and thus correlations between Chinese and foreign markets are increasing (Wang *et al.*, 2014; He *et al.*, 2015; Luo and Schinckus, 2015; Luo and Ye, 2015). For example, Luo and Schinckus (2015) confirm the increasing influence of the US market on the Chinese stock markets. Consistent with the argument of prior studies, comovements between stock markets are time varying (Dajcman *et al.*, 2012) and increase during certain periods (Dalkir, 2009).

To date, ties between the Mainland China and Hong Kong stock markets have been further strengthened as time passes by. Su *et al.* (2007) suggests that the stock prices of the Mainland China markets and the Hong Kong market have started to cointegrate as early as the launch of the Closer Economic Partnership Arrangement. Shi *et al.* (2011) propose that after the 2008 financial crisis, relationships between the Mainland China and Hong Kong stock markets transforms from one-way causation into two-way causation, and the influence of the mainland stock markets on the Hong Kong market, which is little in the past, becomes significant. Chang (2015) puts forward the evidence that the short-run comovements between the Shanghai, Shenzhen, and Hong Kong markets are intensified by the market contagion. Moreover, Chang *et al.* (2014) find that the Shanghai-Hong Kong Stock Connect considerably increases the effect of the Shanghai stock market on the Hong Kong stock market, which is vague before the launch of the stock connect policy.

Though there have been numerous studies on the influence of Chinese opening-up policies on the comovement of the Shanghai and Hong Kong stock markets, little investigation pertaining to the comovements of the Shanghai, Shenzhen, and Hong Kong stock markets exists. However, as the government considers loosening several restrictions and limitations of the Shanghai-Hong Kong Stock Connect in last six months and as the forthcoming Shenzhen-Hong Kong Stock Connect heats up, the linkages among the Shanghai, Shenzhen, and Hong Kong markets will further intensify. The importance of finding out policy influence on the comovements of the three stock markets becomes more and more prominent. Our study aims to bring investors a new sight into the interactions among the three stock markets, which will give them access to explore some novel investment opportunities. Meanwhile, it helps Chinese financial regulators to facilitate the reform and improvement of the Chinese stock markets.

DATA AND METHODOLOGY

Data Description

Data for major policy implementation or announcement are hand-collected from official news releases. Table 1 lists the different stages of the Shanghai-Hong Kong Stock Connect.

Table 1: Implementation of Shanghai-Hong Kong Stock Connect

Time	Significant Step	Potential Influence
2014.4.10	The program is first announced by Premier Li Keqiang	Promote the interconnection between the stock markets of Mainland China and Hong Kong
2014.11.17	The program is officially launched	Embody the next round Chinese financial reform
2014.12.9	Three Shanghai-Hong Kong Stock Connect ETF funds are issued	Spur capital inflows to the Hong Kong stock market
2015.3.2	Short selling is permitted	Help the stock markets smooth out and hedge risks
2015.3.27	Guidelines for public funds participating in the Shanghai-Hong Kong Stock Connect trading are enacted	Encourage mainland investors to enter the Hong Kong stock market
2015.4.8	Daily quota of the Hong Kong Stock Connect runs out for the first time	Mainland capital consistently flows into the Hong Kong stock market

This table presents different stages of the Shanghai-Hong Kong Stock Connect. The Shanghai-Hong Kong Stock Connect is considered as an approach that is under control for mutual market access between the Mainland China and Hong Kong by an array of investors. Qualified investors in Mainland China are able to trade qualified shares listed on the Hong Kong Stock Exchange by local brokers. Meanwhile, Hong Kong and international investors can trade eligible Shanghai-listed shares through local brokers as well.

Transaction-level data for stock indices and stock index futures are obtained from Wind. The data comprise daily closing prices of the Shanghai Composite Index, Shenzhen Component Index, and Hong Kong Hang Seng Index from January 1, 2014 to May 29, 2015. In addition, according to Yang *et al.* (2012), the issue of stock index futures affects the volatility of the stock index. Therefore, we further collect the daily closing prices of the short-term maturity of CSI 300 (Hang Seng) stock index futures contracts (one-month) of the same period.

$P_{1,t}$, $P_{1,t-1}$ ($P_{2,t}$, $P_{2,t-1}$; $P_{3,t}$, $P_{3,t-1}$) denote the closing prices of the Shanghai Composite Index (Shenzhen Component Index; Hang Seng Index) in period t, t–1; $r_{1,t}$ ($r_{2,t}$; $r_{3,t}$) denotes the daily yield rate of the Shanghai Composite Index (Shenzhen Component Index; Hang Seng Index) in period t. We employ the natural logarithm (ln) of all daily index prices for calculation of r_t:

$$r_t = 100 \times (lnP_t - lnP_{t-1}) \tag{1}$$

Similarly, we can obtain f_t, the corresponding daily yield of the CSI 300 (Hang Seng) stock index futures in period t.

Table 2 shows the statistical characteristics of the stock indices. The findings are summarized as follows. First, the r_t of the Shanghai Composite Index has negative skewness and a spike. Second, the Jarque-Bera statistic shows that the r_t series is not a normal distribution and has fat tails. Hence, estimations in the later analyses use the Generalized Error Distribution (GED) to account for the innovation distribution with fat tails. Third, the r_t series passes the Augmented Dickey-Fuller unit root test and is stationary. Finally, the r_t series of the Shenzhen Component Index and Hang Seng Index present similar results.

Table 2: Summary Statistics

Statistical Characteristics	Shanghai Index	Shenzhen Index	Hang Seng Index
Mean	0.2367	0.1895	0.0594
Median	0.1683	0.1403	0.0652
Maxium	6.369	4.727	3.732
Minimum	–8.018	–6.835	–2.619
Std. Dev.	1.334	1.430	0.9261
Skewness	–0.4069	–0.0461	–0.0996
Kurtosis	9.699	5.242	3.923
Jarque-Bera	588.19	65.051	11.523
p-value for JB	<0.0001	<0.0001	0.0031
Augmented Dickey-Fuller	–17.654	–17.891	–16.568
p-value for ADF	<0.0001	<0.0001	<0.0001

This table presents summary and test statistics for the Shanghai Composite Index returns, Shenzhen Component Index returns, and Hong Kong Hang Seng Index returns, respectively. Under the null hypothesis of a normal distribution, the Jarque-Bera (JB) statistic has a chi-squared distribution with two degrees of freedom. Unit root test are conducted using the Augmented Dickey-Fuller (ADF) with trend and intercept.

Methodology

First, we utilize a VAR model to examine the comovements of daily returns of the Shanghai Composite Index, Shenzhen Component Index, and Hang Seng Index. The *s*th order VAR, VAR(*s*), for the endogenous relations between the three indices is specified as

$$r_t = \mathrm{C} + \sum_{j=1}^{s} \mathrm{B}_j r_{t-j} + \sum_{k=1}^{6} \aleph_k D_k + \epsilon_t \tag{2}$$

where B_j and $\aleph_k$ represent the coefficient matrices, which describe the comovement relations and the policy impact, respectively. Indicator variables, D_k, are used to examine the influence of policy announcement or implementation in different stages.

$$D_k = \begin{cases} 1 & After - annoucement \;\; (implementation) \\ 0 & Before - announcement \;\; (implementation) \end{cases} \tag{3}$$

Second, we employ the GARCH-in-Mean (GARCH-M) model to account for heteroscedastic variance and its effect on returns. The model captures the policy influence on both stock performance and volatility for each individual market *i*. The mean equation of the model is

$$r_{i,t} = c + \sum_{j=1}^{s} \beta_j r_{i,t-j} + \tau\sqrt{\sigma_{i,t}^2} + \epsilon_{i,t} \tag{4}$$

The variance equation of the GARCH(p,q)-M model is presented in the following form:

$$\sigma_{i,t}^2 = \omega + \sum_{m=1}^{p} \gamma_m \sigma_{i,t-m}^2 + \sum_{n=1}^{q} \pi_n \epsilon_{i,t-n}^2 + \sum_{k=1}^{6} \varphi_k D_k + \theta f_t \tag{5}$$

where γ_m and π_n are the parameters for the GARCH and ARCH terms; φ_k captures the effect of policy announcement or implementation (D_k) on volatility; and θ controls for the effect of the stock index futures (f_t). In the model selection process, we examine different kinds of commonly used combinations of VAR(s)- GARCH(p,q)-M models according to two most commonly used criteria, the Akaike Information Criterion (AIC) and the Bayesian Information Criterion (BIC). The results suggest the VAR(2)-GARCH(1,1)-M specification is an appropriate model. Namely, for each market the mean and variance equations of the model are

$$r_t = c + \sum_{j=1}^{2} \beta_j r_{t-j} + \tau\sqrt{\sigma_t^2} + \tag{6}$$

$$\sigma_t^2 = \omega + \gamma\sigma_{t-1}^2 + \pi\epsilon_{t-1}^2 + \sum_{k=1}^{6} \varphi_k D_k + \theta f_t \tag{7}$$

where the parameters are as explained above. Among them, τ evaluates the volatility influence on returns. The total influence of information shocks, $\gamma + \pi$, measures the persistence of the market response to the changes in the past and recent information. π allows us to observe the market sensitivity to the new information. φ_k captures the policy influence.

RESULTS AND DISCUSSION

Impact on Stock Returns

We first observe features of the stock returns in the three stock markets. Table 3 shows that all the three stock market returns are affected by their own preceding returns. In addition, the Shanghai stock market

Table 3: Effects of Policy Implementation on Stock Returns

		Shanghai	Shenzhen	Hong Kong
	C	0.2227***	0.1758**	0.0358
		(0.0795)	(0.0856)	(0.0545)
Shanghai	SH_{t-1}	–0.0898	–0.1087	–0.0917†
		(0.1281)	(0.1379)	(0.0878)
	SH_{t-2}	–0.2468**	–0.1212†	–0.0604
		(0.1278)	(0.1376)	(0.0877)
Shenzhen	SZ_{t-1}	0.0737	0.0652	0.0165
		(0.1167)	(0.1257)	(0.0800)
	SZ_{t-2}	0.2318**	0.1873**	0.1000*
		(0.1166)	(0.1255)	(0.0799)
Hong Kong	HS_{t-1}	–0.0597	–0.0544	0.0817*
		(0.0930)	(0.1001)	(0.0638)
	HS_{t-2}	–0.0604	–0.0965†	–0.0036
		(0.0923)	(0.0994)	(0.0633)
Policy	Policy 1st	0.0919	0.1201	0.0534
		(0.1934)	(0.2068)	(0.1334)
	Policy 2nd	0.4806***	0.5224***	0.1118
		(0.1641)	(0.1756)	(0.1144)
	Policy 3rd	0.2634*	0.2376*	0.1366†
		(0.1702)	(0.1825)	(0.1174)
	Policy 4th	0.6638***	0.4777**	0.2925**
		(0.2354)	(0.2539)	(0.1633)
	Policy 5th	0.8771***	0.6867**	0.6863***
		(0.3249)	(0.3499)	(0.2229)
	Policy 6th	0.7785**	0.4104	0.7851***
		(0.3925)	(0.4223)	(0.2681)

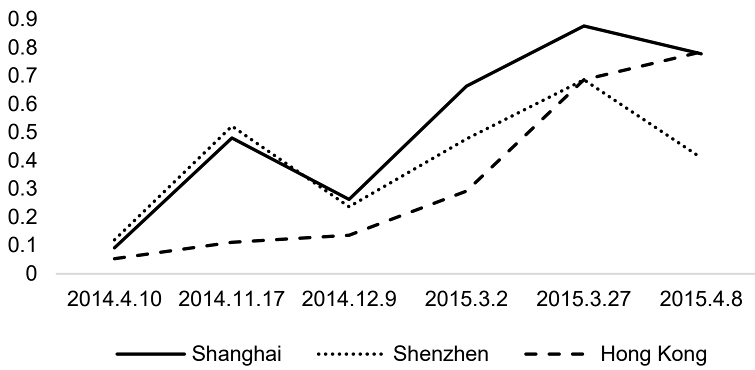
This table presents estimation results of the VAR model for the Shanghai, Shenzhen, and Hong Kong stock markets. The VAR model is as follows:

$$r_t = \mathrm{C} + \sum_{j=1}^{2} \mathrm{B}_j r_{t-j} + \sum_{k=1}^{6} \aleph_k D_k + \epsilon_t$$

*Standard errors are in parentheses. ***, **, *, and † represent statistical significance at the 1%, 5%, 10%, and 15% levels, respectively.*

interacts with the Shenzhen stock market, and the Shenzhen market is affected not only by the Shanghai market but also by the Hong Kong market. Furthermore, the Hong Kong market acts mutually with the Shanghai and Shenzhen markets. The results suggest that the comovements of the three stock markets exist. Then, we obtain the estimated responses of market returns to the policy announcement or implementation, which are detailed in Table 3 and are plotted in Figure 1, respectively. The results show general upward trends for the three stock markets. The three markets all give positive responses to the policy.

Figure 1: Response of Market Returns to Policy Implementation



This figure displays the evolution of the policy impact on stock returns.

Impact on Stock Volatility

Table 4 shows the effects of the policy implementation on stock volatility. The estimated effects are plotted in Figure 2. Interestingly, the Shanghai and Shenzhen stock markets react severely to the new policy, while the response of the Hong Kong market is lukewarm, except for one spike. These differences originate partly from the distinct market features of the Mainland China and Hong Kong stock markets. The Hong Kong market is dominated by institutional investors. Retail investors, by contrast, play the main role in the Mainland China stock markets. In addition, the Mainland China stock markets are generally considered as policy-oriented markets, in which the local investors are relatively more sensitive to new policies. Furthermore, in the initial phase the Chinese government gave certain advantages to the Shanghai stock market, in which the market access threshold is lower (e.g., no need to take a test or personally go to the security company to open the trading account). These reasons account for the instant volatility change in the Mainland China markets, and then, as time goes by, the markets gradually digest the spur of the policy and their volatility returns to the original level.

In contrast, Hong Kong has been an open market for several years, and its investors are far more rational than those in Mainland China. In addition, except for relatively more limitations on investing in the Hong Kong Stock Connect (e.g., investors are restricted to institutional investors and personal investors should have more than 500,000 yuan RMB in their accounts), Mainland investors hesitated to invest in the Hong Kong market due to less knowledge and preparation. Hence, the tepid response of the Hong Kong market is reasonable. However, the fifth step of the policy, which confirms the legitimacy of public funds participating in the Hong Kong Stock Connect trading, considerably stimulated the volatility change of the Hong Kong market due to large amount of capital inflow. Mainland retail investors are then able to invest in the Hong Kong stock market through public funds with a low entry threshold (the minimum required investment is only 100 yuan RMB). Meanwhile, Mainland China experienced a stock boom since the second half of 2014, and Mainland investors are prone to transfer their capital to the Hong Kong market, whose stocks are considered undervalued.

Table 4: Effects of Policy Implementation on Stock Volatility

Panel A: Shanghai					
Model	ω	γ	π	θ	τ
GARCH-M	0.8193***	0.2524***	0.0241***	0.1395***	7.899***
	(0.0364)	(0.0293)	(0.0067)	(0.0070)	(0.2140)
Policy Effects					
Policy 1st	0.0091*	Policy 3rd	0.0578***	Policy 5th	0.0472***
	(0.0068)		(0.0010)		(0.0035)
Policy 2nd	0.0610***	Policy 4th	0.0672***	Policy 6th	–0.0131
	(0.0106)		(0.0049)		(0.0145)
Panel B: Shenzhen					
Model	ω	γ	π	θ	τ
GARCH-M	0.7465***	0.5922***	0.2336***	0.5275***	2.335***
	(0.1403)	(0.0248)	(0.0368)	(0.0633)	(0.1149)
Policy Effects					
Policy 1st	–0.1179***	Policy 3rd	0.1883***	Policy 5th	–0.2686***
	(0.0331)		(0.0435)		(0.0542)
Policy 2nd	0.0997***	Policy 4th	0.0347	Policy 6th	–0.2805***
	(0.0439)		(0.0798)		(0.0694)
Panel C: Hong Kong					
Model	ω	γ	π	θ	τ
GARCH-M	0.1037***	0.0028	0.0027**	0.0205***	3.970***
	(0.0075)	(0.0053)	(0.0017)	(0.0021)	(0.2740)
Policy Effects					
Policy 1st	0.0008	Policy 3rd	–0.0003	Policy 5th	0.0381***
	(0.0010)		(0.0018)		(0.0094)
Policy 2nd	0.0007*	Policy 4th	0.0018*	Policy 6th	0.0045***
	(0.0005)		(0.0012)		(0.0007)

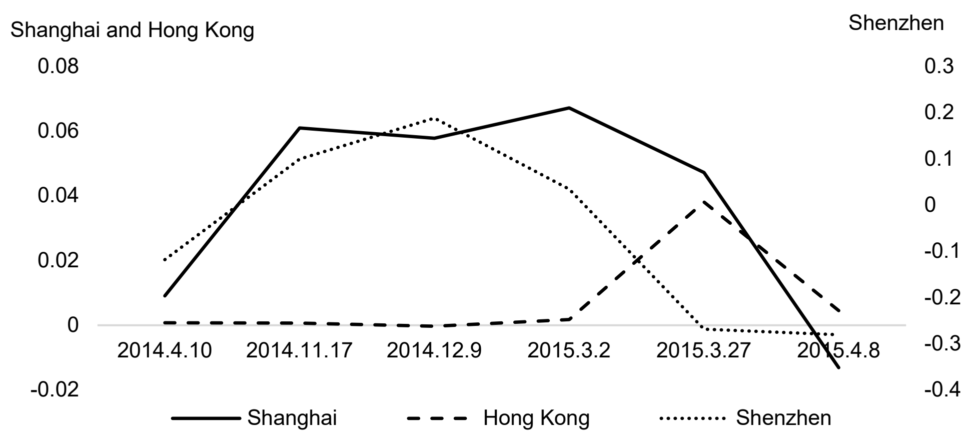
This table presents estimation results of the GARCH models for the Shanghai, Shenzhen, and Hong Kong stock markets in Panels A, B, and C, respectively. The GARCH models are as follows:

$$r_t = c + \sum_{j=1}^{2} \beta_j r_{t-j} + \tau\sqrt{\sigma_t^2} + \epsilon_t$$

$$\sigma_t^2 = \omega + \gamma\sigma_{t-1}^2 + \pi\epsilon_{t-1}^2 + \sum_{k=1}^{6} \varphi_k D_k + \theta f_t$$

*The estimation of the parameters is examined with the Generalized Error Distribution (GED) assumption for the innovations. Standard errors are in parentheses. ***, **, and * represent statistical significance at the 1%, 5%, and 10% levels, respectively.*

Figure 2: Response of Market Volatility to Policy Implementation



This figure shows the evolution of the policy impact on stock volatility.

Table 4 also provides the volatility influence on the mean equation, τ. The corresponding coefficients of the three markets are all statistically significant, suggesting that volatility affects stock returns. Combining the result with those in the previous discussion, the policy implementation has impacts on stock volatility, volatility affects stock returns, and returns of stock markets interact with each other. The overall results imply that the three markets pass on the effects of policy implementation to one another via their comovements. Regarding other coefficients in Table 4, the $\gamma + \pi$ and π in the Mainland China markets are higher than those in the Hong Kong market, suggesting not only that the influence of the shocks lasts longer in the Mainland China markets but also that Mainland investors are more sensitive to new information.

CONCLUDING COMMENTS

This study investigates the influence of the Shanghai-Hong Kong Stock Connect. The policy aims at establishing mutual stock access between the Mainland China and Hong Kong markets. Our results suggest that the policy affects these markets differently because of their distinct characteristics such as different investor structure, entry thresholds, and regulation requirements. In addition, these markets interact with each other and the power of the policy, therefore, spreads among the markets. Furthermore, this study implies that the implementation of the Shanghai-Hong Kong Stock Connect has laid the groundwork for the Shenzhen-Hong Kong Stock Connect. There are reasons to believe that the linkages of the Shanghai, Shenzhen, and Hong Kong stock markets will further intensify with subsequent opening-up policies being launched. It not only indicates that Mainland China financial centers (Shanghai and Shenzhen) integrate with one of international financial centers (Hong Kong), but also symbolizes the gradually increasing strength of Chinese policy effects on global capital markets.

Finally, our study only focuses on the policy impact of the Shanghai-Hong Kong Stock Connect. This study can be extended to a series of opening-up policies. In recent years, capital market internationalization has played an important role in China's reform agenda. Before the stock connect program, many policies have launched such as Qualified Foreign Institutional Investor (QFII) and Qualified Domestic Institutional Investor (QDII) programs. Future research can explore how these policies and forthcoming policies affect the Mainland China, Hong Kong, and other related markets.

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CARRY TRADE STRATEGIES WITH FACTOR AUGMENTED MACRO FUNDAMENTALS: A DYNAMIC MARKOV-SWITCHING FACTOR MODEL

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ABSTRACT

This paper evaluates the performance of carry trade strategies with macro fundamentals in a Markov switching dynamic factor augmented regression framework and compares the performance statistics with the benchmark model of a random walk and momentum strategy. I make simulations with the Japanese Yen, Swiss Franc and US Dollar as funding currencies against six target currencies. Carry trade, a currency speculation strategy between the high-interest rate and low-interest rate currencies, generates high payoffs on average but has a possibility of crash risk. I argue that risk adjusted returns, mean returns and down-side risk perform better when purchasing power parity model is used in a both regime switching and linear factor augmented regression framework for Franc trades and perform as good as benchmark model of momentum strategy for Dollar and Yen trades.

JEL: C22, E32, E37, E43, F31, F37, G15

KEYWORDS: Exchange Rate Models, Carry Trade, Forecasting, Markov-Switching Dynamic Factor

INTRODUCTION

Persistent interest differentials and low exchange rate volatility have underpinned significant cross-currency positioning in recent years. One of the basic principles in finance is, if investors have zero-cost investment, the expected return for that investment should be zero; otherwise there will be an arbitrage opportunity. The carry trade is an example of zero-cost investment, where the investors borrow from low-interest rate currencies and invest in high interest rate currencies in order to profit from the interest rate differentials. Carry trade is profitable contrary to economic and financial theories. Since traders invest in risk-free deposits, the only source of risk comes from exchange rate volatility. According to uncovered interest parity (UIP), the difference in interest rates between the two countries simply shows how much investors expect the high-interest-rate currency to depreciate against the low-interest-rate currency. If UIP holds, the carry trade strategy does not work, as higher yielding currencies will depreciate against lower yielding ones at a rate equal to the interest differential, equalizing expected returns for a given currency. The interest rate differential is expected to be fully offset by currency movements, neutralizing any profitable arbitrage opportunities from carry trading.

A large body of empirical literature documents that UIP fails at short and medium horizons but holds in the long term (Chinn and Quayyum 2012). Indeed, in the rest of the cases the relationship is precisely the opposite of that predicted by UIP: currencies with high interest rate tend to appreciate, not depreciate, while other currencies with low interest rates tend to depreciate, not appreciate. This failure of UIP is so well established that the phenomenon is called the “forward premium puzzle” and has been tested by an extensive literature that includes Frankel (1980), and Fama (1984). Carry trading is profitable for an unhedged currency strategy, when the interest rate differentials are high enough to compensate for exchange rate fluctuations. The profit from the carry trade is the sum of the interest rate differential and the forward premium between the two currencies. Carry trade involves risk due to potential exchange rate movements.

In fact, the high yield currency may depreciate against the low yield currency, increasing the amount initially borrowed in the funding currency in terms of target currency, and driving up the cost of borrowing. Since exchange rate movements are not offset by the interest rate differentials between the countries, carry traders tend to make huge profits.

It has been known that carry trades are profitable on average since the seminal paper by Meese and Rogoff (1983), who argue that the best predictor of next month's exchange rate is today's exchange rate. Thus, investors can make money on average by borrowing in currencies with low interest rates and investing in currencies with high interest rates. With the random walk model of exchange rates, the profit of carry trade comes from the yield spreads. Even though Meese and Rogoff (1983) show that economic models of exchange rates do not outperform the random walk forecast, many studies show the predictive ability of macro fundamentals for currency movements. Earlier research focused on the PPP and monetary approach in exchange rate forecasting, and recent studies have success in the prediction of exchange rate movements using the endogeneity of monetary policy with interest rate feedback rules such as Taylor rules (Molodtsova and Papell 2009). While the predictive power of Taylor rule and other macro fundamentals in exchange rate movements has been studied in the literature, these macro fundamentals and their predictive powers are not emphasized much as currency trading strategies. Jordà and Taylor (2012) show that the crash risk, or negative skewness, of the carry trade can be greatly reduced using fundamentals augmented carry trade strategies that take into account not only interest rate differentials, but also relative Purchasing Power Parity.

Li (2011) evaluates the profitability of the carry trades using Taylor rule fundamentals in exchange rate forecasting. He claims factor augmented Taylor rule fundamentals increase the profits of carry trade in a monthly frequency. This paper studies currency carry trade strategies based on macro fundamentals and regime switching risk premium factor in exchange rate forecasting. The starting point is to forecast exchange rates with macro fundamentals, focusing on Taylor rule and PPP models. These macro fundamental models are augmented with a regime switching risk premium factor. Risk premium factor is derived from excess returns of currency trading. The goal in building a non-linear risk premium factor is to capture both the nonlinearities in the currency market and the co-movements in the excess returns of the currency carry trading. Besides, the information extracted from the risk premium has the potential to increase the forecasting ability of macro fundamentals in exchange rate determination. Chauvet (1998) popularized the use of dynamic factors with Markov switching to characterize business cycles, however there is no paper in the literature that utilizes the nonlinear factor models to characterize the risk premium of currency trading. This empirical study uses time series data on the exchange rates of six major currencies against the Japanese Yen, Swiss Franc and five major currencies against the US Dollar.

For each of the six currencies, equally weighted portfolios are generated and the performance statistics of the returns are calculated. Random Walk (naive carry trade) and Momentum Models are chosen as the benchmark model. Random Walk Model is called as naive model since carry trades are executed in the naive sense, implying the investor's decision to execute carry trade depends on only interest rate differentials. Alternative strategies to the naive strategy are the models incorporating macro fundamentals and/or estimated non-linear and linear risk premium factors in exchange rate forecasting. Total of six trading strategies are simulated as an alternative to benchmark models. The empirical findings suggest that the mean returns, risk adjusted returns, downside risk, or negative skewness and maximum drawdown of the carry trades can be improved if the investors use PPP fundamentals that are augmented with a both nonlinear and linear factor. This result holds for both Franc and Dollar carry trades. In Yen trades, Momentum and PPP factor augmented models perform better than other models in the simulation. The remainder of this paper is organized as follows: The next section examines the related literature. In the following section, I describe the data, design of carry trade strategies, and methodology utilized in this study. Performance of carry trade strategies and discussion of the results are provided in the results section. The paper closes with some concluding comments and suggestions for future research.

LITERATURE REVIEW

The original academic literature claims that macroeconomic variables offer little help in exchange rate forecasting. Meese and Rogoff (1983) show that economic models of exchange rates do not outperform the random walk forecast model. Cheung et al. (2005) find that none of the macro fundamental models used in 1990s such as PPP fundamentals, sticky price monetary, productivity differential, uncovered interest rate parity and composite model of fundamentals can be successfully used by examining five developed countries' currency markets. Exchange rate determination can be consistent with macroeconomic fundamentals when monetary policy is taken to be endogenous with an interest rate feedback rule. Taylor rule models offer a different explanation to the exchange rate determination. Engel, Mark and West (2007) use uncovered interest rate parity directly to produce exchange rate forecast. They replace the interest rate differentials in the UIP by the interest rate differentials implied by Taylor rule, whereas Molodtsova and Papell (2009) used the variables that enter Taylor rule to evaluate the exchange rate forecast. Molodtsova and Papell (2009) find out that by assessing the out of sample performance of 12 currencies, the predictability of these models with Taylor rule fundamentals are stronger for 8 out of 12 currencies.

There are not many papers in the literature measuring the predictive ability of macro fundamentals in carry trading. Li (2011) evaluates exchange rate models with Taylor rule fundamentals from the perspective of the carry trader. The author claims that if the macro fundamental models of exchange rate including Taylor rule fundamentals do better than a random walk, this predictability power of exchange rate models may increase the profitability of carry trade strategies. He finds that carry trade models, using economic fundamentals in a factor augmented regression framework, have lower Sharpe Ratio and better downside risk. The results are robust to different time periods. Jorda and Taylor (2012) show that the crash risk of the carry trade can be reduced substantially by following macro fundamentals augmented carry trade strategies. They find that the nominal interest differential can help to predict exchange rate movements in the short run, but the forecast of exchange rates can be enhanced by including purchasing power parity (PPP). The deviation from PPP helps to forecast movements of the nominal exchange rate as the real exchange rate adjusts to its long run level. The authors show that there is a profitable trading strategy which includes a forecast that real exchange rate will return its long run level when its deviations from the mean are large.

Factor model forecasts of exchange rate are inspired by Engel et al. (2007). The authors mention that exchange rates themselves have an unobservable common component which may contain useful information for prediction. Engel et al. (2015) construct factors from a cross section of exchange rates and then use these estimated factors in the forecast equation of exchange rates. Using quarterly data from 1973 to 2007, factor augmented macro fundamentals model of exchange rate forecasts tends to improve on the forecasts of a random walk model in mean square error for their late sample, starting from 1999 and ending at 2007, although the factors themselves are not statistically significant. Using monthly data from 1999 to 2010, Greenaway, Mark, Sul and Wu (2012) perform a factor analysis on a panel of 23 nominal exchange rates where the factors are extracted from the exchange rate itself.

The authors identify the Euro/Dollar, the Swiss-Franc/Dollar and the Yen/Dollar exchange rates as the empirical counterparts to these common factors and find that the exchange rate factor augmented PPP Model has significant in sample and out of sample predictive power. Lustig et al. (2011) extract common factors from the excess currency returns associated with the carry trade. They claim that the global risk factor is the dominant factor. However, they do not use this factor for explaining the variation in exchange rates. Verdelhan (2015) uses these common risk factors that are derived from excess returns from carry trade to explain the variations in bilateral exchange rates. However, Verdelhan (2015) did not take into account these factors in exchange rate forecasting. This paper models excess return or the risk premium of currency trading by a Markov switching dynamic factor. This risk premium factor then augments both Taylor rule and PPP models of exchange rate forecasting in the forecasting equation of exchange rate. New carry trading strategies utilizing the information that is derived from the risk premium and the macro fundamentals of exchange rate forecasting are examined in measuring the performance of carry trade in terms of profitability and risk.

DATA AND METHODOLOGY

The empirical analysis uses monthly data. The sample period includes the month end daily exchange rate data from FRED between January 1972 and December 2014 for pairs of the eight major currencies: The Australian Dollar (AUD), the Canadian Dollar (CAD), the Euro (EUR), the British Pound (GBP), the New Zealand Dollar (NZD), the Japanese Yen (JPY), the Swiss Franc (CHF), and the US Dollar (USD). Exchange rates of the target currency measured in the funding currency are computed as cross rates from their original dollar values. Of the eight currencies, six CHF and JPY cross rates are formed and five USD exchange rates are used. The data for macroeconomic fundamentals are constructed from the International Financial Statistics (IFS) and OECD Main Economic Indicators (MEI) databases. The seasonally adjusted Industrial Production Index is used as for countries' GDP, since GDP data is only available at quarterly frequency. The inflation rate is calculated from the Consumer Price Index, and is the annual rate measured as the 12-month difference of the CPI. The Money Market Rate is used for the monthly interest rate, which central banks set every period. German exchange rates and macro fundamentals are substituted for those of the Euro Zone before January, 1999.

The output gap calculations are based on potential output. The output gap is calculated as percentage deviations of actual output from a quadratic time trend, since there is no consensus about which definition of output is used by central banks. Quasi real time data in the output gap estimation is used. The quasi real time estimate is constructed in two steps. The first step begins with taking the final vintage of the output series with the observations up to, and including, $t-1$ computing the quasi-real time estimate for period t. Then, in each period, the sample period is extended by one observation and OLS is used for de-trending. In the second step, the first available estimate of the output gap at each point in time that is constructed in the first step is collected. The final sequence of output gap series will be the quasi real time estimation of output gap data.

Carry Trade Strategies

Benchmark Models: The benchmark model is the naive carry trade strategy. Under the random walk theory, the carry trade, in its simplest form, depends solely on the interest rate differentials. This carry trade is called naive since it is unrelated to fundamentals other than interest rates. The second trading strategy is the momentum model of exchange rates. This strategy simply takes the current value of the change in exchange rate to be the best forecast of the change in exchange rate the next period. The naive and the momentum carry trade strategies can be described as:

Naive (Random Walk) (Model 1): The strategy focuses on only interest rate differentials.

$$\Delta\hat{e}_{t+1} = 0 \quad (1)$$

The variable e_t is the log of funding currency in units of target currency, so that an increase in e_t is an appreciation against funding currency.

Momentum (Model 2): The strategy takes the current value of exchange rate change as the best predictor of future.

$$\Delta e_{t+1} = \beta_0 + \beta_e \Delta e_t + \varepsilon_{t+1} \quad (2)$$

Macro Fundamentals Augmented Models: Purchasing Power Parity (PPP) holds in the long run, as many studies have confirmed. Under PPP, the exchange rate forecasting equation includes the price differences of the two countries. Following Jorda and Taylor (2012), PPP is incorporated into uncovered interest parity condition by expressing UIP in real, rather than nominal terms. Specifically, $r_t = i_t - \pi_{t+1}$ with $\pi_{t+1} = \Delta p_{t+1}$ and p_t is the log of national price level of the funding currency country. Jorda and Taylor (2012) form vector time series with changes in nominal exchange rates, differences in inflation rates and nominal interest rates between countries, where the levels of first two entries are $I(1)$ variables which will be co-integrated if the PPP condition holds with co-integrating vector $q_t = e_t + p_t - p_t^*$. Jorda and Taylor (2012) use the weak PPP condition, $q_t = \bar{q} + \boldsymbol{\psi}(p_t - p_t^*)$, as a co-integrating vector, where $\bar{q}$ is the mean fundamental equilibrium exchange rate, and the Vector error correction model (VECM) as a currency trading strategy is expressed as:

VECM (Model 3):

$$\Delta e_{t+1} = \beta_0 + \beta_e \Delta e_t + \beta_\pi(\pi_t - \pi_t^*) + +\beta_i(i_t - i_t^*) + \beta_q(q_t - \bar{q} - \psi(p_t - p_t^*) + \varepsilon_{t+1} \tag{3}$$

The Taylor rule relates changes in the interest rate to inflation and the output gap. Many researchers and policy makers assess the validity of the Taylor rule in both developed and developing countries (Clarida et al. (1998), Osterholm (2005), and Bhattaraii (2008)).

Following Taylor (1993), central banks follow the below reaction function for the monetary policy rule:

$$i_t = \pi_t + \theta(\pi_t - \tilde{\pi}\ ) + \delta y_t + \tilde{r} \tag{4}$$

where i_t is the federal funds rate, π_t is the inflation rate, $\tilde{\pi}$ is the target level of inflation, y_t is the output gap and $\tilde{r}$ is the equilibrium level of real interest rate.

The parameters $\tilde{\pi}$ and $\tilde{r}$ are constant and can be sum up to form single term $= \tilde{r}\ - \theta\tilde{\pi}$. Therefore, the equation (3.5) can be written as:

$$i_t = \mu + \varphi\pi_t + \delta y_t \tag{5}$$

where $\varphi = 1 + \theta$. Clarida, Gali and Gertler (1998) assume that the actual observable interest rate gradually adjust to its target level. Therefore, the Taylor's original formulation with interest rate smoothing becomes as follows:

$$i_t = (1 - \rho)(\mu + \varphi\pi_t + \delta y_t) + \rho i_{t-1} \tag{6}$$

Following Molodtsova and Papell (2009), Taylor rule fundamentals are used for exchange rate determination. The interest rate differentials between the target currency and the funding currency is replaced by the Taylor rule fundamentals. Although Molodtsova and Papell (2009) consider different specifications for the Taylor rule fundamentals, the formulation with interest rate smoothing, where the interest rate is characterized by the inflation gap, the output gap, the equilibrium interest rate, and the lagged interest rate is followed. It is assumed that both central banks follow a similar rule and they respond identically to the inflation and the output gaps. Therefore, the Taylor rule coefficients will be identical for both countries. It is also assumed, the two central banks have different inflation targets and equilibrium interest rates. With these assumptions, the Taylor rule as a currency trade strategy is:

Taylor Rule Fundamentals (Model 4):

$$\Delta e_{t+1} = \beta_0 + \beta_1(\pi_t - \pi_t^*) + \beta_2(y_t - y_t^*) + \beta_3(i_{t-1} - i_{t-1}^*) + \varepsilon_{t+1} \tag{7}$$

Star indicates the values for the target currency country. π_t and y_t are the inflation and output gaps respectively. Alternative models with Taylor rule fundamentals are also considered. For instance, Taylor rule fundamentals in a non-switching factor augmented regression framework and Taylor Rule fundamentals combined with Momentum strategy are used as forecasting equation for the exchange rates.

Factor Augmented Macro Fundamentals Models: VECM and Taylor Rule Model in a non-switching and switching factor augmented regression framework are used as forecasting equation for the exchange rates. *VECM with Non-Switching Factor (Model 5):*

$$\Delta e_{t+1} = \beta_0 + \beta_C \widehat{C_t} + \beta_e \Delta e_t + \beta_\pi(\pi_t - \pi_t^*) + +\beta_i(i_t - i_t^*) + \beta_q(q_t - \bar{q} - \psi(p_t - p_t^*) + \varepsilon_{t+1} \tag{8}$$

Taylor Rule Fundamentals with Non-Switching Factor (Model 6):

$$\Delta e_{t+1} = \beta_0 + \beta_C \widehat{C_t} + \beta_\pi(\pi_t - \pi_t^*) + \beta_y(y_t - y_t^*) + \beta_i(i_{t-1} - i_{t-1}^*) + \varepsilon_{t+1} \tag{9}$$

C_t is the non-switching dynamic factor that is estimated by maximum likelihood estimation.

VECM with Markov-Switching (MS) Factor (Model 7):

$$\Delta e_{t+1} = \beta_0 + \beta_F F + \beta_e \Delta e_t + \beta_\pi(\pi_t - \pi_t^*) + +\beta_i(i_t - i_t^*) + \beta_q(q_t - \bar{q} - \psi(p_t - p_t^*) + \varepsilon_{t+1} \tag{10}$$

Taylor Rule Fundamentals with Markov-Switching (MS) Factor (Model 8):

$$\Delta e_{t+1} = \beta_0 + \beta_F \widehat{F_t} + \beta_\pi(\pi_t - \pi_t^*) + \beta_y(y_t - y_t^*) + \beta_i(i_{t-1} - i_{t-1}^*) + \varepsilon_{t+1} \tag{11}$$

In equation 10 and 11, the Markov switching factor,$\widehat{F_t}$, is estimated by approximate MLE using both the Kalman Filter and the Hamilton Filter together.

<u>Modelling and Estimating the Factor</u>

A vector of excess returns is modeled as a combination of two stochastic autoregressive processes; a single unobserved component, which is the common factor for the observable variable (risk premium), and an idiosyncratic component. The empirical analysis is done by using the log of first difference of the spot exchange rates, and the interest rate differentials of target and funding countries. The sum of these two macroeconomic data is defined as the observable variable displaying co-movements with the aggregate economic conditions. The model is:

$$y_{i,t} = i_{i,t}^* - i_{i,t} + \Delta e_{i,t+1} \qquad i = 1, \dots., n \tag{12}$$

$$y_{i,t} = \lambda_i F_t + \varepsilon_{i,t} \qquad i = 1, \dots., n \tag{13}$$

$$F_t = \mu_{st} + v_t \qquad S_t = 0,1 \tag{14}$$

$$\varepsilon_{i,t} = \gamma_i \varepsilon_{i,t-1} + \epsilon_{i,t} \qquad i = 1, \dots., n \tag{15}$$

The assumptions of the model are:

$v_t \sim i.i.d.\ \ N(0,1)$

$\epsilon_{i,t} \sim i.i.d.\ \ N(0, \Sigma)$

$$p_{ij} = Prob\left[D_{t=j}\middle|D_{t-1=i}\right],\ \sum_{j=1}^{M} p_{ij} = 1 \qquad \forall i\ \in M\ states$$

$y_{i,t}$ is the excess return, the parameters λ_i are the factor loadings, which measure the sensitivity of the i^{th} series to the contractions and expansions in the economy, and F_t is the common factor. The idiosyncratic term $\varepsilon_{i,t}$ is serially uncorrelated at all leads and lags, $\epsilon_{i,t}$ is the measurement error. A nonlinear structure is introduced in the unobserved component in the form of a first order two state Markov switching process. There are two states in the economy: a contraction, $(S_t = 0)$ or an expansion, $(S_t = 1)$. Excess returns of the currency trading are modeled such that the only source of co-movements comes from the unobservable dynamic factor. The basic idea of the model is to allow the mean of unobservable common factor to take two distinct values during the times of expansions and contractions. The regime at any given time is presumed to be the outcome of a Markov chain whose realizations are unobserved. The two regimes at any given time are characterized by the transition probabilities of the Markov process. For example, $Prob[S_t = 1|S_{t-1} = 1] = p$ is the probability of an expansion, and $Prob[S_t = 0|S_{t-1} = 0] = q$ is the probability of contraction. The state space representation for the switching dynamic factor (12) - (15) with the AR (1) process for the disturbance term is explained in Appendix A. The measurement equation and the transition equation in vector notation can be written:

$$Y_t = HB_t \tag{16}$$

$$B_t = \alpha_{st} + ZB_{t-1} + u_t \tag{17}$$

With the dynamic factor model of Stock and Watson (1989) and the regime switching model of Hamilton (1989), excess returns of the observed currency pairs from the carry trade depend on the current and lagged values of an unobserved common factor. This common factor captures the co-movements between the risk premium of each currency trading and is dependent on whether the economy is in the recession state or in the boom state. The dynamic factor model with regime switching is estimated by maximizing its likelihood function. Kim's algorithm (1999) is used to estimate the model. Kim extended Hamilton's Markov switching Model to a linear dynamic state space representation. He allows the regime switching in both the transition and measurement equation. His algorithm combines nonlinear discrete Kalman Filter with Hamilton's nonlinear filter, which allows both the estimation of an unobserved state vector and the transition probabilities. The procedure to estimate the model starts with recursively calculating one step-ahead predictions and updating equations of the dynamic factor, given the starting values and the probabilities of the Markov States. The probability terms are calculated using Hamilton's Filter. This nonlinear filter computes for the two state Markov switching process four forecasts at each date and the number of cases is multiplied by two at each iteration. Since this approach makes the Kalman Filter computationally infeasible, Kim (1999) proposes an approximation consisting of taking weighted averages of updating equations by the probabilities of Markov States.

As a byproduct of the filter, the conditional density of the observable variables that is calculated will then be used to estimate the unknown parameters of the model. These parameter estimates will be recursively substituted into Kalman Filter until the estimates of parameters converge. The maximum likelihood estimators and the sample data are then used in the final application of the filter to draw inferences about the dynamic factor and the probabilities. The estimation procedure is discussed in details in the Appendix B. Several different specifications of the model are estimated, including an AR (1) and an AR (2) factor with an AR (1) and an AR (2) idiosyncratic terms for the observables. Combinations of these models are also tested. However, highly parameterized models with higher dynamic orders have coefficients that are not significant at the 5 percent significance level. The likelihood ratio test is used to choose among the alternative specifications of the model.

For the adequacy of the model selection, the disturbances in the observable variables are analyzed. The correctly specified model has estimated disturbances that are not serially uncorrelated implying the sample autocorrelations should be zero and the disturbances should be white noise. The diagnostic tests for the data state that the specifications that are selected for the model are adequate. Identifying the number of common factors that explain common variations in a set of observable variables is one of the major tasks of factor analysis. The most widely used is the Scree test. The Scree test is a visual test based on the behaviors of the eigenvalues of the second moment matrix of the observable variables. In this paper, the number of factors is verified by checking the eigenvalues of the correlation matrix containing the total variance of the observables and for visual inspection the Scree test is used. The magnitude of the eigenvalues, which contains information about how much of the correlations among the observable variables, is explained by a particular factor, shows there is a single factor in the data.

Designing Carry Trade Strategies

The currency carry trade is designed to exploit the failure of UIP and consists of borrowing in a low interest rate currency and lending in a high interest rate currency.

$$X_t = \begin{cases} > 0 & if\ I_t < I_t^* \\ < 0 & if\ I_t > I_t^* \end{cases} \tag{18}$$

Ignoring the transaction costs, the payoff to the carry trade in domestic currency is:

$$X_t \left[E_t(1 + I_t^*) \frac{1}{E_{t+1}} - (1 + I_t) \right] \tag{19}$$

The variable E_t denotes the spot exchange rate, expressed as domestic currency per foreign currency unit, and X_t is the amount of domestic currency borrowed. The variables, I_t and I_t^*, represent the domestic and foreign interest rate, respectively. Thus, the return of an investment in the foreign currency financed by the domestic currency consists of both interest rate differentials between the two countries and the changes in the exchange rate. The logarithm of nominal exchange rate (units of foreign currency per domestic currency) is denoted by e_t, interest rate by i_t and foreign interest rate by i_t^*. The return of an investment in the foreign currency financed by borrowing in the domestic currency is denoted by:

$$x_{t+1} = i_t^* - i_t + \Delta e_{t+1} \tag{20}$$

$\Delta e_{t+1} = e_{t+1} - e_t$ is the appreciation of the foreign currency (e.g., Δe is the change in yen exchange rate). Equation (20) is the excess return that is gained from carry trading when UIP is violated. If UIP holds, this excess return will not be forecasted and $E_t(x_{t+1}) = 0$. Therefore, x can be considered as an abnormal return to the carry trade strategy where foreign currency is the investment currency and Japanese Yen, Swiss Franc and US Dollars are the funding currency. In this paper, a carry trade is defined as a binary trading strategy that is based on expected returns. There is a trade between the funding currency country and the target currency country if the interest rate differential between the target country and funding country is positive and the expected return is positive as predicted by the model. The execution of carry trade is denoted by $\hat{b}_{i,t} = 1$:

$$\hat{b}_{i,t} = \begin{cases} 1 & if\ i_{i,t}^* - i_{i,t} + E_t(\Delta e_{i,t+1}) > 0 \\ 0 & otherwise \end{cases} \tag{21}$$

Consider the case where e_t follows a random walk:

$$E_t(\Delta e_{t+1}) = 0 \tag{22}$$

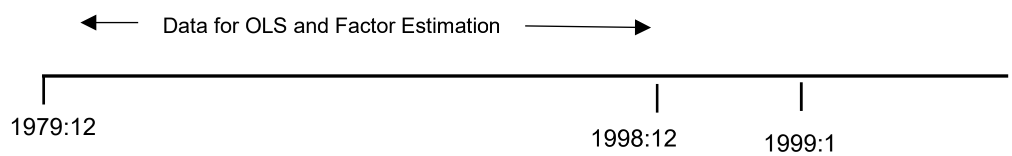
Under the random walk model, the carry trade, in its simplest form, depends solely on the interest rate differentials. This carry trade is called "naive" since it is unrelated to fundamentals other than the interest rate. For one unit of borrowed investment currency, the returns for the different specifications of a carry trade are computed with the realized exchange rates:

$$x_{i,t} = \begin{cases} i^*_{i,t} - i_{i,t} + \Delta e_{i,t+1} & if\ \hat{b}_{i,t} = 1 \\ 0 & if\ \hat{b}_{i,t} = 0 \end{cases} \tag{23}$$

x_t is the return from binary trading strategy at period t.

Forecasting and Statistical Evaluation of Carry Trades

The out-of-sample performance starts in January 1999, when the Euro became official. First, the non-linear unobservable factor and factor loadings are estimated. After obtaining the sequence of factors and factor loadings, the coefficients of the models, which include the factor as an explanatory variable, using the OLS method to forecast exchange rates for that month are estimated. As depicted in (24), the data from 1979:12 through 1998:12 to estimate factors and factor loadings and construct $\hat{F}_{i,t} = \hat{\lambda}_i \hat{f}_t$ for all cross currencies.



(24)

The forecasting equation is combining both the macro fundamentals and the estimated factors in a single equation,

$$\hat{e}_{i,t+1} - \hat{e}_{i,t} = E_t\left(\beta_i + \beta_F \hat{F}_t + z_{i,t}\right) \qquad t = 1999{:}1, \dots \dots \dots, 2014{:}12 \tag{25}$$

$z_{i,t}$ is the different specification of the macro fundamentals. The out of sample forecast is done by estimating each equation by OLS in a rolling regression framework. Each model is initially estimated using the first 229 data points to generate the one-period-ahead forecast. Then the first data point is dropped, an additional data point is added at the end of sample and the model is re-estimated. A one month ahead forecast is generated at each step. The out of sample forecast is then used to determine the value of b_t, the binary decision making function of the carry trade at time t. With JPY and CHF as the funding currencies, this process is performed for each of the six nations, whereas when using USD, it is performed for each of 5 nations. 192 months of trade decisions are computed from 1999:1 to 2014:12. The out of sample period includes the 2008-2009 financial crises, in which several crash episodes took place, providing a realistic assessment of the crash episode returns at that time.

Performance statistics of the carry trade returns include the *Mean Return*, *Standard Deviation*, *Sharpe Ratio*, *Return Skewness*, *Return Kurtosis* and *Maximum Drawdown* of returns from the period 1999:1 to 2014:12. The performance statistics are based on an equally weighted portfolio of 6 currencies against the JPY and the CHF, 5 currencies against the USD. One of the popular methods of summarizing the properties of a return of an asset or an investment is *Sharpe Ratio*. It is calculated as a ratio of returns normalized by the standard error. The Sharpe Ratio is good for evaluating how well the return of an asset compensates the investor for the risk taken. A portfolio or a return may have higher mean returns than its peers, however, it is better when it does not have additional risk. Therefore, the greater the Sharpe Ratio, the better its risk adjusted performance is.

In this paper, *Return Skewness* and *Kurtosis* are used as measures of the risk of large amount of losses. Skewness is a measure of degree of asymmetry of a distribution while Kurtosis measures the height and sharpness of the peak. A negative Skewness implies that the left hand side tail of the probability density function is longer than the right hand side tail, and the mass of values lies to the left of the mean of the distribution. A large positive number for the Kurtosis shows a higher and sharper peak. The exchange rate movements are not symmetric when they go up and down. This asymmetry of exchange rate movement is associated with a crash risk. Brunnermeier (2008) claim that the movements of exchange rates between high yield and low yield currencies are negatively skewed and, therefore, are subject to crash risk. Consequently, in this paper, we used Skewness to show the risk of large losses by carry traders in case of market crashes and Kurtosis to show that whether these changes are abrupt or not. Large negative Skewness implies that there is higher probability of these large losses, while positive big Kurtosis shows that these changes are fast. The *Maximum Drawdown* is also an important performance statistic for the risk of a portfolio. It measures the largest single drop from the peak to bottom before a new peak is reached. Therefore, the Maximum Drawdown measures the largest possible loss since the beginning of the portfolio. Large Maximum Drawdowns indicate higher risk.

RESULTS AND DISCUSSION

Summary Statistics

Some basic statistics for the sample from 1972 to 2014 are presented in Table 1. The basic statistics indicate that since the standard deviations are high, all variables are volatile. Target currencies on average have higher interest rates than funding currencies (note that the interest rate differential is defined as the difference between the target currency country and the funding currency country) which indicates that there is a profit opportunity in borrowing from the funding currency and investing into the target currency. However, due to depreciation of the funding currency over the sample period, which does not fully offset the interest rate differential in most cases, the gain (the sum of interest rate differentials and change in exchange rate in Table 1) from carry trade is positive, but less than interest rate differentials. For instance, the Australian Dollar, a typical investing currency, has a sizeable interest rate differential, which is not offset by the appreciation of funding currency.

Table 1: Summary Statistics

	AUSTRALIA	CANADA	EUROPEAN UNION	UNITED KINGDOM	NEW ZEALAND	UNITED STATES
Panel A: Funding Currency Is Japanese Yen						
Δe	-0.003	-0.002	0.001	-0.003	-0.003	-0.002
	(0.033)	(0.030)	(0.038)	(0.029)	(0.032)	(0.027)
$i^* - i$	0.007	0.005	0.004	0.005	0.008	0.005
	(0.003)	(0.004)	(0.002)	(0.004)	(0.004)	(0.003)
Panel B: Funding Currency Is Swiss Franc						
Δe	-0.003	-0.002	0.001	-0.003	-0.003	-0.002
	(0.033)	(0.030)	(0.038)	(0.029)	(0.032)	(0.027)
$i^* - i$	0.007	0.005	0.004	0.005	0.008	0.005
	(0.003)	(0.004)	(0.002)	(0.004)	(0.004)	(0.003)
Panel C: Funding Currency Is Us Dollar						
Δe	-0.003	-0.002	0.001	-0.003	-0.003	-0.002
	(0.033)	(0.030)	(0.038)	(0.029)	(0.032)	(0.027)
$i^* - i$	0.007	0.005	0.004	0.005	0.008	0.005
	(0.003)	(0.004)	(0.002)	(0.004)	(0.004)	(0.003)

This table shows summary statistics of depreciation of funding currency, interest differentials between target and funding currency country. The numbers in the parenthesis are the standard deviations. An asterisk indicates values for the target currency. Δe is the percentage change in the exchange rate (An increase in the exchange rate implies depreciation of the funding currency). The interest rate is money market rate. The interest rate data of New Zealand is available from 1973:12 to 2014:12, Canada 1975:01 to 2014: 12.

Table 1 shows that there is a positive correlation between average interest rate differentials and average excess returns, which points to the violation of UIP in the data. The currencies with the average positive interest rate differentials against the funding currencies have positive average excess returns and the currencies with average negative interest differentials have negative average excess returns. For instance, an investor making a carry trade in investing in Australian Dollar financed by borrowing Japanese Yen during the sample period would have earned the sum of the average interest rate differential and the change in exchange rate, which is 4 percent annually.

Empirical Results of Markov Switching Dynamic Factor Model

The monthly exchange rate and interest rate data are used to calculate risk premium. The inferred probabilities, parameter estimates and factor loadings are estimated from the switching dynamic factor. The estimates obtained through numerical maximization of the conditional log likelihood function are presented in Table 2. There is significantly positive growth in state 1 and significantly negative growth in state 2 for all currency returns. The asymmetries in the phases of the states are well defined by the switching dynamic factor. The probability of staying in expansion, p, is higher than the probability of staying in contraction, q. The estimated transition probabilities for the expansion state are highly significant and persistent for the Japanese Yen and the US Dollar. For Franc trades, the expansion state is not as persistent as the other currency trades, $p = 0.84$.

Table 2: Approximate Maximum Likelihood Estimates of the Model

		JAPAN	SWITZERLAND	USA
LIKELIHOOD VALUE		**-716.53**	**-869.47**	**-1068.71**
Parameter Estimates of Markov-Switching Dynamic Factor	p (State 1=Expand)	0.96***	0.84***	0.95***
		(0.02)	(0.04)	(0.03)
	q (State 2=Contract)	0.43***	0.64***	0.79***
		(0.12)	(0.14)	(0.12)
	μ_0(State 1 Mean)	-2.64***	-1.14**	-1.16**
		(0.40)	(0.30)	(0.37)
	μ_1(State 2 Mean)	2.82***	1.66***	1.46***
		(0.37)	(0.34)	(0.34)
Factor Loadings	$\lambda_{Australia}$	0.66***	0.62***	0.71***
		(0.04)	(0.04)	(0.05)
	λ_{Canada}	0.78***	0.76***	0.52***
		(0.04)	(0.05)	(0.05)
	$\lambda_{United\ Kingdom}$	0.34***	0.18***	0.35***
		(0.04)	(0.04)	(0.05)
	$\lambda_{European\ Union}$	0.58***	0.48***	0.41***
		(0.04)	(0.04)	(0.05)
	$\lambda_{New\ Zealand}$	0.63***	0.57***	0.70***
		(0.04)	(0.04)	(0.05)
	$\lambda_{United\ States}$	0.72***	0.70***	-
		(0.04)	(0.05)	

This table shows inferred probabilities, parameter estimates and factor loadings that are estimated from the switching dynamic factor. The estimates obtained through numerical maximization of the conditional log likelihood function. The sample period is 1979:12 to 2014:12. Japanese Yen is the funding currency in the first column. The standard errors are given in the parenthesis.

With respect to the factor loadings of the Yen carry trade; the Canadian and the US Dollar excess returns have the highest coefficients, supporting the observation that they are the most sensitive returns to expansions and contractions. Overall, all factor loadings are highly significant, implying the risk premium for all currencies is highly sensitive to the regime switches in the economy. The same results are true for the Franc and the US Dollar trades. The US and the Canadian Dollar have the highest significant factor loadings for the Franc carry trade returns. The New Zealand Dollar has the highest parameter estimates for the US Dollar trade returns, and all of the excess returns are significantly affected by the state of the economy. The Markov Switching Dynamic Factor Model for the risk premium is very useful in several aspects. First, there is a significant unobservable component that is derived from the excess returns of carry trading and this unobservable component's conditional mean changes depending on the contractions and expansions of the economy for all currency pairs. This result implies that the currency risk premium is sensitive to regime switches in the economy. Besides, the expansion state is persistent for both Yen and Dollar returns, indicating that if the economy is in a state of expansion, the duration of that expansion is long.

Performance Statistics of the Carry Trade Returns

The carry trades are constructed with the target currency countries that have higher interest rate differentials on average than the funding currency country. There are six individual carry trades with the Yen and the Franc and five individual trades with the Dollar. In practice an investor can apply the carry trade strategy either to individual currencies or to portfolios of currencies. Burnside (2011) claims that the risk in carry trade strategies is reduced by diversifying the carry trade across different currencies. In this section, the perspective of an individual currency trader is taken into account, and whether this trader gains more by diversifying a carry trade across different currencies or not is examined. Equally weighted carry trade strategies are constructed where the Yen, Franc and Dollar positions are given equal weight at each point in time to all the currencies for which b_t is not equal to zero. Table 3 reports performance statistics of carry trade returns for all currencies. They are based on one period ahead forecast of exchange rates with rolling window samples beginning in January 1999 to December 2014. The out of sample forecasts include the financial crisis of 2008-2009 where crash episodes took place, so that forecasting analysis provides a realistic assessment of the type of returns that could have made at that time.

Table 3: Performance of Carry Trade Returns

	Naive (Random Walk)	Momentum	VECM	Taylor Rule	VECM Factor Aug.	Taylor Rule Factor Aug.	VECM MS-Factor Aug.	Taylor Rule MS-Factor Aug.
	Model 1	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**	**Model 7**	**Model 8**
Panel A: Funding Currency Is Japanese Yen								
Mean	0.04	0.05	0.02	0.04	0.05	0.03	0.05	0.03
SE	0.09	0.06	0.06	0.07	0.06	0.07	0.06	0.07
SR	0.41	1.00	0.38	0.53	0.91	0.51	0.91	0.41
Skew.	-0.15	0.68	0.40	-0.61	0.65	-0.65	0.65	-0.48
Kurtosis	5.29	4.14	3.28	4.32	3.43	4.52	3.48	4.49
Max D.	0.34	0.07	0.19	0.24	0.14	0.23	0.13	0.23
Panel B: Funding Currency Is Swiss Franc								
Mean	0.02	0.02	0.01	0.02	0.03	0.02	0.03	0.01
SE	0.07	0.04	0.05	0.05	0.05	0.05	0.05	0.04
SR	0.26	0.52	0.29	0.48	0.59	0.49	0.56	0.33
Skew.	-1.44	-0.60	2.74	3.26	2.53	2.62	2.72	-0.41
Kurtosis	11.3	1.93	24.7	29.4	20.9	23.5	23.4	1.26
Max D.	0.26	0.13	0.12	0.10	0.10	0.11	0.12	0.11
Panel C: Funding Currency Is Us Dollar								
Mean	0.03	0.05	0.04	0.03	0.04	0.04	0.05	0.05
SE	0.07	0.06	0.06	0.06	0.06	0.05	0.06	0.07
SR	0.43	0.82	0.60	0.48	0.77	0.78	0.83	0.72
Skew.	-0.97	1.74	1.86	-0.66	0.29	0.23	1.89	0.08
Kurtosis	5.22	11.7	12.4	3.36	1.03	1.59	11.6	2.01
Max D.	0.28	0.11	0.12	0.23	0.11	0.10	0.10	0.12

This table reports performance statistics of carry trade returns for all currencies sample period is from 1999:01 to 2014:12. The total number of observations is 192. The Sharpe Ratio is the mean returns divided by standard deviations. All returns are annualized. Equally weighted portfolio is calculated as giving equal weight to each currency trade in time (Funding currencies are: The Australian Dollar, Canadian Dollar, UK Pound, Norwegian Krone, New Zealand Dollar, US Dollar for Panel A and B). Mean is mean return, SE is standard errors, SR is Sharpe Ratio, Skew. is skewness, Max D. is maximum drawdown.

The results are based on an equally weighted portfolio of the six currencies against the Japanese Yen and the Swiss Franc and five currencies against the US Dollar. Performance statistics include the annualized return, Sharpe Ratio, return skewness, kurtosis and maximum drawdown. All carry trading strategies have positive mean returns ranging from 1 % to 6 % annually. The mean return is low in Franc trades compare to Yen and Dollar trades. Models with both factor augmented and dynamic factor augmented PPP (VECM) fundamentals perform better than benchmark models of naive and momentum for Franc trades, and perform as good as benchmark model of momentum for Dollar trades. Factor augmented VECM performs as good as momentum model and better than most of other models, but much better than the naive trading strategy for Yen trades. The Sharpe ratios of carry trade strategies are usually low, since, although the mean excess returns for carry trade strategies are moderate, the volatility for those returns is high. It is clear that carry trade strategies with benchmark model of momentum strategy has larger Sharpe ratio than other models in the simulation, implying carry trades with those models are more profitable on average than the other models in Yen trades. MS-factor augmented VECM model slightly better than momentum strategy in terms of Sharpe ratio for Dollar trades whereas, factor augmented VECM model is slightly better than momentum strategy in terms of Sharpe ratio for Franc trades.

While the Sharpe ratio suggests whether the carry trade strategies have low or high risk return profiles, it does not account for either the crash risk or downside risk. The maximum drawdown measures the largest possible loss, whereas skewness measures the possibility of large losses or gains during market crashes. From Table 3, for the naive model, all currency carry trade returns have negative skewness, high kurtosis and high maximum drawdown, which means that carry trade returns with all currencies have a crash risk and large losses in carry trades based on solely on interest rate differentials will be fast. The results for all currency trade show that the negative skewness is improved when traders use both factor augmented and MS- Factor augmented VECM models in exchange rate forecasting. Table 3 (Panel A) reports that naive Yen carry trade has a skewness of -0.15. Linear and non-linear factor augmented VECM models improve the skewness of the returns. For Dollar carry trades, Table 3 Panel C, the return skewness in the naive model becomes a positive number with MS-factor augmented VECM model (Model 6) as with all other factor augmented macro fundamental models. The payoffs of random walk model in Swiss Franc trades have a significant probability of large losses in a case of market crash with a negative skewness of -1.44. Carry trade returns are positively skewed in all factor augmented macro fundamentals models except Taylor Rule model in Franc trades.

The naive model for all currency carry trades have a maximum drawdown ranging from 26 % to 34 %. The reason for such a large downside risk is simple: There are several episodes of target currency collapses during the simulation period. Every crash in a target currency against the funding currency significantly increases the downside risk in the carry trade. Factor augmented macro fundamental models impressively reduce the downside risk. In Franc and Dollar trades, maximum drawdown is reduced to 10 % (Model 5 and Model 7 respectively). In Yen trades similar improvement in the downside risk can be seen with factor augmented VECM models (Model 5 and Model 7); maximum drawdown decreased to 13 %.

CONCLUSION

This paper provides evidence of enhancing carry trade returns when factor augmented macro fundamentals are used as a trading strategy with an equally-weighted portfolio of individual currency trades. The factor is derived from the excess returns of currency trading and subject to regimes switching. Alternative carry trading strategies with factor augmented macro-fundamentals document that these alternative macro-fundamental trading strategies are better than a naive strategy and they perform as good as momentum strategy. Moreover, factor augmented VECM model performs the best than the benchmark model of the random walk and momentum strategy in terms of mean returns, downside risk and risk adjusted returns for Franc trades. The crash risk of carry trades that is inherit in benchmark model of random walk is reduced, and the negative skewness is improved to a positive level in Dollar carry trades with factor augmented macro fundamental models. However, this paper does not find evidence of superiority of nonlinear factor augmented models over linear factor augmented models. Regime switching factor augmented macro fundamental models perform as good as factor augmented macro fundamental models in most cases. Besides, factor augmented macro fundamentals do not beat the benchmark model of Momentum strategy in most cases. Momentum strategy performs the best in Yen trades, performs as good as factor augmented macro fundamentals in Dollar trades.

Overall, my results are consistent with the view that returns to carry trade have high mean returns and low Sharpe Ratios with a possibility of crash risk. This crash risk is reduced when models with factor augmented macro fundamentals are used as trading strategies throughout the sample period. As well, there is profitable carry trading when PPP (VECM) fundamentals are used in both linear and nonlinear factor augmented framework for Franc trades. This could be the outcome of the predictive power of macro fundamentals in exchange rate movements and the inclusion of an estimated factor derived from risk premium into the forecasting equation of exchange rates. Finally, the result that trading strategies with factor augmented macro fundamentals have better performance in mean and risk adjusted returns would be helpful to the practitioner, since these trading strategies are more profitable than naive carry trade strategy.

This study is limited in several ways. First, emerging markets carry trades are not included in this study. The currencies of the lower-interest countries have been invested in emerging markets in order to benefit high interest differentials between funding currency and emerging country currency, especially after financial crisis of 2008-2009 when the interest rates hit the zero lower bound in the US. A second limitation is the exclusion of transaction cost in the analysis. Some studies use a 10 basis point round-trip transaction cost for trading in currency markets. However, assuming a constant rate of 10 basis point round-trip transaction cost for trading may not be accurate for all currencies. In a future study, I plan to address these issues by measuring transaction costs of currency trading with bid ask spreads, and examining performance of carry trade strategies in emerging market economies.

APPENDIX

Appendix A: State Space Representation of Empirical Model

Measurement Equation:

$$\overset{Y_t}{\begin{vmatrix} Y_{1t} \\ Y_{2t} \\ Y_{3t} \\ Y_{4t} \\ Y_{5t} \\ Y_{6t} \end{vmatrix}} = \overset{H}{\begin{vmatrix} \lambda_1 & 1 & 0 & 0 & 0 & 0 & 0 \\ \lambda_2 & 0 & 1 & 0 & 0 & 0 & 0 \\ \lambda_3 & 0 & 0 & 1 & 0 & 0 & 0 \\ \lambda_4 & 0 & 0 & 0 & 1 & 0 & 0 \\ \lambda_5 & 0 & 0 & 0 & 0 & 1 & 0 \\ \lambda_6 & 0 & 0 & 0 & 0 & 0 & 1 \end{vmatrix}} * \overset{B_t}{\begin{vmatrix} F_t \\ \varepsilon_{1t} \\ \varepsilon_{2t} \\ \varepsilon_{3t} \\ \varepsilon_{4t} \\ \varepsilon_{5t} \\ \varepsilon_{6t} \end{vmatrix}} \quad \text{(A.1)}$$

Transition Equation:

$$
\begin{array}{ccccccccc}
B_t & & \alpha_{st} & & Z * B_{t-1} & & & & u_t \\
\left|\begin{matrix} F_t \\ \varepsilon_{1t} \\ \varepsilon_{2t} \\ \varepsilon_{3t} \\ \varepsilon_{4t} \\ \varepsilon_{5t} \\ \varepsilon_{6t} \end{matrix}\right| & = &
\left|\begin{matrix} \alpha_{1t} S_t + \alpha_{2t} \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{matrix}\right| & + &
\left|\begin{matrix} 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & \gamma_1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & \gamma_2 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & \gamma_3 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & \gamma_4 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & \gamma_5 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & \gamma_6 \end{matrix}\right| & * &
\left|\begin{matrix} F_{t-1} \\ \varepsilon_{1t-1} \\ \varepsilon_{2t-1} \\ \varepsilon_{3t-1} \\ \varepsilon_{4t-1} \\ \varepsilon_{5t-1} \\ \varepsilon_{6t-1} \end{matrix}\right| & + &
\left|\begin{matrix} v_t \\ \omega_{2t} \\ \omega_{3t} \\ \omega_{4t} \\ \omega_{5t} \\ \omega_{6t} \\ \omega_{6t} \end{matrix}\right|
\end{array}
\qquad \text{(A.2)}
$$

Different specifications for each funding currencies are examined. Best model for all currencies is a common factor as a regime switching mean with an autoregressive idiosyncratic term. Thus, the AR (1) parameter of the model is zero:

$$F_t = \mu_{st} + v_t \qquad \text{(A.3)}$$

Although equation A.3 is a tight assumption, restricting the AR parameter of the common factor, it decreases the likelihood value making the transition probabilities highly significant. The likelihood ratio test is used to test whether there is a difference between the restricted and unrestricted model. The test results favors for no difference. In vector notation, the measurement and transition equation will be written as:

$$Y_t = HB_t + \epsilon_t \qquad \text{(A.4)}$$

$$B_t = \alpha_{st} + ZB_{t-1} + u_t \qquad \text{(A.5)}$$

$$\begin{pmatrix} \omega_t \\ u_t \end{pmatrix} \sim N\left(0,\ \begin{pmatrix} R_t & 0 \\ 0 & Q_t \end{pmatrix}\right) \qquad \text{(A.6)}$$

Appendix B: The Algorithm for Estimating the MS-Dynamic Factor

The filter for the state space model with Markov switching in the Appendix A is the combination of the Kalman Filter and the Hamilton Filter with appropriate approximations. Given the state space representation by the equations A.3 and A.4, the Markov switching dynamic factor is estimated by following these steps:

Run the Kalman Filter:

$$\beta_{t|t-1}^{(i,j)} = \alpha_j + Z_j \beta_{t-1|t-1}^{i} \qquad \text{(B.1)}$$
$$P_{t|t-1}^{(i,j)} = Z_j P_{t-1|t-1}^{i} Z_j' + Q \qquad \text{(B.2)}$$
$$\eta_{t|t-1}^{(i,j)} = Y_t - H_j \beta_{t|t-1}^{i} \qquad \text{(B.3)}$$
$$f_{t|t-1}^{(i,j)} = H_j P_{t|t-1}^{i} H_j' + R \qquad \text{(B.4)}$$
$$\beta_{t|t}^{(i,j)} = \beta_{t|t-1}^{(i,j)} + P_{t|t-1}^{(i,j)} H_j' \left[f_{t|t-1}^{(i,j)}\right]^{-1} \eta_{t|t-1}^{(i,j)} \qquad \text{(B.5)}$$
$$P_{t|t}^{(i,j)} = (I - P_{t|t-1}^{(i,j)} H_j' \left[f_{t|t-1}^{(i,j)}\right]^{-1} H_j) \eta_{t|t-1}^{(i,j)} \qquad \text{(B.6)}$$

where $\beta_{t-1|t-1}^{i}$ is an inference on β_{t-1} up to time $t-1$, given $S_{t-1} = i$; $\beta_{t|t-1}^{(i,j)}$ is an inference on β_t up to time $t-1$, given $S_t = j$ and $S_{t-1} = i$; $P_{t|t-1}^{(i,j)}$ is the mean square error matrix of $\beta_{t|t-1}^{(i,j)}$ conditional on $S_t =$

j and $S_{t-1} = i$; $\eta_{t|t-1}^{(i,j)}$ is the conditional forecast error of Y_t based on information up to time $t-1$, given $S_t = j$ and $S_{t-1} = i$ and $f_{t|t-1}^{(i,j)}$ is the conditional variance of forecast error $\eta_{t|t-1}^{(i,j)}$.

2. Run the Hamilton Filter and calculate $\Pr[S_t, S_{t-1}|\psi_t]$ and $\Pr[S_t|\psi_t]$, given that ψ_t denote the vector of observations available as of time t.

3. Approximations: Using the probability terms in step 2, collapse GXG posteriors in equations B.5 and B.5 into $GX1$ using the following equations:

$$\beta_{t|t}^{(j)} = \frac{\sum_{i=1}^{G} \Pr[S_{t-1}=i, S_t=j|\psi_t]\beta_{t|t}^{(i,j)}}{\Pr[S_t=i|\psi_t]} \tag{B.7}$$

$$P_{t|t}^{j} = \frac{\sum_{i=1}^{G} \Pr[S_{t-1}=i, S_t=j|\psi_t][P_{t|t}^{i,j} + \left(\beta_{t|t}^{j} - \beta_{t|t}^{(i,j)}\right)\left(\beta_{t|t}^{j} - \beta_{t|t}^{(i,j)}\right)']}{\Pr[S_t=i|\psi_t]} \tag{B.8}$$

The conditional mean and the conditional variance of the AR (1) process is used as the initial values to start the Kalman Filter. For the Hamilton Filter, the steady state probabilities are used as initial values for the state probabilities. The parameters and probabilities are estimated by the approximate likelihood function:

$$LL = \ln[f(Y_1, Y_2, \dots, Y_T)] = \sum_{t=1}^{T} \ln[f(Y_t|\psi_{t-1})] \tag{B.9}$$

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U.S. CORPORATE PENSION EXPENSE AND THE 2007-2009 FINANCIAL CRISIS: AN INTERRUPTED TIME SERIES ANALYSIS

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ABSTRACT

This research presents a model for predicting corporate pension expenses. By considering changes in financial statement variables that included operating profit margin, working capital levels, and cash levels the model explored directional impact on the dependent variable, pension expenses. Change was measured between 2004 and 2013 using the Kellough interrupted time series analysis to capture the effect of the 2007-2009 financial crisis. The analysis found that operating profit margin has a positive impact on pension expense levels, while higher levels of net working capital and cash have an inverse association. In finding the change variable of the interrupted time series event to have a positive sign, the analysis expands prior research in offering evidence that firms might not use pension expenses as a tool for earnings manipulation. Rather, firms appear to increase pension expense funding as a financial shock occurs but reduce during improving financial and economic conditions.

JEL: C22, G23

KEYWORDS: Pension Expense, Financial Crisis, Time Series

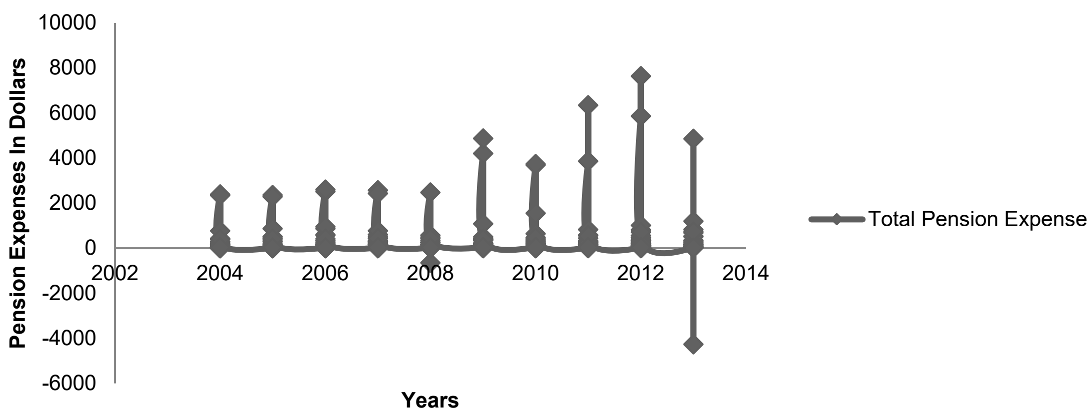
INTRODUCTION

Pension benefits are continuing a transformation in corporate America as firms increasingly adopt defined contribution plans rather than defined benefit or pension plans (Huberman, Iyengar, & Jiang, 2007). In general, pension plan sponsors are concerned with two primary financial issues: Pension Funding and Pension Accounting. Pension funding is the cash contributions made to the pension plan. Laws described in the Internal Revenue Code (IRC), which determines the annual minimum required contribution and annual maximum tax-deductible contribution, govern pension funding. Pension accounting is the annual pension expense calculation and disclosure of a pension plan's assets and liabilities in a company's financial statement. The Financial Accounting Standards Board (FASB) governs pension accounting under generally accepted accounting principles (GAAP) in the U.S. Amounts calculated under pension funding rules are completely different from those calculated for pension accounting (American Academy of Actuaries, 2004). The financial crisis of 2007-2009 was perhaps the most important economic event since the Great Depression, but the gap between crises of this magnitude means we must look towards long historical time series to gain perspective on patterns of global crises. The financial crisis began in early August of 2007 with runs in several short-term markets formerly considered "safe".

The run on money market mutual funds and the resulting turmoil played an important role in transmitting the crisis to the other sectors and internationally (Gorton & Metrick, 2012). Defined benefit pension plans transmit shocks to the rest of the economy through the balance sheet of the sponsor. Accounting standards based on market valuation principles generate volatility in sponsor's balance sheet and income statements

(Impavido & Tower, 2009). Evidence suggests the negative impact of pension plans on corporate financial health has become a reality for many companies, as evidenced by the pension's impact on profitability, cash flows and even credit ratings. The results from this analysis show that these effects are mixed: financial shock is a valid predictor of pension funding, but increases in funding raises questions of a proactive manager increasing funding before earnings suffer. From a financial perspective, pension plans have become a material liability for many sponsors as indicated in Figure 1. From a business standpoint, defined benefit plans are affecting key strategic decisions, such as mergers and acquisitions, competitive positioning and capital expenditures, with the strain on finances limiting many companies' ability to invest in new initiatives and to manage outstanding financial arrangements. Operationally, many financial executives spend a considerable amount of time on pension plans – distracting them from other business initiatives. Four major factors have led to the pension management issues plan sponsors are facing today: pension financing remains volatile; pension costs continue to increase; accountability is unclear; and corporate strategies are unmet. (Morris, 2005).

Figure 1: Total Pension Expense Trends 2004 – 2013



The trend in pension expenses (see Figure 1) for the sample of firms in this analysis, 2004-2013, finds that expenses are increasing overall with a jump in 2009 and more volatility in 2013. From 2004 to 2008, pension expenses were relatively stable. These data are in nominal terms.

Existing literature explores corporate investment decisions surrounding funding of defined benefit plans (Webb, 2007), the relationship between pension expenses and capital structure (Shivdasani & Stefanescu, 2010), and optimal corporate pension strategies that consider the effects of insurance and taxes in the presence of capital market imperfections (Bicksler & Chen, 1985). This analysis contends, however, that such corporate decisions ebb and flow over time. Financial shock, such as the Great Recession, upsets the basis and outcome of the decisions that are evident through financial statement ratios. Financial accounting standards that identify cash flows and financial statement ratios offer insight into liquidity and cash management, especially in light of dire financial and economic conditions. Influence on pension expenses – before, during, and after the financial crisis – are considered in measuring the use of current assets and liquidity and the directional impact of such relationship. Research analysis extends from these assumptions. We contend that prior studies have inadequately addressed the use of cash relative to pension funding, especially in an environment with financial and economic shock present. The research questions are as follows: 1) To what extent do financial statement ratios of current account management explain pension funding? 2) Do financial and economic conditions affect pension funding over time?

LITERATURE REVIEW

Constraints of accounting and tax rules affect the implementation of a firm's pension funding policy. The intent of the generally accepted accounting principles (GAAP) calculation is to account for current and past service costs and adjust for changes in actuarial assumptions. However, the Financial Accounting Standards Board (FASB) smoothing mechanisms, the GAAP requirement to accrue interest on discounted liabilities, and differences in actuarial assumptions will cause large differences between the net periodic pension cost (NPPC) calculation and the tax calculation. Most companies only report two accounts in the financial statements: NPPC and an intangible asset or liability. The intangible records the difference between the NPPC and plan contributions.

If, at year-end, plan contributions are more than accumulated NPPC, the balance sheet will report an asset that reflects prepaid pension costs; otherwise, it will show an accrued pension liability. GAAP requires extensive disclosure in the pension footnote (Klamm & Spindle, 2006). When implementing GAAP rules, companies frequently have two objectives: reduce expense to maximize income, and maintain a constant expense to provide income stability (Canan, 1997). Over the past decade, a large number of employers have made changes to their retirement plans. The motivations for change are varied, but cost reduction is a primary reason. The recent economic crisis has strained defined benefit (DB) plans and made cost a pressing issue for both active and closed DB sponsors. Increased levels of health care costs are also spurring budget cuts. Some companies have frozen or closed their DB plans to all or newly hired employees or switched to a hybrid DB plan which is a more portable account-based plan. The shift from DB to defined contribution (DC) only plans has been a trend that started to escalate in 2004. At the end of 2004, 73 *Fortune* 100 companies offered either a traditional or a hybrid DB plan. In 2013, only 30 *Fortune* 100 companies offered a DB plan to new salaried hires. Almost 10% of companies have made no changes to their plans since 1998 (McFarland, 2013).

Recent trends have been toward DC plans as opposed to DB. In fact, defined benefits in the private sector have been vanishing since the collapse of the dot-com bubble at the turn of the century when healthy companies began closing their defined benefit plans. The 2008 financial collapse provided another push in the shift to defined contribution plans. The pressures created by the financial markets reinforce other explanations offered to explain the shift. These include a desire to cut compensation, growing health care costs, concerns about costs and risks of DB plans, and the evolution of a two-tiered pension system with defined contribution plans for rank-and-file employees and defined benefit plans for upper management (Munnell, 2011). The cost of the financial crisis is immense. One number is sufficient to indicate the scale of the costs in the United States: The crisis is responsible for reducing employment by eight million jobs and perhaps more depending on exactly when the recovery begins. Large banks that get into financial trouble not only affect shareholders and employees, but also firms and employment across the country and around the world (Poole, 2010). The chaos in the global financial markets within the financial crisis badly affected pension plan funding, with most of the damage occurring in the last quarter of 2008. The crisis reduced U.S. firms' balance sheet strength, leading to consequences for several areas of the business, including capital expenditure decisions, loan covenants and credit rating decisions (Global Investor, 2014). The decrease in funding ratios will cause pension expenses to increase in future years when sponsors face borrowing constraints. As of October 2008 estimated pension expenses among the S&P 500 constituents averaged US$35 billion for 2009 after a fall in the index of 20% from the peak. However, the S&P 500 index has since fallen another 35% implying a significantly higher amount of expensing will be necessary to catch up (Impavido & Tower, 2009).

By looking at the cumulative effects of all pension rate assumptions on pension expense and focusing directly on pension expense as a whole, Parker and Sale (2007) extends prior research. Rationale is provided that pension expense is likely the earnings management lever of choice as it allows managers to manipulate earnings directionally as needed without easily being detected by interested outside parties while remaining transparent and representative of actual financial position (Parker, Swanson, & Dugan, 2011). Pension accounting is complicated; the principles governing cost determination are complex, and the required disclosures are confusing enough that even sophisticated market participants have difficulty understanding them. Quarterly pension costs are one of the largest single expense items for firms with pension plans (around 15% of income before extraordinary items in our sample). Under FASB codification ASC 270, net pension costs are recognized when incurred, or as the benefit provided by the expense is realized. Over the period of 2004-2010, there is significant variation in quarterly pension costs firms reported. In addition, income-increasing changes in pension costs are significantly associated with meeting or beating analysts' forecasts in a given quarter. Income-decreasing changes to net periodic pension costs that would cause a firm to miss it earnings forecast are extremely rare. Finally, evidence suggests that income-increasing and income-decreasing changes in quarterly pension costs are "settled up" in the fourth quarter (e.g., they reverse) (Blankley, Comprix, & Hong, 2013).

Results suggest that the current smoothing mechanism tends to induce significant biases in the recognized pension expenses. For a majority of the sample firms, the tendency is to overstate the sponsoring firms' earnings in the long run. Largely, such biases reflect the combination of both ineffective amortization of the deferred gains and losses and questionable latitude in pension rate discretions (Jiang, 2011). The need to properly administer and account for pension funds becomes apparent when considering the size of these funds. For example, in 2004 the pension expense as a percentage of pre-tax income is 52.27% for General Motors Corporation, 14.16% for Hewlett-Packard, 1.96% for Coca-Cola. Financial and operating performance is also measured for these firms. First, average stock returns (AR) are measured to observe if the stocks of the firms in each portfolio have positive or negative returns. Then, cash flows to total assets (CF/TA), net income to total assets (NI/TA), sales to total assets (Sales/TA) and sales to net income (Sales/NI) ratios are calculated at the end of a fiscal year (Castro-Gonzalez, 2012).

There has long been an important disconnect between the financial impact of the pension plan implied by accounting accruals, and the information disclosed in the footnotes. Despite much attention from the accounting profession and Wall Street, results suggest that investors still do not correctly perceive how DB pension plans influence corporate valuation in the U.S. marketplace. As a result, over the past decade, pension accruals embedded in the financial statements have been particularly poor stand-ins for pension value. Indeed, pension accruals are potentially worse than noise, as there are times when they negatively correlate with the value of pension assets (Coronado, Mitchell, Sharpe, & Nesbitt, 2008). Earnings before interest and taxes (EBIT) reflect the pension cost (or income) recorded on the income statement, but this expense differs from the pension contribution, which is the tax-deductible amount. In general, EBIT as reported in the income statement overstates (understates) taxable-income when the pension expense is below (above) the pension contribution (Shivdasani & Stefanescu, 2010).

DATA AND METHODOLOGY

The methodology for this analysis considers selected variables that represent changes in income statement, balance sheet, and statement of cash flow effects and pension expenses. For the model, three scenarios are considered: Earnings Before Interest and Taxes (EBIT) as a percent of net income; Net Working Capital (NWC) as a percent of total assets as a balance sheet variable; and net cash flow as a measure of positive or negative cash flows. The following regression equation was estimated to identify determinants of pension expense funding

$$\text{(PEF): PEF} = \alpha + \beta 1(\text{EBIT/NI}) + \beta 2(\text{NWC/total assets}) + \beta 3(\text{net cash flow}) + \beta(\text{BEFORE}) + \beta(\text{CHANGE}) + \beta(\text{AFTER}) \quad (1)$$

EBIT as a percent of net income is also known as operating margin, a measure of pricing strategy that describes a company's operating efficiency. The higher the operating margin, the more profitable is a company's core business. It is a measure of managerial flexibility and competency, particularly during harsh economic times. A healthy operating margin is required to be able to pay for its fixed costs, such as interest on debt. Working capital to total assets ratio is a liquidity ratio used to analyze the extent of assets tied up in working capital or the amount of assets required to run the day-to-day operations of a company.

Net change in cash is a gauge of the firm's cash flows that may be used to develop new products, buy back stock, pay dividends, reduce debt, or conduct day-to-day business. Revenues and expenses are drivers of net cash flow. Data were collected from OneSource Business Global Browser and compiled for years 2004 to 2013, inclusive, with annual frequency observation of data. The data includes a random selection of 400 firms listed on the S&P 500 stock exchange. This represents 40 firms per year over ten years. Pension expenses represent total pension expenses that include all expenses related to funding and maintaining a defined benefit plan. This analysis utilizes a methodology that is similar to the interrupted time-series analysis model used by Kellough (1990); Netter, Wasserman, and Kutner (1990, pp. 370-375); Miller and Pierce (1997); and Landry, Boozer, and Lowe (2012). As Kellough noted, the limited number of pre and post data points suggests that time-series is preferred to another modeling technique known as autoregressive integrated moving average (ARIMA) that could have otherwise been used as a statistical technique. The interruption in the model for this study is the change in economic conditions at the middle of the 2007-2009 Great Recession. We use 2008 as that fulcrum point. The model examines if economic conditions affect the relationship between pension funding and current asset management, especially to the extent that directional impact changes. An essential component of this measure is the extent that such change occurs concurrently or before or after a change in economic conditions.

Backwards regression was employed for this analysis. This is a variation of stepwise regression that involves adding or deleting variables from a model based on statistical significance of that variable. All variables are initially included in the model and removed as necessary between iterations. Data are entered as cases in a year-by-year format for a total of ten years for each of the 40 firms analyzed: four years before the change in economic conditions; the contemporaneous year of the change in economic conditions; and five years after the change in economic conditions. Each firm is considered independently. Three independent variables are employed. A counter variable is employed that is coded one for the first year of the analysis, two for the second year, and three for the third year, four for the fourth year, etc. This counter variable is called BEFORE. The second independent variable is dichotomous in nature and is coded zero for the five years of analysis before and including the year of the change in economic conditions, and one for observations for the five years immediately after the change year. This variable is called CHANGE. The remaining independent variable is a post-intervention counter that is also coded in the following manner: coded as zero for observations five years prior to and including the contemporaneous year of change of economic conditions, one for first year after change in economic conditions, two for the next year, three for the next year, and so forth. This variable is called AFTER.

The intercept for the multiple regression equation describes the value of the dependent variable at the beginning of the time period. The coefficient, or slope, for the BEFORE variable describes the annual increase or decrease in the dependent variable that was happening before the change in economic conditions. The estimated increase or decrease in those years is unaffected by the counter AFTER variable, as that variable is coded zero for all years prior to the change in economic conditions. The coefficient for CHANGE estimates the one-time increase or decrease in the value of the independent variable that came about in the first year following the change in economic conditions. The coefficient, or slope, of the AFTER variable estimates the increase or decrease in slope that occurred after the change in economic conditions. The coefficient for the counter AFTER variable must be added to the coefficient for BEFORE to get the estimated slope after the change. For the analysis, three interrupted time-series regression analyses were run for pension expenses as the dependent variable. For each analysis, three independent variables – BEFORE, CHANGE, and AFTER – were included. Each of the three iterations also included a fourth independent variable: OPER_INC as a measure of operating income derived from dividing Earnings Before Interest and Taxes (EBIT) by Net Income (NI); WORK_CAP to denote net working as a percentage of total assets (TA); and CASH as a measure of the net change in cash from operations, investment, and financing from prior year to current year. Independent variables are categorized according to counter variables or financial statement variables. Ordinary Least Squares estimates were obtained. Table 1 summarizes each independent variable in the model. Output results are presented in Table 2.

Table 1: Variables Analyzed within the Model

Counter Variables	
BEFORE CHANGE AFTER	Measure of change in financial statement variable before, concurrently, and after change year of financial crisis, respectively.
Financial Statement Variables	
OPER_INC	Operating profit margin
WORK_CAP	Net working capital as a percentage of total assets
CASH	Net change in cash available from prior year

This table presents a description of independent variables used in the analysis. These are listed as counter variables – BEFORE, CHANGE, and AFTER – and financial statement variables – OPER_INC, WORK_CAP, and CASH.

Autocorrelation may be present in a model when serial data is utilized (Miller & Pierce, 1997). The existence of autocorrelation violates a basic assumption of Ordinary Least Squares (OLS) regression. Autocorrelation leads to an underestimation of the variance of the error terms and an overestimation of the significance of the coefficients. The Durbin-Watson statistic is a test statistic used to detect the presence of autocorrelation in the residuals from a regression analysis (Durbin & Watson, 1950) and is used in this study to indicate if autocorrelation is present. If the Durbin-Watson statistic is outside an acceptable range, transformation of the data, through the Cochrane-Orcutt (CORC) estimation procedure, is necessary to take into account the correlation of the error terms (Cochrane & Orcutt, 1949). Panels A, B, and C of Table 2 summarize the multivariate statistical output of the model. For each analysis, all independent variables are included in the regression, with predictor variables removed in finding the best fit for the model.

Operating income (OPER_INC) is a statistically significant predictor of pension expense allocation. The relationship is positive, where Pension Expenses = 34.246 + .261(OPER_INC). With a coefficient of determination of .068, only 6.8% of the variance of the dependent variable is explained by the one independent variable included in the model. BEFORE, CHANGE, and AFTER are excluded from the model using backwards regression. Interestingly, CHANGE is almost significant at the $p < .10$ level of significance and including that variable increases R squared to .074. The variable has a coefficient of .075 and would have a very small impact on the model if included. Durbin-Watson coefficient is in an acceptable range. Panel A of Table 2 summarizes this output.

Table 2: Time-Series Regression Output of Sample Firms

Panel A: Operating Income				
Variable	**Coefficient**	**t-statistic**	**Durbin-Watson**	**R-square**
Pension expenses			2.050	.068
Constant	34.246	.533		
OPER_INC	.261	5.398***		
Panel B: Net Working Capital				
Variable	**Coefficient**	**t-statistic**	**Durbin-Watson**	**R-square**
Pension expenses			2.089	.067
Constant	492.613	5.988***		
WORK_CAP	-.248	-5.098***		
CHANGE	.100	2.051**		
Panel C: Net Change In Cash				
Variable	**Coefficient**	**t-statistic**	**Durbin-Watson**	**R-square**
Pension expenses			2.125	.117
Constant		4.241***		
CASH	-.332	-7.049***		
CHANGE	.080	1.703*		

*This table shows backwards regression output for each independent variable in the model on pension expenses. Each independent variable consists of financial statement variables and counter variables. Panel A shows results for operating income of sample firms. Panel B shows results for net working capital of sample firms. Panel C shows results of net changes in cash of sample firms. In addition to regression output results, a Durbin-Watson statistic measures the extent of autocorrelation and R-square reflects to what extent the variable explains changes in pension expenses. ***, **, and * indicate significance at the one, five, and ten percent levels, respectively.*

Unlike operating income, net working capital (WORK_CAP) has an inverse impact on the dependent variable, pension expenses. The coefficient for WORK_CAP of -.248 shows that for every dollar increase in pension expenses net working capital declines by $0.248. CHANGE is also a statistically significant predictor in the model and has a positive relationship with pension expenses. During the full year associated with the beginning of the financial crisis, firms with higher levels of current assets versus current liabilities allocate more to pension expenses. With an R squared of 6.7% the two predictor variables account for a relatively small variance in pension expenses. Durbin-Watson value is in an acceptable range. BEFORE and AFTER variables were excluded from the backwards regression output. See Panel B of Table 2 for a summary of the net working capital analysis. Net changes in cash (CASH) from prior year investment, financing, and operations activities show that an inverse relationship exists with allocations for pension expenses. The relationship is that as a company allocates each dollar to pension expenses $0.332 less cash is available to the firm from prior year. CHANGE is also an acceptable predictor variable at $p < .10$ and has a positive relationship. Durbin-Watson coefficient is in an acceptable range. The two variables in the model account for 11.7 percent of the variance in pension expenses. BEFORE and AFTER variables were excluded from the backwards regression output. See Panel C of Table 2 for a summary of net changes in cash for sample firms.

RESULTS AND DISCUSSION

The goal of the research was to examine to what extent do financial statement ratios of current account management explain pension funding and if financial and economic conditions affect pension funding over time. Output from the analysis found statistically significant relationships between each financial statement variable and pension expenses and between one counter variable in two separate analyses. Although the coefficient of determination was low for each of the three analyses, we did not expect the variables analyzed to be responsible for high levels of variance in the dependent variable. Rather, our goal was to measure how well relevant balance sheet and income statement accounts and ratios predict pension expense funding and if that relationship changed because of the Great Recession of 2007 – 2009. The model shows that higher operating margins positively relate to more pension expense funding, but that higher levels of net working capital and changes in cash available have a negative impact. It is interesting that the latter two analyses, WORK_CAP and CASH, each impact pension expenses inversely but the change coefficient is positive for each analysis. These results are consistent with Beaulier (2012) and suggest that the financial crisis affected the way firms manage cash within a larger macroeconomic environment.

Results from the analysis clearly indicate that financial shocks that Impavido and Tower (2009) identified are valid in this analysis. While the model does not address a time period beyond the nine years before, during, and after the financial crisis, volatility is present in balance sheet and income statement accounts. Pension funding and underfunding represents a need for cash and a cash drain to those firms who are underfunded. We expected operating income to be positively related to pension expenses, since higher levels of income are available for pension responsibilities. We did not expect working capital and cash to have an inverse impact, given an environment of funding difficulties that demand higher levels of current assets. Although a small coefficient, we did not expect the change variable to be positive in suggesting that firms began to allocate more resources to pension funding as the recession began. Parker et al., (2007, 2011) raised a question of pension expenses and corporate earnings that this analysis extends through the interrupted time series effect of measurement. Increases in pension expenses or funding during weak economic conditions in part dispels the idea of manipulation but also raises a question of managers proactively increasing funding before earnings suffer. Although the time period after the crisis started (AFTER) was not statistically significant, in two of the three analyses that variable expressed a negative coefficient that suggests funding levels were reduced after the crisis but while earnings had not recovered.

CONCLUDING COMMENTS

The analysis illustrates how selected financial statement variables offer predictive value in a multivariate model. The model extends Parker et al., (2007, 2011) research and offers a basis for directional impact of earnings manipulation over a time period including a financial shock. Referring to Figure 1 it is easy to see that the variance in the measure of pension expenses has increased over the last few years, the period of time concurrent with and post to the financial crisis. With low coefficients of determination, our model was not developed to explain much of this variance but forms a basis that extends prior research addressing corporate design-making (Webb, 2007) in times of market turmoil (Bicksler & Chen, 1985). Finding that funding changes appear to coincide with firms proactively addressing slower earnings is consistent with managing income and expenses (Canan, 1997), but shows that funding for at least this account is made in anticipation of falling earnings to come. To take this research forward, other financial statement variables could be included beyond the three broad measures incorporated in this analysis. While the dataset used in this analysis considered exclusively pension expenses for defined benefit plans, the relationship between pension plans and the proliferation of defined contribution plans would add a different perspective to the analysis. Matching percentages, trends toward corporate offering of either type of retirement plan, and even employee participation are areas that could be beneficial for future research.

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CASH DIVIDEND CHANGE ANNOUNCEMENT EFFECT ON SHARE PRICE RETURNS: EVIDENCE FROM NAIROBI SECURITIES EXCHANGE

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ABSTRACT

Whether to pay dividends or not is a critical decision that every company must make. Conversely, whether to invest in a divided paying company is decision investors must consider. However, the relationship between dividend and share returns is not clear and how shareholders react to dividend increases or decreases is still a puzzle. This paper seeks to identify if cash dividend change announcements have any effect on share returns. It also examines whether stock price returns react the same to an increase and a decrease in dividend announced. Using daily closing prices from 2005-2012, the paper employs a 40-day event methodology to examine the reaction of share price returns to dividend change announcements before, during and after the event. Results show, dividend announcements have a significant effect on share price returns. Dividend decreases resulted in negative returns while dividend increases resulted in positive returns. Dividend decreases cause a larger decline in returns than an increase leads an increase in returns. Based on this evidence, dividend announcements have information content and hence dividend-paying companies listed in Nairobi Securities Exchange (NSE) should consider this before announcing a change in dividend.

JEL: G140

KEYWORDS: Dividend Announcements, Share Prices, Abnormal Returns, Information Content

INTRODUCTION

"*The harder we look at the dividend picture, the more it seems like a puzzle, with pieces that just don't fit together"* Black (1976). Black's sentiments are also shared by Bhattacharya (2007) who stated that a difficult challenge facing financial economists was explaining dividend policy. He further stated that despite decades of study, factors influencing dividend policy and their interaction were yet to be understood. Baker (1999) reported that since 1976, there has been a dramatic increase in empirical and theoretical research done on dividend policy. He added that it was still not clear why companies decided to pay or not to pay dividends. Furthermore, it was still problematic why investors paid so much attention to dividends. Baker concluded that setting of a dividend policy for a company is still debatable and needs prudence by decision makers. Amidu and Abor (2006) noted that companies earn income which can be invested in the business or distributed as dividends to shareholders. They identified several issues that a company considers when it decides to distribute income; (i) how much of the income will be distributed to shareholders; (ii) if cash or stock should be distributed or buying back some shares from the shareholders and; (iii) stability of the distribution. A stable distribution produces better positive signal on the future of the company than a volatile distribution because changes cause uncertainty. There are often arguments of whether the dividend decision affects the value of the firm (relevancy theories) or not (irrelevance theories). The irrelevance of dividend policy where there are no transaction costs or taxes and all investors have full information on the uncertain future cash flows of the company was proved by Miller and Modigliani (1961). They stated the firm value cannot be altered by changing the dividend policy. In contrast, Walter's Model and Gordon's Model advocated the relevance of dividends to financial decision making.

Walter (1956) concluded that stock prices reflected the present values of the expected dividends over longer periods and so the value of the firm is affected by dividends. Conversely, Gordon (1959) asserted the price of a share equaled to the discounted value of its expected future dividends and thus concluded that current income would be preferred to future income by investors. Explanations for dividend relevance have been developed which include the signaling, agency costs, tax preference and bird-in-the-hand explanations (Baker 1999). The bird-in-the-hand argues that investors prefer dividend payment in the present to an uncertain future price appreciation. Dividend policy based on tax differential between dividends and capital gains was developed by Brennan (1970), Stapleton (1972) among others. According to the explanation of tax preference, investors favor dividends nonpayment because of tax related reasons as dividends are taxed twice while the capital gains are taxed once or not taxed in some countries. Several researchers (Ross (1977), Bhattacharya (1979, 1980), Miller and Rock (1985), John and Williams (1985), Yoon and Starks (1995), Adelegan (2009), Asamoah (2010), Akbar and Baig (2010), Aamir and Ali Shah (2011), Waweru, Pokhariyal and Mwaura (2012) and Olweny (2012)) have discussed dividend payment as a signaling tool. It suggests that dividend announcement carries information on future prospects of the company and the investors assess stock price of the firm using dividend announcements information. This paper seeks to find out if there is any relationship between dividend announcement (information content) and share price of companies listed in the Nairobi Securities Exchange (NSE). It also seeks to look into the effect of cash dividend increase as well as cash dividend decrease on the share price return. The rest of the paper is organized as follows. First, the literature review is presented followed by data and methodology. Then the results, their implications, and recommendations for further research are given. Finally, conclusions of the paper are presented.

LITERATURE REVIEW

Bhattacharya (1979), Miller and Rock (1985) and John and Williams (1985) are credited with developing the classical signaling models based on information asymmetry hypothesis. They showed that under imperfect information, dividends act as a costly signal of expected future performance of a firm. These models showed that informed insiders use dividends as signals to convey the future prospects of firms to the outsiders who are less informed. They assumed that dividends are the only signaling mechanism. Moreover, Waweru et. al. (2012) suggests that dividend announcement carries information on future prospects of the company and the investors assess stock price of the firm using dividend announcements information. Information signaling therefore suggests that dividend changes should lead to earnings changes as dividend change announcements are positively associated with share returns in the days surrounding the announcement (Baker 1999).

According to Lintner (1956), managers prefer stable dividends and they are reluctant to dividend changes that might be reversible. He further stated that stable and predictable dividends provide smaller uncertainty to the investors than the variable dividends because of the information content effect. Aharony and Swary (1980) in their study of quarterly dividends and earnings announcement and stockholders' returns showed that increasing (decreasing) dividend announcements resulted in positive (negative) abnormal returns around the announcement days meaning that changes in dividend payments carried new information about the firm. Their findings were corroborated by Allen and Michaely (2003) who established that dividend changes were associated with stock price changes of the same sign around the dividend change announcement and immediate price reaction was related to the size of the dividend. On the contrary, Uddin and Chaundhary (2005) investigated dividend announcement impact on stock prices of Dhaka stock exchange and found that dividend had no information content and returns supported the dividend irrelevance theory. Their findings were corroborated by Mamun and Hogue (2013) did a study on stock price reaction to dividend announcement for companies listed on the Dhaka Stock

Exchange in Bangladesh. They concluded that dividend declaration does not bring any gains to investors, they instead lose due to substantial fall in share prices both in the pre and post dividend period.
According to Chen et al. (2009), a cash dividend increase announcement is an optimistic signal on a firm's future operation and cash flow for investors. They stated that an increase in cash dividend is usually followed by positive abnormal returns. On the contrary, they further stated that, negative abnormal returns follow the announcement of a cash dividend decrease as it is a pessimistic signal. They concluded that these empirical studies support the dividend signaling hypothesis and investors' expectations of a firm's cash flow are adjusted after cash dividend changes. Gupta et al. (2012) did a study on stock price reaction to dividend announcements for listed companies in the Bombay Stock Exchange who announced dividend increases. The study exposed the fact that stock prices react to increase in dividend announcements and that dividend announcements possess signaling property. According to Akron (2011), business cycle is a critical parameter in investor's interpretation of dividend announcements as during busts a dividend announcement is perceived as a strong and reliable signal about the state of the corporation compared to times of normality.

He examined the impact of business cycles on the market reaction to dividend announcements for large capital firms in the Tel-Aviv Stock Exchange. Among listed firms in the Nairobi Securities Exchange, the relationship between firm performance and dividend payout was sought by Murekefu and Ouma (2012). Their findings pointed out there were a strong and positive relationship. They also showed that among listed firms in Kenya, cash dividends were the commonly used type of dividends while other types of dividends were not employed by firms. They concluded that firm performance was mainly affected by dividend payout and this showed that dividend policy was relevant. Their finding was corroborated by Olweny (2012) who sought to determine the extent to which there is information content in dividend announcements, the effect dividend announcements had on the firm value and its implications on the semi strong efficiency of the Nairobi Stock Exchange (NSE). He concluded there was information content in dividend announcements which affected the value of the firm.

This conclusion arose from the findings there was a significant relationship between abnormal stock returns and unexpected dividend announcements. Mokaya et al. (2013) did a study on the effect of dividend policy on market share value in the banking industry in Kenya. Their study sought to establish the effects dividend policy had on the value of shares in the banking industry using National Bank of Kenya as a case study. They found out that according to the investors, dividend payments influenced the share value and as dividend payments increase so does the price of the share. Waweru et al. (2012) investigated the signaling hypothesis by testing the displacement property of dividends for 40 companies listed on the Nairobi securities Exchange between 1998 and 2010. The study applied panel corrected standard errors (PCSE) to time series cross section (TSCS) data. The findings provided further empirical evidence that dividends are used as signals about future earnings prospects of the firm and shed further insights on the controversy about the information content of dividend changes about future profitability.

DATA AND METHODOLOGY

Data Presentation

The paper investigated the effect of cash dividend announcement on abnormal return using 40 days' event study. It focused on the companies listed on the Nairobi Securities Exchange (NSE) for the period 2005 to 2012. This period is significant as Kenya experienced postelection violence (PEV) in 2007/2008 where NSE recorded one of the worst performances. In addition, the companies must have declared a final dividend each year resulting to a sample of 44 companies. Daily closing prices data was collected from the NSE website while the dividend paid was collected from the company's annual financial report and prospects. For the dividend change model, 325 observations were used.

Methodology

The study used the event study method to investigate the effect on cash dividend announcement on prices of shares for firms listed on the NSE. The event window was 41 days; 20 days before and 20 days after the event date which is the announcement date with the announcement day being day 0. The choice of the event window was made to consider other possible pre-event reaction due to the peculiar nature of the information environment in developing countries; there are possibilities that market reaction starts long before the actual announcements. A 352 dividend event observations were used (44 companies paying annual dividend for eight years). Stock price reaction is the drift or change in the share price. To estimate abnormal returns for the different event windows, the Market Adjusted Return Model was used. In Market Adjusted Return Model, the measure of risk (β) is assumed to be 1 and the intercept (α) to be zero. It is argued that using Market Model Adjusted Return Model is not superior to Market Adjusted Return Model and in small markets; Market Adjusted Return Model gives good results as the Market Model Adjusted Return Model (Brown and Warner, 1980; Armitage, 1995; Travlos et al., 2001). The market adjusted return was calculated as below:

$$AR_{it} = R_{it} - R_{mt} \qquad (1)$$

Where:

AR_{it} is the Market Adjusted Abnormal return of firm *i* on day *t* in the event window

R_{it} is the return of firm *i* on day *t* within the event window

R_{mt} is the NSE 20 return on day *t* within the event window

The Average Abnormal Return (AAR) and Cumulative Abnormal Return (CAR) were used to measure and test the abnormal return significance. The AAR and CAR was calculated as below:

$$AAR_t = \sum_t^i AR\,/N \qquad t = -20, -19, \ldots, 20 \qquad (2)$$

$$CAR_t = \sum_t^i AR \qquad t = -20, -19, \ldots, 20 \qquad (3)$$

Collected data was subjected to statistical analysis using Gen Stat ver. 14 software. Dividend change was calculated by the dividend change model. The event date was then established for companies with dividend changes to determine the event window.

RESULTS AND DISCUSSION

Effect of Dividend Cash Announcement on Share Price

A two-sample t-test for AAR and CAR was carried out to find out whether cash dividend announcement had a general effect on share price returns regardless of other market environment and economic factors. The results are as presented in Table 1.

Table 1: Two-Sample T-Test for AAR and CAR for the Period 2005 – 2012

Sample	AAR		CAR	
	Before	**After**	**Before**	**After**
Size	20	20	20	20
Mean	-0.603	1.867	-135.1	418.2
Variance	16.22	6.32	813,604	316,935
Standard deviation	4.027	2.513	902.0	563.0
Standard error of mean	0.9004	0.5620	201.7	125.9
Test statistic t	-2.33**		-2.33**	
Probability	0.026**		0.026**	
95% Confidence interval	-4.632, -0.3078		-1,038, -68.94	

*This table shows the two sample t-test analysis. Column two and three shows results for AAR while column four and five shows results for CAR. ** indicates significance at 5 percent level.*

The results showed there was statistically significant ($P<0.05$) difference between the means before cash dividend announcements and after cash dividend announcements in both AAR and CAR. In addition, the mean before was negative while after was positive suggesting a positive change in mean return after the dividend announcement. It can therefore be inferred the difference in the means before and after cash dividend announcements were likely due to the cash dividend announcements. Consequently, the dividend announcements had a significant effect on the share prices. The announcements had information content that determined the share prices.

The empirical findings of this study corroborated those of Dasilas and Leventis (2011) who did a study in the Greek market on the trading volume and stock price sensitivity to dividend announcements. In their conclusion, they supported the information content in dividends as they found out there was a significant market reaction to announcements. The study however, contrasted that of Uddin and Chaundhary (2005) who did a study on the Dhaka Stock Exchange to investigate dividend announcement impact on stock prices of Dhaka market and concluded that dividend had no information content and the returns supported the dividend irrelevance theory. In conclusion therefore, the cash dividend announcement has effect on the abnormal returns and subsequently on the share prices.

Effect of Dividend Increase and Decrease Announcements

The paper first established the frequency of dividend increases, decreases and those that remained constant for the 8-year period. As shown in Table 2, the panel data consisted of 352 observations which were divided into; dividend increase events (137), no change events (119) and dividend decrease events (96).

Table 2: Frequency of Dividend Changes Per Year for the Period 2005-2012

	Dividend Increases	**No Change**	**Dividend Decreases**	**Total Per Year**
	Number	**Number**	**Number**	**Number**
2005	19	18	**7**	44
2006	12	17	15	44
2007	18	21	5	44
2008	15	16	13	44
2009	16	15	13	44
2010	20	13	11	44
2011	15	11	18	44
2012	22	8	14	44
	137	**119**	**96**	**352**

This table shows the frequency of dividend changes per year. Column two shows dividend increases, column three no changes, column four dividend decreases and column five the total dividends per year.

The paper further investigated the effect of cash dividend increase and cash dividend decrease announcements on share price returns. A two-sample t-test was done for the abnormal returns and results presented in Table 3.

Table 3: Two-Sample T-Test for Dividend Increase and Decrease for the Period 2005 – 2012

Sample	Dividend Increase				Dividend Decrease			
	CAR		AAR		CAR		AAR	
	Before	After	Before	After	Before	After	Before	After
Size	20	20	20	20	20	20	20	20
Mean	-282.3	258.6	-2.107	1.930	159.6	147.	1.773	1.635
Variance	513,713	181,194	28.61	10.09	124,260	127,417	15.34	15.73
Std. deviation	716.7	425.7	5.349	3.177	352.5	357.0	3.917	3.966
Std. error of mean	160.3	95.2	1.1960	0.7103	78.82	79.82	0.8758	0.8869
Test statistic t	-2.90**		-2.90**		-0.11**		-0.11**	
Probability	0.007**		0.007**		0.012**		0.012**	
95% Confidence interval	-921.1, -160.7		-6.874, -1.199		-239.5, 214.6		-2.662, 2.385	

*This table shows the two sample t-test analysis for dividend increases and decreases. Column two shows results for dividend increases for both AAR and CAR before and after announcement. Column three shows results for dividend decreases for both AAR and CAR before and after announcement. ** indicates significance at the 5 percent level.*

The results showed there was statistically significant ($P<0.05$) difference between the means before cash dividend increase announcements and after cash dividend increase announcements. It can therefore be concluded the difference in the means before and after cash dividend increase announcements was due to the cash dividend increase announcements. Consequently, the dividend increase announcements had a significant effect on the share prices indicating the dividend increase announcement was received positively by the investors as the share price returns increased after the announcement. It was therefore, concluded that dividend increase announcement affected the share prices positively. The dividend increase announcement met the investors' expectations therefore the share price increased.

Further, the results (Table 3) indicated there was statistically significant ($P<0.05$) difference between the means before cash dividend decrease announcements and after cash dividend decrease announcements. This could imply the difference in the means of before and after cash dividend decrease announcements was due to the cash dividend decrease announcements. Therefore, the dividend announcements had a significant effect on the share prices. The dividend decrease announcement was received negatively by the investors as the share price reduced after the announcement. It was therefore, concluded that dividend decrease announcement affected the share prices negatively. The value of the firm is determined by investors' expectations, investors rate badly firms that do not meet their expectations and so the dividend decrease announcement did not meet the investors' expectations hence affected the share price. The study contrasted a study done by Uddin and Chaundhary (2005) who concluded that dividend announcements did not have any effect on share price. The results are however similar to Waweru et.al. (2012) who found dividends carry certain information and hence to have signaling effects. Similarly, Olweny (2012) found there was information content in dividend announcements which affected the value of the firm. He found out there was a significant relationship between abnormal stock returns and unexpected dividend announcements. We can therefore conclude that cash dividend increases signals the market to expect an increase in share price while a cash dividend decreases signals a decrease in share prices.

CONCLUSION

The paper looked into the information content of cash dividend announcement. A 40 days' event window was used to determine the effect of cash dividend on abnormal return of shares 20 days before and after the event. The abnormal return was determined using both the Average Abnormal Return (AAR) as well as Cumulative Abnormal Return (CAR). T-test analysis was done and both measures produced similar results. There was statistically significant difference in returns before and after the event. Further, the paper investigated the effect of cash dividend increase and decrease on share price. A two-sample t-test for the abnormal returns for both dividend increases and decreases was run and the results showed there was statistically significant difference between the abnormal returns before cash dividend announcements and after cash dividend announcements. It was also evident that share prices reacted positively to dividend increase and negatively to dividend decrease. Dividend increase announcements had positive returns while dividend decrease announcement had negative returns and so there was information content in the dividend announcements which affected the share prices. In conclusion therefore, the paper found that cash dividend paid had information content.

The investors in Kenya are aware of dividends as a signal of a firm's future earnings. The management of a company should therefore pay close attention to dividend paid and more importantly, to the dividend increase or decrease as it has an effect on the future share prices. Fluctuating dividend send mixed signal to the market and the market may not be able to interpret it. For future research, a study based on the other types of dividends like stock dividends which was not the focus of this study should be done with a view of finding out how they affect the share price during different economic periods. This will establish whether investors react the same way to all types of dividends or they have a preferred type of dividend. Future research may focus on various aspects. First, scholars should consider both the interim and final dividend and whether there is any difference. Further, it will be important to test whether the dividend increase or decrease had same effect on the share price. Second, a sector by sector research of the firms listed in NSE should be done to find out how share prices react to dividend change announcement during different economic periods as particular sectors/ industries tends to be affected in a similar manner. Third, it would be important to determine the best days to be used for the event window in the Kenyan market. This is so because days that apply for the developed countries may not apply for the developing countries. There is a difference in development of countries and markets react differently depending on the level of development and so it would be important to know the best days to use for event window for the Kenyan market according to her development level and based on how long the market reacts to announcements and the efficiency of the market.

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CREDIT RISK FACTORS DURING THE ASIAN AND GLOBAL FINANCIAL CRISES

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ABSTRACT

This study measures the effects of specific credit risk factors of companies that defaulted during the Asian currency and global credit crises. Using Taiwanese listed companies' data, the predictability of specific credit risk factors were discrepancies during these 2 crises. First, I captured variables from Altman's (1968) Z-score model, a pioneer and notable model based on Accounting Data, from the Merton distance to default (DD) model, and from the naïve probability model-an alternative of the Merton DD model. The significance of the Z-score model variables are examined by applying the logit model. Furthermore, the forecasting ability of the logit model, Merton DD model, naïve probability, and the Taiwan corporate credit rating index are compared. The findings of this study indicate that the financial ratio of sales to total assets was the most crucial factor during the Asian financial crisis. Moreover, the ratio of retained earnings to total assets and the Merton DD were critical factors during the Global financial crisis. The predictability of the traditional logit model using the Z-score model variables performed well.

JEL: G00, G33, G39

KEYWORDS: Credit Risk, Financial Crises, Logit Model, Merton Model, Z-Score Model

INTRODUCTION

The credit crises experienced by enterprises and financial institutions are usually exacerbated during the sudden onset of a financial tsunami. In other words, financial crises often cause widespread credit crises among enterprises. Thus, these two issues, credit crises and financial crises, are highly correlated and should be assessed simultaneously. This study examines whether there are different credit risk factors that affected defaulted companies during the 1997 Asian financial crisis and the 2007 Global financial crisis. In addition, this study examines the effectiveness of specific credit risk prediction models. These two financial crises are assessed for the following reasons. First, the causes of these crises differ. In contrast with the Asian currency attack in 1997, the global crisis was the result of credit and liquidity difficulties. Thus, an analysis of these two events could provide a suitable basis for comparison. Second, Taiwan was not the storm centre of these two crises; however, Taiwan was substantially affected by these events. Finally, because the Asian and Global financial crises were the most recent financial tsunami to affect Taiwan, these crises are valuable empirical events for researching credit risks for Taiwanese listed companies. This study could assist enterprises and financial institutions in resisting any future financial crises.

In *The New York Times* on June 27, 2010, Paul Krugman predicted that the world economy might soon experience a third recession. Unlike the previous two crises, the third recession is anticipated to cause an extended period of high currency volatility, economic instability, and high unemployment. It is likely that numerous unhealthy enterprises would experience substantial credit problems during such a financial crisis, which would negative consequences for creditors and financial institutions. In consideration of the potential consequences of a third recession, this study provides a proactive assessment of specific credit risk factors under various financial crises to provide pre-warning signals that might assist enterprises during a recession. First, this study measures the prediction accuracy of credit risk factors associated with the Asian and global financial crises for Taiwanese listed companies. The traditional financial ratio-based Z-score variables (Altman, 1968) are applied to capture the accounting data and market value information. The reason why I use Z-score variables is because the Z-score model is the basis of many commercially prevalent models, such as Moody's KMV RiskCalc, Standard and Poor's credit model, and the BondScore model. In addition to the credit risk factors based on the accounting data and market values model, I serve the distance to default of the Merton DD model as the stock price variable. However, Bharath and Shumway (2008) indicated that "the usefulness of the MKMV probability is due to the functional form suggested by the Merton model. The iterative procedure used to solve the Merton model for default probability does not appear to be useful" (p. 1367-1368). Therefore, I apply the naïve probability model proposed by Bharath and Shumway (2008) as an alternative model. Under the logit model, the information from these credit risk variables can be transformed into a default probability. Further, the significance of the credit risk variables can be detected. Second, this study further examines the forecasting ability of certain credit risk prediction models. Third, this study introduces the Taiwan corporate credit rating index (TCRI), and compares the effectiveness of TCRI with these credit risk models.

I find that the estimated coefficients for *SR/TA* are negative and statistically significantly different from zero and they are -10.328, -8.686, and -10.842 respectively for 1Q, 2Q, and 3Q in Model 2 during the Asian financial crisis. During the global financial crisis, RE/TA had a statistically significant and negative effect on default probability and the coefficients of RE/TA are -5.961, -4.195, and -6.474 respectively for 1Q (p < .01), 2Q (p < .05%), and 3Q (p < .01) in Model 2. Furthermore, the coefficient of DD_{Merton} variable is only statistically significantly different from zero during the global financial crisis. The remainder of this study is organised as follows. Literature review is introduced in the following section. Section 3 details the research data, variable definitions, and descriptive statistics. Section 4 shows the empirical results, including the logit model results and the predictive power of the logit, Merton DD, and naïve probability models, as well as the TCRI. Finally, Section 5 presents the conclusion for this study.

LITERATURE REVIEW

Credit risk is has been widely discussed in academic research and practical analysis for decades (Sobehart et al. 2000, Crosbie and Bohn, 2003, Delianedis and Geske, 2003, Duffie and Singleton, 2003, Huang and Huang, 2003, Leland, 2004, Parnes, 2006). Particularly, after the Basel II agreement introduced the internal rating-based approach to banks and financial institutions, banks could build internal rating models. The practitioners commenced assessing the measurement techniques of credit risk and subsequently developed numerous credit risk models. Cauette et al. (2008) separated traditional credit risk models into the following two categories: (a) models based on accounting data and market values; and (b) models based on stock prices. To predict business failures using financial ratios, Beaver (1966) built a univariate model based on the accounting data and market values model and predicted business failure by analysing specific financial ratios five years prior to a business default. Altman (1968) and Deakin (1972) also developed a multivariate model to predict business failure by employing multivariate discriminant analysis. To identify business that might vulnerable to financial failure, analysts can employ the Altman Z-score, which is calculated by applying the following five financial ratios: (a) liquidity ratio; (b) profitability ratio; (c) leverage ratio; (d) solvency capability; and (e) asset turnover ratio. Altman et al. (1977) introduced the ZETA model, which is a revision of Altman's Z-score, to predict retail business failure in response to changes in the macroeconomic conditions and accounting principles.

Despite their widespread application, multivariate models possess numerous limitations. First, the prediction accuracy decreases when nonlinear variables are analysed by applying a linear discriminant analysis method. Second, the accounting data and market values model capture the accounting book value, which occasionally fails to reflect the actual financial activities of the obligor. Third, financial experts have expressed concern over a lack of theoretical foundation supporting the validity of multivariate analysis. That's why, it is popularly accepted by the academic research when Merton (1974) interpreted company equity value as a call option on company assets, and estimated the business failure rate by applying Black-Scholes' option valuation model. In addition to the accounting variables, it seems necessary to gather other information and relevant variables to improve the accuracy of models (Ohlson, 1980). Merton (1974) included assets value to measure credit risk by applying an option pricing model. Merton's model, a pioneer model using assets value, established a more comprehensive theoretical foundation than previous research that had analysed financial ratios only. Hereafter, there are several practical techniques implementing Merton's model. For example, the expected default frequency (EDF) model of Moody's KMV (MKMV) is quite well-known in practice. To solve Merton's equations, certain studies have employed equity value and its volatilities (Ronn and Verma, 1986), and Vassalou and Xing (2004) constructed a complex iterative procedure.

DATA AND METHODOLOGY

This study examines the credit risk factors and investigates the predictive power of certain credit risk models in Taiwan during the Asian and global financial crises. Using data Taiwanese listed companies, the default companies form the experimental group, and the non-default companies are the control group. The financial ratios, stock price data, and default information employed in this study are derived from the *Taiwan Economic Journal* (*TEJ*) database. In this study, all default companies refer to companies that are categorised as "companies with insolvent problems" in the *TEJ*. During the collection of the samples, the companies with insolvent problems were chosen during the Asian financial crisis (1997–2000), and the global financial crisis (2007–2009) (Chang and Kuo, 2010). The sample excludes the finance industry as well as the building and construction industry because their industry characteristics exhibit unique capital structures in comparison with other industries. For example, the debt ratio of a typical financial institution is greater than 90%, and the asset turnover rate of a construction company different substantially from other manufacturing companies. Under these sampling criteria, there were 44 defaulted companies during the Asian financial crisis, among which 10 operated in the iron and steel industry. In addition, 43 companies failed during the global financial crisis, among which 31 operated in the electronics industry.

Next, the sample size of the non-default sample, which has similar capital to the corresponding default company during the same period, is selected twice as big as the default one. To analyse the default forecasting models, I collected data from the financial statements announced three quarters prior to defaulting. However, because three companies had missing data during Asian financial crisis period and two companies had missing data during the global financial crisis in the first quarter prior to defaulting (1Q), the sample of non-default companies was reduced to six during the Asian financial crisis, and to four during the global financial crisis. The basic inputs for the logit model in this study include the following default information and five financial ratios: (a) working capital *WC*; (b) retained earnings *RE*; (c) earnings before interest and tax *EBIT*; and (d) sales revenues *SR*. Each of these are divided by the total assets *TA*, and the market value of equity *ME* divided by the total liability *TL*, and the default indicator y_i. To capture the credit risk factor based on the stock price model, two variables were set into the logit model—the distance to default estimated from the Merton DD model and the naïve probability. The inputs to the Merton DD model and the naïve probability are *ME*, market value of each firm's equity F, face value of debt r, risk-free rate r_{it-1}, stock return of Company i over the previous year, and time T. *ME* is calculated from the *TEJ* database as the product of the share price of Company i at the end of the day and the number of outstanding shares. F is the debt in current liabilities plus half of the long term debt (Vassalou and Xing, 2004, Bharath and Shumway, 2008).

For r, this study employed the 1-year deposit rate set by the Bank of Taiwan. σ_E, the annualised standard deviation of returns, is estimated from the prior year log stock return data for each month. Data from financial statements typically contain several extreme values. To ensure that the statistical results are not affected by outliers, it is necessary to follow the Winsorisation method in Bharath and Shumway (2008). First, the prediction variables are sorted. Subsequently, all observations lower than the 1st percentile of each variable are set equal to 1st percentile, and all values higher than the 99th percentile of each variable are winsorized in the same manner. Tables 3 and 4 provide several descriptive statistics and t test results for all of the winsorized variables from the Asian and the global financial crises, respectively. First, I conducted a basic statistical analysis. Subsequently, I calculated a sample mean t test for the logit model variables to determine whether a significant difference exists for each variable between the default and non-default companies. The descriptive statistics show that the means of all logit model variables for the non-default companies are significantly greater than those for the default companies.

This shows that prior to defaulting, the default companies experienced problems associated with a lack of available funds, and their short-term solvency was relatively poor and deteriorating. Moreover, from the third quarter prior to defaulting (3Q) to 1Q, I observed that as the defaulting point approaches, the decreasing velocity of all of the variable means for the default companies is faster; however, the means are relatively stable for the non-default companies during both the Asian and global financial crises. Based on this result, it can be speculated that because of excessive borrowing, the default companies experienced short-term liquidity shortages, and mismanagement resulted in a loss that ultimately led to the financial crises. According to Table 1, during the Asian financial crisis period, the results of the sample mean *t* test are statistically significantly different from zero (p < .01) for all variables except *EBIT/TA* and $DD_{Naïve}$ in 1Q–3Q. The *EBIT/TA* *t* test is non-significant in the second quarter prior to defaulting (2Q), and the $DD_{Naïve}$ *t* test is only significantly at p < .05. The estimated results indicate that these predictor variables differ substantially between the default and non-default companies, implying that the liquidity, profitability, operating efficiency, solvency, and asset turnover rate of the non-default companies compared with the default companies are good in substance during the Asian financial crisis. In addition, the forecasting ability of $DD_{Naïve}$ seems poorer than that of $DD_{Mertton}$.

Table 1: Descriptive Statistics and T-tests (during the Asian Financial Crisis)

Panel A: The First Quarter Prior to Defaulting										
	Default				Non-Default				t-test	
Variable	Mean	Stdev	Min	Max	Mean	Std. dev.	Min	Max	t-test	p-value
WC/TA	-0.093	0.244	-0.570	0.596	0.151	0.162	-0.294	0.596	-5.800	0.000
RE/TA	-0.184	0.280	-0.995	0.069	0.040	0.068	-0.127	0.191	-5.057	0.000
EBIT/TA	-0.089	0.189	-0.783	0.030	0.013	0.016	-0.034	0.043	-3.431	0.001
ME/TL	1.558	2.053	0.200	10.015	3.638	2.822	0.240	11.609	-4.652	0.000
SR/TA	0.117	0.067	0.022	0.303	0.200	0.115	0.022	0.581	-5.029	0.000
DD_{Merton}	-0.586	4.156	-6.459	12.018	2.266	2.420	-4.569	8.657	-4.064	0.000
$DD_{Naïve}$	0.013	2.683	-4.603	6.838	1.512	1.670	-2.169	6.521	-3.274	0.002
Panel B: The Second Quarter Prior to Defaulting										
	Default				Non-Default				t-test	
Variable	Mean	Stdev	Min	Max	Mean	Std. dev.	Min	Max	t-test	p-value
WC/TA	0.006	0.210	-0.385	0.572	0.148	0.162	-0.279	0.572	-3.941	0.000
RE/TA	-0.050	0.107	-0.327	0.123	0.046	0.072	-0.188	0.194	-5.352	0.000
EBIT/TA	0.004	0.034	-0.072	0.081	0.012	0.019	-0.070	0.056	-1.486	0.071
ME/TL	1.783	2.152	0.307	11.432	4.112	3.155	0.363	13.228	-4.986	0.000
SR/TA	0.120	0.085	0.021	0.410	0.190	0.110	0.013	0.647	-4.041	0.000
DD_{Merton}	0.112	3.680	-5.004	12.076	2.897	2.407	-2.828	8.319	-4.557	0.000
$DD_{Naïve}$	0.373	2.159	-3.736	5.174	1.811	1.907	-1.907	7.658	-3.746	0.000
Panel C: The Third Quarter Prior to Defaulting										
	Default				Non-Default				t-test	
Variable	Mean	Stdev	Min	Max	Mean	Std. dev.	Min	Max	t-test	p-value
WC/TA	0.040	0.217	-0.315	0.582	0.155	0.166	-0.264	0.582	-3.086	0.003
RE/TA	-0.043	0.106	-0.301	0.137	0.051	0.078	-0.185	0.226	-5.226	0.000
EBIT/TA	-0.014	0.051	-0.175	0.061	0.015	0.021	-0.063	0.063	-3.592	0.001
ME/TL	2.051	2.447	0.342	11.153	4.595	4.846	0.458	25.827	-4.007	0.000
SR/TA	0.119	0.077	0.014	0.378	0.207	0.123	0.016	0.735	-5.027	0.000
DD_{Merton}	0.766	3.669	-4.388	11.259	3.028	2.540	-2.900	8.177	-3.638	0.001
$DD_{Naïve}$	0.920	2.130	-3.064	6.051	1.733	1.923	-2.729	7.164	-2.117	0.038

This table reports the descriptive statistics and t tests for all variables used in the logit model for the Asian financial crisis. WC is working capital, RE is retained earnings, EBIT is earnings before interest and tax, ME is the market value of equity, SR is sales revenues, TA is total assets, and TL is total liability. DD_{Merton} *is the Merton distance to default and is calculated based on Equation (11).* $DD_{Naïve}$ *is the naïve distance to default and is calculated based on Equation (16).*

Table 2 shows the results of sample mean *t* test for the logit variables during the global financial crisis. The results of the sample mean *t* test for the ratios (*WC/TA*, *RE/TA,* and *EBIT/TA*) and variables ($DD_{Mertton}$ and $DD_{Naïve}$) all differ significantly from zero (p < .01) for 1Q–3Q during the global financial crisis. The difference in the estimated results for *SR/TA* is statistically significant from zero in 2Q (p < .01) and 3Q (p < .05). However, the *ME/TL* ratio is only significantly different from zero in 2Q (p < .05). The estimation results imply that certain financial conditions of the non-default and default companies are all affected by the overall economic environment; consequently, the differences in solvency and asset turnover rate are less obvious between the default and non-default companies during the global financial crisis. Moreover, the stock price information was a highly critical credit risk factor during the global financial crisis.

Table 2: Descriptive Statistics and T-tests (During the Global Financial Crisis

Panel A: The First Quarter Prior to Defaulting										
	Default				Non-Default				t-test	
Variable	**Mean**	**Stdev**	**Min**	**Max**	**Mean**	**Std. dev.**	**Min**	**Max**	**t-test**	**p-value**
WC/TA	-0.090	0.303	-0.852	0.395	0.238	0.190	-0.241	0.640	-6.346	0.000
RE/TA	-0.570	0.508	-1.841	0.001	0.035	0.176	-0.889	0.344	-7.399	0.000
EBIT/TA	-0.165	0.286	-1.105	0.039	0.002	0.075	-0.606	0.070	-3.681	0.001
ME/TL	2.364	8.613	0.117	55.388	5.262	8.802	0.302	55.388	-1.746	0.085
SR/TA	0.175	0.134	0.029	0.672	0.211	0.136	0.029	0.672	-1.404	0.164
DD_{Merton}	-1.647	2.333	-6.449	6.542	1.877	2.648	-3.619	8.267	-7.544	0.000
$DD_{Naïve}$	-1.056	2.164	-6.127	3.973	0.850	1.774	-3.057	5.488	-4.881	0.000
Panel B: The Second Quarter Prior to Defaulting										
	Default				**Non-Default**				**t-test**	
Variable	**Mean**	**Stdev**	**Min**	**Max**	**Mean**	**Std. dev.**	**Min**	**Max**	**t-test**	**p-value**
WC/TA	0.023	0.220	-0.382	0.464	0.251	0.198	-0.200	0.714	-5.733	0.000
RE/TA	-0.326	0.365	-1.255	0.069	0.056	0.144	-0.764	0.337	-6.616	0.000
EBIT/TA	-0.105	0.178	-0.663	0.009	0.013	0.036	-0.194	0.074	-4.293	0.000
ME/TL	2.561	8.387	0.142	55.113	5.794	9.114	0.283	55.113	-2.004	0.048
SR/TA	0.159	0.098	0.029	0.373	0.229	0.150	0.033	0.737	-3.148	0.002
DD_{Merton}	-0.968	2.288	-5.201	6.576	2.228	2.657	-2.861	8.575	-7.080	0.000
$DD_{Naïve}$	-0.708	2.217	-5.283	3.185	1.049	1.925	-2.931	8.612	-4.429	0.000
Panel C: The Third Quarter Prior to Defaulting										
	Default				Non-Default				t-test	
Variable	Mean	Stdev	Min	Max	Mean	Std. dev.	Min	Max	t-test	p-value
WC/TA	0.083	0.239	-0.397	0.728	0.260	0.193	-0.163	0.728	-4.208	0.000
RE/TA	-0.231	0.262	-0.870	0.110	0.063	0.134	-0.702	0.326	-6.902	0.000
EBIT/TA	-0.028	0.032	-0.118	0.017	0.016	0.028	-0.076	0.087	-7.556	0.000
ME/TL	3.315	10.226	0.208	66.030	6.681	9.903	0.313	66.030	-1.781	0.079
SR/TA	0.174	0.104	0.026	0.445	0.230	0.151	0.031	0.758	-2.468	0.015
DD_{Merton}	-0.310	2.533	-4.500	6.925	2.769	2.886	-4.862	10.070	-6.193	0.000
$DD_{Naïve}$	-0.346	2.306	-4.930	3.803	1.326	2.329	-3.095	9.666	-3.862	0.000

This table reports the descriptive statistics and t tests for all variables used in the logit model for the global financial crisis. WC is working capital, RE is retained earnings, EBIT is earnings before interest and tax, ME is the market value of equity, SR is sales revenues, TA is total assets, and TL is total liability. DD_{Merton} *is the Merton distance to default and is calculated based on Equation (11).* $DD_{Naïve}$ *is the naïve distance to default and is calculated based on Equation (16).*

In this study, the logit model is the first model to be employed to code the information of the five financial ratios of Altman's (1968) Z-score model and the information of stock price into a score, and to apply logistic regression to link the score to the default probability. Let β denote the coefficients attached to the five financial ratios; subsequently, I can obtain the scores for Company i by applying

$$z_i = \beta_0 + \beta_1 x_{i1} + \beta_2 x_{i2} + \beta_3 x_{i3} + \beta_4 x_{i4} + \beta_5 x_{i5} + \beta_6 x_{i6} + \beta_7 x_{i7}, \qquad (1)$$

where z_i is the score for Company i. The definitions of $x_{i1} \sim x_{i5}$ are identical to those shown in Equation (1), x_{i6} is the distance to default of the Merton DD model, and x_{i7} is the distance to default of the naïve probability model. $\beta_1 \sim \beta_7$ are the weights of $x_{i1} \sim x_{i7}$, and β_0 is the constant. Furthermore, y_i denotes the default indicator, and $y_i = 1$ if Company i defaulted (0 otherwise). To obtain the appropriate β coefficients, a logistic distribution function should be applied to connect the scores with the default probability by setting the default probabilities equal to function F of the scores

$$P(y_i) = F(z_i) = \frac{exp(z_i)}{1+exp(z_i)} = \frac{1}{1+exp(-z_i)} \ , \qquad (2)$$

where $P(y_i)$ is the probability of the default rate of Company i, and function F ranges from 0 to1.
By employing the maximum likelihood method, I can estimate the β coefficients. The likelihood of a set

of N companies can be expressed as:

$$L = \prod_{i=1}^{N} \left(F(z_i)\right)^{y_i} \left(1 - F(z_i)\right)^{1-y_i} \tag{3}$$

Our second method to calculate the probability of default is the probability of Merton distance to default. According to Merton (1974), a firm's liabilities comprise only one zero-coupon bond with the notional value F maturing in time T; thus, the default probability is the probability that the value of the assets V is below the value of the liabilities at time T. With no dividends, the firm's equity value E can be determined by applying the Black-Scholes European call option formula. The bond value is the asset value minus the equity value; thus, the value of the bond at time 0 is $F = V - E$. Accordingly, the default probability is the probability that the value of the assets is below the value of the liabilities at time T:

$$\begin{aligned} Prob(Default) &= Pr\left[ln\, V^0 + \left(\mu - \frac{\sigma_V^2}{2}\right)(T-t) + \sigma_V\sqrt{T-t}Z \leq ln\, F\right] \\ &= \mathcal{N}\left[-\left(\frac{ln\frac{V}{F} + \left(\mu - \frac{\sigma_V^2}{2}\right)(T-t)}{\sigma_V\sqrt{T-t}}\right)\right], \\ &= \mathcal{N}(-DD_{Merton}) \end{aligned} \tag{4}$$

where $\mathrm{DD}_{\mathrm{Merton}}$ is the Merton distance to default, V^0 is the asset value at time 0, μ is the expected return on the firm's assets, $(T-t)$ is time-to-maturity, σ_V^2 is the variance of the asset value, and $\mathcal{N}(.)$ denotes the cumulative standard normal distribution. However, when I estimated the default probability, specific problems became apparent. First, the market value of the assets could not be observed, and second, the asset volatility could not be derived. Based on research by Vassalou and Xing (2004) and Bharath and Shumway (2008), I resolved this problem by implementing an iterative approach. In Merton DD model, the underlying value of a firm and its volatility are difficult to observe. Bharath and Shumway (2008) showed that a sufficient statistic for default probability can be calculated without solving the underlying value of the firm and its volatility. Thus here we calculate the naïve probability of Merton (1974) as our third method for robustness check of Merton. We use the functional form to estimate the asset value, which is already implied in the Merton DD model (Merton, 1974). First, the market value of the firm's debt is approximated by the face value of its debt, $naïve\ D = F$, and the volatility of the firm's debt is approximated as $naïve\ \sigma_D = 0.05 + 0.25 * \sigma_E$. (5) Finally, the naïve probability is then obtained by applying

$$\pi_{naïve} = \mathcal{N}\left(-\left(\frac{ln[(E+F)/F] + \left(r_{it-1} - 0.5 naïve\ \sigma_V^2\right)(T-t)}{naïve\ \sigma_V\sqrt{T-t}}\right)\right) = \mathcal{N}(-DD_{naïve}). \tag{6}$$

where $DD_{naïve}$ is the naïve distance to default.

Compared with the iterative procedure, it is relatively easy to calculate the naïve probability. Bharth and Shumway (2008) showed that the naïve predictor performs slightly better than the Merton DD model, and a reduced-form model that uses identical inputs. Löffler and Posch (2011) indicated that the cumulative accuracy profile (CAP) and receiver operating characteristics (ROC) can be employed to evaluate the discriminatory power of these credit risk models; however, the Brier score can be used to assess the discrimination and calibration. By evaluating the discriminatory power, I could examine the quality of the rank ordering produced by the credit risk models; however, by verifying the calibration, I could observe how well the estimated probability of a default matches the true probability of the default.

RESULTS AND DISCUSSION

Logit Model Results

I implemented the Z-score variables with the stock price information variables (i.e., DD_{Merton} and $DD_{Naïve}$) through the logit regression method. Tables 3 and 4 show the results for the Asian and global financial crises, respectively. Model 1 is the logit model only with Z-score variables, Model 2 combines the Z-score variables and DD_{Merton} in the logit model, and Model 3 adds $DD_{Naïve}$ into Model 2. First, I focused on the statistics for overall fit. The null hypothesis (i.e., the five financial ratios do not contribute to the predictive ability of the model) of the likelihood ratio (LR) test can be rejected with high confidence. Although the p values in Table 3 only show three decimal points, the actually value is less than 10^{-8}. The LR test implies that the logit model is highly significant. Therefore, the logit model reliably predicted the default events. From the figure of $Pseudo\text{-}R^2$, I can summarise that the goodness of fit of the logit model during global financial crisis is superior to the model in the Asian financial crisis. Table 3 shows the regression coefficients. During the Asian financial crisis, the estimated coefficients for *SR/TA* have the expected negative sign, and are statistically significantly different from zero for 2Q–3Q (p < .01) and 1Q (p < .05). The coefficients for 4 of the 5 financial ratios (i.e., besides *WC/TA*) are statistically significant for 2Q. The predictability of Ratio *EBIT/TA* improved as the crisis point approached. Both DD_{Merton} and $DD_{Naïve}$ were non-significant predictors during the Asian financial crisis.

However, data in Table 4 show that during the global financial crisis, *RE/TA* had a statistically significant and negative effect on default probability for 1Q (p < .01), 2Q (p < .05%), and 3Q (p < .01). The coefficients for *WC/TA* and *EBIT/TA* exhibit a statistically significant difference in 1Q (p < .01) and 3Q (p < .05). According to the logit model analysis, I can observe various credit risk factors based on the accounting data during these two financial crises. The logit model results support those of the sample mean t test; that is, the differences in the solvency and asset turnover rate are less obvious between the default and non-default companies during the global financial crisis. The other critical finding is that DD_{Merton} is a significant default predictor, even when $DD_{Naïve}$ is included in Model 3. This implies that the stock price information model was a critical credit risk factor during the global financial crisis. However, the coefficient for $DD_{Naïve}$ is statistically non-significant.

Table 3: Logit Model Results (during the Asian Financial Crisis)

	1Q			2Q			3Q		
Variable	**Model 1**	**Model 2**	**Model 3**	**Model 1**	**Model 2**	**Model 3**	**Model 1**	**Model 2**	**Model 3**
CONST	1.090	0.964	0.984	1.047	0.923	0.997	1.368	1.348	1.377
	(0.150)	(0.215)	(0.220)	(0.063)	(0.104)	(0.086)	(0.018)*	(0.020)*	(0.021)*
WC/TA	-0.357	-0.240	-0.239	0.383	0.741	0.867	1.903	2.376	2.398
	(0.867)	(0.9106)	(0.911)	(0.812)	(0.649)	(0.597)	(0.239)	(0.158)	(0.156)
RE/TA	-6.830	-6.096	-6.006	-13.212	-12.799	-12.821	-7.777	-6.740	-6.573
	(0.150)	(0.203)	(0.218)	(0.003)**	(0.005)**	(0.005)**	(0.056)	(0.108)	(0.123)
EBIT/TA	-29.335	-29.485	-29.594	29.497	34.068	35.312	-7.412	-8.942	-9.377
	(0.051)	(0.049)*	(0.049)*	(0.037)*	(0.024)*	(0.019)*	(0.427)	(0.332)	(0.320)
ME/TL	-0.261	-0.168	-0.173	-0.265	-0.111	-0.108	-0.199	-0.099	-0.098
	(0.160)	(0.467)	(0.465)	(0.043)*	(0.495)	(0.512)	(0.067)	(0.377)	(0.385)
SR/TA	-10.209	-10.328	-10.300	-8.041	-8.686	-8.765	-10.203	-10.842	-10.902
	(0.026)*	(0.024)*	(0.025)*	(0.010)**	(0.006)**	(0.006)**	(0.002)**	(0.002)**	(0.001)**
DD_{Merton}		0.087	0.076		0.177	0.143		0.140	0.134
		(0.533)	(0.658)		(0.181)	(0.298)		(0.249)	(0.279)
$DD_{Naïve}$			0.020			0.131			0.031
			(0.916)			(0.388)			(0.832)
LR test	74.046	74.439	74.450	48.664	50.535	51.287	47.781	48.612	48.658
	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**
Pseudo-R^2	0.473	0.475	0.476	0.290	0.301	0.305	0.284	0.293	0.293

This table reports the estimation results of the logit model for the Asian financial crisis. CONST is the constant term, WC/TA is the company's financial ratio of working capital to total assets, RE/TA is the company's financial ratio of retained earnings to total assets, EBIT/TA is the company's financial ratio of earnings before interest and taxes to total assets, ME/TL is the company's financial ratio of market value equity to book value of total debt, and S/TA is the company's financial ratio of sales to total assets. DD_{Merton} *is the Merton distance to default and is calculated based on Equation (11).* $DD_{Naïve}$ *is the naïve distance to default and is calculated based on Equation (16). 1Q, 2Q, and 3Q mean the first, second, and third quarter prior to defaulting, respectively. The parenthesised values are p-values (* p < .05, ** p < .01).*

Table 4: Logit Model Results (During the Global Financial Crisis)

	1Q			2Q			3Q		
Variable	**Model 1**	**Model 2**	**Model 3**	**Model 1**	**Model 2**	**Model 3**	**Model 1**	**Model 2**	**Model 3**
CONST	-1.118	-2.360	-2.231	-0.633	-0.783	-0.701	-0.765	-0.558	-0.509
	(0.073)	(0.009)**	(0.014)*	(0.257)	(0.247)	(0.304)	(0.150)	(0.339)	(0.391)
WC/TA	-5.836	-3.307	-4.673	-3.007	-0.979	-0.982	-0.982	1.626	1.643
	(0.005)**	(0.140)	(0.078)	(0.088)	(0.6108)	(0.614)	(0.537)	(0.382)	(0.377)
RE/TA	-6.965	-5.961	-5.008	-4.696	-4.195	-3.745	-6.392	-6.474	-6.303
	(0.001)**	(0.003)**	(0.005)**	(0.041)*	(0.041)*	(0.079)	(0.002)**	(0.001)**	(0.002)**
EBIT/TA	0.454	-0.332	-2.957	-20.535	-16.124	-17.201	-29.878	-25.294	-25.366
	(0.907)	(0.928)	(0.497)	(0.052)	(0.089)	(0.084)	(0.012)*	(0.039)*	(0.040)*
ME/TL	0.000	0.101	0.104	-0.028	0.050	0.047	-0.021	0.024	0.024
	(0.998)	(0.031)*	(0.046)*	(0.486)	(0.230)	(0.246)	(0.547)	(0.540)	(0.543)
SR/TA	0.526	1.374	1.231	-1.082	-2.945	-3.104	-0.249	-2.423	-2.530
	(0.855)	(0.683)	(0.723)	(0.677)	(0.344)	(0.327)	(0.908)	(0.325)	(0.309)
DD_{Merton}		0.714	0.562		0.586	0.546		0.519	0.506
		(0.003)**	(0.013)*		(0.001)**	(0.003)**		(0.001)**	(0.002)**
$DD_{Naïve}$			0.540			0.148			0.069
			(0.053)			(0.445)			(0.660)
LR test	86.224	100.953	105.385	76.778	91.440	92.038	68.169	80.532	80.726
	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**
Pseudo-R^2	0.551	0.645	0.673	0.468	0.557	0.561	0.415	0.493	0.494

This table reports the estimation results of the logit model for the global financial crisis. CONST is the constant term, WC/TA is the company's financial ratio of working capital to total assets, RE/TA is the company's financial ratio of retained earnings to total assets, EBIT/TA is the company's financial ratio of earnings before interest and taxes to total assets, ME/TL is the company's financial ratio of market value equity to book value of total debt, and S/TA is the company's financial ratio of sales to total assets. DD_{Merton} is the Merton distance to default and is calculated based on Equation (11). $DD_{Naïve}$ is the naïve distance to default and is calculated based on Equation (16). 1Q, 2Q, and 3Q mean the first, second, and third quarter prior to defaulting, respectively. The parenthesised values are p-values (p < .05, ** p < .01).*

Predictive Power Among the Logit, Merton DD, and Naïve Models

To determine which model is superior in forecasting accuracy among the logit, Merton DD, and naïve models, I employed the CAP and ROC to test the discrimination, and employed the Brier score to test both the discrimination and calibration. Furthermore, the accuracy ratios, AUC, and Brier score are computed using the probabilities of default estimated by each model, and the default indicator variable for three quarters prior to default. Table 5 shows the estimated results, including two logit model results. The logit model in Model 1 only includes the traditional financial ratio-based Z-score variables. Model 4 combines the Z-score variables and DD_{Merton} in one logit model.

The results clearly show that the forecasting accuracy of all models improves as the crisis point approaches for both the Asian and global financial crisis. The average of the three quarters accuracy ratio is 73.27% in the logit model with only the Z-score variables during the Asian financial crisis; however, it reached 86.41% during the global financial crisis. The accuracy ratios, AUC, and Brier score all indicate that the logit model has better predictive power, followed by the Merton DD model, and finally the naïve model. Moreover, for the listed companies in Taiwan, the predictive power of the default probability for each model is better during the global financial crisis than during the Asian financial crisis. These estimated results show that the forecasting power of these models for predicting credit risk remains constant; thus, it is reasonable to assert that they maintain their applicability over time. Regarding the logit model in Model 1 (i.e., the Z-score variables only) and Model 4 (i.e., the Z-score variables and DD_{Merton}), the prediction ability of Model 4 is worse than Model 1 in 1Q and 2Q during the Asian financial crisis; however, compared with Model 1, Model 4 achieved considerable predictive power during the global financial crisis. This result supports the logit regression results shown in Section 4.1 and proves that the stock price information of the Merton DD model was a critical default predictor during the Global financial crisis.

Table 5: Validation of Credit Risk Models

	The Asian Financial Crisis Period			the Global Financial Crisis Period		
Model 1: Logit model (only with Z-score Variables)						
	1Q	2Q	3Q	1Q	2Q	3Q
CAP	0.822	0.697	0.679	0.901	0.853	0.838
ROC	0.911	0.849	0.840	0.951	0.926	0.919
Brier	0.107	0.148	0.151	0.077	0.099	0.113
Model 2: Merton DD Model						
	1Q	2Q	3Q	1Q	2Q	3Q
CAP	0.503	0.512	0.447	0.692	0.649	0.581
ROC	0.751	0.756	0.724	0.846	0.825	0.790
Brier	0.203	0.201	0.203	0.187	0.194	0.202
Model 3: Naïve Model						
	1Q	2Q	3Q	1Q	2Q	3Q
CAP	0.353	0.347	0.226	0.493	0.399	0.358
ROC	0.676	0.674	0.613	0.747	0.700	0.679
Brier	0.236	0.248	0.264	0.243	0.258	0.275
Model 4: Logit Model						
	1Q	2Q	3Q	1Q	2Q	3Q
CAP	0.820	0.694	0.687	0.933	0.898	0.876
ROC	0.910	0.847	0.843	0.967	0.949	0.938
Brier	0.106	0.143	0.145	0.066	0.086	0.098

This table reports the quality of credit risk models by evaluating the discriminatory power and calibration. CAP represents the accuracy ratio of the cumulative accuracy profile curve. ROC represents the area under the receiver operating characteristic curve. Brier is the Brier score. The logit model in Model 1 only includes the traditional financial ratio-based Z-score variables. Model 4 combines the Z-score variables and DD_{Merton} *into one logit model*

TCRI

TCRI is a credit rating index introduced by the *TEJ*. Having started to build this index since August 1991, the *TEJ* has formally provided the TCRI database for listed and public companies since August 1996. The TCRI is based on a "semi-expert judgment" process to obtain the rating of each company. First, the TCRI financial data are analysed using financial statement analyses and statistical models to calculate its "comprehensive scores." Subsequently, a "basic rating" is assigned according to the comprehensive scores. Second, the *TEJ* calculates two threshold limits by considering its risk-tolerance level and revenue scale. Finally, the *TEJ* employs certain non-quantitative factors, such as accounting quality, information before next financial reports released, industry future prospects, and the risk preferences level of the management team to determine the TCRI (See the TEJ website, http://www.tej.com.tw/twsite/.). The accuracy ratios and AUC shown in Table 6 are very close to 100% in 1Q during the Asian and global financial crises. This implies that the TCRI can discriminate 100% and 99% of the failed companies during Asian and global financial crises, respectively. Comparing with Models 1 and 4 of Table 5 shows that the accuracy ratios, AUC, and Brier score all demonstrate that the capability of discrimination and calibration of the TCRI is worse than that of the logit model in 3Q. The logit model with only the Z-score variables can predict the default crisis earlier than the TCRI. This also implies that the Z-score introduced by Altam almost 40 years ago is more effective than the other models.

Table 6: Validation of TCRI

	The Asian Financial Crisis Period			The Global Financial Crisis Period		
	1Q	2Q	3Q	1Q	2Q	3Q
CAP	1.000	0.805	0.616	0.993	0.921	0.825
ROC	1.000	0.902	0.808	0.997	0.961	0.913
Brier	48.902	39.621	34.568	47.130	41.116	37.519

This table reports the quality of TCRI by evaluating discriminatory power and calibration. CAP represents the accuracy ratio of the cumulative accuracy profile curve. ROC represents the area under the receiver operating characteristic curve. Brier is the Brier score.

CONCLUDING COMMENTS

This study examined the differences among credit risk factors in Taiwan during the Asian and global financial crises. Using Taiwanese listed companies' data, First, I captured variables from Altman's (1968) Z-score model, a pioneer and notable model based on Accounting Data, from the Merton distance to default (DD) model, and from the naïve probability model-an alternative of the Merton DD model. The significance of the Z-score model variables are examined by applying the logit model. Furthermore, the forecasting ability of the logit model, Merton DD model, naïve probability, and the Taiwan corporate credit rating index are compared. The results show that *SR/TA* was the most critical financial ratio during the Asian financial crisis; conversely, *RE/TA* was the most crucial financial ratio during the global financial crisis. Observing the contribution of the stock price information, the Merton distance to default was a critical predictor of credit risk during the global financial crisis; however, the performance of the naïve distance to default was poor. Regarding the model forecasting ability, the logit model using Altman's Z-score variables offers superior predictive power, and forecasts the default crisis for Taiwanese listed companies earlier than the TCRI. By incorporating DD_{Merton} variable into the logit model, the predictive ability of the traditional logit model can be improved quite substantially for the global financial crisis. Bharath and Shumway (2008) conclude that (a) DD_{Merton} is not a sufficient statistic for forecasting default, and (b) the iterative procedure for solving the Merton DD model is not useful. However, according to this study, the introduction of $DD_{Naïve}$ does not get the result of Bharath and Shumway (2008). The most serious limitation of my paper is that default samples of Taiwanese listed companies' data samples is too small to enhance the accuracy of the predictive power of the model. Constructing a new prediction model of default rate is my directions for future research.

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WHY SHARE REPURCHASES ARE NOT A PANACEA FOR INCREASING SHARE PRICES

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ABSTRACT

This research examines factors deteriorating share price performance before and after repurchase announcements. We find share price performance before announcements can be attributed to operating performance and agency problems. But, operating performance is the primary factor determining undervaluation. We also find that, regardless of whether firms are undervalued before repurchase announcements, those that experience negative abnormal returns after repurchase announcements have inferior operating performance and lower buyback premiums. Our regression analysis shows that an improvement in future operating profits determines prosperous share price performance after repurchase announcements. Lack of investment, or those made with agency problems, better explain poor share-price performance.

JEL: G35, G14

KEYWORDS: Share Repurchase, Abnormal Returns, Operating Performance, Agency Problems

INTRODUCTION

Share repurchases have emerged as an important payout device in Taiwan since August 2000. However, the research on share repurchases in Taiwan is limited because most research focuses on repurchases in mature markets, such as the U.S. and U.K. One well-known motivation for announcing repurchases is that management expresses its disagreement with current share price performance (Brav, Graham, Harvey, and Michaely, 2005). Other studies advocate the signalling hypothesis and the free cash flow hypothesis. The former hypothesis predicts repurchase announcements as an intermediary to convey information about future improvement in earnings or profits (Grullon and Ikenberry, 2000). By contrast, the latter suggests that repurchases are carried out to disgorge excess free cash flow and mitigate agency problems existing in firms with fewer investment opportunities. The controversial propositions of previous studies and the versatile nature of share repurchases make us suspect that undervaluation preceding repurchase announcements is not merely a problem of mispricing. Instead, it may reflect investors' evaluation based on a certain under performance of repurchasing firms. For instance, undervaluation may result from agency problems existing in firms. Distributing excess cash flow by repurchase mitigates agency problems, which in turn increases future share price. Neglecting the existence of agency problems could lead to the conclusion that share repurchases convey information about undervaluation. Thus, discovering whether share price before repurchase announcements relates to firms' performance is helpful for understanding underlying reasons firms buy back. We presume that the share price relates to either operating performance or agency problems before repurchase announcements.

In addition, although good news is thought to be implicit in repurchase announcements, not all firms experience increases in share price after the announcements. Su and Lin (2012), who examine share repurchases in Taiwan, discover the long-term abnormal returns after repurchase announcements are negative. Little attention has been paid to the firms which experience negative abnormal returns after repurchase announcements. This paper conjectures the phenomenon may result from either false information about future operating performance or the existence of agency problems.

Because repurchases are not expected to be a recurrent event, such as dividend announcements, firms that foresee a recession in or are less confident about future operating performance may mimic their competitors' payout policies and use repurchases to convey false signals (D'Mello and Shroff, 2000). Investors may not be capable of unravelling this information in the short term. However, a 12-month period should be enough for them to distinguish between true and false information. This research contrasts firms which have negative 12-month buy-and-hold abnormal returns after repurchase announcements with those which have positive abnormal returns to verify the conjecture. We expect to discover different firm characteristics existing between firms with positive and negative abnormal returns. Furthermore, we aim to identify determinants of share price after repurchase announcements.

We examine share repurchases announced by listed firms in Taiwan from 2000 to 2008. Our evidence shows that both operating performance and agency problems affect share price performance after repurchase, but the former factor primarily determines undervaluation. For both undervalued and non-undervalued firms, we found that those experiencing negative abnormal returns after repurchase had worse operating performance and buyback with lower premiums. The experience of positive abnormal returns after repurchase is more likely the reward for the improvement in operating profits. By comparison, lack of capital investments or those made by firms with agency problems deteriorates share price after repurchase, consistent with the free cash flow hypothesis. The rest of this paper is organised as follows: The next section reviews related literature on share repurchase. Next, we describe the data and the empirical method employed to detect factors affecting share price performance. The following section discusses the empirical results. The paper closes with some concluding comments.

LITERATURE REVIEW

Many empirical studies indicate that share repurchases that express management's disagreement with current prices successfully raise firm value afterwards. In the U.S. and Canadian markets, Ikenberry, Lakonishok, and Vermaelen (1995) and Ikenberry, Lakonishok, and Vermaelen (2000) find that positive long-term cumulative abnormal returns last for four years after share repurchases are announced, and their findings are more apparent for undervalued firms. In the U.K., Rau and Vermaelen (2002) and Oswald and Young (2004) show that abnormal returns following repurchases negatively relate to those preceding the announcements. In Taiwan, Chen, Kao, and Lin (2011) discover that undervaluation before repurchases is negatively associated with one-month and twelve-month abnormal returns after repurchase. Li and McNally (2003), Jagannathan and Stephens (2003), and Hatakeda and Isagawa (2004), among others, also provide evidence supporting the undervaluation hypothesis.

However, undervalued firms may announce share repurchases for other purposes. Both Dann, Masulis, and Mayers (1991) and Lie (2005) demonstrate an improvement in operating performance following repurchase announcements, supporting the signalling hypothesis. Lie and McConnell (1998) further present that the firms repurchased by Dutch auction have better operating performance than their competitors for five years following the repurchase. Evidence from Chen *et al.* (2011) indicates that improvement in operating profit explains both short- and long-term future abnormal returns. Hung and Chen (2010) find that undervalued firms with higher buyback prices experience better future operating performance for at least three years.

The free cash flow hypothesis, on the other hand, proposes that repurchases are carried out to disgorge excess free cash flow and mitigate agency problems existing in firms with fewer investment opportunities. Nohel and Tarhan (1998) show that firms with agency problems have better operating performance after disgorging free cash flow by repurchases. Dittmar (2000) applies the Tobit Model and examines a number of potential motivations for repurchases. She suggests that repurchases are carried out to release information about undervaluation and disgorge excess cash flow. Fenn and Liang (2001) confirm that firms with fewer investment opportunities pay higher dividends or repurchase more shares. Grullon and Michaely (2004) suggest that mature firms normally have less investment opportunities and excess free cash flow. They buy back to distribute excess cash flow and signal their maturation. Mitchell and Dharmawan (2007) examine the Australian market and propose that reducing agency costs is more likely the motivation for large firms and firms that buy back a high percentage of shares. By contrast, small firms tend to repurchase to signal undervaluation. Although some studies simultaneously examine more than one motivation for repurchases, most neglect the potential relation that may exist between the motivations. This research presumes that undervaluation before repurchase announcements may result from poor operating performance or agency problems. We further argue that, particularly in the long term, share repurchase is not always an effective device to increase share price. We presume that share price performance is determined by improvement in operating performance or the existence of agency problems after repurchase announcements rather than repurchases *per se*.

DATA AND METHODOLOGY

This paper examines repurchase programmes announced by firms listed on the Taiwan Stock Exchange (TWSE) from August 2000 to the end of 2008. Details of repurchase programmes were acquired from the Market Observation Post System (MOPS) affiliated with the TWSE. The Taiwan Economic Journal database (TEJ) provided financial data and share prices of the firms. During the eight-year period, there were a total of 1,920 repurchase programmes announced by 468 firms. The firms listed in the finance sector, Taiwan Depositary Receipts (TDRs), Real Estate Investment Trusts (REITs) and foreign companies whose financial statements are reported in foreign currencies and were dropped from the sample. For those firms that announced a repurchase twice or more in a financial year, this research only adopted the first announcement. The sample does not contain announcements that were not carried out afterwards. After applying the above criteria, 858 firm-year observations were retained in the sample. In addition, a match firm-year within the same industry section was assigned for each firm-year observation based on the other two criteria:

Criteria 1-$0.25 \times (\mathrm{TA}_{\mathrm{RP\ firm}}) \leq \mathrm{TA}_{\mathrm{Match\ firm}} \leq 2 \times (\mathrm{TA}_{\mathrm{RP\ firm}})$

$$Min(|EBITDA_{RP\ Firm} - EBITDA_{Match\ Firm}|)$$

where TA denotes the total assets at the end of the year before repurchase announcements. EBITDA is earnings before interest, taxes, depreciation and amortisation at the end of the year before repurchase announcements scaled by TA. The first criterion ensures that both repurchase firms and match firms have similar firm size. The second criterion minimizes the divergence of EBITDA before repurchase announcements because the variable simultaneously reflects firms' operating performance and, to some extent, cash flow before deducting non-cash items and spending for interest and taxes. We expect firms with the same industry sector, similar firm size and operating performance should perform similarly in share price returns.

This research splits the observations respectively based on the buy-and-hold abnormal returns for 12 months before and after repurchase announcements (hereafter $BHAR_i(-12,-1)$ and $BHAR_i(1,12)$, respectively). We employed two benchmarks to estimate BHARs. The first benchmark was return of the Taiwan Capitalization Weighted Stock Index (i.e. market return). The second was the return of match firms. BHARs were calculated as the difference between the buy-and-hold returns of repurchase firm and each of the benchmarks over the given period. We designated firms with negative $BHAR_i(-12,-1)$ as undervalued firms. Those with positive $BHAR_i(-12,-1)$ were non-undervalued firms. Panel A and Panel B of Table 1, respectively, present the numbers of observations and share price performance of the groups formed by the market-adjusted BHARs and the match-firm-adjusted BHARs (hereafter match-adjusted BHARs). Because similar patterns are shown in the two panels, we only discuss Panel A to keep the discussion compact. Panel A shows that 617 out of 858 observations were designated as undervalued firms (Group A), while 241 observations were non-undervalued (Group B). Group A experienced -34.28% $BHAR_i(-12,-1)$ on average, and Group B experienced 20.25%. When forming the groups by match-adjusted $BHAR_i(-12,-1)$, Panel B shows that 505 firms were undervalued before repurchase. The number of undervalued firms dominated 58.86% of the full sample, but they were slightly less than those presented in Panel A. The non-undervalued firms accounted for the other 41.14% of observations.

Table 1: Summary Statistics

Panel A: Market- adjusted BHARs				
Groups	**Group A (Undervalued)**		**Group B (Non-undervalued)**	
	$BHAR_i(-12,-1) < 0$		$BHAR_i(-12,-1) > 0$	
N	617		241	
% of the Sample	71.91%		28.09%	
Mean	-0.3448		0.2025	
Median	-0.2941		0.1533	
Groups	1	2	3	4
	$BHAR_i(1,12) < 0$	$BHAR_i(1,12) > 0$	$BHAR_i(1,12) < 0$	$BHAR_i(1,12) > 0$
N	249	368	109	132
% of the Group	40.36%	59.64%	45.23%	54.77%
Mean	-0.2537	0.3168	-0.2326	0.2629
Median	-0.2054	0.2597	-0.2026	0.2111
Panel B: Match-adjusted BHARs				
Groups	**Group A (Undervalued)**		**Group B (Non-undervalued)**	
	$BHAR_i(-12,-1) < 0$		$BHAR_i(-12,-1) > 0$	
N	505		353	
% of the Sample	58.86%		41.14%	
Mean	-0.3862		0.3123	
Median	-0.3103		0.2357	
Groups	1	2	3	4
	$BHAR_i(1,12) < 0$	$BHAR_i(1,12) > 0$	$BHAR_i(1,12) < 0$	$BHAR_i(1,12) > 0$
N	237	268	157	196
% of the Group	46.93%	53.07%	44.48%	55.52%
Mean	-0.3577	0.3811	-0.3275	0.4044
Median	-0.2836	0.3348	-0.2576	0.3204

Notes: The return of the Taiwan Capitalization Weighted Stock Index is the benchmark for the market-adjusted BHARs in Panel A. The return of the match firm in the same industry, with similar size and EBITDA performance is the benchmark for the match-adjusted BHARs in Panel B. N is the number of observations in each group.

This research further splits Group A and Group B based on whether their observations experienced negative BHARs after repurchase announcements (i.e. $BHAR_i(1,12)$). Panel A shows that 59.64% of the undervalued firms experienced positive BHARs of 31.68% in the 12 months after repurchase announcements (Group 2). By comparison, 40.36% of the undervalued firms continuously encountered negative BHARs of -25.37% (Group 1). We also found that 45.23% of the non-undervalued firms experienced negative BHARs afterwards (Group 3). The mean (median) $BHAR_i(1,12)$ for Group 3 was -23.26% (-20.26%), which was significantly different from zero (not shown in the table). The presence of Group 3 highlighted our primary question: why share repurchases do not always lift share price for repurchasing firms.

RESULTS AND DISCUSSION

Undervaluation and Firm Performance before Repurchase Announcements

This section examines whether undervaluation can be attributed to firm performance before repurchase announcements. If the undervaluation essentially results from the market's incorrect or irrational pricing, we predict that undervalued and non-undervalued firms have similar performance in operating profits, free cash flow, or capital expenditures. The examinations were carried out by contrasting both raw performance and match-adjusted performance. We computed match-adjusted performance as the difference between the performance of repurchasing firms and match firms. The examination of the match-adjusted performance took account of the fact that investors' evaluations of firm value may vary with changes in economy and industry conditions across years. For example, a drop in annual earnings is not favourable information, but it happens to a majority of firms in a recessionary period. In this scenario, one should compare a firm's performance to its competitors' when evaluating firm value. The change in operating profits over the four quarters before repurchase announcements ($\Delta OP_{i,t-1}$) was employed to measure operating performance, which was already known when firms announce share repurchases. Employment of the four-quarter financial items rather than year-end annual items helped reflect more recent firm performance. If undervaluation resulted from poor operating performance, non-undervalued firms were predicted to have higher $\Delta OP_{i,t-1}$ than undervalued firms.

In addition, change in free cash flow ($\Delta FCF_{i,t-1}$) and capital expenditures ($CE_{i,t-1}$) over the four quarters before repurchase announcements were employed to determine whether repurchasing firms suffer from agency problems. We compute free cash flow as cash flow from operating activities less net investment in fixed assets, interest payments, and taxes. Capital expenditures include net spending on long-term investment and fixed assets. Firms with fewer investment opportunities tend to have higher free cash flow and fewer capital expenditures. Without announcing repurchase and disgorging excess cash flow, management may abuse free cash flow and invest in negative NPV programs, decreasing firm value. If undervaluation results from agency problems, the free cash flow hypothesis predicts that undervalued firms should have higher $\Delta FCF_{i,t-1}$ and lower $CE_{i,t-1}$.

Table 2 shows that the main divergence between undervalued firms (Group A) and non-undervalued firms (Group B) was found amid the change in operating profits ($\Delta OP_{i,t-1}$). While non-undervalued firms experienced positive $\Delta OP_{i,t-1}$ of 0.0129, undervalued firms had negative $\Delta OP_{i,t-1}$ of -0.0091. The difference in match-adjusted $\Delta OP_{i,t-1}$ also suggests that non-undervalued firms outperformed undervalued firms in operating profits before repurchase announcements. In addition, Table 2 shows that non-undervalued firms had an increase in free cash flow (0.0172) that was significantly higher than the change in free cash flow of undervalued firms (-0.0023). However, no significant difference was found for match-adjusted $\Delta FCF_{i,t-1}$ between the two groups. We developed the following model to examine whether firm performance directly influences $BHAR_i(-12,-1)$:

$$BHAR_i(-12,-1)=\alpha+\beta_1\Delta OP_{i,t-1}+\beta_2\Delta FCF_{i,t-1}+\beta_3\Delta FCF_{i,t-1}*DQ+\beta_4 CE_{i,t-1}+\beta_5 CE_{i,t-1}*DQ+\varepsilon_{i,t-1} \quad (1)$$

where DQ is a dummy of Tobin's Q employed as a proxy for agency problems. Tobin's Q is calculated as the ratio of market to book value of total assets. The dummy variable takes the value of one when the Q ratio is smaller than one, an indication of agency problems, and zero otherwise. The inclusion of the interaction variables, $\Delta FCF_{i,t-1}*DQ$ and $CE_{i,t-1}*DQ$, examined whether the existence of agency problems with free cash flow or capital expenditures caused undervaluation before repurchase announcements. We respectively regressed market-adjusted $BHAR_i(-12,-1)$ on raw variables and match-adjusted $BHAR_i(-12,-1)$ on match-adjusted variables.

Table 2: Contrasting Firm Performance before Repurchase Announcements

		Group A		Group B		T	Z
		Mean	**Median**	**Mean**	**Median**		
Panel A: Groups formed by market-adjusted BHARs							
Raw Variables	$\Delta OP_{i,t-1}$	-0.0091	-0.0051	0.0129	0.0082	-7.245***	-7.567***
	$\Delta FCF_{i,t-1}$	-0.0023	-0.0028	0.0172	0.0125	-2.443**	-2.610***
	$CE_{i,t-1}$	0.0263	0.0119	0.0228	0.0108	0.856	-1.180
Panel B: Groups formed by match-adjusted BHARs							
Match-adjusted Variables	$\Delta OP_{i,t-1}$	-0.0186	-0.0101	0.0133	0.0078	-7.612***	-7.512***
	$\Delta FCF_{i,t-1}$	0.0039	0.0021	-0.0038	0.0036	0.679	-0.183
	$CE_{i,t-1}$	0.0009	0.0006	0.0008	-0.0001	0.018	-1.481

*Notes: The significance levels of the means and medians are based on two-tailed t-test and Wilcoxon signed rank test. The significance at 0.01, 0.05 and 0.1 levels are marked with ***, **, and * respectively.*

For the full sample, Table 3 shows that both operating performance and agency problems affected BHARs before repurchase announcements. The coefficient estimates for $\Delta OP_{i,t-1}$ in Columns 1 and 2 were 1.637 and 2.213, respectively, both of which are significant at one percent level. The strong effect found for $\Delta OP_{i,t-1}$ indicated that share price performance before repurchase is primarily associated with firms' operating performance. The negative coefficient estimates found for the interaction variables, $\Delta FCF_{i,t-1}$*DQ and $CE_{i,t-1}$*DQ, suggest that increases in free cash flow or capital expenditures associated with agency problems deteriorated BHARs before repurchase. For undervalued firms, Columns 3 and 4 show that change in operating profits ($\Delta OP_{i,t-1}$) appeared to be the primary factor determining $BHAR_i$(-12,-1). Column 3 also shows the coefficient estimate for the interaction variable of $CE_{i,t-1}$*DQ was -0.968 and marginally significant, indicating the presence of agency problems hampers the positive effect of capital expenditures on share price before repurchase announcements.

Table 3: Determinants of Abnormal Returns before Repurchase Announcements

Variables	Expt. sign	Full Sample		Group A		Group B	
		(1)	(2)	(3)	(4)	(5)	(6)
$\Delta OP_{i,t-1}$	+	1.637***	2.213***	1.082***	1.987***	-0.696	0.855**
		(4.07)	(6.19)	(3.55)	(5.52)	(-1.17)	(2.56)
$\Delta FCF_{i,t-1}$	+	0.261	-0.003	-0.044	-0.095	0.573**	0.215
		(1.11)	(-0.02)	(-0.20)	(-0.49)	(2.01)	(0.89)
$\Delta FCF_{i,t-1}$*DQ	-	-0.793**	-0.300	-0.406	-0.133	-0.139	-0.023
		(-2.54)	(-0.94)	(-1.50)	(-0.46)	(-0.32)	(-0.08)
$CE_{i,t-1}$	+	0.175	-0.040	0.440	-0.078	0.378	0.713
		(0.51)	(-0.07)	(1.15)	(-0.19)	(1.36)	(1.40)
$CE_{i,t-1}$*DQ	-	-1.330**	0.154	-0.968*	0.033	0.686	-0.334
		(-2.49)	(0.23)	(-1.87)	(0.06)	(1.02)	(-0.35)
R^2		0.077	0.101	0.074	0.139	0.082	0.082
F- Statistics		5.80***	8.15***	4.41***	6.54***	1.84	2.25*
Observations		853	853	614	502	239	351

*Notes: For Column 1, 3, and 5, the dependent variable is market-adjusted BHARs and the explanatory variables are raw variables. For Column 2, 4, and 6, the dependent variable is match-adjusted BHARs, and the explanatory variables are match-adjusted variables which are the paired differences between the performance of the repurchase firms and the performance of their match firms. Expt. sign is the expected signs of coefficients based on the predictions of the hypotheses. The model is estimated by fixed-effect approach. Standard errors are robust to heteroscedasticity. The t-statistics are in parentheses. The significance at 0.01, 0.05 and 0.1 levels are marked with ***, **, and * respectively.*

The findings suggest that the market's irrational pricing or mispricing is unlikely the primary factor responsible for undervaluation. For non-undervalued firms, the change in match-adjusted operating profits and the change in free cash flow had a positive effect on BHARs before repurchase. Column 6 shows the coefficient for match-adjusted $\Delta OP_{i,t-1}$ was 0.855 with significance at the five percent level. The effect of

$\Delta OP_{i,t-1}$ for non-undervalued firms was not as explicit as that for undervalued firms. It may have resulted from the fact that investors normally react more strongly to bad news than to good news. Additionally, Column 5 shows that change in free cash flow was positively associated with BHARs before repurchase announcements. For non-undervalued firms, the increase in free cash flow does not cause agency problems which would deteriorate share price. The result implies that signalling for operating performance could be the primary purpose for non-undervalued firms to repurchase.

Factors Affecting Share Price after Repurchase Announcements for Undervalued Firms

As the findings in Table 3 suggest that poor performance in operating profits is the primary factor causing undervaluation before repurchase announcements, we presumed that undervalued firms announced repurchases to signal better prospects for future operating performance. The experience of negative BHARs after repurchase announcements was a penalty for failing to achieve the announcements signalled performance. The marginal and negative interaction effect found for capital expenditures and agency problems in Table 3 also indicates that the continuous existence of agency problems could also be the factor determining share price after repurchase.

According to the signalling hypothesis, we presumed that firms with negative abnormal returns after repurchase announcements (Group 1) have worse operating performance than those with positive abnormal returns (Group 2). Post-announcement operating performance was measured by the changes in operating profits over the four quarters after repurchase announcements (including the event quarter). The change in free cash flow ($\Delta FCF_{i,t}$) and the capital expenditures ($CE_{i,t}$) over the four quarters after repurchase announcements were employed to examine the free cash flow hypothesis.

After repurchase, Group 1 was predicted to retain more free cash flow and have less capital expenditure, both of which may cause agency problems and a decline in share price. In addition, we contrasted buyback premium ($PM_{i,t}$) and repurchase ratio ($RP_{i,t}$) to find out whether increases in cash payouts by repurchase could please investors and lift share price for a 12-month period. Buyback premium ($PM_{i,t}$) was calculated by subtracting one from the ratio of the average buyback price to the announcement day share price. Repurchase ratio ($RP_{i,t}$) was calculated as the ratio of payouts on repurchase to market capitalisations on the announcement day.

A different extent of undervaluation may affect BHARs after repurchase. To control for this effect, we contrasted $BHAR_i(-12,-1)$ to ensure the two groups had similar return performance before repurchase announcements. Table 4 shows the main differences between the two groups existed in the change in operating profits after repurchase announcements ($\Delta OP_{i,t}$) and buyback premium ($PM_{i,t}$). Although both Group 1 and Group 2, on average, experienced a decline in operating profits after repurchase, Group 1 had worse performance. The divergence becomes larger when $\Delta OP_{i,t}$ is adjusted by the performance of match firms. Group 2 clearly outperformed Group 1 in the change in market-adjusted operating profits after repurchase announcements. Higher mean and median buyback premiums ($PM_{i,t}$) were also found for Group 2, regardless of whether the groups were formed by market- or match-adjusted BHARs. In addition, Table 4 shows that Group 2 had a larger median $\Delta FCF_{i,t}$ (0.0220) and higher median match-adjusted $CE_{i,t}$ (0.0013) than Group 1. The latter result is consistent with the free cash flow hypothesis prediction.

To discover whether differences between the two groups directly affected share price performance after repurchase announcements, we developed the following regression model:

$$BHAR_i(1,12)=\alpha+\gamma_1\Delta OP_{i,t}+\gamma_2\Delta FCF_{i,t}+\gamma_3 CE_{i,t}+\gamma_4 CE_{i,t}*DQ+\gamma_5 BHAR_i(-12,-1)+\gamma_6 PM_{i,t}+\gamma_7 RP_{i,t}+\varepsilon_{i,t} \quad (2)$$

where the change in operating profits after repurchase announcements ($\Delta OP_{i,t}$) was predicted to have a positive effect on $BHAR_i(1,12)$ if share repurchases were announced to signal future operating performance. On basis of the free cash flow hypothesis, we presumed that disgorging free cash flow by repurchase and high capital expenditures would mitigate agency problems and result in an share-price increase. Inclusion of the interaction variable of capital expenditure and agency problem ($CE_{i,t}$*DQ) was to examine whether investments of a firm with agency problems have negative effects on share price after repurchase. The inclusion of $BHAR_i(-12,-1)$ examined whether undervaluation was followed by a bounce back in share price after repurchase. Buyback premium ($PM_{i,t}$) and repurchase ratio ($RP_{i,t}$), on the other hand, were included to examine whether increasing cash payouts by repurchase could successfully lift share price. Market-adjusted and match-adjusted $BHAR_i(1,12)$ were respectively regressed on raw and match-adjusted explanatory variables.

Table 4: Contrasting Firm Performance after Repurchase Announcements – Undervalued Firms

		Group 1		Group 2		T	Z
		Mean	**Median**	**Mean**	**Median**		
Panel A: Groups Formed by Market-Adjusted BHARS							
Raw Variables	$\Delta OP_{i,t}$	-0.0170	-0.0125	-0.0028	0.0000	-4.521***	-5.201***
	$\Delta FCF_{i,t}$	0.0152	0.0064	0.0268	0.0220	-1.299	-2.183**
	$CE_{i,t}$	0.0210	0.0093	0.0197	0.0087	0.361	-0.228
	$BHAR_i(-12,-1)$	-0.3479	-0.2924	-0.3427	-0.2991	-0.246	-0.145
	$PM_{i,t}$	0.2505	0.1911	0.3710	0.2869	-3.277***	-3.176***
	$RP_{i,t}$	0.0291	0.0223	0.0283	0.0227	0.384	-0.129
Panel B: Groups Formed by Match-Adjusted BHARS							
Match-adjusted Variables	$\Delta OP_{i,t}$	-0.0249	-0.0158	0.0102	0.0055	-6.044***	-6.670***
	$\Delta FCF_{i,t}$	-0.0042	-0.0082	0.0008	0.0069	-0.315	-0.616
	$CE_{i,t}$	-0.0051	-0.0017	0.0014	0.0013	-1.256	-2.269**
	$BHAR_i(-12,-1)$	-0.3869	-0.3078	-0.3855	-0.3110	-0.047	-0.297
	$PM_{i,t}$	0.3149	0.2457	0.3936	0.3219	-1.883*	-2.271**
	$RP_{i,t}$	0.0263	0.0189	0.0292	0.0223	-1.304	-1.420

*Notes: $BHAR_i(-12,-1)$ is twelve-month buy-and-hold returns adjusted by market returns (Panel A) or returns of the match firms (Panel B). Match-adjusted variables are the paired differences between the performance of the repurchase firms and the performance of their match firms. The significance levels of the means and medians are based on two-tailed t-test and Wilcoxon signed rank test. The significance at 0.01, 0.05 and 0.1 levels are marked with ***, **, and * respectively*

Table 5 shows that, for the full sample, the change in operating profits ($\Delta OP_{i,t}$) had significant and positive effects on $BHAR_i(1,12)$. The coefficients for $\Delta OP_{i,t}$ in Columns 1 and 2 were 2.060 and 2.435, both of which were predominant in explaining $BHAR_i(1,12)$ for the full sample. The effect of capital expenditures ($CE_{i,t}$) for those firms with existing agency problems was inconclusive. Column 2 in Table 5 shows that match-adjusted $CE_{i,t}$ appeared to induce positive BHARs after repurchase announcements. For firms with existing agency problems, match-adjusted BHARs decreased with match-adjusted $CE_{i,t}$. On the other hand, Column 1 shows that the interaction variable $CE_{i,t}$ *DQ is positively associated with market-adjusted $BHAR_i(1,12)$. This finding is contrary to the prediction of the free cash flow hypothesis. In addition, the negative relation between BHARs before and after repurchase announcements indicated that more negative abnormal returns before the announcements are followed with a larger reverse afterwards.

For undervalued firms, the change in operating profits ($\Delta OP_{i,t}$) is the only factor that simultaneously affects $BHAR_i(1,12)$ for both Group 1 and Group 2. The coefficient for $\Delta OP_{i,t}$ in Column 4 is 1.253 with significance at the ten-percent level. The effect suggests that undervalued firms experience a decline in share price after repurchase announcements partially due to their poor operating performance. Column 4 also presents that coefficient estimates for the change in match-adjusted free cash flow ($\Delta FCF_{i,t}$) and match-adjusted $CE_{i,t}$ *DQ were -0.368 and -1.975, both of which were significant at the ten percent level. These findings suggest that while agency problems exist in undervalued firms, increases in free cash flow and high capital investment are likely to decline BHARs after repurchase announcements. The evidence is consistent with the prediction of the free cash flow hypothesis. In addition, the significantly negative coefficient for repurchase ratio ($RP_{i,t}$) in Column 4 implies that without decent operating performance, management cannot please investors by increasing the repurchase ratio.

Table 5: Determinants of Abnormal Returns after Repurchase Announcements – Undervalued Firms

Variables	Expt.	Full Sample		Group 1		Group 2	
	sign	(1)	(2)	(3)	(4)	(5)	(6)
$\Delta OP_{i,t}$	+	2.060***	2.435***	1.009	1.253*	1.339*	1.103**
		(4.65)	(5.74)	(1.56)	(1.86)	(1.81)	(2.12)
$\Delta FCF_{i,t}$	-	0.199	-0.080	0.026	-0.368*	0.290*	0.077
		(1.41)	(-0.59)	(0.11)	(-1.70)	(1.77)	(0.26)
$CE_{i,t}$	+	-0.782	1.374***	-1.193	0.765	0.592	-1.427
		(-1.35)	(2.68)	(-1.28)	(0.92)	(1.12)	(-0.67)
$CE_{i,t}$ *DQ	-	1.201**	-1.489*	1.485*	-1.975*	-0.997	2.402
		(2.21)	(-1.69)	(1.94)	(-1.81)	(-0.81)	(0.94)
$BHAR_i(-12,-1)$	-	-0.286***	-0.046	-0.164	-0.126	-0.184	-.0414
		(-5.98)	(-0.83)	(-1.27)	(-0.91)	(-1.12)	(-0.31)
$PM_{i,t}$	+	0.010	-0.008	-0.117	0.162	0.141	0.154*
		(0.22)	(-0.18)	(-1.36)	(1.14)	(1.53)	(1.66)
$RP_{i,t}$	+	-0.390	0.904	0.846	-5.053**	1.859	0.276
		(-0.64)	(0.91)	(1.47)	(-2.53)	(1.63)	(0.16)
R^2		0.127	0.120	0.157	0.214	0.118	0.146
F- Statistics		11.66***	6.59***	4.18***	2.41**	1.87*	1.64
Observations		853	853	248	236	366	266

*Notes: For column 1, 3, and 5, the dependent variable is market-adjusted BHARs and the explanatory variables are raw variables. For Column 2, 4, and 6, the dependent variable is match-adjusted BHARs, and the explanatory variables are match-adjusted variables. Expt. sign is the expected signs of coefficients based on the predictions of the hypotheses. The model is estimated by fixed-effect approach. Standard errors are robust to heteroscedasticity. The t-statistics are in parentheses. The significance at 0.01, 0.05 and 0.1 levels are marked with ***, **, and * respectively.*

Columns 5 and 6 present a more prominent effect of the change in operating profits ($\Delta OP_{i,t}$) for Group 2 than for Group 1. Buyback premium ($PM_{i,t}$) and the change in free cash flow ($\Delta FCF_{i,t}$) were the other positive factors that affected $BHAR_i(1,12)$, but the effects were weaker than $\Delta OP_{i,t}$. The evidence for Group 2 suggests that improvement in operating performance is the primary factor leading to positive returns after repurchase, while increases in free cash flow and buyback premium also favour share price. Combined with the findings in Table 3, the evidence for undervalued firms implies that operating performance is the primary factor determining share price after repurchase. The evidence supports our initial presumption, which suggested that repurchases announced by undervalued firms may either signal improvement in operating performance or the release of false information. Apparently, firms which did not have satisfying operating performance were penalised with negative BHARs after repurchase. In addition, we found the free cash flow hypothesis was only capable of explaining share price performance for Group 1. Group 2, which experienced positive BHARs after repurchase. This finding was well predicted by the signalling hypothesis.

<u>Factors Affecting Share Price after Repurchase Announcements of Non-Undervalued Firms</u>

We repeated the examinations and estimated Model 2 for non-undervalued firms. Particularly for non-undervalued firms that experienced positive BHARs before repurchase announcements, we attempted to discover the factors causing disappointing share price performance after repurchase announcements. Table 6 demonstrates that Group 3, which experienced negative BHARs after repurchase announcements, had worse operating performance than Group 4. Group 3 not only experienced a decline in operating profits (-0.0166) but also a decline in adjusted operating profits (-0.0138). It is unlikely that Group 3 announced repurchases to signal improvement in operating profits. Instead, it seemed to be releasing false information or trying to please investors with repurchase payouts. Even if Group 3 repurchased to please investors, Group 4 on average paid a buyback premium ($PM_{i,t}$) of 0.6080, which was much higher than the 0.3128 of Group 3. For Group 3, the costs of repurchase perhaps were too high to mimic.

Table 6: Contrasting Firm Performance after Repurchase Announcements – Non-Undervalued Firms

		Group 3		Group 4		T	Z
		Mean	Median	Mean	Median		
Panel A: Groups Formed By Market-Adjusted Bhars							
Raw Variables	$\Delta OP_{i,t}$	-0.0166	-0.0093	0.0000	0.0024	-2.699^{***}	-3.687^{***}
	$\Delta FCF_{i,t}$	0.0049	0.0042	-0.0032	0.0033	0.622	-0.051
	$CE_{i,t}$	0.0241	0.0084	0.0261	0.0128	-0.312	-0.086
	$BHAR_i(-12,-1)$	0.2197	0.1811	0.1882	0.1403	1.432	-1.420
	$PM_{i,t}$	0.3828	0.3365	0.6080	0.4761	-3.481^{***}	-2.970^{***}
	$RP_{i,t}$	0.0278	0.0178	0.0286	0.0227	-0.266	-0.620
Panel B: Groups Formed By Match-Adjusted Bhars							
Match-adjusted	$\Delta OP_{i,t}$	-0.0138	-0.0141	0.0136	0.0128	-4.983^{***}	-5.374^{***}
Variables	$\Delta FCF_{i,t}$	0.0069	-0.0106	0.0073	0.0015	-0.026	-0.446
	$CE_{i,t}$	-0.0064	0.0000	0.0065	0.0004	-1.901^{*}	-1.408
	$BHAR_i(-12,-1)$	0.3022	0.2199	0.3205	0.2385	-0.623	-0.297
	$PM_{i,t}$	0.3541	0.2946	0.4345	0.2931	-1.520	-1.823^{*}
	$RP_{i,t}$	0.0289	0.0205	0.0301	0.0251	-0.439	-1.210

*Notes: $BHAR_i(-12,-1)$ is twelve-month buy-and-hold returns adjusted by market returns (Panel A) or returns of the match firms (Panel B). Match-adjusted variables are the paired differences between the performance of the repurchase firms and the performance of their match firms. The significance levels of the means and medians are based on two-tailed t-test and Wilcoxon signed rank test. The significance at 0.01, 0.05 and 0.1 levels are marked with ***, **, and * respectively.*

Table 7 presents the factors determining share price performance after repurchase announcements for non-undervalued firms. Columns 1 and 2 show that the change in operating profits after repurchase announcements ($\Delta OP_{i,t}$) was not the primary factor responsible for negative $BHAR_i(1,12)$ for Group 3. Instead, the negative $BHAR_i(1,12)$ can be attributed to the change in free cash flow ($\Delta FCF_{i,t}$) and capital expenditures ($CE_{i,t}$). Column 2 demonstrates that $\Delta FCF_{i,t}$ was positively associated with $BHAR_i(1,12)$, which implies a decline in free cash flow would cause a share price decrease after repurchase announcements. Moreover, the coefficient estimates for $CE_{i,t}$ in columns 1 and 2 are 0.883 and 1.823, respectively. The latter estimate was significant at one-percent level.

The positive effect found for $\Delta FCF_{i,t}$ and $CE_{i,t}$ may imply that investors prefer firms in Group 3 to retain more free cash flow for future investment. Relatively, the coefficient estimates for the interaction variable, $CE_{i,t}$ *DQ, were -2.751 and -0.109. In Column 1, the prominent and negative interaction effect indicates that investments made by firms with existing agency problems were important factors causing negative BHARs after repurchase announcements. In addition, the positive coefficient of $BHAR_i(-12,-1)$ in Column 2 suggests that worse share price performance before repurchase announcements would generate more negative BHARs after the announcements. By comparison, the positive $BHAR_i(1,12)$ of Group 4 were primarily determined by the change in operating profits ($\Delta OP_{i,t}$) and capital expenditures ($CE_{i,t}$). Consistent with signalling hypothesis predictions, Column 3 shows that an increase in operating profits resulted in positive abnormal returns after repurchase announcements. In addition, for firms in Group 4, it seems that high capital expenditures were not what investors looked forward to, as the coefficient estimate for capital expenditures in Column 4 was negatively associated with $BHAR_i(1,12)$. Column 4 also shows that an increase in free cash flow had little effect on $BHAR_i(1,12)$. Both of the results opposed the prediction of the free cash flow hypothesis.

Implications of the evidence for non-undervalued firms are twofold. The signalling hypothesis was appropriately predicted Group 4 but not Group 3. Although members of Group 3 were found to have inferior operating performance to those of Group 4 and their competitors, the change in operating performance was not the primary factor leading to negative abnormal returns after repurchase. The free cash flow hypothesis better predicted Group 3. High capital expenditures could remedy the poor share price performance after repurchase announcements, but those spent by firms with existing agency problems could decrease share price.

Table 7: Determinants of Abnormal Returns after Repurchase Announcements – Non-Undervalued Firms

Variables	Expt. Sign	Group 3		Group 4	
		(1)	(2)	(3)	(4)
$\Delta OP_{i,t}$	+	-0.155	0.786	2.884***	1.783
		(-0.47)	(1.34)	(3.73)	(0.85)
$\Delta FCF_{i,t}$	-	0.690	0.609***	0.391	0.789*
		(1.47)	(4.12)	(1.02)	(1.85)
$CE_{i,t}$	+	0.883	1.823***	-1.413	-3.274***
		(1.16)	(3.50)	(-0.67)	(-3.36)
$CE_{i,t}$ *DQ	-	-2.751***	-0.109	2.948	1.452
		(-2.87)	(-0.17)	(1.12)	(0.73)
$BHAR_i(-12,-1)$	+	-0.140	0.448***	0.220*	0.353
		(-1.33)	(3.00)	(1.87)	(1.63)
$PM_{i,t}$	+	0.103	-0.058	-0.007	-0.114
		(1.19)	(-1.08)	(-0.12)	(-0.82)
$RP_{i,t}$	+	0.624	-0.847	-0.994	-0.271
		(0.36)	(-0.47)	(-0.91)	(-0.17)
R^2		0.398	0.486	0.314	0.200
F- Statistics		6.94***	12.39***	4.04***	2.98
Observations		108	156	131	195

*Notes: For Column 1, 3, and 5, the dependent variable is market-adjusted BHARs and the explanatory variables are raw variables. For Column 2, 4, and 6, the dependent variable is match-adjusted BHARs, and the explanatory variables are match-adjusted variables. Expt. sign is the expected signs of coefficients based on the predictions of the hypotheses. The model is estimated by fixed-effect approach. Standard errors are robust to heteroscedasticity. The t-statistics are in parentheses. The significance at 0.01, 0.05 and 0.1 levels are marked with ***, **, and * respectively.*

CONCLUSIONS

While share repurchases have been wildly considered a useful device to lifting share price, this research examines why some firms do not experience an increase in share price after announcing repurchases. We presume that pre-announcement undervaluation is not necessarily due to investors' mispricing. The undervaluation could result from poor operating performance or agency problems. Similarly, we presume that poor future operating performance or the continuous existence of agency problems could be determinants which make some repurchasing firms experience poor share price performance after repurchase announcements. By examining 1,920 repurchase announcements released by 468 firms during the period of 2000 to 2008, this research contrasts the operating performance, free cash flow and capital expenditures before and after repurchase announcements. Furthermore, regression models are formed to directly examine whether the variables explain long-term abnormal returns before or after repurchase announcements. Our findings indicate that, before repurchase announcements, undervaluation primarily results from poor operating performance. The existence of agency problems also has marginal and negative effect on the share price. The findings, therefore, support our presumption that undervaluation is not merely a problem of mispricing, so share repurchase announcements may convey additional information other than management's disagreement with current share price.

Furthermore, regardless of whether firms are undervalued before repurchase announcements, those that experience negative abnormal returns after the announcements tend to have worse operating performance and lower buyback premiums. For undervalued firms, poor operating performance, as well as agency problems and high repurchase ratio, are responsible for negative abnormal returns after repurchase. Positive abnormal returns after repurchase announcements are primarily explained by improvement in operating profits. For non-undervalued firms, it seems that investors prefer more free cash flow retained for future investments. However, investments made with the presence of agency problems become the primary factors causing negative abnormal returns after repurchase announcements. While this research tried to comprehensively examine potential factors affecting share price and abnormal returns before and after repurchase announcements, there are still other motivations for repurchase announcements which merit further consideration. This research focuses on undervaluation, signalling and free cash flow hypothesis. Other factors, such as increases in earnings per share or debt ratio after repurchases, may also affect share price performance (Brav *et al.*, 2005). In addition, the repurchase approach could also convey different information which in turn influences subsequent share price (Louis and White, 2007). However, share repurchases in Taiwan are only carried out by open-market repurchases, which is another limitation of this research. Future research is suggested to take account these factors when examining the determinants of share price performance around repurchase announcements.

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LOT WINNING RATE AND THE CLASSIFICATION OF SEASONED EQUITY OFFERINGS: EVIDENCE FROM TAIWAN

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ABTRACT

This paper classifies two types of improved Season equity offerings (SEO) and regular SEO to investigate whether there are differential cumulative abnormal returns (CARs) around the announcement date of SEO in Taiwan. We find that regular SEO experiences negative CAR whereas improved SEO receive positive CAR during announcement period. The performance of regular SEO with large size firms and high B/M ratio is worse than that of improved SEO with small size firms and low B/M ratio.

JEL: G14, G32

KEYWORDS: Seasoned Equity Offering (SEO), Regular SEO, Improved SEO

INTRODUCTION

Seasoned equity offering (SEO) is a popular approach for listed firms to raise funds from capital markets. Firms can improve scales of economy, retain earnings, increase investment opportunity or capital inflow as well as improve their market returns through funds from SEO. Wang et al. (2014) points out that SEO events lead to increased stock shares outstanding, equity amounts, and asset size. Thus, a firm frequently issues SEO to raise their capital after going public. According to the reports of annual statistical data issued by Taiwan Stocks exchange (TSE) in 2015, the dollar amount of new SEO issues have increased when in bull stock markets. In contrast, when the Taiwan stock market experienced the global financial crisis in 2008 and the Eurozone debt crisis in 2012, SEO experienced a phenomenon of adjusting downward.

Generally, SEO announcements in Taiwan result in positive effects on the stock market (Lee and Lin, 2001). Chen et al. (2001) investigate the effect of Taiwan SEO announcements by using the Fama-French model and find that most SEO issuers can run-up the stock price on SEO announcements owing to growth potential. Nevertheless, in the U.S., most SEO cannot effectively enhance the performances of the issuing firm, because most of SEO issuers are not growing firms and do not have high M/B ratios, thus presenting an image of deterioration of future operation of profits of the issuing firms (DeAngelo, 2010). Moreover, Chan et al. (2012) classify U.S. SEOs into two types, improved SEO and regular SEO, and find that regular SEO firms with low relative offer size, low share price, and high average B/M ratio exhibit negative and significant announcement effects on the offer date. Improved offerings record significantly positive price reaction on the offer date.

In this study, we analyze the abnormal returns of 506 issuing firms listed on the TSE from 2006-2012. We classify the SEO into improved SEO and regular SEO. This classification is similar with that of Chan et al. (2012) for U.S. SEO. Our classification differs from Chan et al. (2012) because they define SEO offers as Improved if the offering proceeds exceed the amount filed at registration, and the complement as regular. Nevertheless, the SEO process in Taiwan equals the amount filed initially at registration on TSE data. We use the lot winning rate in the Taiwan stock market, which can reflect the demand for stocks. If investors increasingly subscribe the stocks of SEO firms, the lot winning rate would decrease, indicating undervaluation of SEO firms (Chen, 2001). This study classifies the SEO based on Lot Winning Rate. If the lot winning rate of SEO is lower than the median of our sample and the stock of SEO firm experiences price appreciation, we classify the SEO as Improved, otherwise it is classified as Regular.

The findings of this paper are as follows. We find the classification of SEO announcements in Taiwan can clearly distinguish the motivation of firms issuing SEO. That is, improved SEO experience positive abnormal returns whereas regular SEO generate negative returns. Moreover, improved SEO are clustered in small firms because small firm intends to issue SEO to seek funds for growth needs. Regular SEO, clustered in the majority of large firms, produces negative abnormal returns at the announcement date. This study contributes a different classification on SEO, which combines both Lot Winning Rate and market price reaction to disclosed revised proceeds. This classification can clearly distinguish the motivation of firms issuing SEO in Taiwan. The remainder of this paper is organized as follows. The next section discusses the relevant literature. The data and methodology section describes the data and defines the variables. In the results and discussion section, we show the regression results. The conclusion comments section provides our closing statements.

LITERATURE REVIEW

In the US, SEO announcements are associated with significant negative effects. If overvalued firms necessarily issue SEO for financing, the managers may reveal negative information at pre-announcement by selling overvalue stock. Overvaluation of firms would drift a negative announcement effect (McLaughlin, 1996). Chan et al. (2012) examine the offer-size decision of U.S SEO issuers and classify an observation as Regular if the offering proceeds complete the amount filed initially at registration. They show that Regular issuers experience significantly negative stock price returns during their respective registration periods. Improved issuers, on the contrary, make relatively positive stock price reaction when the offering proceeds exceed the amount filed initially at registration. In the same vein, research on Taiwan markets have documented that listed and Over-The-Counter (OTC) firms have negative abnormal stock returns when issuing SEOs (Chiang, 2004). They suggest that CAPM theory is a parsimonious powerful model to capture time-varying systematic risks. Zhou and Elder (2004) document that issuing firms are associated with short-run overvaluation in their seasoned offerings because the SEO allows them to have higher announcement return.

Gombola et al. (1999) record that insider buying influences the market reaction to positive announcements of the SEO. Hill and Snell (1989) support that when institutional investors hold more shares than external investors. The signal of institutional investors represents the bullish prospects of the firm and willingly issues equity to push development. Chen et al. (2001) employ the Fama-French model to measure the cumulative abnormal return during the SEOs period. They show that both growth potential and insider buying are the main factors for influencing the stock price upward. They support that the growth potential can drive a positive price reaction to SEO announcements. In Hong Kong, investors also believe that positive abnormal returns to SEO announcements are conditioned on the purchase actions of insiders (Ching et al., 2006).

DATA AND METHODOLOGY

The source of the SEO firms for the sample is listed and OTC firms chosen from public subscription announcements on the Taiwan Stock Exchange (TSE). We delete firms in the finance and insurance industries due to their unique nature of financial reporting and to avoid survivorship bias (Kothari et al., 1995). The sample period is from January 2006 to December 2014. We set the announcement date to be the resolution of the board of director, to examine whether the announcement of SEO has the influence on the stock price. This study focuses on the open market (public) and classifies SEO firms in Taiwan into the Improved SEO and Regular SEO based on lot winning rate. When the demand for SEO stock is more than the offers during the subscription period, TSE could use a lottery to let investors acquire the stock of SEO firms fairly. Thus, we construct the SEO firm sample as Improved SEO if its lot winning rate is lower than the median rate and its stock price experiences appreciation during the registration period, and Regular SEO otherwise.

We use the market-adjustment model to calculate abnormal returns. Significant results indicate that price fluctuation of the stock with the event is different from the performance without the event, thus creating abnormal returns. The announcement day is defined as day 0, – *t* as *t* trading days before announcement day, and *t* as *t* days after the announcement day. The test period is chosen two days before the announcement day to five days after, totaling 8 trading days. The model is presented as follows.

$$ARjt = Rjt - Rmt \tag{1}$$

$$\text{CARi} = \sum_{t=b}^{e} AR_{jt} \tag{2}$$

where *Rjt* is actual returns rate of sample stock j on day t during the event period; *Rmt* is the market return of the value weighted index on day t during the event period; *ARjt* is abnormal returns rate of sample stock j on day t during the event period; *CARi* is the cumulative abnormal returns rate of sample stock i in the event window; *b* is the starting date of the event window; *e* is ending date of event window. This study performs different t-tests to determine whether the average CAR for the improved SEO, regular SEO in SEO event varies significantly. We also estimate non-diagonal variance-covariance matrix as in Chiou et al. (2003) as shown in Equation 3.

$$T\ test = \frac{\overline{CAR_1(t_b, t_e)} - \overline{CAR_2(t_e, t_b)}}{\sqrt{\frac{Var(\overline{CAR_1(t_e, t_b)})}{n_1} + \frac{Var(\overline{CAR_2(t_e + t_b)})}{n_2}}} \tag{3}$$

We use OLS regression to measure the effect of classification of SEO on CAR around the SEO event. The independent variables are improved variable (*ID*), SEO firm size (*size*), Book-to-market (*B/M*), return on equity (*ROE*) and Leverage. Table 1 presents the definition of those variables.

Table 1: Variables and Definitions

Variable Names	Variable Definitions
CAR	The sum of the differences between the raw return and the return predicted by the market model
ID	ID is the dummy variable that sets for measuring the classification of improved SEO and regular SEO. If sample firm is audited by 1, which are improved SEO for sample firm and is 0, which are regular SEO for sample firm.
SIZE	Size is the market value of equity at the previous year-end of SEO. It is defined as the number of common equity shares outstanding multiplied by the stock price on previous year-end SEO.
B/M	B/M is the natural logarithm of the most recent market-to-book ratio. It defined as book value of equity divided by the market value of equity on previous year-end SEO.
ROE	ROE is the return on equity on previous year-end SEO. It defines as net income at the end of prior year of SEO divided Return on Equity on previous year-end SEO.
Leverage	Leverage is the debt-to-equity ratio on previous year-end SEO. It defines as total liabilities at the end of prior year of SEO divided total asset on previous year-end SEO.

Table 2 presents summary statistics for various measures of the full sample of 506 SEOs in Panel A. Panels B and C show the classification of 140 improved versus 366 regular SEOs respectively. As shown in Panel A, the mean (median) of ID is 25.3% (0.0%) indicating that there is 25.3% of improved SEO to trade during the period of the SEO event. Meanwhile, the average market value (size) is 7,306.4 (in millions of NT dollars); the average B/M ratio is 0.08%, the average ROE is 8.16%, and the average leverage is 48.51%.

Table 2: Summary Statistics of ID, SIZE, B/M Ratio, ROE and Leverage

Variables	*N*	Mean	Median	S.D.	Min.	Max.
Panel A: Full Sample of SEO Firm						
SIZE(million)	*506*	7306.4	30640	13808	53.000	11000
B/M ratio (%)	*506*	0.0008	0.0006	0.0011	0.00003	0.0175
ROE (%)	*506*	8.1656	10.020	18.33	-85.300	76.020
Leverage (%)	*506*	0.4851	0.4994	0.1663	0.0086	0.9467
Panel B: Improved SEO Firm						
SIZE(million)	*140*	4351.5	2397.5	6341.9	203.00	46426
B/M ratio (%)	*140*	0.0007	0.0005	0.0005	0.00006	0.0029
ROE (%)	*140*	8.1009	10.395	17.416	-41.190	76.020
Leverage (%)	*140*	0.4569	0.4869	0.1728	0.0086	0.7909
Panel C: Regular SEO Firm						
SIZE(million)	*366*	8,306.9	3,348.5	15,424	53.000	119,500
B/M ratio (%)	*366*	0.0008	0.0006	0.0012	0.00003	0.0175
ROE (%)	*366*	8.1875	9.9150	18.651	-85.300	64.010
Leverage (%)	*366*	0.4946	0.5062	0.1631	0.0364	0.9467

The sample contains 506 Seasoned Equity Offerings conducted by Taiwan listed and OTC firms. The classification includes 140 improved SEO and 366 regular SEO for the year 2006-2014. Data is from Taiwan Economics Journal (TEJ) database. ID is a dummy variable that takes the value of 1 if the sample firm is improved SEO, 0 otherwise. Size is the market value of equity at the previous year-end of SEO. B/M ratio is the book value of equity divided by the market value of equity on previous year-end SEO. ROE is the net income at the end of prior year of SEO divided Return on Equity on previous year-end SEO. Leverage is the total liabilities at the end of prior year of SEO divided total asset on previous year-end SEO.

The comparison between two types of SEO firms show that the mean (median) of size for improved SEO and regular SEO are 4,351.5 (2,397.5, in million of NT dollars) and 8,306.9 (3348.5, million), respectively. Meanwhile, the mean (median) B/M ratio for improved SEO and regular SEO are 0.07% (0.05%) and 0.08% (0.06%); the mean (median) leverage ratio for improved SEO and regular SEO are 45.69% (48.69%) and 49.46% (50.62%). Thus, most of firms of improved SEO with low M/B ratio and low leverage ratio conduct an SEO because of fund investment. That is, improved SEOs may be in the growth-stage with an associated need for capital as posited by Harry et al. (2010).

Table 3 presents a comparison of CAR based on full sample and subsamples of improved versus regular SEO. In the full sample of SEO, the mean of CAR from two-days prior to announcement to five-days after the announcement is -69.58%. The negative impact of SEO announcement on stock return is inconsistent with Lee and Lin (2001). SEOs tend to occur when stock prices are high (Hovakimian et al., 2001) and on average firms are selling overvalued seasoned equity (DeAngelo, DeAngelo, and Stulz, 2010; Dong, Hirshleifer, and Tech, 2012), the SEO announcements therefore would result in stock prices to fall.

Table 3: Summary Statistics for CAR (-2, 5) Relative to Classification between Improved SEO and Regular SEO

	CAR(-2,5) Of Full Sample	CAR(-2,5) Of Improved SEO	CAR(-2,5) Of Regular SEO
Mean	-0.6958	0.3802	-1.0603
Median	-1.1089	-0.8746	-1.2380
S.D	7.3019	7.5541	7.1883
Min.	-24.087	-15.998	-24.087
Max.	36.519	21.552	36.519

This table shows empirical results of summary statistic of the cumulative abnormal returns (CAR) for improved SEO and regular SEO firms. The time series is from prior two-days of the announcement date (the date of the resolution of board of director) to five-days after.

When SEO firms are classified into improved SEO and regular SEO, there is a significant difference between them. The mean of CAR is positive (38.02%) in improved SEO firms whereas regular SEO firms encounter negative mean value of about -1.06%, which is consistent with Chan et al. (2012) for U.S SEO. Therefore, it suggests that improved SEO are more likely to fund capital needs. Positive returns during SEO period occur for improved SEO. Regular SEO should be the market timer.

RESULTS AND DISCUSSION

Table 4 shows the average CAR and difference between the average CAR for improved SEO. It also shows the average CAR for regular SEO from two-days prior to the announcement date to five-days after

SEO announcement. In the event window (-2, 5), the average CAR for improved SEO are 87.23%, which is positive and significant at 10% level. In contrast, the average CAR for regular SEO presents -124.8%, which is negative and significant at 1% level. Moreover, the average CAR for improved SEO is greater than that for regular SEO by 282.3%, which is significant at 1% level, suggesting that improved SEO encourages the SEO announcement and produces a positive market reaction.

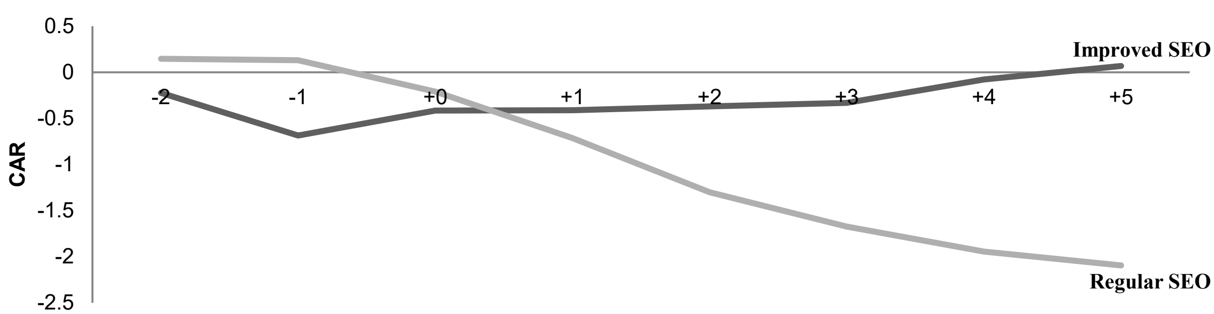
Table 4: Average CAR Difference T Test between Improved SEO and Regular SEO

Event	Improved SEO		Regular SEO		Difference
window	Average	P value	Average	P value	
(-2, 5)	0.8723*	0.0941	-1.2482***	0.0003	2.8203***
(0, 1)	0.5102*	0.0789	-0.6407***	0.0005	2.8168***
(0, 3)	0.7006*	0.0778	-1.2820***	0.0006	3.4801***
(0, 5)	1.0796**	0.0332	-1.5691***	0.001	3.9509***

*This table indicates the empirical results of the average CAR difference T test between improved SEO and regular SEO during SEO announcement period. ***, **, and * denote significant at 1%, 5%, and 10% level.*

Improved SEO also shows a gradually growth of average CAR from announcement day to five-days after, which is 51.02% in event window (0, 1), 70.06% in event window (0, 3), and 107.9% in event window (0, 5). Conversely, regular SEO presents significantly opposite returns after an announcement, which is -64.07% in event window (0, 1), -128.2% in event window (0, 3) and -156.9% in event window (0, 5) significant at the 1% level, respectively. According to Chen et al. (2012), positive SEO returns can be an outcome of increased demand for external investors (e.g., institutional investors) in response to the issuer's road-show. Therefore, our results suggest that improved SEO enjoy better market returns through funds of SEO to enlarge the scale of economy. Figure 1 provides the CAR of improved SEO and regular SEOs during the announcement period. We find that improved SEO experiences negative CAR before announcement, but revises positive at announcement day as well as the following five days after. Conversely, regular SEO shows positive CAR before an announcement, but becomes negative CAR after SEO announcement.

Figure 1: Cumulative Abnormal Returns between Improved SEO and Regular SEO



The figure shows the comparison of CAR for improved SEO and regular SEO firms. The sample spans 2006-2012. Day 0 is defined as the announcement day.

In Table 5, we run the regression to examine whether the CAR is affected by two types of improved SEO and regular SEO. According to Fidrmuc et al. (2006), we control for other determinants (size, B/M ratio, ROE and leverage) that may influence the CAR in announcement period.

$$CAR_i = \alpha_1 + \alpha_2 ID_i + \beta_3 SIZE_i + \beta_4 BM + \beta_5 ROE_i + \beta_6 Leverage_i + \varepsilon_i \quad (4)$$

We identify the dummy variable (ID), which equals one if SEO announcement is an improved SEO, and regular SEO as zero. Table 5 presents that the coefficient of ID shows significantly positive at 10% level in event window (-2, 5), significant at the 1% level, in event (-1, 0) and at 5% level in event (0, 5). This result confirms that the firms issuing SEO for growth need a positive price reaction in the announcement period. Firms with less growth potential experience negative market reaction. Thus, we argue that SEO firm with growth opportunity start showing significantly positive CAR on the announcement day.

Table 5: Regressions of Classification on Cumulative Abnormal Returns

$CAR_i = \alpha_1 + \alpha_2 ID_i + \beta_3 SIZE_i + \beta_4 BM + \beta_5 ROE_i + \beta_6 Leverage_i + \varepsilon_i$

	Constant	ID	Size	B/M Ratio	ROE	Leverage	Adj. R-sq
Panel A: Improved SEO and Regular SEO							
CAR(-2,5)	-1.0860	1.4556*	0.0005	-96.786	-0.0130	0.3577	-0.0012
	(0.3212)	(0.0554)	(0.8307)	(0.7504)	(0.4723)	(0.8586)	
CAR(-1,0)	-0.0859	0.450***	-0.000001	-1.7720	-0.0026	2693***	0.7929
	(0.4793)	(0.0076)	(0.9702)	(0.9788)	(0.5071)	(0.00003)	
CAR(0,1)	-0.0509	0.2334	-0.00004	57.033	-0.0079	-0.6431	-0.0066
	(0.9317)	(0.5711)	(0.7459)	(0.7301)	(0.4188)	(0.5556)	
CAR(0,3)	-1.2325	0.8820	-0.000001	-244.15	0.0004	1.1331	-0.0009
	(0.1561)	(0.1431)	(0.3120)	(0.3120)	(0.9746)	(0.4770)	
CAR(0,5)	-1.7447*	1.4260**	-0.000001	153.71	0.0076	0.7925	0.0009
	(0.0824)	(0.0406)	(0.5011)	(0.5815)	(0.6440)	(0.6667)	

*This table presents the regression results on CAR. The main independent variables are the classification dummy variable of improved SEO and regular SEO. The regression dependent variable is the cumulative abnormal return (CAR). ID is a dummy variable that takes the value of 1 if the sample firm is improved SEO, 0 otherwise. Size is the market value of equity at the previous year-end of SEO. B/M ratio is the book value of equity divided by the market value of equity on previous year-end SEO. ROE is the net income at the end of prior year of SEO divided Return on Equity on previous year-end SEO. Leverage is the total liabilities at the end of prior year of SEO divided total asset on previous year-end SEO. *, **, and *** indicate significant levels at the 10%, 5%, and 1% level.*

CONCLUDING COMMENTS

This study classifies the SEO events in Taiwan during 2006-2014 into improved SEO and regular SEO to observe the CAR around the SEO announcement period. We find the classification of SEO announcements in Taiwan into two types of SEO can clearly distinguish the motivation of firms issuing SEO. That is, improved SEO experiences positive abnormal returns whereas regular SEO generates negative returns in the event period (-2, 5). Moreover, improved SEO are clustered in small firms because small firm intends to issue SEO to fund growth needs. Regular SEO, clustered in the majority of large firms, performs negative abnormal returns at announcement date. Our results indicate that regular SEO is associated with high B/M ratio and high leverage ratio. It may lead to a low market valuation and a low growth prospect, which is consistent with DeAngelo et al. (2010).

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INNOVATION ACCOUNTING OF TAX-REVENUE DRIVERS: COINTEGRATION EVIDENCE FROM GHANA

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ABSTRACT

This study uses cointegration, and innovation accounting analysis to examine the volatility and extent of the short-term and long-term relationships between the drivers of tax revenues and tax revenues in Ghana from 1980 to 2011. The principal and consistent discovery from this study is that cocoa farmers' tax (CFTAX) is the least volatile and import taxes (IMPTAX), is the most volatile in the observed period. The estimated cointegrating relationships identify at least two long-run vectors for the drivers of tax revenues. We also find that among the drivers of tax revenues, the cocoa farmers' income taxes are the quickest to adjust to long-run equilibrium in the current year. The forecast error variance decompositions reveal that the cocoa farmers' income taxes are the strongest endogenous of the VAR system driver of tax revenues, and that they play a dominant role in Ghanaian tax revenues in the observed period. The empirical evidence supports the descriptive statistics that cocoa farmers' income tax revenues remain the largest and most reliable source of income for the Ghanaian economy. Since tax revenues from cocoa farmers continue to drop because of falling cocoa futures and low production, Ghanaian policymakers must diversify their tax-revenue drivers to include a sales tax on discretionary goods and services such as imported tobacco and imported alcohol. As tax revenue increase option has become elusive, the hardline option is to gradually eliminate government expenditures in the areas of colonial delicacies such as free fuel, chauffeurs for government officials (ministers and members of parliament etc), excessive per diems from the president to other government officials and many more, just to mention but few.

JEL: C32, F33, H6, O11, P51

KEYWORDS: Cointegration; Innovation Accounting; VAR Models, Macro-Dynamics, Tax-Revenue Drivers, and Ghana

INTRODUCTION

At the microstructure, individuals in many transitional economies live leveraged consumption lifestyles as they cannot balance their income statements periodically. Generally, voluntary savings are low, leading to poor capital formation (net worth from the balance sheets is always negative) over time. Persistent budget constraints put many at the disadvantage by not paying their fair shares of the tax burden and avoiding taxes through tax loopholes, and non-compliance government policies. Adverse financial statements by the citizens are transferred indirectly to the government by decreases in total tax revenues from year to year. Therefore, the budget deficit story runs from individuals in the country to the nation as a whole. The tax base continues to dwindle as the informal sector grows and few people pay their fair shares of the tax burden. The tax system continues to be inefficient because of weak compliance and enforcement mechanisms. The informal sector has increased relative to the formal sector (money laundering and currency trafficking as well as drugs and other underground activities) and without discretionary taxing powers of the government of Ghana, there will be no improvements in the tax base (few drivers of tax revenues (Amoako-Adu, 1984). As the government tax revenues continue to lag behind the high expenditure associated with economic development, the budget deficits have continued to grow over time. The continued widening budget deficit has been a major constraint to fiscal and debt sustainability.

In 2011, government revenue as a percentage of Gross domestic product was 19.13%, lagging behind government expenditure as percentage of Gross domestic product by 5% (24.35%). In 2013, the gap between the government revenue as a percentage of GDP and expenditure as a percentage of GDP further widened about 10%, (16.72% - 26.72%). In 2015, the gap between government revenue as a percentage of GDP and expenditure as a percentage of GDP dropped to 6% (19.20% - 25.72%). The projection for the 2016 indicated that by the end of 2016, the government expenditure would stand at GHC45.0 billion and revenues at GHC32.638 (about deficits of–GHC12.87 billion). The sad story is that the budget deficits are not going to get better over time as the economy is not growing and tax reforms and collections are also riddled with bribery and corruption. Most African countries are in transition (Keller, 2007) and their economies are not generating sufficient revenues to offset government expenditures. Governments derive revenues for development from taxes and other sources such as exports, foreign aids, and loans. Lower tax revenues in both established and transitional economies lead to deficits and higher debts, higher interest rates on debts, and fewer development projects for citizens. Government revenue sources and taxation policy are of great concern to government, leaders, and economists because of the effects of insufficient revenues on the political, social, and economic development of African countries (Kayaga, 2007).

Reducing deficits is a concern for both developed and transition economies. Osei and Quartey (2005) indicate that for the past two decades, Ghana depended on foreign aid to meet a gap between government revenues and expenditures (deficits). They suggest that government can resolve deficit problems by either generating more tax revenue or reducing expenditures. Reducing expenditures would harm key sectors of the economy like education, health, and infrastructure that have helped reduce poverty. Increasing economic performance in total revenue will reduce deficits, and limit Ghana’s dependence on foreign aid. Governments of both developed and transition economies have a legitimate interest in understanding the factors that drive total tax revenues (Clausing, 2007). The in-depth insight on the inherent riskiness of the various drivers of government revenue will help policy-makers, administrators, and leaders of Ghana and similar transition economies to develop policies to reduce negative performance indicators that influence the fluctuation of inflow of revenue. Some effective tax administration strategies included simplified tax laws (Bird, 2014), targeted potential taxpayers (Shome, 2004), and cooperative compliance model instead of deterrence strategies to enforce compliance (Whait, 2012). A personal income tax with a volatility rate of 5% and company tax rate of 10% was an indication to policymakers that personal income taxes inflow was more certain than company taxes inflow.

This study adds to the empirical literature by setting for itself three goals, which we pursue in the following ways: First, we reexamine the nature and degree of the volatility of the drivers of tax revenues. Second, we employ the error-correction term (ECT) for the selected autoregressive distributed lag (ARDL) model to find out the length of the degree (speed of convergence to equilibrium) to which each drivers of tax revenues is out of equilibrium. If the speed of adjustment of a driver of tax revenues is slow, this may indicate that it is temporarily out of equilibrium. The larger the error-correction coefficient (in absolute value), the faster the driver’s return to equilibrium, once shocked. Whatever is in fact true? Third, we use the variance decomposition analysis to determine which driver of tax revenues is able to withstand political, economic and global shocks in the long run. In other words, how long is each of the drivers of tax revenues able to deal with shocks? Are the shocks long or short lasting? The rest of this article is organized as follows: section 2 reviews the empirical literature, section 3 presents data sources and research methodology, section 4 discusses the study empirical results, and section 5 offers conclusions, discussions, limitations and future research.

LITERATURE REVIEW

Osei and Quartey (2005) show a disturbing phenomenon in Ghana with respect to drivers of total revenue, which are, direct taxes, indirect taxes, and non-tax revenues. They find that between 1980 and 2002, direct tax revenue as a percentage of total revenue ranged between 19.5% and 33%. Between 1983 and 1985 direct taxes increased but they declined to 21.9% of total tax revenue in 1986, increased in 1987 to 24% and 31.2% in 1988, declined to 19.5% by 1991 and increased again to 29.3% between 1992 and 1997 and 32.7% between 1999 and 2002. Indirect taxes as a percentage of total tax revenue ranged between 66.9% and 80.5% of total tax revenue between 1980 and 2002. The Individual tax rate is a progressive tax with the top rate of 25% while the corporate rate ranged from 32.5% to 25% between 2001 and 2006.

As Prichard (2009), notes in 1995, Ghana introduced the original value-added tax (VAT) of 17.5% to replace the sales tax. Since then, the VAT went through changes, including a withdrawal of the tax in 1995 following public protest against it, reintroduction of the tax at a 10% rate in 1998, which increased to 12.5% in 1999 and 15% in 2003. Osei and Quartey (2005), observed that, indirect taxes have contributed more to tax revenue than direct taxes. Direct and indirect taxes in Ghana averaged 26.1% and 73.9% respectively of total tax revenue over the period 1980 to 2002. The taxes identified and measured in a study by Akazili, Gyapong, and McIntyre (2011) include direct taxes (such as income taxes and company taxes), and indirect taxes (such as the VAT, the National Health Insurance Levy, fuel levies, and import duties), which together accounted for over 95% of the total revenues from tax collection in Ghana in 2010**.**

In a review of Ghana's tax systems sponsored by the U.S Agency for International Development, Agribusiness Commercial, Legal, and Institutional Reform AgCLIR (2008) argued that Ghana's taxation agencies provided adequate information to encourage compliance across all types of taxes at each level of society. All societal segments agreed that the taxation administration was too centralized, requiring central offices to tend to tax business and make payments. Critics of the Ghanaian tax system claimed that there were not enough Internal Revenue Services (IRS) centers throughout the country, and that IRS processing was slow, if mostly functional. In response to these criticisms, additional IRS offices have been established to meet the needs of agribusiness workers and other entrepreneurs.

Goerke (2007) assessed the effects of Company tax behaviors on personal income taxes and concluded that a manager's income depends on whether the firm's activities are detected or not, and that as a result, Company and personal income tax evasion choices cannot be separated. Focusing on the United States, and using a survey instrument as a research tool, Pantuosco and Seyfried (2004) investigated a shift in the tax burden away from company taxes as a result of the decline in the manufacturing sector. Company tax revenue in Ghana increased from 7.4% to 18% between 1983 and 1988 and declined to 8.4% by 1993. Kusi (1998) attributed the decline to the reduction in the marginal rates of company taxes. A study on variation among member countries of the Organization for Economic Cooperation and Development regarding the size of corporate income tax revenues as a function of gross domestic product (GDP) from 1979 to 2002 helped to explain the variation as a function of the statutory tax rate, the breadth of the tax base, corporate profitability, and the corporate sector's share of the economy or GDP (Clausing, 2007). The conclusion can be replicated to explain the volatility of the Company tax revenue in Ghana from 1980 to 2011. These studies used statistical analysis but stopped short of establishing a rigorous empirical relationship between corporate taxes and total tax revenues.

Self-employed workers and Small and medium-sized Enterprises (SMEs) remain an important part of Ghana's business environment (Amidu, Effah, & Abor, 2011). According to Kayanula and Quartey (2000), the dynamic role SMEs in developing countries has been highly emphasized as the means for these countries to industrialize and reach other development goals. According to Abor and Quartey (2010), SMEs account for about 92% of Ghana's businesses, providing approximately 85% of manufacturing employment, and representing 70% of Ghana's GDP. Workers in SMEs represent 61% of overall employment (Abor &

Quartey, 2010). Robson and Freel (2008) investigated the characteristics of exporters in the three main non-governmental sectors of the Ghanaian economy (manufacturing, services, and agriculture) and concluded that since 1980 as a result of the Ghanaian government's reform efforts, the focus had shifted to significantly reducing state-based economic interventions or replacing them with market mechanisms, reflecting ideological commitments to market economics and capitalism (Briggs & Yeboah, 2001; Robson & Freel, 2008). Parker, Riopelle, and Steel (1995) conclude that the SMEs in Ghana and Malawi employed between 15.5% and 14.09% in 1993. Other authors have given figures from 22% to 61% that varied over time (Abor & Quartey, 2010; Daniels & Ngwira, 1993; & Gallagher, 1993). The variance in these statistics may mean that self-employed workers and SMEs do not report accurate figures or that they do not pay significant taxes because many SMEs, recently formed, have low profits. Again, these studies did not find an empirical relationship between the SME taxes and total tax revenues in the observed periods.

Cocoa production generated major contributions to the country's revenues, GDP, and net national income as a result of direct and indirect taxes on cocoa producers and processors (Ocansey, 2010). Cocoa production in Ghana fell by 74% over two decades until the government enacted policies entitling farmers to higher percentages of international market prices (Breisinger et al., 2008). Breisinger et al. (2008) find the decline in taxes collected from Ghana's cocoa farmers' contributed directly to a reduction in government revenues from an average of 16% in the 1960s to 12% in the 1990s, to approximately 5% in 2005. And yet, despite depressed production and revenue cocoa export receipts still averaged 60% of annual foreign exchange earned by Ghana, and 13.7% of the GDP, causing it to remain a major source of government revenue (Asare, 1987; Atta, 1981). According to Codexa Capital (2012), Ghana experienced positive economic momentum after government reforms in the 1990s, and much of the growth in GDP resulted from cocoa production. Kolavalli and Vigneri (2011) noted that, following the 1990s, cocoa farmers and their families experienced improved living standards relative to other food crop farmers and a reduction in poverty from approximately 60% in 1990 to 24% in 2005.

The increased reduction in cocoa taxes resulted in less revenue for the government. Blankson (2012) indicated that during the three years prior to 2012, Ghana produced more cocoa because of the Ghana Cocoa Board's interventions. These interventions included paying farmers 80% of the world cocoa market price to discourage smuggling to neighboring countries for illegal sale. The board embarked on a six-year replanting of cocoa trees nationwide and provided jobs for youth in the cocoa areas. Increased employment in the cocoa sector helped increase personal income tax receipts, resulting in an infusion of approximately $1.5 billion into the Ghanaian economy (Blankson, 2012). These studies were limited to empirical analysis of cocoa farmers' income taxes and total tax revenues. Obeng,Brafu-Insaidoo, and Ahiakpor (2011) analyze the quantitative effects of import liberalization on tariff revenue in Ghana to examine how different components of the sources of change in import taxes contributed to changes in import tax revenue. They find that Ghana lost revenues as a result of liberalization, which reduced average official duty rate levels, but gained revenues from currency depreciation. Obeng, Brafu-Insaidoo, and Ahiakpor (2011) recommend that public policies focus on determining and targeting the optimum level of the average official import duty rates, focusing on the identification of the major sources of duty revenue leakage, and substituting sales taxes for tariffs to increase tax revenue sufficiently.

DATA AND METHODOLOGY

This section contains information about the construction of the data series to be used in the estimated model. The original data consists of personal income and property taxes (PIPTAX), import taxes (IMPTAX), cocoa farmers' taxes (CFTAX), domestic goods and services taxes (DGSTAX), a tax reform dummy (TRDUM), and tax revenues from 1980 to 2011. The series are collected from Ghana Statistical Services, the Ministry of Finance, and the Ghana Cocoa Board (COCBOD). The dummy coefficient incorporated with the tax reforms assumes the binary values of 1 and 0 in the equation. 1= tax reform period, and 0 = period of no tax reform. The reason for this is that, with the application of tax reform, any changes in tax revenues (such

as an increase or decrease in the computerization of tax databases in the country) will cause changes in tax revenues. Furthermore, the dummy variable is about the marginal effects in a binary choice model. It is the derivative with respect to the binary variable (computerized tax collection data bases [1995 to 2011] versus non-computerized tax collection databases [1980-1994] as if it were continuous, providing an approximation that is often surprisingly accurate (Greene, & Hensher, 2012).
To investigate the relationship between tax revenues and the drivers of tax revenues the following model is applied:

$$TAXREV = f\,(PIPTAX, IMPTAX, CFTAX, DGSTAX, TAXDRUM) + ut \quad (1)$$

Where, TAXREV = total tax revenues, and other variables have already been explained.
We investigated our first goal by adopting a generic auto-regressive distributed lLag (ARDL) that looks like the equation below:

$$\Delta y_t = \beta_0 + \Sigma\beta_i\Delta y_{t-i} + \Sigma\gamma_j\Delta X_{1t-j} + \Sigma\delta_k\Delta_{2t-k} + \varphi z_{t-1} + e_t \quad (2)$$

Where, z, the error-correction term, is the Ordinary Least Squares (OLS) residuals series from the long-run cointegrating regression

$$Y_t=a_0+a_1X_t+a_2X_{2t}+v_t \quad (3)$$

The ranges of summation in (2) are from 1 to p, o to q_1, and to q_2 respectively.
Finally, we investigated the second goal by using the following variance decomposition model, a vector auto-regressive (VAR)- a moving average representation.

$$y_{1,t} = \tilde{E}_{1\,1}V_{1,t} + \tilde{E}_{1\,2}V_{2,t} + \tilde{E}_{1\,3}V_{1,t-1} + \tilde{E}_{1\,4}V_{2,t-1} + .. \quad (4)$$

$$y_{2,t} = \tilde{E}_{2\,1}V_{1,t} + \tilde{E}_{2\,2}V_{2,t} + \tilde{E}_{2\,3}V_{1,t-1} + \tilde{E}_{2\,4}V_{2,t-1} + .. \quad (5)$$

Since the development of the lagged error terms is already known, the only uncertainty concerns the present error terms $v_{1,t}$ and $v_{2,t}$. The second goal is achieved by using MICROFIT software on the VAR system to find the short-term adjustment of the variables to equilibrium and to trace out the system's reaction to a shock (innovation) in one of the variables.

EMPIRICAL RESULTS

The descriptive statistics summarized and presented the essential information contained in the data on the drivers of tax-revenue and total tax revenue in the observed period. It showed that the mean of the dependent variable (total tax revenues) was the largest with C2.132 trillion and standard deviation of 2533 while the tax reform dummy with the mean of C1.715 trillion and standard deviation of 2684, was the most volatile in the series. The cocoa farmers' tax with a mean of C82.47 billion and the standard deviation of 93.37 was the least volatile in the series. Tables 2 and 3 exhibited the estimated correlation matrix for the drivers of Ghanaian tax revenues in the observed period. The mean, mode, and the median measured the central tendency of the variables. Again, Table 1 indicates that the distribution of the variables is not symmetric because the three measures have different values representing the distribution's center of each of the independent variables. Since the mean is the largest of all the three measures (mean, median, and mode), the distribution is positively skewed. If the means were to be the lowest among the three measures, the distribution would be deemed negatively skewed. According to Lind, Marchal, and Wathen (2011), the mean should not be used to represent the data if the distribution were highly skewed. In this study, the distribution is highly skewed because the means of the independent variables were largest of all the three measures. The most frequent component contributor to total revenue (in billions) measured by the mean of the variables was PIPTAX (609.62), IMPTAX (596.10), DGSTAX (495.73), and CFTAX (82.47). In Table 1, IMPTAX had the highest standard deviation of 837.43 and CFTAX had the lowest standard deviation of 93.37. The PIPTAX and DGSTAX had 811.72 and 492.13 standard deviations respectively. The volatility test using EXCEL at 95% confidence level show that all the drivers of tax-revenues are volatile from the following tests: IMPTAX (837.42> 301.93, PIPTAX (811.72 > 292, DGSTAX 492 > 177.43, and 93.37 > 33.66, respectively. The principal and consistent discovery from this table is that cocoa farmers' tax (CFTAX) has the lowest volatility and import taxes (IMPTAX), has the highest volatility with all the series in the observed period.

Table 1: Descriptive Statistics on the Drivers of Tax-Revenues in Ghana 1980-2011

Statistics	PIPTAX	IMPTAX	CFTAX	DGSTAX
Mean	609.62	596.10	82.47	495.73
Standard error	143.49	148.04	16.51	87.00
Median	265.65	191.15	31.50	402.40
Mode	1.10	N/A	0.00	N/A
Standard Deviation	811.72	837.43	93.37	492.13
Coefficient of Var. (CV)	1.33	1.40	0.99	1.13
Sample variance	658,886.60	701,290.70	8,717.68	242,192.20
Kurtosis	1.95	1.29	0.31	-0.40
Skewness	1.60	1.54	1.15	0.69
Range	3,032.30	2,829.50	316.70	1,762.20
Minimum	0.70	0.30	0.00	1.00
Maximum	3,033.00	2,829.80	316.70	1,763.20
Sum	19,507.90	19,075.30	2,638.90	15,863.40
Observations	32	32	32	32
Confidence level (95%)	292.66**	301.93**	33.66**	177.43**

*Notes: PIPTAX stands for Personal Income Taxes, IMPTAX stands for import taxes, CFTAX stands for Cocoa farmers' taxes, DGSTAX stands for Domestic goods and services taxes. The sample size is 32. **One tailed Significance at the 5 percent level. Data sources from various issues of Ghana Statistical Services, Accra Ghana, ., the Government of Ghana Survey and the Government of Ghana Quarterly Digest of Statistics, Brown (1972) study, African Economic Research Consortium (AERC, 1998), Bank of Ghana (2003), and the World Bank (2003) to collect data. Tax Revenues are in billions of Ghanaian Cedis.*

Table 2 indicates that IMPTAX is highly correlated with PIPTAX (.9818), and DGSTAX is highly correlated with PIPTAX (.8577), IMPTAX (.8337), and CFTAX (.5892). The correlations of the independent variables with total tax revenues are arranged in ascending as CFTAX (0.5205), DGSTAX (0.9049), TRDUM (0.515), PIPTAX (0.9788), and IMPTAX (0.9863), respectively. Table 2 shows that the model has no multicollinearity problem because the drivers of tax-revenues are well-behaved.

Table 2: Pearson Correlation Matrix of the Total Tax Revenues and Drivers of Tax-Revenues in Ghana from 1980-2011

	TAXREV	PIPTAX	IMPTAX	CFTAX	DGSTAX	TRDUM
TAXREV	1.0000					
PIPTAX	0.9788***	1.0000				
	< 0.0001					
IMPTAX	0.9863***	0.9818***	1.0000			
	< 0.0001	< 0.0001				
CFTAX	0.5205**	0.3747**	0.4226**	1.0000		
	0.0023	0.0346	0.0160			
DGSTAX	0.9049***	0.8577***	0.8337***	0.5892***	1.0000	
	< 0.0001	< 0.0001	< 0.0001	< 0.0001		
TRDUM	0.9515***	0.9558***	0.9595***	0.3013*	0.8497***	1.0000
	< 0.0001	< 0.0001	< 0.0001	0.0938	< 0.0001	

*Notes: PIPTAX stands for Personal Income Taxes, IMPTAX stands for import taxes, CFTAX stands for Cocoa farmers' taxes, DGSTAX stands for Domestic goods and services taxes, TAXREV stands for total tax revenues, and TRDUM stands for Tax Dummy (1= tax reform policies after 2001, and 0= Otherwise). *** One tailed significance at the 1 percent level, ** One tailed significance at the 5 percent level, and * One tailed significance at the 10 percent level. There is absence of multicollinearity in the model, implying that the drivers of tax-revenues are well behaved and do not explain each other.*

Table 3 reports the results of the maximum likelihood procedure (not demonstrated in this study) for co-integration analysis proposed by Johansen (1988) and Johansen and Juselius (1990) to assess the degree of integration among the drivers of Ghanaian tax revenues. The Johansen procedure provides a general framework for estimating and testing the existence of multiple co-integrating vectors. The trace test assesses the null hypothesis that the number of co-integrating vectors is less than or equal to *r* as against a general alternative. The maximum eigenvalue test also examines the number of co-integrating vectors versus that number ± 1. Evidence of weak integration would imply that there is no long-run relationship between the drivers of tax revenues and tax revenues in the observed period. The opposite is true. The results in table 1 shows that we are able to reject the null hypothesis of no co-integration among the drivers of tax revenues at least 2 (when r =1) for both eigen values and trace tests when *VAR* is equal (***VAR =2)***. This implies that at least two of the drivers of tax revenues have long-run equilibrium relationships even when they deviate from each other in the short-run.

Table 3: Hypothesis Test Statistics

H_0	**H_a**	**Eigen Value**	**5% Critical Value**	**10% Critical Value**
r=0	r=1	45.3820[b]	22.1200	18.2450
r≤ 1	r≥ 2	18.4231	15.3478	12.3480
r≤ 2	r≥3	8.4658	11.4530	9.8960
	Conclusion	**R=2**		
H_0	H_A	Trace test	5% critical value	10% critical value
r=0	r≥ 1	74.1929[b]	39.5680	33.8390
r≤ 1	r≥ 2	22.1103	21.3560	19.2385
r≤ 2	r≥3	8.0772	11.8540	9.5456
	Conclusion	**r=2**		

*Notes: r=the number of cointegrating vectors in the model. [b]significant at the 5% level or more. The Johansen (1988) test is used to test the multivariate co-integration. Having r=2 means at least two of the drivers of tax revenues have long-run equilibrium relationships. Johansen's cointegration test for the **VAR=3.** Included in the series are TAXREV- PIPTAX, IMPTAX, CFTAX, DGSTAX and TAXDUM.*

Table 4 shows the results of the ARDL dynamics. The results of Panels A - C attempt to answer the first main purpose of this study (the short-run dynamics of the ARDL. In Panel A, the lags of the drivers of tax revenues (PIPTAX, IMPTAX, CFTAX, and DGSTAX) statistically explained the lags in the Ghanaian tax revenues at the 1% level of significance. However, the lags in the tax dummy (TRDUM) are not statistically significant in explaining the lags in the total tax revenues at the 10% level during the observed period. The coefficient of the error-correction model (ECMt-1) in: Panel A is found to be relatively small (-0.0985) and statistically significant at the 1% level. The numerical explanation is that about 10% of the disequilibria of the previous year's tax revenues adjust back to the long-run equilibrium in the current year.

In Panel B, we find that the lags in tax revenues (ΔTAXREV) are statistically and positively explained by the lags in personal income taxes at the 1% level of significance. However, the lags in cocoa farmers' income taxes (ΔCFTAX), and the lags in the tax reform dummy (ΔTRDUM) statistically and negatively explained the lags in the personal income taxes at the 1% and 5% levels of significance, respectively during the observed period. The coefficient of the error-correction model (ECM_{t-1}) in Panel B is found to be relatively small (-0.1680) and statistically insignificant even at the 10% level.

Table 4: Short-Run Autoregressive Distributed Lag Model Dynamics

Regressor.	Coefficient	Standard error	T-Ratio	[Prob. of not.]
Panel A: Lags in Ghanian Tax Revenues				
Δ $PIPTAX_2$	0.6283	0.1587	3.96***	[0.0005]
Δ$IMPTAX_1$	1.6933	0.1841	9.20***	[0.0001]
Δ$CFTAX_1$	2.6303	0.4052	6.49***	[0.0001]
ΔDGS TAX_2	0.8257	0.1269	6.51***	[0.0001]
Δ$TRDUM_1$	0.0531	0.0369	1.44	[0.1626]
Constant Δ	21.9338	28.0983	0.78	[0.4421]
Ecm (-1)	-0.0985	0.0450	-2.19**	[0.0132]
Panel B: Lags in Personal Income Taxes				
Δ $TAXREV_1$	0.5988	0.1512	3.96***	[0.0005]
Δ $IMPTAX_1$	-0.3988	0.3623	-1.10	[0.2811]
Δ $CFTAX_2$	-2.4395	0.4257	-5.73***	[0.0001]
Δ $DGSTAX_2$	-0.1984	0.1970	-1.01	[0.3231]
Δ $TRDUM_1$	-0.0727	0.0346	-2.10**	[0.0456]
Constant Δ	-4.8446	2.7739	-1.75*	[0.0578]
Ecm (-1)	-0.1680	0.1272	-1.32	[0.2280]
Panel C: Import Taxes				
Δ $TAXREV_1$	0.4518	0.0591	7.64***	[0.0001]
Δ $PIPTAX_2$	-0.1116	0.0511	-2.18**	[0.0145]
Δ $CFTAX_2$	-0.8218	0.2480	-3.31***	[0.0072]
Δ $DGSTAX_2$	-0.4765	0.0506	-9.42***	[0.0001]
Δ **$TRDUM_1$**	0.0089	0.0197	0.45	[0.6563]
Constant Δ	5.0803	2.2340	2.27**	[0.0187]
Ecm (-1)	-0.1243	0.0234	-5.31***	[0.0001]
Panel D: Lags in Coco Farmer Income Taxes				
Δ $Taxrev_1$	0.2351	0.0362	6.49***	[0.0001]
Δ $Piptax_2$	-0.2288	0.0399	-5.73***	[0.0001]
Δ $Imptax_1$	-0.2753	0.0999	-2.76**	[0.0105]
Δ $Dgstax_1$	-0.0992	0.0583	-1.70	[0.1009]
Δ $Trdum_2$	-0.0366	0.0089	-4.09***	[0.0003]
Constant Δ	-3.1526	1.0985	-2.87***	[0.0009]
Ecm (-1)	-0.8257	0.0815	-10.13***	[0.0001]
Panel E: Domestic Goods and Services Taxes				
Δ $Taxrev_1$	0.7504	0.1153	6.51***	[0.0001]
Δ $Piptax_2$	-0.1245	0.0520	-2.39**	[0.0235]
Δ $Imptax_2$	-0.8540	0.0765	-11.16***	[0.0001]
Δ $Cftax_2$	-1.0091	0.4932	-2.05**	[0.0165]
Δ $Trdum_1$	0.0333	0.0360	0.92	[0.3638]
Constant Δ	5.2556	3.0090	1.75*	[0.0578]
Ecm (-1)	-0.3380	0.1585	-2.13**	[0.0110]
Panel F: Lags in Tax Reform				
Δ $Taxrev_1$	1.3874	0.9853	1.41	[0.1616]
Δ $Piptax_2$	-1.9944	0.9500	-2.10**	[0.0256]
Δ $Imptax_2$	0.8707	1.9342	0.45	[0.6563]
Δ $Cftax_2$	-10.7019	2.4171	-4.43***	[0.0001]
Δ $Dgstax_1$	0.9568	1.0351	0.92	[0.3638]
Constant Δ	-137.3064	51.4560	-2.67**	[0.0108]
Ecm (-1)	-0.2568	0.0590	-4.35***	[0.0001]

*Panel A: Notes: Adjusted R^2 =0.99, Akaike information Criterion =-164.9256, Durbin-Watson =2.202. Error-correction representation for the selected autoregressive distributed lag (ARDL) model. The ARDL model (2, 1, 1, 2, 1) was selected on the Akaike Information Criterion. Dependent variable was Δ in REVTAX-. Panel C: Notes: Adjusted R^2 =0.960, Akaike information Criterion =-76.8856, Durbin-Watson =2.216, Error-correction representation for the selected autoregressive distributed lag (ARDL) model. The ARDL model (1, 2, 2, 1, 1) was selected on the Akaike Information Criterion. Dependent variable was Δ in IMPTAX. Panel B: Notes: Adjusted R^2 =0.98, Akaike information Criterion =-152.8856, Durbin-Watson =1.565. Error-correction representation for the selected autoregressive distributed lag (ARDL) model. The ARDL model (1, 1, 2, 2, 1) was selected on the Akaike Information Criterion. Dependent variable was Δ in PIPTAX.. Panel D: Notes: Adjusted R^2 =0.89, Akaike information Criterion =-156.8856, Durbin-Watson =1.886. Error-correction representation for the selected autoregressive distributed lag (ARDL) model. The ARDL model (1, 2, 1, 1, 2) was selected on the Akaike Information Criterion. Dependent variable was Δ in CFTAX. Panel E: Notes: Adjusted R^2 =0.96 Akaike information Criterion =-132.4437, Durbin-Watson =1.935. Error-correction representation for the selected autoregressive distributed lag (ARDL) model. The ARDL model (1, 2, 2, 2, 1) was selected on the Akaike Information Criterion. Dependent variable was Δ in DGSTAX. Panel F: Notes: Adjusted R^2 =0.96Akaike information Criterion =-132.4437, Durbin-Watson =1.821. Error-correction representation for the selected autoregressive distributed lag (ARDL) model. The ARDL model (1, 1, 2, 2, 1) was selected on the Akaike Information Criterion. Dependent variable was Δ in TRDUM. In all panels *** indicates two tailed significance at the 1% level with critical value of ± 2.78. ** indicates two-tailed significance at the 5% level with critical value of ± 2.06, * indicates significance at the 10% level with two-tailed with critical value of ± 1.71.*

In Panel C, the lags in tax revenue (ΔTAXREV) statistically and positively explains import taxes at the 1% level of significance. However, the lags in cocoa farmers' income taxes (ΔCFTAX) and the lags in domestic goods and services taxes (ΔDGSTAX) statistically and negatively explained the lags in import taxes at the 1% level of significance. The lags in personal income taxes (ΔPIPTAX) also statistically and negatively explain total revenues at the 5% level of significance. The coefficient of the error-correction model (ECM_{t-1}) in Panel C is found to be relatively small (-0.1245) and statistically significant at the 1% level. The numerical explanation is that 12.43% of the disequilibria of the previous year's import taxes adjust back to the long-run equilibrium in the current year. In Panel D, the lags in tax revenue (ΔTAXREV) statistically and positively explains the lags in cocoa farmers' income taxes at the 1% level of significance. However, the lags in personal income taxes (ΔPIPTAX) and tax reform dummy (ΔTRDUM) statistically and negatively explain the lags in cocoa farmers' income taxes at the 1% level of significance. The lags in import taxes (ΔIMPTAX) also statistically and negatively explain the lags in cocoa farmers' income at the 5% level of significance. The coefficient of the error-correction model (ECM_{t-1}) in Panel D is found to be relatively big (-0.8257) and statistically significant at the 1% level. Numerically, 83% of the disequilibria of cocoa farmers' income taxes in the previous year adjust back to the long-run equilibrium in the current year. In Panel E, the lags in tax revenue (ΔTAXREV) statistically and positively explains the lags in domestic goods and services taxes (ΔDGSTAX) at the 1% level of significance.

However, the lags in import taxes (ΔIMPTAX) statistically and negatively explain the lags in domestic goods and services taxes at the 1% level of significance. In addition, the lags in personal income taxes (ΔPIPTAX) and cocoa farmers' income taxes (ΔCFTAX) statistically and negatively explain the lags in domestic goods and services (ΔDGSTAX) at the 5% level of significance. The coefficient of the error-correction model (ECM_{t-1}) in Panel E, is found to be relatively big (-0.3380) and statistically significant at the 5% level. Numerically, 34% of the disequilibria of the previous year's domestic goods and services taxes adjust back to the long-run equilibrium in the current year. Finally, in Panel F, the lags in cocoa farmers' income taxes (ΔCFTAX) statistically and negatively explain the lags in tax reform dummy (ΔTRDUM). However, the lags in personal income taxes (ΔPIPTAX) statistically and negatively explain the lags in tax reform dummy (TRDUM). The coefficient of the error-correction model (ECM_{t-1}) in Panel F, is found to be relatively small (-0.2568) and statistically significant at the 1% level.

To further test for the second goal of our study variance decomposition of the drivers of tax revenues (a variant of the innovation accounting technique) is used together with the changing inter-temporal nature of these relationships. The VAR system of the drivers of tax revenues is shocked internally and externally and the forecast variance of each of the drivers of tax revenues is partitioned (Finn & Hodgson, 2005). Table 5 is read similarly to the variance-covariance matrix. By observing the main diagonal, we determine the extent to which each drivers of tax revenues is endogenously determined, because this represents how much of the drivers of tax revenues' own variance is explained by movements in its own shock over the forecast horizon (Amoateng & Deshkovski, 2011).

Conversely, the off-diagonals represent exogeneity from the point of view of the other drivers of tax revenues. In Table 5, with the order of VAR=4, we observe that the cocoa farmers' income taxes (CFTAX) are the most endogenous driver of tax revenues in the VAR system in the observed period. This driver explains its own variance after four years by 66% and with marginal exogenous influences of 12.11%, 8.86%, 5.16%, 4.39%, and 3.34% from TAXREV, TRDUM, PIPTAX, DGSTAX, and IMPTAX, respectively. We also observe that domestic goods and services taxes (DGSTAX) are the second most endogenous driver of tax revenues in the VAR system during the observed period. This driver explains its own variance after four years 43.45% and with marginal exogenous influences of 18.36%, 17.04%, 9.11%, 7.05%, and 4.99% from IMPTAX, TAXREV, CFTAX, PIPTAX, and TRDUM, respectively. Furthermore, we observe that the tax reform dummy (TRDUM) is the third most endogenous driver of tax revenues in the VAR system during the observed period. It explains its own variance after four years by 42% and with marginal exogenous influences of 21.80%, 17.09%, 9.63%, 5.86%, and 3.92% from CFTAX, PIPTAX, TAXREV, DGSTAX, and IMPTAX, respectively. The fourth; fifth; and sixth most endogenous drivers of tax revenues are IMPTAX, PIPTAX, and TAXREV, respectively. The least endogenous variable in the VAR system is the tax revenues during the observed period.

Table 5: Shows the Variance Decomposition Analysis

Period in Years	TAXREV%	PIPTAX%	IMPTAX%	CFTAX%	DGSTAX%	TRDUM%
1	97.20	0.00	2.09	0.61	0.10	0.00
2	71.80	3.17	13.25	8.25	2.58	0.95
3	52.90	12.48	20.40	8.71	4.21	1.30
4	**30.40**[6]	16.11	29.33	13.94	6.89	3.33
1	6.60	86.49	1.78	3.78	1.15	0.20
2	10.17	70.30	4.93	9.04	4.16	1.40
3	18.05	55.17	6.65	12.15	5.68	2.30
4	28.48	**34.30**[5]	7.37	19.72	7.02	3.11
1	1.01	0.00	98.16	0.10	0.73	0.00
2	3.58	0.44	90.37	1.23	3.08	0.30
3	7.21	1.89	78.93	3.44	6.87	1.66
4	19.85	7.70	**36.57**[4]	11.08	14.71	10.09
1	1.33	0.77	0.45	96.35	0.15	0.95
2	5.88	2.14	1.02	85.19	1.09	4.68
3	9.34	4.80	3.11	70.86	3.98	7.91
4	12.11	5.16	3.34	**66.14**[1]	4.39	8.86
1	0.59	0.10	3.47	0.00	95.84	0.00
2	6.28	1.97	6.71	2.49	80.98	1.57
3	11.31	4.51	12.80	6.79	61.39	3.20
4	17.04	7.05	18.36	9.11	**43.45**[2]	4.99
1	0.61	1.19	0.00	1.96	0.20	96.04
2	1.84	3.35	0.39	5.14	1.16	88.12
3	4.00	12.87	1.60	16.80	3.33	61.40
4	9.63	17.09	3.92	21.80	5.86	**41.70**[3]

Notes: The columns and rows may not add to 100% because of rounding. Orthogonized forecast error variance decomposition analysis (unrestricted vector autoregressive model) order of VAR=4. Percent of forecast error variance of innovation in the ranking of the most dependent variables in the system aftershocks are shown in the upper case. The figures in bold tell us about each driver explains its own variance (both external and internal shocks) after 4 years.

CONCLUSIONS, DISCUSSION, LIMITATIONS, AND POLICY RECOMMENDATIONS

The principal and consistent discovery from this study is that cocoa farmers' tax (CFTAX) has the lowest volatility and import taxes (IMPTAX), has the highest volatility with all the series in the observed period. Increases in the volatility of the drivers of tax-revenue continue to bring about heightened discrepancies in the government revenues and spending, leading to chronic budget deficits in Ghana and many transitional economies. Policy makers should design tax collection processes that are eliable and effective. Cocoa farmers' tax (CFTAX) designed by Cocoa Marketing Board (COBOD) is reliable and effective because of enforcement and compliance. The estimated cointegrating relationships identify at least two long-run vectors for the drivers of tax revenues. The implication of this finding is that at least two of the drivers of tax revenues are expected to come back to long-run equilibrium relationships after short-term disturbances in the observed period. We consistently find that the lags in tax revenues positively and significantly explain the lags in the drivers of tax revenues, with the exception of the lags in the tax reform dummy. Also, we find that cocoa farmers' income taxes are the quickest drivers of tax revenues to adjust to long-run equilibrium in the current year. Cocoa farmers' income taxes continue to remain the largest contributor and most reliable source of tax revenues in Ghana (Ocansey, 2010; Asare, 1987). Import taxes are slowest drivers of tax revenues to adjust to long-run equilibrium in the current year because the collection process is riddled with loopholes, bribery and corruption**.**

Interestingly, the tax reform dummy is fairly quick to adjust to long-run equilibrium in the current year after short-run disturbances. Tax reforms in the form of technological innovations to enhance tax collection processes, public disclosure and accountability of personal taxes, and measures to reduce bribery and corruption are increasing over time but key drivers of tax-revenues such as import tax (IMPTAX), personal income tax (PIPTAX) and domestic good and services tax (DGSTAX) are not designed to enforcement and compliance measures. The forecast error variance decompositions reveal that cocoa farmers' income taxes are the strongest endogenous variable in the VAR system exogenous driver of tax revenues, and play a dominant role in Ghanaian tax revenues during the observed period. The dominance of cocoa farmers' income taxes in total Ghanaian tax revenues in the long-run relationships is supported using weak exogeneity tests, which indicate that cocoa farmers' income taxes do not adjust to long-run disequilibrium. In contrast, personal income taxes are weakly exogenous and adjust back to long-run disequilibrium.

The limitation of this study is the data used. Data collected on taxes prior to 1994 to the present might contain errors because they were manually collected. From 1994 to the present, records keeping and reporting on taxes has been more accurate because of the increased use of new technologies/computers to collect and analyze data. We could not find reliable data from 2012 to 2015 because of the slow data recording process. The heavy reliance on cocoa farmers' income taxes, which are in steady decline, will require the government to diversify its tax base to generate enough tax revenues to cover growing government expenditures. However, the large underground economy, which is riddled with non-compliance, with tax collection, reduces tax revenues, causes the tax equity problems, and threatens the legitimacy of the entire tax system. Since tax revenue increase option has become elusive to policymakers, the hardline option is to gradually eliminate government expenditures in the areas of colonial delicacies such as free fuel, chauffeurs for government officials (ministers and members of parliament etc), excessive per diems from the president to other government officials and many more, just to mention but few. Another important limitation of our study is that there must be qualitative research approach that uses surveys to find from the ever growing informal sector why citizens under report their true incomes and what are the enforcement and compliance mechanisms in place to make citizens pay their fair share of the tax burden.

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ANTI-DUMPING DUTIES AND MACROECONOMIC DYNAMICS IN A FIXED EXCHANGE RATE REGIME

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ABSTRACT

This paper uses New Open Economy Macroeconomics with micro-foundation as an analytical framework integrates the characteristics of imperfect competition market and anti-dumping behavior into the two-country (home country and foreign country) model. The goal is to discuss the dynamic effect on different macroeconomic variables (e.g. consumption, output, price) if the home country executes anti-dumping duties when foreign countries engage in dumping behaviors. Through theoretical inference and simulation analysis, this paper discovers that when the dumping margin is lower, the consumption and output will show the phenomenon of mis-adjustment, and the price will appear to be undershooting by an anti-dumping duty shock. When the dumping margin is higher, consumption will present undershooting, the output will appear to be overshooting, and the price will present mis-adjusting or undershooting by an anti-dumping duty shock.

JEL: F12, F13, F41

KEYWORDS: Anti-Dumping Duties, Micro Foundations, Fixed Exchange Rate Regime, Macroeconomic Dynamics, New Open Economy Macroeconomics

INTRODUCTION

With the increasing speed of globalization, companies compete with rivals from all over the world to gain a larger market share (Amiri Aghdaie et al., 2012; Riasi and Amiri Aghdaie, 2012). Although globalization can help improve supply chains (Riasi, 2015a), financing channels (Riasi, 2015b), and marketing strategies (Ansari and Riasi, 2016; Riasi and Pourmiri, 2015, 2016), it might cause various damages to the economy as well. One possible damage of globalization is the threat of dumping and predatory pricing.

Since the World Trade Organization (WTO) was established in 1995, liberalization and globalization have become the mainstream in global economic and trading. However, after several years of operating, some countries in development or low-development realized that opening their markets may not bring direct economic and trade benefits. They have thus refused to open their markets. On the other hand, developing and developed countries usually use many safeguard measures against imports, like antidumping policies, to execute their protectionism. According to General Agreement on Tariffs and Trade (GATT), dumping means "one country sells their products to other country with a price lower than normal value." According to the "Agreement on Anti-dumping" of WTO, if a foreign country was proved to engage in dumping on a home country, and was causing material injury in the home country, the home country can execute antidumping duties toward the foreign country. Hence, in the last 30 years, antidumping policies have become one of the main financial tools of every country.

Furthermore, since the exchange rate represents the currency value inside and outside of country, it bears the important mission of bridging and adjusting finances inside and outside of country. Therefore, most of the literature analyzed the effects of antidumping duty under the floating exchange rate regime (Feinberg, 1989; Knetter and Prusa, 2000; Irwin, 2005). However, if a country prefers a fixed exchange rate regime, the exchange rate will lose its function of transmission in the economic system. The dynamic effect of antidumping duties on macroeconomic variables has not been fully examined. Examining this phenomenon is the purpose of this paper.

The initial development of open economy analysis is mainly presented in the Mundell-Fleming model (Mundell, 1963; Fleming, 1962) and Dornbusch (1976)'s model of Keynes doctrine as the base of theory. Although these early models of open economy revealed and explained the relationship between some of the major macroeconomic variables, there is a common defect, namely, lack of a micro-foundation. Lucas (1976) suggested that changes in macroeconomic variables may affect decisions of individuals, resulting in a change in the relationship among macroeconomic variables. So, the shortage of micro-foundation analysis on the macro economy will produce a bias. The birth of New Open Economy Macroeconomics (hereinafter referred to as NOEM) further opened a new phase to open development of macroeconomics. NOEM is a new generation method to open economy research proposed by Obstfeld and Rogoff (1995). NOEM is characterized by both micro-foundation and monopolistic competition market structure. It is suitable for analyzing the impact of exogenous shocks in the macro economy. This paper used NOEM as the basis for analysis.

This paper is divided into four sections. Section 2 constructs a theoretical model. Section 3 provides a simulation analysis, which discusses the dynamic effect of antidumping duty shock on microeconomic variables. Section 4 presents conclusions and suggestions.

LITERATURE REVIEW

Literature about the effects of antidumping measure can generally be divide into three types as follows. The first type is empirical analysis on the effect of antidumping duties on the upstream/downstream industry. Research in this area includes Webb (1992), Kelly and Morkre (1998), Moore and Zanardi (2011), Amiri Aghdaie et al. (2012), Riasi and Amiri Aghdaie (2012), Riasi (2015a), Riasi (2015b), Ansari and Riasi (2016), Riasi and Pourmiri (2015; 2016). The second type analyzes the effect of antidumping duty on welfare. Related research in this area includes Prusa (1996; 1999), and Staiger and Wolak (1994). The final type examines the effect of antidumping duties on international trade. Related research in this area includes Feinberg and Kaplan (1993), suggested that antidumping could create protection to the production industry. Krupp and Pollard (1996) discussed how antidumping would affect the imports of both related and unrelated import countries. Consider a country charging an import country for dumping. If the final result of an antidumping investigation proves positive, the imports of factories from the exporting country to the charging country would notably drop during and after the investigation.

Prusa (1999) found that industrialized countries would use antidumping to protect their industries, and developing countries would aggressively imitate. The effect of antidumping duty was enormous. In cases when antidumping duty was executed, the imports would reduce by 70% and the import price would increase 30%. In the cases that the dumping charge was disproved, the investigation itself reduced imports by 20%. Prusa (2001) along with Durling and Prusa (2006) also found that antidumping duties would notably reduce. This showed the destructive power for trading of antidumping. Vandenbussche and Zanardi (2010) found that antidumping measures considerably affect trade in industries which are not directly involved in the investigation. They thereby characterize antidumping investigations as a potentially powerful tool of alternative import protection. Brown (2013) found that recent increases to applied tariffs in the textiles and steel industry alone may affect up to 9 percent of Turkey's manufacturing imports.

Summarizing the above, most literature focuses on analyzing the effects of antidumping duties on industry, welfare and trade. It includes only limited discussion of macroeconomic variable impacts. Therefore, to discuss how antidumping duty affects macroeconomic variables of a country, this paper expands the New

Open Economy Macroeconomics (hereinafter referred to as NOEM) suggested by Obstfeld and Rogoff (1995). Documents related to NOEM are relevant as that theory structure used incomplete competitive market structure as an analysis framework with clear micro-foundation. For this reason, many scholars preferred the model. The model assumes that prices display rigidity in the short-term. Therefore, as the economic system faces an external shock, a dynamic adjustment process occurs. This helps us analyze long-term and short-term effects. The NOEM is suitable for analyzing dynamic effects when shocks occur. Hence, this paper uses NOEM as our analysis foundation.

Fender and Yip (2000) discussed how protective policies (tariffs) affect production and welfare based on the NOEM model. Their research showed that if the tariff is raised for the short-term, domestic production would drop. But, it had no certain effets on foreign production. Tariff policy in the long-term has the same effect as the short-term. In terms of welfare, the tariff increase would increase the domestic welfare, but would reduce foreign welfare. Hence, the import tariff would create a beggar-thy-neighbor effect. However, what really caught our attention was that antidumping policy has become a world-wide tool for trading policy. This occurred despite the lack of evidence that can clearly explain what part of the antidumping duty was playing in an open economy. Therefore, this paper discusses the long-term and short-term effect of antidumping policy on macroeconomic variables (such as consumption, output, price…etc.) if a country executes antidumping duty against a foreign country conducting dumping behavior.

THEORETICAL MODEL

Model Setting

This paper follows NOEM proposed by Obstfeld and Rogoff (1995) as a theoretical basis. The main assumptions are as follows:

1. There are two countries in the world, "home country" and "foreign country", all of the following foreign economic variables are marked as "*" for identification.
2. World population is distributed in the interval [0,1], where individuals of home country are distributed between [0,) and foreign individuals are distributed between [,1].
3. Each individual is both a consumer and producer, and operates a monopoly competitor factory using labor for production.
4. Dumping behavior exists in economic system.
5. A Fixed exchange rate regime is implemented domestically.

Household

Assuming that all individuals have the same preferences, utility (U) is a function to the consumption (C), real money balances (M/P) and output level (y), the lifetime utility function is set as follows:

$$U_t = \sum_{s=t}^{\infty} \beta^{s-t} \left[\log C_s + \frac{\chi}{1-\varepsilon} \left(\frac{M_s}{P_s} \right)^{1-\varepsilon} - \frac{\kappa}{2} y_s(z)^2 \right], \ \varepsilon > 0 \tag{1}$$

Where β is the discount factor ($0 < \beta < 1$), ε is the marginal elasticity of demand for real money balances, χ and κ represent the degree of significance of real money balances and output on the utility function, z refers to a particular product.

In Equation 1, the consumption index of the representative consumer is defined as the function of constant elasticity of substitution (CES):

$$C_t = \left[\int_0^n c_{h,t}(z)^{\frac{\delta-1}{\delta}} dz + \int_n^1 c_{f,t}(z)^{\frac{\delta-1}{\delta}} dz \right]^{\frac{\delta}{\delta-1}} , \ \delta > 1 \tag{2}$$

Where $c_h(z)$ is the consumption of domestic consumer for domestic specific products z, $c_f(z)$ is the consumption of domestic consumer for foreign specific product z, and δ is the elasticity of substitution of goods between two countries.

We can deduce domestic price index (P) from the definition of consumption index (Eq. (2)) by the problem of expenditure minimization as follows:

$$P_t = \left[\int_0^n p_{h,t}(z)^{1-\delta} dz + \int_n^1 (1+\tau)(1-\lambda) p_{f,t}(z)^{1-\delta} dz \right]^{\frac{1}{1-\delta}}, \quad \tau \le \lambda \tag{3}$$

Likewise, the foreign price index (P^*) is as follows:

$$P_t^* = \left[\int_0^n (1+\tau^*)(1-\lambda) p_{h,t}^*(z)^{1-\delta} dz + \int_n^1 p_{f,t}^*(z)^{1-\delta} dz \right]^{\frac{1}{1-\delta}}, \quad \tau^* \le \lambda \tag{4}$$

Where $p_h(z)$ stands for the price of domestic product z in domestic currency, $p_f(z)$ stands for the price of foreign product z in domestic currency, $p_h^*(z)$ stands for the price of domestic product z in foreign currency, $p_f^*(z)$ stands for the price of foreign product z in foreign currency. Additionally, because dumping behavior exists in the economic system, we assume the ratio of price for export products sold by both countries is lower than the price of the product sold in the domestic market is λ. Both countries will impose antidumping tax against the dumping behavior of the other rival country. The rate of antidumping duty for home country and foreign country are τ and τ^* respectively. The imposition of antidumping duties is an important tool taken by government against the unfair trade behavior of selling below normal value to maintain fair trade and stabilize the domestic industry development. However, antidumping duty in general is assessed as equal to or less than the dumping margin, that is, $\tau \le \lambda$. For each product, the law of one price is held as follows:

$$p_{h,t}(z) = E_t p_{h,t}^*(z) \tag{5}$$

$$p_{f,t}(z) = E_t p_{f,t}^*(z) \tag{6}$$

Where E represents the exchange rate.

From Equations 2 and 3, the domestic consumption on the specific domestic and foreign products are derived as follows:

$$c_{h,t}(z)=\left(\frac{p_{h,t}(z)}{P_t}\right)^{-\delta}C \quad (7)$$

$$c_{f,t}(z)=\left(\frac{(1+\tau)(1-\lambda)p_{f,t}(z)}{P_t}\right)^{-\delta}C \quad (8)$$

Likewise, the foreign consumptions on the specific domestic and foreign products are derived as follows:

$$c^*_{h,t}(z)=\left(\frac{(1+\tau^*)(1-\lambda)p^*_{h,t}(z)}{P^*_t}\right)^{-\delta}C^* \quad (9)$$

$$c^*_{f,t}(z)=\left(\frac{p^*_{f,t}(z)}{P^*_t}\right)^{-\delta}C^* \quad (10)$$

Where $c^*_h(z)$ is foreign consumption on the specific domestic product z, and $c^*_f(z)$ is foreign consumption on the specific foreign product z.

Government

To emphasize the analysis of antidumping duty effects, assume the government does not have consumption expenditure, the government returns seigniorage revenue and antidumping duty revenue to the agents in a lump-sum fashion. Hence the government budget constraint is shown below:

$$\frac{M_t-M_{t-1}}{P_t}+\frac{\tau(1-n)p_{f,t}(z)}{P_t}=T_t \quad (11)$$

Where the first item on the left of equation is the real seigniorage revenue, the second item on the left of equation is the real antidumping duty revenue, and the right side of equation is the real government transfer payments.

Asset Market

We assuming there exists an integrated international capital market between the two countries, either of which can trade real bonds (B) in the market. The relationship between bond maturity real interest rate (r) and nominal interest rate (i) is based on the Fisher equation, expressed as:

$$1+i_t=\frac{P_{t+1}}{P_t}(1+r_t) \quad (12)$$

The possession of bonds reflects the lending relationship between agents of the two countries, and therefore it satisfies the equation of $nB_t+(1-n)B^*_t=0$, or

$$B^*_t=-\frac{n}{1-n}B_t \quad (13)$$

Where B stands for the bond possession volume of the representative domestic individual, while B^* stands for the bond possession volume of the representative foreign individual.

Budget Constraint

The budget constraint of representative individual is expressed as:

$$M_t + P_t C_t + P_t B_t = M_{t-1} + P_t(1+r_{t-1})B_{t-1} + p_{h,t}(z)y_{h,t}(z) + P_t T_t \quad (14)$$

Where the consumers' income sources in period t include the money balances of period $t-1$ (M_{t-1}), the principal and interest of the bonds $(P_t(1+r_{t-1})B_{t-1})$, output revenue ($p_{h,t}(z)y_{h,t}(z)$), government transfer income ($P_t T_t$). Consumers can use the income for holding the money (M_t), consumption ($P_t C_t$) and bonds purchases ($P_t B_t$).

Aggregate Demand

From Equations 7 and 9, demand for goods that domestic manufacturers face can be expressed as:

$$y_{h,t}(z) = nc_{h,t}(z) + (1-n)c^*_{h,t}(z) = n\left(\frac{p_{h,t}(z)}{P_t}\right)^{-\delta} C + (1-n)\left(\frac{(1+\tau^*)(1-\lambda)p^*_{h,t}(z)}{P^*_t}\right)^{-\delta} C^* \quad (15)$$

Likewise, from Equations 8 and 10, demand for goods that foreign manufacturers face can be expressed as:

$$y^*_{f,t}(z) = nc_{f,t}(z) + (1-n)c^*_{f,t}(z) = n\left(\frac{(1+\tau)(1-\lambda)p_{f,t}(z)}{P_t}\right)^{-\delta} C + (1-n)\left(\frac{p^*_{f,t}(z)}{P^*_t}\right)^{-\delta} C^* \quad (16)$$

First Order Conditions

Under the budget constraint, specified by Equation 14, the first-order conditions of utility, specified by Equation 1 maximization is expressed as:

$$C_{t+1} = \beta(1+r_t)C_t \quad (17)$$

$$\frac{M_t}{P_t} = \left(\frac{(1+i_t)\chi}{i_t} C_t\right)^{\frac{1}{\varepsilon}} \quad (18)$$

$$[y_t(z)]^{\frac{\delta+1}{\delta}} = \left(\frac{\delta-1}{k\delta}\right) C_t^{-1} (C_t^W)^{\frac{1}{\delta}} \quad (19)$$

Equation 17 is the Euler Equation, which describes intertemporal consumption behaviors. Equation 18 is a money demand equation, which explains the substitution relationship between real money demand and consumption. Equation 19 is a labor supply equation, which defines the substitution relationship between labor supply and consumption, and C^W stands for the world consumption, $C_t^W \equiv nC_t + (1-n)C_t^*$.

Derivation of Steady-State

The following sections discuss the effects of antidumping duty shock on macroeconomic variables. First, consider an economic system that does not exist dumping behavior, and an antidumping duty shock was not served in the initial state (0 steady state) as a baseline, and then to seek a long-term steady state of economy system. The following symbols, the subscript "$_t$" represents the macroeconomic variable in the long-term steady state, and the subscript "$_0$" represents the macroeconomic variable in the initial state. For example: C_t and C_0 represent the consumption in the long-term steady state and initial state respectively. When we complete the analysis of short-term equilibrium, we change to express macroeconomic variables in a long-term steady state with null subscript and the subscript "$_t$" represents the macroeconomic variable in a short-term steady state, with which to differentiate them.

By substituting the government budget constraint (Equation 11) to the private budget constraint (Equation 14), and assuming that $B_{t-1} = 0$, the following equation is obtained:

$$C_t = -B_t + \frac{p_{h,t}(z)y_{h,t}(z) + \tau(1-n)p_{f,t}(z)}{P_t} \tag{20}$$

Likewise, the following equation is obtained for the foreign country:

$$C_t^* = -\hat{B}_t^* + \frac{p_{f,t}^*(z)y_{f,t}^*(z) + \tau^* n p_{h,t}^*(z)}{P_t^*} \tag{21}$$

<u>Log-linearization</u>

To get a closed-form solution, this paper used the approach suggested by Uhlig (1995). The model was first given the log-linearization process and then its parameters are given values for simulation analysis. The variables are given the log-linearization process near the initial state to obtain their volatility. The superscript symbol "$\wedge$" denotes the variables going through the log-linearization process. For example, given $\hat{X}_t$ is the result of variable X_t going through the log-linearization process near initial state (X_0), then:

$$\hat{X}_t \equiv \ln\frac{X_t}{X_0} \cong \frac{X_t - X_0}{X_0} \cong \frac{dX_t}{X_0}$$

<u>Log-Linearized Versions of Price Index</u>

By substituting Equations 5 and 6 into Equations 3 and 4, respectively, and process the log-linearization under fixed exchange rate regime ($\hat{E}_t = 0$), then the following equations are obtained:

$$\hat{P}_t = n\hat{p}_{h,t}(z) + (1-n)(1-\lambda)(\hat{p}_{f,t}^*(z) + \hat{\tau}) \tag{22}$$

$$\hat{P}_t^* = n(1-\lambda)(\hat{p}_{h,t}(z) + \hat{\tau}^*) + (1-n)\hat{p}_{f,t}^*(z) \tag{23}$$

Subtract Equation 23 from Equation 22 to get the difference of price index changes of the two countries:

$$\hat{P}_t - \hat{P}_t^* = n\lambda p_{h,t}(z) - (1-n)\lambda\hat{p}_{f,t}^* + (1-n)(1-\lambda)\hat{\tau} - n(1-\lambda)\hat{\tau}^* \tag{24}$$

Log-Linearized Versions of the Law of One Price

Under the fixed exchange rate regime ($\hat{E}_t = 0$), applying Equations 5 and 6 the process of log-linearization, results in the following equations:

$$\hat{p}_{h,t}(z) = \hat{p}_{h,t}^*(z) \tag{25}$$

$$\hat{p}_{f,t}(z) = \hat{p}_{f,t}^*(z) \tag{26}$$

Log-Linearized Versions of World Budget Constraint

Based on Equations 20 and 21, the world budget constraint is obtained as follows:

$$C_t^W = nC_t + (1-n)C_t^* \\ = n\left(-\hat{B}_t + \frac{p_{h,t}(z)y_{h,t}(z) + \tau(1-n)p_{f,t}(z)}{P_t}\right) + (1-n)\left(-\hat{B}_t^* + \frac{p_{f,t}^*(z)y_{f,t}^*(z) + \tau^* np_{h,t}^*(z)}{P_t^*}\right) \quad (27)$$

And then, based on Equations 25 and 26, gives Equation 27 the log-linearization process to obtain the following equation:

$$\hat{C}_t^W = n(-\hat{B}_t + \hat{p}_{h,t}(z) + \hat{y}_{h,t}(z) - \hat{P}_t + (1-n)(\hat{p}_{f,t}^*(z) - \hat{P}_t^*) + \hat{\tau}) \\ + (1-n)(-\hat{B}_t^* + \hat{p}_{f,t}^*(z) + \hat{y}_{f,t}^*(z) - \hat{P}_t^* + n(\hat{p}_{h,t}(z) - \hat{P}_t) + \hat{\tau}^*) \quad (28)$$

Log-Linearized Versions of Demand Function

Give Equations 15 and 16 the process of log-linearization, and the following equations are obtained:

$$\hat{y}_{h,t}(z) = -\delta(n(\hat{p}_{h,t} - \hat{P}_t) + (1-n)(1-\lambda)(\hat{p}_{h,t}^*(z) - \hat{P}_t^* + \hat{\tau}^*)) + \hat{C}_t^W \quad (29)$$

$$\hat{y}_{f,t}^*(z) = -\delta(n(1-\lambda)(\hat{p}_{f,t}(z) - \hat{P}_t) + (1-n)(\hat{p}_{f,t}^*(z) - \hat{P}_t^* + \hat{\tau})) + \hat{C}_t^W \quad (30)$$

Log-Linearized Versions of Labor Supply Function

Give Equation 19 the log-linearization process to obtain the following equation:

$$(1+\delta)\hat{y}_{h,t}(z) = -\delta\hat{C}_t + \hat{C}_t^W \quad (31)$$

Likewise, the foreign labor supply function is processed to obtain the following equation:

$$(1+\delta)\hat{y}_{f,t}^*(z) = -\delta\hat{C}_t^* + \hat{C}_t^W \quad (32)$$

Log-Linearized Versions of Money Demand Function

Give Equation 18 the log-linearization process to obtain the following equation:

$$\hat{M}_t - \hat{P}_t = \frac{1}{\varepsilon}\hat{C}_t \quad (33)$$

Likewise, the foreign money demand function is processed to obtain the following equation:

$$\hat{M}_t^* - \hat{P}_t^* = \frac{1}{\varepsilon}\hat{C}_t^* \quad (34)$$

Subtract Equation 33 from Equation 34 and use Equation 24 to obtain the following equation:

$$\hat{M}_t - \hat{M}_t^* = \frac{1}{\varepsilon}(\hat{C}_t - \hat{C}_t^*) + n\lambda p_{h,t}(z) - (1-n)\lambda\hat{p}_{f,t}^* - (1-n)(1-\lambda)\hat{\tau} - n(1-\lambda)\hat{\tau}^* \quad (35)$$

Log-Linearized Versions of Terms of Trade

The term of trade (referred to as *TOT*) is defined as the ratio of export good price to import good price, expressed as:

$$TOT = \frac{p_{h,t}(z)}{E_t p^*_{f,t}(z)} \tag{36}$$

Under the fixed exchange rate regime ($\hat{E}_t = 0$), the above equation is given a log-linearization process to obtain the following equation:

$$T\hat{O}T = \hat{p}_{h,t}(z) - \hat{p}^*_{f,t}(z) \tag{37}$$

Steady-State Solution

Equations 20 and 21 are given the log-linearization process to obtain the following equations:

$$\hat{C}_t = -\hat{B}_t + \hat{p}_{h,t}(z) + \hat{y}_{h,t}(z) - \hat{P}_t + (1-n)(\hat{p}^*_{f,t}(z) - \hat{P}^*_t + \hat{\tau}) \tag{38}$$
$$\hat{C}^*_t = -\hat{B}^*_t + \hat{p}^*_{f,t}(z) + \hat{y}^*_{f,t}(z) - \hat{P}^*_t + n(\hat{p}_{h,t}(z) - \hat{P}_t + \hat{\tau}^*) \tag{39}$$

Under a fixed exchange rate regime ($\hat{E}_t = 0$), the price can be fixable adjusted in the long-term, also $\hat{B}_t = \hat{B}_{t+1} = 0$. We then seek a solution for a total of 12 simultaneous equations which including log-linearized versions of price index (Equations 22 and 23), law of one price (Equations 25 and 26), world consumption (Equation 28), demand function (Equations 29 and 30), labor supply function (Equations 31 and 32), terms of trade (Equation 37), private budget constrains (Equations 38 and 39) to acquire correlation equations for tariff shock ($\hat{\tau}$) and antidumping duty shock and domestic consumption ($\hat{C}_t$), foreign consumption ($\hat{C}^*_t$), world consumption ($\hat{C}^W_t$), domestic output ($\hat{y}_{h,t}(z)$), foreign output ($\hat{y}^*_{f,t}(z)$), domestic prices of particular product produced by domestic country ($\hat{p}_{h,t}(z)$), foreign prices of particular product produced by domestic country ($\hat{p}^*_{h,t}(z)$), foreign prices of particular product produced by foreign country ($\hat{p}^*_{f,t}(z)$)), domestic prices of particular product produced by foreign country ($\hat{p}_{f,t}(z)$), domestic price index ($\hat{P}_t$), foreign price index ($\hat{P}^*_t$) and terms of trade ($T\hat{O}T_t$).

In the short-term, prices have rigidity ($\hat{p}_{h,t}(z) = 0$; $\hat{p}^*_{f,t}(z) = 0$), and if we log-linear the Euler equation with domestic consumption in its initial state and use the Euler equation with foreign consumption, we know the world consumption in the short-term is:

$$\hat{C}^W_t = \hat{C}^W - (1-\beta)\hat{r}_t \tag{40}$$

Under the fixed exchange rate regime ($\hat{E}_t = 0$), we can put log-linearized versions of price index (Equation 22), world consumption (Equation 28), demand function (Equations 29 and 30), labor supply function (Equations 31 and 32), private budget constrains (Equations 38 and 39) and long-term and short-term world consumption relative equation (Equation 40) to obtain the relationships between the nine endogenous and exogenous variables ($\hat{\tau}$), the nine endogenous variables are domestic consumption ($\hat{C}_t$), foreign consumption ($\hat{C}^*_t$), world consumption ($\hat{C}^W_t$), domestic output ($\hat{y}_{h,t}(z)$), foreign output ($\hat{y}^*_{f,t}(z)$), domestic price index ($\hat{P}_t$), domestic current account ($\hat{B}_t$), foreign current account ($\hat{B}_t^*$) and interest rate ($\hat{r}_t$).

DATA AND METHODOLOGY

Because of the complexity of the model setting, two methods are frequently used to obtain a closed-form of solution between exogenous variables and endogenous variables: log-linearization and numerical simulations. Our model uses log-linearization incorporated with numerical simulation. In simulation, values of parameters must be specified as follows.

To simplify the analysis, this paper sets two economic systems with similar scale on the basis of NOEM. Therefore, when choosing the parameter value, we try our best to introduce empirical data, which focuses on USA and other countries with similar scale (e.g. OECD countries or European Union), to analyze the effect of antidumping duty shock. First, we follow the setup of Bergin et al. (2007) to set the elasticity of substitution of products between countries (δ) to 5. Then, we follow the practice from Mankiw and Summers (1986) and Schmidt (2006), to set the elasticity of marginal utility for real money balances (ε) to 1. We then refer to the current announcement from the US Financial Department about judgement results of an antidumping case about the Solar powered products sold from China to USA. In this case, the antidumping duty was 26.33% to 58.87%. This paper uses this data the export price is 25% lower than the proportion of domestic selling prices (λ) and 60% lower than the changes in domestic anti-dumping duty rate ($\hat{\tau}$). Other policy variables, from inside/outside the country, like domestic monetary supply ($\hat{M}$), foreign monetary supply ($\hat{M}^*$), foreign antidumping duty shock ($\hat{\tau}^*$) are not the focus of this discussion. We assume the rate of change of those variables is 0. Parameter (Variable) is set as seen in Table 1.

Table 1: Parameters (Variables) Selected Values

Symbol	Meaning	Value
n	Country Size	0.5
δ	Elasticity of Substitution of Products between Countries	5
ε	Elasticity of Marginal Utility for Real Money Balances	1
λ	Ratio of export product price selling below its retail price	25%; 60%
$\hat{\tau}$	Rate of Antidumping Duty	25%; 60%

Table 1 shows the parameters (variables) selected values in this paper (including country size, elasticity of substitution of products between countries, elasticity of marginal utility for real money balances, ratio of export product price selling below its retail price, and rate of antidumping duty).

RESULTS

To explore the effects of anti-dumping duty on consumption, price, output, and terms of trade, we use the parameters established from the previous section for the simulation. The results of the simulation analysis are shown in Table 2. It is worth noting that antidumping tax should not exceed the margin of dumping.

Through Table 2, we find that in the long-term, when dumping margin is lower, an increase in antidumping duty would raise the domestic consumption, foreign consumption, world consumption, domestic price index, foreign price index, domestic prices of particular product produced by domestic country, foreign prices of particular product produced by domestic country, foreign prices of particular product produced by foreign country, and domestic prices of particular product produced by foreign country. However, it will also cause a drop of domestic and foreign output and worsen the terms of trade. When the dumping margin is higher, the effect of antidumping duty to every macroeconomic variable will change, which means when the dumping margin is higher, a raise of antidumping duty will reduce the domestic consumption, but the domestic output will increase and terms of trade will improve. When the dumping margin and antidumping duty are both at the high level, the raise of antidumping duty will cause the domestic index to drop.

Table 2: Long-Term Effect of Domestic Antidumping Duty on Macroeconomic Variables

Domestic Consumption ($\hat{C}_t$)				**Foreign Consumption ($\hat{C}_t^*$)**				**World Consumption ($\hat{C}_t^W$)**			
		$\hat{\tau}$				$\hat{\tau}$				$\hat{\tau}$	
		0.25	0.6			0.25	0.6			0.25	0.6
λ	0.25	0.932	-	λ	0.25	1.023	-	λ	0.25	0.978	-
	0.6	-0.352	-0.845		0.6	-0.579	-0.465		0.6	-0.465	-1.117
Domestic Output ($y_{h,t}(z)$)				**Foreign Output ($y_{f,t}^*(z)$)**				**Domestic Price Index ($\hat{P}_t$)**			
		$\hat{\tau}$				$\hat{\tau}$				$\hat{\tau}$	
		0.25	0.6			0.25	0.6			0.25	0.6
λ	0.25	-0.614	-	λ	0.25	-0.690	-	λ	0.25	7.699	-
	0.6	0.216	0.518		0.6	0.405	0.971		0.6	1.060	-2.543
Foreign Price Index ($\hat{P}_t^*$)				The Price of Domestic Product z Denoted in Domestic Currency ($\hat{p}_{h,t}(z)$)				The Price of Domestic Product z Denoted in Foreign Currency ($\hat{p}_{h,t}^*(z)$)			
		$\hat{\tau}$				$\hat{\tau}$				$\hat{\tau}$	
		0.25	0.6			0.25	0.6			0.25	0.6
λ	0.25	7.675	-	λ	0.25	8.452	-	λ	0.25	8.452	-
	0.6	-1.380	-3.313		0.6	-1.328	-3.188		0.6	-1.328	-3.188
The Price of Foreign Product z Denoted in Domestic Currency ($\hat{p}_{f,t}(z)$)				**The Price of Foreign Product z Denoted in Foreign Currency ($\hat{p}_{f,t}^*(z)$)**				**Terms of Trade ($\hat{TOT}_t$)**			
		$\hat{\tau}$				$\hat{\tau}$				$\hat{\tau}$	
		0.25	0.6			0.25	0.6			0.25	0.6
λ	0.25	9.011	-	λ	0.25	9.011	-	λ	0.25	-0.559	-
	0.6	-2.229	-5.350		0.6	-2.229	-5.350		0.6	0.901	2.163

Table 2 shows the long-term effects of anti-dumping duty on the domestic consumption, foreign consumption, world consumption, domestic output, foreign output, domestic price index, foreign price index, the price of domestic product denoted in domestic currency, the price of domestic product denoted in foreign currency, the price of foreign product denoted in domestic currency, the price of foreign product denoted in foreign currency and terms of trade are ambiguous in a fixed exchange rate regime. It depends upon the dumping margin.

The economic intuition behind the conclusion above can be understood based on the explanation here. Under an open economy system with incomplete competitive market, since the government returns all income from antidumping duties to agents, the raise of antidumping duty means more quota transfer the agents will receive and consumption will also rise. As consumption increases, the price will rise and cause the terms of trade to worsen. Furthermore, as the dumping margin and antidumping duty get larger, the raise of antidumping duty might have an opposite effect on macroeconomic variables. Under the short-term, the simulation analysis result is shown in Table 3.

The results in the comparison of long-term and short-term simulation analysis in Tables 2 and 3 show:

(1). In terms of consumption, when the dumping margin is lower, consumption will show phenomenon of mis-adjustment. As the dumping margin is higher, consumption will reveal a phenomenon of undershooting by an antidumping duty shock.

(2). In terms of output, when the dumping margin is lower, output will show a phenomenon of mis-adjustment. As the dumping margin is higher, output will present overshooting by an antidumping duty shock.

(3). In terms of price, when the dumping margin is higher, price will show phenomenon of mis-adjustment. As the two situations when "the dumping margin and antidumping duty rate are low" and "dumping margin is high but antidumping duty rate is low," price will present undershooting by an antidumping duty shock.

Table 3: Short-Term Effect of Domestic Antidumping Duty on Macroeconomic Variables

	Domestic Consumption ($\hat{C}_t$)			Foreign Consumption ($\hat{C}_t^*$)			World Consumption ($\hat{C}_t^W$)	
		$\hat{\tau}$			$\hat{\tau}$			$\hat{\tau}$	
		0.25	0.6		0.25	0.6		0.25	0.6
λ	0.25	-0.346	–	0.25	0.475	–	0.25	0.064	–
	0.6	-0.285	-0.684	0.6	0.556	1.332	0.6	0.135	0.324
	Domestic Output ($y_{h,t}(z)$)			Foreign Output ($y_{f,t}^*(z)$)			Domestic Price Index ($\hat{P}_t$)	
		$\hat{\tau}$			$\hat{\tau}$			$\hat{\tau}$	
		0.25	0.6		0.25	0.6		0.25	0.6
λ	0.25	0.299	–	0.25	-0.385	–	0.25	0.094	–
	0.6	0.26	0.624	0.6	-0.44	-1.056	0.6	0.05	0.12
	Interest Rate ($\hat{r}_t$)			Domestic Current Account ($\hat{B}_t$)			Foreign Current Account ($\hat{B}_t^*$)	
		$\hat{\tau}$			$\hat{\tau}$			$\hat{\tau}$	
		0.25	0.6		0.25	0.6		0.25	0.6
λ	0.25	18.004	–	0.25	0.676	–	0.25	-0.906	–
	0.6	-25.125	-99.42	0.6	0.62	1.488	0.6	-1.02	-2.448

Table 3 shows that an increase in antidumping duty rates will have positive effects on foreign consumption, world consumption, domestic output, domestic price index, and domestic current account, but negative effects on the domestic consumption, foreign output, and foreign current account, the interest rate effect of changes of antidumping duty rates is ambiguous in the short-term.

CONCLUDING COMMENTS

According to the description of Agreement on Anti-dumping from WTO, when the export price of one product is lower than its domestic price, it automatically becomes a suspect of dumping toward an import country. When a specific product appears to be dumping and has created damage to industry of an import country, and this damage has any relation to dumping, the import country can apply an investigation toward specific products from the specific country. Once the import country proves the low price is damaging the industry of the import country, the import country can execute an antidumping duty toward this low priced import product. Considering antidumping policy is a fairly common trading policy tool in actual practice, this paper analyzes the dynamic effect of antidumping duty under a fixed exchange rate as analysis topic. We hope to provide reference for related government departments to execute trading relief measures.

Furthermore, there has been 20 years since NOEM was developed. However, compare to the popularity effect on monetary and fiscal shock, research on trade shock (such as antidumping duty) is rarely seen. For the above reasons, this paper discusses the dynamic effect of antidumping duty. Through theoretical deduction and simulation analysis, we discover that under a fixed exchange rate system, the dynamic effect of antidumping duty on macroeconomic variables like domestic consumption, output and price index are affected by dumping margin and antidumping duty rate. As any mutation appears in dumping margin and antidumping duty level, the process of dynamic adjustment of macro economy will appear to be undershooting, overshooting or in mis-adjustment.

NOEM theory structure displays an important role in many macroeconomic topics, but for easier explanation, the structure is usually built upon many assumptions. If we loosen one of the assumptions or setup (e.g. the type of consumption index), the result will be different. This represents a limitation of this paper.

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