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CONTAGION AND FLIGHT-TO-QUALITY: EVIDENCES FROM THE ASIA-PACIFIC ECONOMIC COOPERATION (APEC) REGION

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ABSTRACT: *This paper investigates the existence and determinants of contagion and flight-to-quality phenomena during crisis periods in the stock and bond markets of APEC countries between 1995 and 2010. The findings show the presence of contagion effects among stock markets of APEC countries and between the U.S. and Canadian bond markets. There are evidences of flight-to-quality from majority of the stock markets to the U.S. bond market. Market sentiment plays an important role in explaining both contagion and flight-to-quality phenomena. Our findings suggest that governments should facilitate bond market development to prevent the propagation of crises across countries.*

JEL Classification: *G15, G01, F15, F30, F60, E44*

Keywords: *Financial crisis, spillover, stock market, bond market, market sentiment*

1. INTRODUCTION

Due to extensive globalisation over the past decades, the Global Financial Crisis (GFC hereafter) that originated in the U.S. has propagated to many countries around the world. Bordo *et al.* (2001) observe that due to increasing capital mobility, the frequency of global crisis after 1973 has doubled comparing to that of during the 1920s and 1930s. Indeed, intensified cross-market linkages have led to increasing probability of financial contagion. Whereas the benefits of diversification are reduced in the presence of contagion, the phenomenon of flight-to-quality encourages investors to diversify across asset classes. This paper adopts the very restrictive definition of contagion from the World Bank where contagion is defined as a significant increase in correlations during crisis periods as compared to 'tranquil' periods. Following Baur & Lucey (2009), we define flight-to-quality from stock to bond markets as the scenario where there is a

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negative change in correlation between stock and bond returns and the correlation ended up in the negative level.

Although studies on contagion effects are abundant, the existing literature has yet to reach a consensus on the presence of contagion during crisis periods. Moreover, most studies on contagion focus on the stock markets while studies on contagion effect within the bond markets are relatively limited. In addition, while Asia-Pacific economies have experienced tremendous growth throughout the past two decades, its integration with the developed markets mean that they are not immune to financial crisis. Accordingly, this paper employs a sample of APEC countries, consisting of both developed and developing countries, over a sample covering eight crisis periods to comprehensively examine the following research questions: (1) Is there a significant change in correlation of stock returns among APEC countries during crises? (2) Is there a significant change in correlation of bond returns among APEC countries during crises? (3) Is there a significant change in correlation of APEC stock returns and US government bond returns during crises? (4) Is investor sentiment associated with contagion effect, or flight-to-quality phenomenon, among APEC countries during crises?

This study contributes to the literature in three important ways. First, this study investigates contagion within bond markets in the Asia-Pacific region, which provides insights on how bond markets behave over eight crisis periods between 1995 and 2010. Second, this paper extends the literature on flight-to-quality to the Asia-Pacific markets. Third, this paper makes a novel contribution by investigating possible determinants of flight-to-quality. The findings will have important implications for policy makers, practitioners and investors. Identification of contagion effect is critical for crisis management so that governments can design appropriate policy responses during market turmoil. Moreover, identifying factors that contribute to contagion and flight-to-quality are crucial so that these factors can be established as potential crisis indicators.

Besides, the findings of this study have important implications to international diversification. Diversification has long been an objective of international investment to reduce country specific risk. Investors seeking to diversify might find decreasing benefits of diversification due to increasing integration among financial markets. Thus, a better understanding of correlations among asset markets is critical for investors to build a diversified portfolio of investments in the emerging and developed markets.

We find the presence of contagion effects in stock market returns among APEC countries and contagion effect in the bond market returns only between the U.S. and Canada. There is also evidence of flight-to-quality phenomenon from stock markets to the U.S. government bond market during crisis periods. The levels of contagion and flight-to-quality are closely associated with the severity of the crisis. After controlling for fundamental economic factors, the Consumer Sentiment Index is found to be an important determinant in explaining both contagion and flight-to-quality phenomena.

The remainder of the paper is organised as follows. Section 2 reviews the relevant literature, followed by descriptions of data and method in Section 3. In Section 4, the findings regarding contagion, flight-to-quality and their determinants are presented. We summarise and conclude the findings in Section 5.

2. LITERATURE REVIEW

2.1. Contagion in Stock Markets

There is extensive empirical literature that examines the existence of contagion in the stock markets. The methods employed in the literature can be summarised into six main categories: cross-market correlation coefficients, GARCH model, dynamic conditional correlation (DCC) model, cointegration test, probit model and Markov-switching (MS) model.

The first method for detecting contagion involves comparing cross-market correlation coefficients during tranquil and crisis periods. One of the early papers that apply this method is King and Wadhwani (1990), who found an increase in correlation between stock markets in the U.S., U.K. and Japan during the 1987 U.S. market crash. However, Forbes and Rigobon (2002) criticise this method as being dubious without accounting for interdependence. After taking interdependence into account, they conclude that contagion is not present.

The second stream of contagion literature adopts the GARCH frameworks to examine cross-market linkages. Bollerslev *et al.* (1988) extend the standard univariate GARCH to a multivariate GARCH model. They also generalise the GARCH model to allow for the covariance term to influence the return process. Dungey *et al.* (2010) use the GARCH framework to examine the 1997 Asian crisis, concluding that the transmission of crisis from Hong Kong to Korea and Thailand is through contagion effect.

The third method that is widely adopted in recent times is the Dynamic Conditional Correlation (DCC) model. According to Engle (2002), multivariate GARCH model usually suffers from dimensionality problem where the number of parameters becomes too large to estimate with prevailing computing technology. Therefore, another form of GARCH model – DCC model is proposed. Since the number of parameters is independent of the number of series included, large correlation matrices can then be estimated. Since then, DCC has become a popular method to test for contagion. Chiang *et al.* (2007) apply DCC test to U.S. and nine Asian markets affected by the 1997 Asian financial crisis. They identify two phases of the crisis. The first phase features increasing correlations, and the second phase displays significant increase in correlations across Asian countries. Lahrech and Sylwester (2011) similarly established the increase in integration between Latin American equity markets and the US equity market by employing the DCC method.

The fourth approach for analysing market linkages is the estimation of cointegrating vector between markets. Chou *et al.* (1994) examine six developed countries, namely U.S., Canada, U.K., Germany, France and Japan, and conclude that there are long-run equilibrium relationships among stock market returns. Estimating dynamic cointegration using a three year rolling window, Yu et al. (2010) find significant indication of cointegration in Asian equity markets during the Asian Crisis period which may be attributed to market contagion and volatility spillover, although the long run evidence of integration is weak.

The fifth method employed to examine contagion is the probit model. In their seminal paper, Eichengreen *et al.* (1996) adopt the probit model to estimate the probability of a crisis occurring in the U.S. and other G-7 countries. They find that the probability of an attack on the domestic currency is expected to rise when a currency crisis exists elsewhere.

The final method used to investigate contagion during turbulent period is the Markov-switching (MS) model, proposed by Hamilton (1989). The MS model allows for the construction of models of stock index returns that switch between multiple regimes. Ang and Bekaert (1999) apply several MS models for stock markets in U.S., U.K. and Germany. They find evidence of two regimes, where high-volatility corresponds to high-correlation and low-volatility corresponds to low-correlation.

2.2. Contagion in Bond Markets

Similar to stock markets, empirical evidences have shown an increase in integration level among international bond markets throughout the decades (Solnik *et al.*, 1996). Hartmann *et al.* (2004) employ an external dependence measure for bond markets in the G-5 and show that, given a crash in bond market; the conditional probability of having another bond market crash is higher, thus indicating the existence of contagion. To the contrary, Hunter and Simon (2004) examine bond markets of U.S., U.K., Japan and Germany during the period of January 1992 to September 2002, concluding that the return correlations did not increase during periods of heightened volatility. Dungey *et al.* (2006) analyse the effect of the Russian and LTCM crises on several emerging markets, and have identified significant contagion effects from Russia to developing markets during the Russian crisis and to the mature markets during the LTCM near collapse.

2.3. Contagion and Flight-to-Quality from Stock to US Bond Markets

Empirical studies of contagion and flight-to-quality between stock and bond markets with an emphasis on turbulent periods are scarce relative to studies that focus on stock markets. Only several papers have documented that stock-bond correlation is on average positive over the long-term, with sub-periods of negative correlations (Fleming *et al.*, 2003; Gulko, 2002; Hartmann *et al.*, 2004). Illmanen (2003) argues that one of the reasons for negative stock-bond correlations is high-volatility stock market regimes. Kaminsky and Reinhard (2002) additionally investigate the integration of bonds, equities, foreign exchange and domestic money markets between 1997-1999 and find that bond markets display the highest degree of co-movements while the domestic money markets display the lowest degree of co-movements among sample countries with the exception of G-7 countries.

Baur and Lucey (2009) employ the DCC method to examine stock and bond market returns from the U.S., U.K., Germany and Japan. They find that flight-to-quality occurs frequently during high volatility periods. They also observe that stock markets tend to fall simultaneously and bond markets increase simultaneously if flight-to-quality is a common feature in a crisis period. However, Asian bond markets, except for Japan, are frequently ignored in the prior literature. This paper extends the DCC analysis of stock-bond correlation to the APEC region to provide new insights on the flight-to-quality phenomenon during periods of high market volatility.

2.4. Determinants of Contagion and Flight-to-Quality

Contagion is defined as transmissions of crisis beyond countries' fundamental economic links (Forbes & Rigobon, 2002; Moser, 2003). Therefore, it is essential to account for other fundamental economic factors when investigating the role of investor sentiment factors, in contributing to the contagion effect (Khan & Park, 2009).

Investigating daily stock indices from 13 countries from the period of 1988 to 1998, Johnson and Soenen (2002) conclude that differential in inflation rates, interest rates, and gross domestic products (GDP) growth rates have negative impacts on co-movements between stock markets. Using stock market returns of the G-7 countries, Morana (2008) finds that economic integration explains co-movements of international stock markets from 1980 to 2005. Key variables employed as proxies for economic fundamentals in the study are GDP, inflation and oil price. Apart from the developed countries, Salvatore (1998) investigates emerging economies, and identifies a set of macroeconomic and financial indicators that determine financial crisis. Among the macroeconomic indicators, current account deficit is found to be the most important indicator of a potential crisis in developing country. Abumustafa (2006) focuses on the Middle Eastern countries, and finds that all individual indicators, including the real exchange rate, provide warning signals two years prior to the crises. Similarities in macroeconomic factors also influence the probabilities of contagion. Bae *et al.* (2003) find that exchange rate changes, interest rate levels and regional conditional volatility explain the joint occurrences of large absolute value returns in their sample countries. Similarly, Dasgupta *et al.* (2011) compares the relative importance of trade competition, financial links and institutional similarity to the 'ground zero" country in explaining contagion and find that institutional similarities in macroeconomic factors play an important role in determining the direction of contagion in emerging markets.

In addition to macroeconomic factors, herding and investor sentiment factors have also been found to explain co-movements in asset returns. According to Chiang and Zheng (2010), herding behaviour refers to less sophisticated investors attempting to follow the activities of successful investors, resulting in a group of investors trading in the same direction over a period of time. Calvo and Reinhart (1996) find that herding behaviours explained the co-movements in both bond and stock returns among emerging countries in Latin America during the Mexican crisis. The Volatility Index (VIX) (Dennis & Mayhew, 2002; Whaley, 2000), Consumer Sentiment Index, TED spread and intra-day trading patterns (Lucey and Sevic, 2010) are commonly employed in prior literature to measure market sentiment. Using the University of Michigan Consumer Sentiment Index (CSI), both Fisher and Statman (2003) and Charoenrook (2005) confirm that there is a positive and statistically significant relationship between CSI and contemporaneous U.S. stock returns, and a negative relationship between CSI and future U.S. stock returns. Lashgari (2000) investigates S&P 500 index from January 1988 to December 1998, indicating that there is a negative correlation between TED spread and index return.

3. DATA AND METHOD

3.1. Data

Daily stock and bond indices from APEC countries are collected from *Bloomberg* and *Datastream* to estimate daily stock and bond returns. Stock markets indices from 14 countries from the APEC region, including Australia (AU), Canada (CA), Chile (CL), Hong Kong (HK), Indonesia (ID), Japan (JP), Korea (KR), Malaysia (MY), Mexico (MX), Peru (PE), Philippine (PH), Taiwan (TW), Thailand (TH) and the U.S. (US), and long term government bond indices from 6 countries, namely Australia (AU), Canada (CA), Japan (JP), New Zealand (NZ), Singapore (SG) and the U.S. (US), are included for analysis. Our sample countries form an interesting sample as it consists of both developed and developing economies which are tied with economic links. The

sample periods are from 1/1/1995 to 30/07/2010 covering eight crisis periods with 4067 daily observations of stock and bond market indices.

The proxies employed in this study for investor sentiment are VIX, TED spread and CSI. VIX is retrieved from *Datastream*, while the TED spread is calculated using monthly U.S. 3-month LIBOR minus 3-month Treasury bill rate. Finally, the monthly CSI data is downloaded from the *FRED*® (Federal Reserve Economic Data). The fundamental economic factors included as control variables are the world oil price, real exchange rate, differentials in interest rate, inflation rate, GDP growth rate, and current account balance as per prior literature (see for example, Bae *et al.*, 2003). These are collected from the *IMF Statistics* and *Datastream*.

3.2. Crisis Periods

Since financial contagion is investigated by comparing the correlations between non-crisis periods and crisis periods, it is necessary to identify the starting and ending dates of a crisis. This study investigates eight crisis periods, namely Mexican, Asian, Russian, Long-Term Capital Management (LTCM), Brazilian, Dot-com, Argentina and Global financial crises. The dates are based on existing literature (see Han *et al.*, 2003; Yiu *et al.*, 2010; and Fry *et al.*, 2010). The dating of the eight crisis periods are summarised in Table 1.

Table 1
Crisis period Dates and the Source Country

Crisis Periods	*Start of period*	*End of period*	*Source Country*	*Literature*
Mexican	1 Jan 1995	31 Mar 1995	Mexico	Han, Lee & Suk (2003)
Asian				
Total period	2 Jul 1997	31 Dec 1998		
Phase 1	2 Jul 1997	17 Nov 1997		
Phase 2	18 Nov 1997	31 Dec 1998		
Russian	17 Aug 1998	31 Dec 1998	Russia	Fry, Hsiao & Tang (2010)
LTCM	23 Sep 1998	15 Oct 1998	US	Fry, Hsiao & Tang (2010)
Brazil	7 Jan 1999	25 Feb 1999	Brazil	Fry, Hsiao & Tang (2010)
Dot-com	28 Feb 2000	7 June 2000	US	Fry, Hsiao & Tang (2010)
Argentina	11 Oct 2001	3 March 2005	Argentina	Fry, Hsiao & Tang (2010)
GFC				
Total period	26 Jul 2007	30 July 2010		
Regime 1	26 Jul 2007	9 March 2009		
Regime 2	10 Mar 2009	30 July 2010		

Note: The non-crisis periods includes all data not defined to be in crisis.

3.3. Method

In this paper, we adopt the Dynamic Conditional Correlation (DCC) model to investigate contagion and flight to quality. Engle (2002) highlighted that the conventional multivariate GARCH typically suffers from dimensionality problem where number of parameters becomes too large to estimate with prevailing technology. Therefore, recent literature (see for example, Chiang *et al.*, 2007) employed the DCC model to estimate large correlation matrices as the number of parameters in this model is independent of the number of series included.

3.3.1. Vector Autoregression (VAR) Model

We examine the returns of both bond and stock market indices among the APEC countries from January 1995 to July 2010 by adopting a two-step approach. In order to run a DCC model, we first use the VAR model to demean the market return series and remove the serial-correlation. The VAR model has the characteristic of accounting for the dynamic behaviour of financial time series. Following prior literature (Cheung et al., 2008; Yiu et al., 2010), US stock returns are included as an exogenous global factor. Specifically, the general form of a VAR model can be expressed as follows:

$$\begin{bmatrix} r_t \\ US_t \end{bmatrix} = \begin{bmatrix} \mu_r \\ \mu_{US} \end{bmatrix} + \sum_{j=1}^{p} A_j \begin{bmatrix} r_{t-j} \\ US_{t-j} \end{bmatrix} + \begin{bmatrix} \varepsilon_{r,t} \\ \varepsilon_{US,t} \end{bmatrix} \tag{1}$$

where r_t is the return series of indices from other countries; US_t is the return series of US index; μ_R and μ_{US} are the unconditional mean of other indices and return series of US index, respectively. The order of lags, p, is selected in order to eliminate autocorrelation in the residuals. It is assumed that the residuals are multivariate normally distributed with time-varying covariance. The conditional covariance of the residuals is assumed to take the following form:

$$\begin{bmatrix} \varepsilon_{r,t} \\ \varepsilon_{US,t} \end{bmatrix} | I_{t-1} \sim N(0, H_t), \quad H_t \equiv \begin{bmatrix} \sigma^2_{r,t} & \sigma_{r,US,t} \\ \sigma_{r,US,t} & \sigma^2_{US,t} \end{bmatrix} \tag{2}$$

where I_{t-1} is the information set up to time $t - 1$.

3.3.2. Dynamic Conditional Correlation (DCC) Model

Following Chiang *et al.* (2007), a conditional variance of the residuals is then decomposed as follows:

$$H_t \equiv D_t R_t D_t \tag{3}$$

where D_t is the $n \times n$ diagonal matrix of time varying standard deviations from univariate GARCH model with $\sqrt{h_{ii,t}}$ on the i-th diagonal; R_t is the $n \times n$ time varying correlation matrix, which may or may not be time varying. The dynamic of $h_{ii,t}$ is given by:

$$h_{ii,t} = \omega_i + \sum_{j=1}^{p} \alpha_{i,j} \varepsilon^2_{i,t-j} + \sum_{j=1}^{q} \beta_{ij} h_{ii,t-j} \tag{4}$$

The DCC model involves a two-step estimation of the conditional covariance matrix, H_t. First, estimates of $\sqrt{h_{ii,t}}$ are attained by fitting univariate volatility models for each of the return series. Next, residual series are transformed by their estimated standard deviations from the first step, $u_{i,t} = \varepsilon_{i,t} / \sqrt{h_{ii,t}}$ $u_{i,t}$ is then used to estimate the parameters of the conditional correlation. The dynamic correlation structure in the DCC model is given by:

$$Q_t = (1 - \alpha - \beta)\bar{Q} + \alpha u_{t-1} u'_{t-1} + \beta Q_{t-1} \tag{5}$$

$$R_t = Q_t^{*-1} Q_t Q_t^{*-1} \tag{6}$$

where $Q_t = q_{ij,t}$ is the $n \times n$ time-varying covariance matrix of u_t; $\bar{Q} = E[u_t u'_t]$ is the $n \times n$ unconditional variance matrix of u_t; α and β are non-negative scalar parameters which satisfy the restriction that $(\alpha + \beta) < 1$. The typical element of R_t will be of the form:

$$\rho_{ij,t} = \frac{q_{ij,t}}{\sqrt{q_{ii,t} q_{jj,t}}},\ i, j = 1, 2, ..., n, and\ i \neq j \tag{7}$$

3.3.3. Determinants of Contagion and Flight-to-Quality

3.3.3.1 Defining Contagion and Flight-to-Quality

From Eq.(7), let $\hat{\rho}_{r,source,t}$ be the estimated DCC coefficients (off-diagonal element of R_t). $\hat{\rho}_{r,source,t}$ is then modelled as an AR model with intercept break as follows:

$$\hat{\rho}_{r,source,t} = \gamma_0 + \sum_{i=1}^{p} \gamma_i \hat{\rho}_{r,source,t-i} + \sum_{j=1}^{q} \gamma_j DM_{j,t} + \nu_t \tag{8}$$

where $DMR_{j,t}$ are dummy variables taking values of 1 during crisis periods and 0 during tranquil periods. The country pairs are formed based on the source country of crises, namely, Mexico, Thailand, Hong Kong and the U.S.. The dummy variables are used to test the hypothesis that the crises have significant impact on the DCC coefficients. If the dummies are statistically significant, this would indicate the existence of contagion within the same asset class (defined as a significant increase in correlations during crisis periods as compared to 'tranquil' periods) or flight-to-quality (defined as a negative change in correlation between stock and bond returns and the correlation ended up in the negative level as per Baur and Lucey (2009)). Accordingly, DCON (DFTQ) is coded as 1 if contagion (flight-to-quality) exists within a crisis period and 0 otherwise.

3.3.3.2. Logistic Regressions

The logistic regression is employed to investigate potential determinants of contagion (DCON) and flight-to-quality (DFTQ) phenomena. For the independent variables, we include VIX, CSI and TED as investor sentiment factors; OIL, RER, DIR, DINF, DGDP and DCAB as fundamental economic factors. We then estimate the following multiple logistic regression models:

$$\begin{aligned} DCON\ or\ DFTQ = {} & \beta_0 + \beta_1 VIX + \beta_2 CSI + \beta_3 TED + \beta_4 OIL \\ & + \beta_5 RER + \beta_6 DIR + \beta_7 DINF + \beta_8 DGDP + \beta_0 DCAB + \epsilon \end{aligned} \tag{9}$$

Where VIX = Volatility index

CSI = Consumer sentiment index

TED = TED spread

OIL = World oil price

RER = Real exchange rate

DIR = Differential in interest rates

DINF = Differential in inflation rates

DGDP = Differential in GDP growth rates

DCAB = Differential in current account balance.

The variables definition and expected sign are detailed in Table 2.

Table 2
Variable definitions

Variable		*Expected Sign*	*Definition*
Dependent Variable			
Contagion	DCON		Value = 1 if contagion is significant during the crisis, 0 otherwise.
Flight-to-quality	DFTQ		Value = 1 if flight-to-quality phenomenon is significant during the crisis, 0 otherwise.
Independent Variable – Sentimental Factors			
Volatility Index	VIX	(+)	Change in daily Chicago Board Options Exchange Volatility Index of S&P 500
Consumer Sentiment Index	CSI	(–)	Change in monthly The University of Michigan Consumer Sentiment Index
TED spread	TED	(+)	Change in monthly TED spread, which is calculated using monthly U.S. 3-month LIBOR minus 3-month Treasury bill rate
Independent Variable – Fundamental Economic Factors			
World Oil Price	OIL	(?)	Change in daily crude oil price (US$ per barrel).
Real Exchange Rate	RER	(?)	Change in daily real exchange rate. The currencies in the source countries are used as the base currency.
Differential in Interest Rates	DIR	(–)	Absolute difference of change in daily interest rate, which is calculated by interest rate in source country minus interest rate in pair country.
Differential in Inflation Rates	DINF	(–)	Absolute difference of change in annual inflation rate, which is calculated by inflation rate in source country minus inflation rate in pair country.
Differential in GDP Growth Rates	DGDP	(–)	Absolute difference of change in annual GDP growth rate, which is calculated by GDP growth rate in source country minus GDP growth rate in pair country.
Differential in Current Account Balance	DCAB	(–)	Absolute difference of change in annual CAB (as a percentage of GDP), which is calculated by CAB in source country minus CAB in pair country.

In terms of the investor sentiment factors, VIX is the 'investor fear gauge' (Whaley, 2000). Higher levels of VIX correspond to higher degrees of market turbulences. It is expected that VIX has a positive association with the probability of contagion and flight-to-quality. CSI, a measure consumer expectation regarding the overall economy, is expected to be positively correlated with contemporaneous stock returns. Hence, we expect a negative relationship between CSI and the probability of contagion and flight-to-quality. Finally, TED spread is employed as an indicator of perceived credit risk in the general economy. According to Lashgari (2000), there is a negative correlation between TED spread and return of the index. Thus, a positive association is expected between TED spread and the probability of contagion and flight-to-quality.

As for the fundamental economic factors, Ewing and Thompson (2007) document that crude oil prices are procyclical and oil index are positively associated with market index. Therefore, during economic downturns, it is expected that crude oil prices are lower. An increase in oil price, indicating boom period, decreases the probability of contagion and flight-to-quality. However, prior literature also documents a negative relationship between shocks to oil prices and market indices (Huang & Masulis, 1996). Therefore, we are unable to form an expectation of the sign of association between oil price (OIL) and contagion or flight-to-quality.

Literature investigating the association between real exchange rate and stock market returns has also found mixed effects. Some studies conclude that real exchange rates exert no impact on stock markets (Griffin & Stulz, 2001), while others find that exchange rate fluctuations strongly affect market indices (Doukas *et al.*, 1999; Patro *et al.*, 2002). Therefore, we are unable to assign an expected sign to real exchange rate (RER). Haile and Pozo (2008) find that crashes are more likely to propagate to other countries that have similar macroeconomic fundamentals (i.e. lower differentials in fundamental economic factors). Thus, differentials in fundamental economic factors (DIR, DINF, DGDP and DCAB) are expected to have a negative association with the probability of contagion and flight-to-quality.

4. RESULTS AND DISCUSSIONS

4.1. Dynamic Conditional Correlations of Stock and Bond Markets

Table 3 summarises the descriptive statistics of the dynamic conditional correlations of stock market returns between countries pairs using MX, TH, HK and US as the source country, respectively. These countries have been selected because they are recognised as the source countries for the Mexican Crisis (Mexico), Asian Crisis (Thailand and Hong Kong) and the Global Financial Crisis (US). Correlations between the stock returns are positive on average during the crisis and non-crisis periods, with higher correlation during crisis periods (except for the correlations between MX and PH (Panel A) and US and PH (Panel D)). It is observed that countries within the same region display higher mean correlations than those of different regions. For example, with MX as the source country in Panel A, CL and PE display greater mean correlation relative to other countries. With TH and HK as the source country in Panels B and C, respectively, AU, ID, JP, KR, MY, PH and TW exhibit higher mean correlation relative to other countries. Furthermore, the standard deviations of correlations shown are also generally higher during the market turmoils.

Table 3
Descriptive Statistics on Dynamic Conditional Correlation of Source Country Stock Market Returns versus Sample Stock Market Returns

	AU	*CA*	*CL*	*HK*	*ID*	*JP*	*KR*	*MY*	*PE*	*PH*	*TW*	*TH*	*US*
Panel A: MX as source country													
Non-crisis periods													
Mean	0.125	0.450	0.374	0.160	0.100	0.101	0.146	0.087	0.267	0.079	0.072	0.121	0.125
Std. Dev.	0.027	0.053	0.048	0.047	0.040	0.038	0.040	0.032	0.044	0.028	0.044	0.041	0.027
Skewness	0.227	-0.254	-0.169	0.293	-0.062	-0.109	-0.351	1.025	0.020	-0.020	0.049	0.802	0.227
Kurtosis	-0.057	-0.427	-1.108	-0.546	-0.559	-0.784	-0.462	1.968	0.095	-0.636	-0.971	0.310	-0.057
Crisis periods													
Mean	0.144	0.532	0.443	0.194	0.135	0.103	0.159	0.124	0.356	0.074	0.101	0.159	0.619
Std. Dev.	0.031	0.054	0.073	0.042	0.051	0.032	0.038	0.052	0.067	0.047	0.046	0.046	0.063
Skewness	-0.236	-0.264	0.311	0.102	0.219	-0.226	-0.353	0.267	0.214	1.359	-0.262	0.357	-0.157
Kurtosis	-0.521	-0.520	-1.277	-0.792	-0.751	0.496	-0.053	-0.310	-1.090	1.413	-0.632	-0.276	-0.232
Panel B: TH as source country													
Non-crisis periods													
Mean	0.253	0.118	0.137	0.347	0.306	0.249	0.256	0.301	0.121	0.116	0.239	0.194	0.079
Std. Dev.	0.047	0.028	0.035	0.058	0.053	0.044	0.063	0.037	0.041	0.035	0.053	0.056	0.029
Skewness	-0.524	-0.108	-0.176	-0.245	-0.587	-0.600	-0.561	0.777	0.802	0.789	0.062	-0.265	0.191
Kurtosis	0.152	-0.196	-0.306	-0.963	-0.474	1.124	-0.350	-0.100	0.310	1.575	-1.149	-0.520	-0.444
Crisis periods													
Mean	0.281	0.131	0.161	0.374	0.343	0.285	0.313	0.336	0.159	0.138	0.244	0.268	0.110
Std. Dev.	0.064	0.050	0.043	0.078	0.077	0.070	0.066	0.062	0.046	0.077	0.070	0.071	0.050
Skewness	-0.371	0.444	0.144	-0.034	-0.049	-0.340	-0.278	-0.061	0.357	0.443	0.090	-0.677	0.504
Kurtosis	-0.574	-0.539	-0.759	-0.776	-0.964	-0.280	-0.419	-0.293	-0.276	-0.748	-0.604	0.106	0.031

Table 3
Descriptive Statistics on Dynamic Conditional Correlation of Source Country Stock Market Returns versus Sample Stock Market Returns (Continued)

	AU	*CA*	*CL*	*HK*	*ID*	*JP*	*KR*	*MY*	*PE*	*PH*	*TW*	*TH*	*US*
Panel C: HK as source country													
Non-crisis periods													
Mean	0.424	0.163	0.151	0.333	0.412	0.374	0.327	0.160	0.100	0.259	0.304	0.347	0.146
Std. Dev.	0.044	0.026	0.043	0.051	0.053	0.096	0.053	0.047	0.034	0.053	0.064	0.058	0.030
Skewness	-1.511	-0.342	-0.501	-0.163	0.215	-0.223	-0.154	0.293	0.993	-0.468	0.589	-0.245	0.149
Kurtosis	3.174	0.620	-0.490	-0.127	-0.930	-1.255	-0.585	-0.546	0.834	-0.544	-0.543	-0.963	-0.699
Crisis periods													
Mean	0.486	0.182	0.155	0.382	0.466	0.462	0.374	0.194	0.133	0.308	0.407	0.374	0.167
Std. Dev.	0.061	0.033	0.040	0.086	0.063	0.111	0.066	0.042	0.070	0.062	0.088	0.078	0.034
Skewness	0.088	0.019	0.168	0.060	-0.538	-1.267	0.133	0.102	0.077	-0.096	-0.613	-0.034	-0.237
Kurtosis	-1.161	-0.695	-0.963	-1.061	-0.532	0.299	-1.283	-0.792	-1.117	-1.397	-0.590	-0.776	-0.863
Panel D: US as source country													
Non-crisis periods													
Mean	0.138	0.628	0.361	0.146	0.076	0.110	0.124	0.057	0.552	0.228	0.076	0.079	0.079
Std. Dev.	0.024	0.035	0.072	0.030	0.037	0.026	0.031	0.040	0.068	0.032	0.027	0.031	0.029
Skewness	0.032	-0.397	-0.025	0.149	0.606	-0.052	-0.254	0.773	-0.268	0.436	0.839	-0.115	0.191
Kurtosis	-0.933	-0.608	-0.972	-0.699	-0.024	-0.540	-0.518	0.698	-0.740	-0.79	02.099	0.105	-0.444
Crisis periods													
Mean	0.144	0.691	0.427	0.167	0.097	0.133	0.148	0.077	0.619	0.304	0.068	0.102	0.110
Std. Dev.	0.031	0.033	0.065	0.034	0.040	0.036	0.031	0.050	0.063	0.070	0.042	0.043	0.050
Skewness	-0.134	-0.406	0.337	-0.237	-0.172	0.078	-0.628	0.090	-0.157	0.900	0.766	-0.823	0.504
Kurtosis	-0.467	-0.598	-0.799	-0.863	-0.819	0.454	0.944	-0.235	-0.232	0.482	0.786	0.519	0.031

Note: Numbers reported are dynamic conditional correlations (DCC). DCC is calculated by first using Eq.(1) to demean the return series. The conditional variance of the residuals can be decomposed into three components as denoted in Eq. (3). The time-varying conditional correlation is then retrieved from the time-varying correlation matrix**.** The sample countries are Australia (AU), Canada (CA), Chile (CL), Hong Kong (HK), Indonesia (ID), Japan (JP), Korea (KR), Malaysia (MY), Mexico (MX), Peru (PE), Philippine (PH), Taiwan (TW), Thailand (TH) and the U.S. (US).

Similarly, the conditional correlations on bond market returns (as shown in Table 4) are positive during both crisis and non-crisis periods. The time-varying conditional correlation between Canadian and the U.S. bond returns (0.804 in Table 4) is higher than the stock markets (0.691 in Table 3). Whereas AU and JP exhibit the opposite patterns in their bond (0.129 and 0.093 in Table 4) and stock returns (0.144 and 0.133 in Table 3). This finding could be attributed to the more developed and therefore more integrated bond markets of US and CA, as compared to AU and JP. Similar to the stock markets, each country pair shows a higher mean correlation in the bond market returns during the market turbulence relative to the non-crisis periods. Therefore, the descriptive statistics suggest the existence of contagion among bond markets in APEC countries during the crisis periods.

Table 4
Descriptive Statistics on Dynamic Conditional Correlations of US Bond Market Returns versus Selected Bond Market Returns

	AU	*CA*	*JP*	*NZ*	*SG*
Panel A: Non-crisis periods					
Mean	0.102	0.793	0.080	0.091	0.353
Std. Dev.	0.045	0.035	0.059	0.047	0.083
Skewness	0.341	-0.503	0.252	-0.053	0.164
Kurtosis	-0.138	0.702	-0.783	0.017	-0.614
Panel B: Crisis periods					
Mean	0.129	0.804	0.093	0.105	0.398
Std. Dev.	0.062	0.045	0.061	0.051	0.082
Skewness	-0.217	-2.198	0.819	0.009	-0.208
Kurtosis	0.581	8.820	1.522	-0.410	-0.494

Note: Numbers reported in the table are dynamic conditional correlations (DCC). DCC is calculated by first using Eq. (1) to demean the return series. Then, the conditional variance of the residuals can be decomposed into three components as denoted in Eq. (3). The time-varying conditional correlation is then retrieved from the time-varying correlation matrix. The sample countries are Australia (AU), Canada (CA), Japan (JP), Singapore (SG), New Zealand (NZ) and the U.S. (US).

Finally, Table 5 presents the changes in conditional correlation between US bond market return and other countries' stock market returns. Contrary to the single asset class analysis, correlations between the US bond market return and other countries' stock market returns are lower during the crisis periods relative to the non-crisis periods, highlighting a decrease in correlations during the crisis periods and that the correlations ended up in the negative level. These findings support the existence of the flight-to-quality phenomenon. In the next section, we extend these preliminary analyses by employing an AR model to test for structural breaks in the time varying conditional correlations due to the financial crises.

4.2. Determinants of Contagion and Flight-to-Quality

4.2.1. Contagion in Stock and Bond Markets

4.2.1.1. Contagion in Stock Markets

Table 6 presents the tests of changes in dynamic correlations when MX stock market return is used as the source country. During the Mexican crisis, there is a significant decrease in correlation

Table 5
Descriptive Statistics on Dynamic Conditional Correlations of US Bond Market Returns versus Selected Stock Market Returns

	AU	*CA*	*CL*	*HK*	*ID*	*JP*	*KR*	*MY*	*MX*	*PE*	*PH*	*TW*	*TH*	*US*
Panel A: Non-crisis periods														
Mean	-0.026	0.000	-0.049	-0.044	-0.029	-0.042	-0.032	-0.039	-0.045	-0.060	-0.009	-0.047	-0.035	0.031
Std. Dev.	0.046	0.107	0.070	0.039	0.046	0.039	0.036	0.030	0.089	0.051	0.039	0.030	0.043	0.143
Skewness	0.029	0.519	-0.077	-0.476	0.660	-0.391	-0.200	-0.026	0.417	-0.219	-0.814	0.007	-1.211	0.468
Kurtosis	-0.966	-0.528	-0.841	0.144	0.390	-0.808	-0.644	-0.237	-0.596	-0.079	-0.187	0.079	1.531	-0.905
Panel B: Crisis periods														
Mean	-0.058	-0.161	-0.147	-0.091	-0.054	-0.077	-0.086	-0.059	-0.188	-0.136	-0.044	-0.089	-0.075	-0.186
Std. Dev.	0.042	0.125	0.089	0.049	0.038	0.039	0.036	0.044	0.107	0.073	0.038	0.036	0.033	0.159
Skewness	-0.197	1.016	0.537	-0.062	0.118	0.061	0.283	-0.049	0.774	0.167	0.344	-0.273	-0.150	1.024
Kurtosis	-0.418	1.128	-0.401	-0.947	-0.739	0.254	0.003	-0.547	0.317	-0.568	0.085	-0.414	-0.649	0.818

Note: Numbers reported in the table are dynamic conditional correlations (DCC). DCC is calculated by first using Eq. (1) to demean the return series. Then, the conditional variance of the residuals can be decomposed into three components as denoted in Eq. (3). The time-varying conditional correlation is then retrieved from the time-varying correlation matrix. The sample countries are Australia (AU), Canada (CA), Chile (CL), Hong Kong (HK), Indonesia (ID), Japan (JP), Korea (KR), Malaysia (MY), Mexico (MX), Peru (PE), Philippine (PH), Taiwan (TW), Thailand (TH) and the U.S. (US).

Table 6
Tests of Changes in Dynamic Correlations between MX Stock Market Returns versus Selected Stock Market Returns during Different Crisis Periods

	AU	*CA*	*CL*	*HK*	*ID*	*JP*	*KR*	*MY*	*PE*	*PH*	*TW*	*TH*	*US*
Constant	0.187***	0.110	0.216***	0.078***	0.096***	0.068***	0.116***	0.069***	0.210***	0.089***	0.035**	0.054**	0.026
ρ_{t-1}	0.985***	0.998***	0.994***	0.995***	0.991***	0.992***	0.992***	0.993***	0.992***	0.988***	0.994***	0.995***	0.999***
Mexico	-0.080	-0.113**	0.046	-0.044	-0.075	0.037	-0.089	0.012	0.133	0.016	0.047	-0.057	-0.108
Asia 1	0.080	0.185	0.136	0.028	0.004	-0.003	0.000	-0.050	0.186	0.022	-0.043	-0.036	0.180**
Asia 2	0.085**	-0.015	0.019	0.077**	0.058**	0.038	0.008	0.066**	0.100***	0.172***	0.000	0.081***	-0.021
Russia	0.055	0.015	0.045	-0.052	-0.115	0.030	-0.091	-0.049	0.019	-0.047	0.021	-0.078	0.027
LTCM	-0.113	0.087	0.083	-0.019	-0.060	-0.113	0.006	0.010	0.069	-0.025	-0.099	-0.132	0.086
Brazil	0.061	-0.124	0.097	-0.112	-0.049	0.015	-0.064	-0.063	0.170**	-0.022	0.058	0.001	0.018
Dot-Com	0.073	0.076	0.094***	0.040	-0.089	-0.011	0.036	-0.104	0.062	0.034	0.094	0.057	0.043
Argentina	0.026	0.013	0.000	0.015	0.002	0.025	0.023	0.006	0.033	-0.022	0.045**	0.017	0.005
GFC 1	-0.001	0.033	0.126***	0.020	0.071***	0.001	0.025	0.028	0.137***	-0.011	0.032	0.047**	0.024
GFC 2	0.076***	0.044	0.084***	0.049**	0.103***	0.009	0.028	0.082***	0.191***	-0.022	0.045**	0.039	-0.002

Notes: This table reports the regression output of Eq.(8). ρ_{ij} is the time-varying correlation between the stock returns of Mexico and the stock returns of selected economies. ρ_{t-1} is the time-varying correlation lag one period. *Mexico* is the dummy variable for the Mexican crisis (1/1/95-31/3/95), *Asia 1* is the dummy variable for the first phase of Asian crisis (2/7/97-17/11/97), *Asia 2* is the dummy variable for the second phase of Asian crisis (18/11/97-31/12/98), *Russia* is the dummy variable for the Russian crisis (17/08/98-31/12/98), *LTCM* is the dummy variable for the LTCM crisis (23/9/98-15/10/98), *Brazil* is the dummy variable for the Brazilian crisis (7/1/99-25/2/99), *Dot-Com* is the dummy variable for Dot-Com crisis (28/2/00-7/6/00), *Argentina* is the dummy variable for Argentinean crisis (11/10/01-3/3/05), *GFC 1* is the dummy variable for the first phase of GFC (26/7/07-9/3/09), and *GFC 2* is the dummy variable for the second phase of GFC (10/3/09-30/7/10). The sample countries are Australia (AU), Canada (CA), Chile (CL), Hong Kong (HK), Indonesia (ID), Japan (JP), Korea (KR), Malaysia (MY), Mexico (MX), Peru (PE), Philippine (PH), Taiwan (TW), Thailand (TH) and the U.S. (US). *** and ** indicate statistical significance at 1% and 5% levels, respectively.

between MX and CA, which is inconsistent with expectation. However, significant contagion effects (positive change in correlation) are found during the Asian, Dot-Com and GFC crises when Mexico is employed as the source country.

As presented in Table 7 and Table 8, using either TH or HK stock market returns as the source country, the evidence of an increase in correlation are prominant during the second phase of the Asian crisis. There is a significant increase in correlation between TH stock market returns and the stock market returns of various Asian (namely, HK, MY, PH, TW) and emerging economies (namely, MX and CL). When HK is used as the source country, significant increases in correlation between HK stock market returns with the various Asian (namely, MY, PH, TW, TH) and emerging economies (namely, MX, TL) are also found. Interestingly, we also observed significant increase in correlations between TH, HK (as source countries) and developed economies such as US.

Consistent with Chiang *et al.* (2007), this study argues that investors seem to focus on the local country factors during the early phase of the Asian crisis. After realising the full impact of the crisis on the global economy, they withdrew funds from all Asian economies fearing that the crisis may transmit to other Asian countries. This created an overall crash in the Asian stock markets, producing a wide spread contagion effect in the region. In addition, correlations increase significantly during the GFC, illustrating the existence of contagion effects between the stock market returns of APEC countries with HK and TH as the source country, respectively.

Table 9 reports the findings when US stock market return is used as the source country. We find that contagion effect exists in most of the APEC countries, but not during every crisis period. The evidence reveals that the correlations of most APEC countries increase significantly during the GFC period, highlighting the presence of contagion effect and the significant role of US as the source country of the crisis.

Overall, the significant increases in correlations between stock markets especially during the Asian crisis and the GFC highlighted the presence of contagion effects. This finding is consistent with the existing literature (Caramazza *et al.*, 2004; Cheung *et al.*, 2010; Dungey *et al.*, 2010). Besides, the results also suggest that diversification benefits in international equity markets are reduced when they are needed most during the market turmoils. It should also be noted that the magnitude of a crisis is closely associated with the level of contagion effects. Crises such as the 1997 Asian crisis and GFC are the ones that produce significant increases in correlations in most country pairs. GFC, which results in the largest recession since the Great Depression, created a widespread fear among international investors, causing massive withdrawals of funds in international equity markets. Therefore, every single stock market in the sample suffered a contagion effect during the GFC.

4.2.1.2. Contagion in Bond Markets

Table 10 reports the change in correlations of U.S. bond returns versus Australia, Canada, Japan, New Zealand and Singapore bond market returns during the crisis periods. In contrast to the stock markets findings, majority of the country pairs do not exhibit a significant increase in correlation during market turbulence, except for CA and US during the earlier stage of the Asian crisis and the Argentinean crisis. We argue that since the Canadian and the U.S. bond

Table 7
Tests of Changes in Dynamic Correlations between TH Stock Market Returns versus Selected Stock Market Returns during Different Crisis Periods

	AU	*CA*	*CL*	*HK*	*ID*	*JP*	*KR*	*MY*	*MX*	*PE*	*PH*	*TW*	*US*
Constant	0.112***	0.081***	0.096***	0.137***	0.087**	0.089**	0.077**	0.174***	0.054**	0.078***	0.066**	0.067**	0.055***
ρ_{t-1}	0.995***	0.993***	0.993***	0.995***	0.997***	0.996***	0.997***	0.994***	0.995***	0.993***	0.997***	0.996***	0.992***
Mexico	0.025	0.025	-0.086	0.117**	0.078**	0.062	-0.098**	0.186***	-0.057	-0.009	0.111***	0.086**	0.013
Asia 1	0.072	-0.019	-0.005	-0.065	0.093	0.034	0.048	-0.029	-0.036	0.024	0.024	0.021	0.008
Asia 2	0.060	0.046	0.106***	0.115***	0.047	0.054	0.048	0.082***	0.081***	0.010	0.106***	0.079**	0.072**
Russia	0.035	-0.012	-0.101	-0.063	-0.015	-0.022	-0.031	-0.085	-0.078	0.036	-0.068	-0.097	-0.049
LTCM	-0.021	-0.056	-0.128	0.086	0.218	-0.021	0.006	-0.093	-0.132	0.065	0.111	0.109	-0.131
Brazil	0.030	-0.045	-0.114	0.094	-0.058	0.009	0.112	0.002	0.001	-0.014	0.047	-0.056	-0.001
Dot-Com	0.060	-0.007	0.023	0.107	-0.059	0.133	0.035	0.008	0.057	0.016	0.069	0.067	-0.019
Argentina	0.010	-0.004	0.004	0.017	0.010	0.035**	0.027	0.000	0.017	-0.026	0.005	0.037	0.014
GFC 1	0.086***	0.063***	0.042	0.099***	0.072**	0.098***	0.084***	0.079***	0.047**	0.121***	0.071***	0.095***	0.070***
GFC 2	0.043	0.057	0.072***	0.068***	0.039	0.046	0.028	0.048	0.039	0.045	-0.005	0.052	0.073**

Notes: This table reports the regression output of Eq.(8). ρ_{ij} is the time-varying correlation between the stock returns of Thailand and the stock returns of selected economies. ρ_{t-1} is the time-varying correlation lag one period. *Mexico* is the dummy variable for the Mexican crisis (1/1/95-31/3/95), *Asia 1* is the dummy variable for the first phase of Asian crisis (2/7/97-17/11/97), *Asia 2* is the dummy variable for the second phase of Asian crisis (18/11/97-31/12/98), *Russia* is the dummy variable for the Russian crisis (17/08/98-31/12/98), *LTCM* is the dummy variable for the LTCM crisis (23/9/98-15/10/98), *Brazil* is the dummy variable for the Brazilian crisis (7/1/99-25/2/99), *Dot-Com* is the dummy variable for Dot-Com crisis (28/2/00-7/6/00), *Argentina* is the dummy variable for Argentinean crisis (11/10/01-3/3/05), *GFC 1* is the dummy variable for the first phase of GFC (26/7/07-9/3/09), and *GFC 2* is the dummy variable for the second phase of GFC (10/3/09-30/7/10). The sample countries are Australia (AU), Canada (CA), Chile (CL), Hong Kong (HK), Indonesia (ID), Japan (JP), Korea (KR), Malaysia (MY), Mexico (MX), Peru (PE), Philippine (PH), Taiwan (TW), Thailand (TH) and the U.S. (US). *** and ** indicate statistical significance at 1% and 5% levels, respectively.

Table 8
Tests of Changes in Dynamic Correlations between HK Stock Market Returns versus Selected Stock Market Returns during Different Crisis Periods

	AU	*CA*	*CL*	*ID*	*JP*	*KR*	*MY*	*MX*	*PE*	*PH*	*TW*	*TH*	*US*
Constant	0.499***	0.273***	0.094***	0.199**	0.290	0.055	0.175***	0.078***	0.093***	0.231***	0.140	0.137***	0.169***
ρ_{t-1}	0.988***	0.983***	0.993***	0.994***	0.993***	0.998***	0.994***	0.995***	0.99***	0.991***	0.995***	0.995***	0.988***
Mexico	0.029	0.039	-0.080	0.067	-0.006	-0.147***	0.148***	-0.044	0.005	0.051	0.059	0.117**	0.031
Asia 1	-0.074	-0.003	-0.008	0.056	-0.031	0.022	0.028	0.028	-0.011	0.133**	-0.023	-0.065	-0.026
Asia 2	0.040	0.127***	0.104***	0.031	0.002	-0.009	0.078***	0.077**	0.089***	0.123***	0.093**	0.115***	0.067**
Russia	0.056	-0.043	-0.082	-0.048	-0.037	0.036	-0.143***	-0.052	-0.004	-0.058	-0.096	-0.063	-0.001
LTCM	-0.112	0.029	0.016	0.156	-0.009	0.186	0.057	-0.019	0.086	0.150**	-0.059	0.086	-0.022
Brazil	0.072	-0.100	-0.118	0.111	-0.071	0.066	-0.028	-0.112	0.082	0.118	-0.051	0.094	-0.020
Dot-Com	0.073	-0.022	0.035	0.014	0.091	0.115	0.087	0.040	0.042	0.100	0.026	0.107	-0.060
Argentina	0.027	0.016	0.002	-0.008	0.038	0.013	0.013	0.015	-0.030	-0.012	0.070	0.017	0.018
GFC 1	0.175***	-0.015	0.026	0.113**	0.109	0.058	0.092***	0.020	0.136***	0.140***	0.123	0.099***	0.002
GFC 2	0.173***	0.110***	0.009	0.102	0.085	0.024	0.083***	0.049**	0.087***	0.081***	0.114	0.068***	0.083***

Notes: This table reports the regression output of Eq.(8). $\rho_{i,j}$ is the time-varying correlation between the stock returns of Hong Kong and the stock returns of selected economies. ρ_{t-1} is the time-varying correlation lag one period. *Mexico* is the dummy variable for the Mexican crisis (1/1/95-31/3/95), *Asia 1* is the dummy variable for the first phase of Asian crisis (2/7/97-17/11/97), *Asia 2* is the dummy variable for the second phase of Asian crisis (18/11/97-31/12/98), *Russia* is the dummy variable for the Russian crisis (17/08/98-31/12/98), *LTCM* is the dummy variable for the LTCM crisis (23/9/98-15/10/98), *Brazil* is the dummy variable for the Brazilian crisis (7/1/99-25/2/99), *Dot-Com* is the dummy variable for Dot-Com crisis (28/2/00-7/6/00), *Argentina* is the dummy variable for Argentinean crisis (11/10/01-3/3/05), *GFC 1* is the dummy variable for the first phase of GFC (26/7/07-9/3/09), and *GFC 2* is the dummy variable for the second phase of GFC (10/3/09-30/7/10). The sample countries are Australia (AU), Canada (CA), Chile (CL), Hong Kong (HK), Indonesia (ID), Japan (JP), Korea (KR), Malaysia (MY), Mexico (MX), Peru (PE), Philippine (PH), Taiwan (TW), Thailand (TH) and the U.S. (US). *** and ** indicate statistical significance at 1% and 5% levels, respectively.

Table 9
Tests of Changes in Dynamic Correlations between US Stock Market Returns versus Selected Stock Market Returns during Different Crisis Periods

	AU	*CA*	*CL*	*HK*	*ID*	*JP*	*KR*	*MY*	*PE*	*PH*	*TW*	*TH*	*US*
Constant	0.193***	0.221**	0.066	0.169***	0.073***	0.131***	0.160***	0.046***	0.026	0.175***	0.097***	0.075***	0.055***
ρ_{t-1}	0.986***	0.997***	0.998***	0.988***	0.991***	0.988***	0.987***	0.993***	0.999***	0.992***	0.987***	0.988***	0.992***
Mexico	0.032	-0.035	-0.025	0.031	-0.009	-0.051	-0.047**	0.053	-0.108	-0.020	-0.019	0.102***	0.013
Asia 1	-0.033	0.108	0.135	-0.026	-0.067	-0.029	-0.008	-0.008	0.180**	0.101	-0.034	-0.107	0.008
Asia 2	0.043	-0.003	0.004	0.067**	0.026	0.038	0.029	0.035	-0.021	0.036	0.126***	0.014	0.072**
Russia	0.033	0.042	0.001	-0.001	-0.068	0.032	-0.030	-0.048	0.027	-0.019	-0.009	0.036	-0.049
LTCM	-0.056	-0.005	0.119	-0.022	-0.068	-0.040	0.038	0.012	0.086	0.117	-0.058	-0.131	-0.131
Brazil	0.051	-0.092	-0.061	-0.020	0.029	0.047	0.037	-0.043	0.018	0.132**	0.203**	0.222**	-0.001
Dot-Com	-0.016	0.023	0.053	-0.060	-0.051	-0.089	-0.044	-0.063	0.043	-0.002	-0.027	0.136***	-0.019
Argentina	-0.008	0.017	0.008	0.018	-0.001	0.062***	0.034**	-0.011	0.005	0.022	-0.038**	0.087***	0.014
GFC 1	-0.014	0.022	0.049**	0.002	0.053**	0.025	0.046**	0.011	0.024	0.089***	-0.024	0.056**	0.070***
GFC 2	0.063**	0.044***	0.022	0.083***	0.062**	0.037	0.091***	0.086***	-0.002	0.196***	-0.027	0.095***	0.073**

Notes: This table reports the regression output of Eq. (8) ρ_{ij} is the time-varying correlation between the stock returns of the U.S. and the stock returns of selected economies. ρ_{t-1} is the time-varying correlation lag one period. *Mexico* is the dummy variable for the Mexican crisis (1/1/95-31/3/95), *Asia 1* is the dummy variable for the first phase of Asian crisis (2/7/97-17/11/97), *Asia 2* is the dummy variable for the second phase of Asian crisis (18/11/97-31/12/98), *Russia* is the dummy variable for the Russian crisis (17/08/98-31/12/98), *LTCM* is the dummy variable for the LTCM crisis (23/9/98-15/10/98), *Brazil* is the dummy variable for the Brazilian crisis (7/1/99-25/2/99), *Dot-Com* is the dummy variable for Dot-Com crisis (28/2/00-7/6/00), *Argentina* is the dummy variable for Argentinean crisis (11/10/01-3/3/05), *GFC 1* is the dummy variable for the first phase of GFC (26/7/07-9/3/09), and *GFC 2* is the dummy variable for the second phase of GFC (10/3/09-30/7/10). The sample countries are Australia (AU), Canada (CA), Chile (CL), Hong Kong (HK), Indonesia (ID), Japan (JP), Korea (KR), Malaysia (MY), Mexico (MX), Peru (PE), Philippine (PH), Taiwan (TW), Thailand (TH) and the U.S. (US). *** and ** indicate statistical significance at 1% and 5% levels, respectively.

markets are well developed and demonstrate a high integration level relative to other countries, investors are more likely to think alike of the two markets, resulting in a higher possibility of a positive contagion effect. This also corresponds to the 'neighbourhood effect' proposed by Haile and Pozo (2008), where they argue that when neighbouring countries are in crisis, the probability of a crisis in the country also increases due to the macroeconomic similarities. Unlike stock markets, government bond markets are generally guaranteed by the governments, thus, investors are less likely to withdraw their funds from the markets due to fear. We therefore observe that contagion effects are not as significant in the bond markets as compared to those in the international equity markets.

Table 10
Tests of Changes in Dynamic Correlations between US Bond Market Returns versus Selected Bond Market Returns during Different Crisis Periods

	AU	*CA*	*JP*	*NZ*	*SG*
Constant	0.116***	0.957***	0.131***	0.147***	0.189**
ρR_{t-1}	0.988***	0.988***	0.983***	0.984***	0.995***
Mexico	0.112	-0.083	-0.193	-0.018	-0.067
Asia 1	0.023	0.062**	0.130	-0.188	-0.021
Asia 2	0.030	-0.044	0.032	0.071	-0.008
Russia	-0.118	-0.214	0.331	-0.086	0.000
LTCM	0.514	0.424	-0.119	0.363	0.276
Brazil	0.053	0.040	0.121	0.037	0.081
Dot-Com	0.101	0.013	-0.116	-0.034	-0.020
Argentina	0.040	0.055**	0.015	0.041	0.040
GFC 1	0.049	0.003	0.056	0.011	0.014
GFC 2	0.052	-0.024	-0.055	0.032	-0.078

Notes: This table reports the regression output of Eq.(8). $\rho_{i,j}$ is the time-varying correlation between the bond returns of the U.S. and the bond returns of selected economies. ρ_{t-1} is the time-varying correlation lag one period. *Mexico* is the dummy variable for the Mexican crisis (1/1/95-31/3/95), *Asia 1* is the dummy variable for the first phase of Asian crisis (2/7/97-17/11/97), *Asia 2* is the dummy variable for the second phase of Asian crisis (18/11/97-31/12/98), *Russia* is the dummy variable for the Russian crisis (17/08/98-31/12/98), *LTCM* is the dummy variable for the LTCM crisis (23/9/98-15/10/98), *Brazil* is the dummy variable for the Brazilian crisis (7/1/99-25/2/99), *Dot-Com* is the dummy variable for Dot-Com crisis (28/2/00-7/6/00), *Argentina* is the dummy variable for Argentinean crisis (11/10/01-3/3/05), *GFC 1* is the dummy variable for the first phase of GFC (26/7/07-9/3/09), and *GFC 2* is the dummy variable for the second phase of GFC (10/3/09-30/7/10). *** and ** indicate statistical significance at 1% and 5% levels, respectively.

4.2.1.3. Flight-to-Quality from Stock to U.S. Bond Markets

Table 11 presents the changes in correlation between US government bond market return and other APEC countries' stock markets returns. We find significant negative change in correlations during the crisis periods, indicating the existence of the flight-to-quality phenomenon. However, similar to the stock markets, the level of flight-to-quality phenomenon is closely linked to the severity of a crisis. Consistent with Illmanen (2003) and Baur and Lucey (2009), this study also finds that flight-to-quality phenomenon is more noticeable when stock markets are more volatile, such as during the Asian crisis and the GFC. Specifically, investors in the equity markets are concerned about the possibility of an overall crash in the international stock markets during the crises. Hence, they withdraw their funds from stock markets and invest in U.S. Treasury bill,

Table 11
Tests of Changes in Dynamic Correlations between US Bond Market Returns versus Selected Stock Market Returns during Different Crisis Periods

	AU	*CA*	*CL*	*HK*	*ID*	*JP*	*KR*	*MY*	*MX*	*PE*	*PH*	*TW*	*TH*	*US*
Constant	-0.017	0.017	-0.010	-0.028**	-0.016	-0.038***	-0.039***	-0.044***	-0.001	-0.022	-0.010	-0.059***	-0.030**	0.019
ρR_{t-1}	0.992***	0.999***	0.995***	0.992***	0.990***	0.990***	0.987***	0.991***	0.997***	0.995***	0.988***	0.987***	0.990***	0.999***
Mexico	0.018	0.059	0.069	-0.005	-0.100	-0.092	-0.067	0.067	0.092	0.054	-0.152	0.007	-0.044	0.139**
Asia 1	0.001	-0.117	-0.027	-0.009	0.022	0.035	-0.068	-0.044	-0.063	-0.065	-0.088	-0.038	0.027	-0.130
Asia 2	0.008	-0.107***	-0.038	-0.096***	-0.101***	-0.069**	-0.057	-0.063	-0.093**	-0.056	-0.071	-0.032	-0.093***	-0.099***
Russia	-0.073	-0.023	-0.198**	0.051	0.095	0.013	0.025	0.068	-0.099	-0.054	-0.059	-0.134**	0.094	-0.101
LTCM	0.034	-0.080	0.272	-0.279	-0.340	-0.030	-0.038	-0.045	0.175	0.128	-0.159	-0.249	-0.283	0.122
Brazil	-0.137**	0.073	-0.023	-0.157	-0.048	0.114	-0.201**	0.066	-0.012	-0.095	-0.186	0.053	-0.218	0.061
Dot-Com	0.098	-0.135**	-0.105	0.065	-0.030	0.067	0.080	0.070	-0.109	-0.023	0.113	0.058	0.025	-0.082
Argentina	-0.052***	-0.027	-0.042**	-0.044**	-0.018	-0.054***	-0.072***	0.020	-0.035	-0.029	-0.036	-0.042**	-0.038	-0.030
GFC 1	-0.040	-0.100***	-0.154***	-0.046	-0.081**	-0.061**	-0.132***	-0.033	-0.111***	-0.099***	-0.047	-0.098***	-0.068**	-0.105***
GFC 2	-0.024	-0.047	-0.084**	-0.045	-0.048	-0.039	-0.11***	-0.028	-0.068	-0.108***	-0.012	-0.048	-0.035	-0.055

Notes: This table reports the regression output of Eq. (8). $\rho_{i,j}$ is the time-varying correlation between the bond returns of the U.S. and the stock returns of selected economies. ρ_{t-1} is the time-varying correlation lag one period. *Mexico* is the dummy variable for the Mexican crisis (1/1/95-31/3/95), *Asia 1* is the dummy variable for the first phase of Asian crisis (2/7/97-17/11/97), *Asia 2* is the dummy variable for the second phase of Asian crisis (18/11/97-31/12/98), *Russia* is the dummy variable for the Russian crisis (17/08/98-31/12/98), *LTCM* is the dummy variable for the LTCM crisis (23/9/98-15/10/98), *Brazil* is the dummy variable for the Brazilian crisis (7/1/99-25/2/99), *Dot-Com* is the dummy variable for Dot-Com crisis (28/2/00-7/6/00), *Argentina* is the dummy variable for Argentinean crisis (11/10/01-3/3/05), *GFC 1* is the dummy variable for the first phase of GFC (26/7/07-9/3/09), and *GFC 2* is the dummy variable for the second phase of GFC (10/3/09-30/7/10). The sample countries are Australia (AU), Canada (CA), Chile (CL), Hong Kong (HK), Indonesia (ID), Japan (JP), Korea (KR), Malaysia (MY), Mexico (MX), Peru (PE), Philippine (PH), Taiwan (TW), Thailand (TH) and the U.S. (US). *** and ** indicate statistical significance at 1% and 5% levels, respectively.

which are less likely to default during the market turmoils. The change in correlations between stock and bond market returns becomes negative in the face of a crisis, causing a flight-to-quality phenomenon. An implication of this finding is that governments should facilitate the development of their local bond markets to enable investors to diversify their investments, thereby limiting a wipe-out of asset returns during a financial crisis.

4.2.2. Logistic Regressions

Panels A and B of Table 12 present the descriptive statistics (in percentage) for the independent variables in both the contagion logit regression and flight-to-quality logit regression, respectively. Among the independent variables, TED is the most volatile variable as evidenced by the higher standard deviation (43.07) relative to other variables. This is possibly due to TED being an investor sentiment factor, which fluctuates more than the macroeconomic factors.

Table 12
Descriptive Statistics of Investor Sentiment and Fundamental Economic Factors in the Logistic Regressions

	VIX	*CSI*	*TED*	*OIL*	*RER*	*DIR*	*DINF*	*DGDP*	*DCAB*
Panel A: Contagion logit regression (DCON)									
Mean	0.156	-0.081	6.189	0.037	-0.002	-0.1288	4.1717	2.4962	2.1585
Median	-0.316	-0.760	-2.564	0.000	0.000	0.000	2.7570	3.466	1.715
Std. Dev.	6.239	5.146	43.071	2.508	1.130	17.36	7.2960	3.953	5.468
Panel B: Flight-to-quality logit regression (DFTQ)									
Mean	0.154	-0.093	6.156	0.036	0.008	-0.160	4.200	2.459	2.742
Median	-0.316	-0.760	-2.817	0.000	0.000	0.000	2.762	3.466	2.144
Std. Dev.	6.235	5.155	43.055	2.507	0.983	19.99	7.32	4.167	5.445

Note: Numbers reported in the table are expressed as percentage (%).

Panels A and B of Table 13 present the results of contagion logit regression and flight-to-quality logit regression, respectively. The results are significant and of mixed sign for the macroeconomic differential variables (namely, DINF, DGDP and DCAB). Contrary to expectations, an increase in DINF and DCAB (i.e. less similar macroeconomic factors between countries) increases the odds of contagion during crisis periods by 1% and 5% respectively. While the coefficient on DGDP confirms our expectations that the smaller the differentials, the more likely contagion exist during market turmoils, the coefficient of OIL indicates that an increase in world oil price reduces the odds of contagion by 0.6%. This is possibly because oil price is positively associated with the market index as indicated in Ewing and Thompson (2007). Hence, an increase in oil price leads to an increase in stock returns, diminishing the fear for stock market crash and probability of contagion effects. In addition, consistent with expectation, there is a negative relationship between the change in CSI and probability of contagion, since CSI is positively correlated with contemporaneous stock returns as indicated by prior literature (Charoenrook, 2005; Fisher & Statman, 2003). For a 1% increase in CSI, we expect to see a 1.4% decrease in the odds of contagion.

Similar to the contagion logit regression, the results for flight-to-quality logit regression (as shown in Panel B) also reveal that most control variables are significant. However, the

results for the control variables are again mixed. As expected, higher DGDP and DCAB (less similarities in macroeconomic environment) decrease the odds of flight-to-quality by 8.8% and 7.5%, respectively. In terms of the investor sentiment factors, CSI decreases 1.7% and and TED increases 0.1% the odds of flight-to-quality. This association is as expected because an increase in TED spread (proxy for credit risks) lowers the stock market returns (Lashgari, 2000), encouraging the market participants to invest their funds in the bond markets, which results in a flight-to-quality phenomenon.

Overall, after controlling for macroeconomic factors, investors sentiment factors still play an important role in determining the existence of both contagion and flight-to-quality phenomenon. Specifically, among the investor sentiment factors, Consumer Sentiment Index is the most significant factor in explaining the presence of contagion and flight-to-quality during the crisis periods. Therefore, the contagion effect identified in this study is argued to be beyond the countries' fundamental economic links as defined in the contagion literature. This evidence is in favour of the justification for the local government and IMF to provide financial aids to crisis affected country during the crisis periods, as crashes are propagated through the channel of investor sentiments and herding behaviours.

4.3. Robustness Tests

To evaluate the robustness of the model, a series of robustness tests have been conducted. First, we include more countries, which were previously excluded due to data availability, for a shorter time period. Four more stock markets (New Zealand, Russia, Singapore and Vietnam) and three more bond markets (Hong Kong, Korea and Taiwan) which are members of the APEC are included in the sample. The sample periods are from 1/1/2001 to 30/7/2010 with 2498 observations for stock markets; 1/7/2000 to 30/7/2010 with 2629 observations for bond markets. The results (unreported) are consistent with our previous findings. It is concluded that contagion effect exists in stock but not in the bond markets during market turmoils. The evidence also supports the existence of flight-to-quality phenomenon during crisis periods.

Second, we employ different cut-off dates of the crisis periods as defined in prior literature. According to Mathur *et al.* (2002), Mexican crisis ends on 31/1/1995 when funds for U.S. support package become available. This date is employed as the end date of Mexican crisis in the robustness test. For the Asian crisis, Kallberg *et al.* (2005) define the start of the second phase of Asian crisis as on 20/10/1997, when the crashes propagated to Hong Kong and the Hong Kong Dollar fell victim to speculation. In terms of the Russian and the LTCM crises, the alternative start date is 3/8/1998 and 31/8/1998, respectively (Dungey et al., 2006). Eventually, Bartram and Bodnar (2009) argue that the GFC has been ongoing since the early 2007 when Freddie and Fannie made the announcement of ceasing to buy subprime mortgages on 27/2/2007. The real collapse of the equity markets are on 15/9/2008, when Lehman Brothers bankrupted and AIG was bailed out. Therefore, we define the alternative start and end date of regime 1 of GFC as from 27/2/2007 to 14/9/2008 and regime 2 of GFC from 15/9/2008 to 30/7/2010. Overall, the results (unreported) are robust to the changes of crisis period dates, where correlation changes are significantly positive, resulting in positive correlations within stock markets (contagion effect), and significant negative correlation changes across bond and stock markets (flight-to-quality phenomenon) during the Asian crisis and the GFC.

Table 13
Determinants of Causes of Contagion and Flight-to-quality using the Logistic Regression

	Constant	*VIX*	*CSI*	*TED*	*OIL*	*RER*	*DIR*	*DINF*	*DGDP*	*DCAB*
Panel A: Contagion logit regression (Dependent Variable: DCON)										
β	-0.930***	0.002	-0.014***	0.000	-0.006**	0.010	-0.001	0.010***	-0.060***	0.049***
	(-65.800)	(1.447)	(-10.138	(0.935)	(-2.134)	(1.779)	(-1.205)	(10.066)	(-17.796)	(28.260)
McFadden R-squared		0.008								
LR statistic		1110.863								
Prob (LR statistic)		0.0000								
Panel B: Flight-to-quality logit regression (Dependent Variable: DFTQ)										
β	0.244***	0.001	-0.017***	0.001***	-0.004	0.003	0.003	0.008***	-0.084***	-0.072***
	(8.539)	(0.339)	(-7.086)	(3.304)	(-0.790)	(0.1935)	(0.6219)	(3.4277)	(-13.079)	(-22.436)
McFadden R-squared		0.024								
LR statistic 917.89										
Prob(LR statistic)		0.0000								

Note: Panel A reports results from the logit regression where contagion dummy is dependent variable and take on value of 1 when contagion exists and 0 otherwise. Panel B reports results from the logit regression where flight-to-quality dummy is dependent variable and take on value of 1 when flight-to-quality exists and 0 otherwise. Z-statistics are reported in the blanket.5T*** and ** indicate statistical significance at 1% and 5% levels, respectively.

5. SUMMARY AND CONCLUSIONS

The aim of this paper is to examine whether contagion and flight-to-quality phenomena exist in stock and bond markets among the APEC countries across eight crises periods between 1995 to 2010. In addition, this paper investigates the determinants of both contagion and flight-to-quality phenomena. The results show that contagion effects are present in the stock markets of APEC countries but only between the bond markets of US and Canada during crisis periods. Moreover, we also find evidence of flight-to-quality phenomenon from the stock market to the U.S. government bond markets during the crises. The levels of contagion and flight-to-quality are closely associated with the severity of the crisis since they are more prominent during the Asian crisis and the GFC. During the Asian crisis and the GFC, investors withdrew funds from stock markets due to the fear of global stock market crashes (contagion effect), and invested in the bond market in search of a more secured return (flight-to-quality phenomenon). The results from the logit models further demonstrate that, after controlling for the fundamental economic factors, the Consumer Sentiment Index still plays an important role in determining both the contagion and flight-to-quality phenomena. These findings suggest that short-term policies aimed at stabilizing the economy, such as foreign exchange intervention, government guarantee on the banking sector, can possibly limit the spread of the crisis. Our findings have several implications for policy makers, practitioners and investors.

For international practitioners and investors, the ability to forecast market volatility and correlations between asset markets is important. Our results demonstrate that during the high-stressed periods, diversification benefits within the stock markets are reduced due to contagion effect. Our findings suggest that investors need to consider diversifying their investments across asset classes such as stock and bond markets, as the presence of flight-to-quality to the bond market can limit the losses incurred in the stock markets. For policy makers, the flight-to-quality phenomenon in APEC region reinforces the importance of establishing well-functioning local bond markets to limit the negative impact from financial crisis, and to foster the stability of capital markets in the APEC region.

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