Griffith Business School

Discussion Papers | Finance

Stock market interdependence between Australia and its trading partners: does trade intensity matter?

Sudharshan Reddy Paramati, Rakesh Gupta, Eduardo Roca

No. 2015-06

Series Editors: Dr Suman Neupane and Professor Eduardo Roca

Copyright © 2015 by the author(s). No part of this paper may be reproduced in any form, or stored in a retrieval system, without prior permission of the author(s).

Stock market interdependence between Australia and its trading partners: does trade intensity matter?

Sudharshan Reddy Paramati, ^{*,**} Rakesh Gupta, Eduardo Roca
*Department of Accounting, Finance and Economics, Griffith University, 170
Kessels Road, Nathan, Brisbane Australia-4111*

Abstract

We investigate the extent and manner of stock market interdependence between Australia and its trading partners and examine whether this is affected by trade intensity. Based on trade intensity, we classify Australia's trading partners into major, medium and minor. We hypothesise that markets with greater (lower) trade intensity will be more (less) interdependent with Australia. We perform correlation (unconditional and conditional) analyses between Australia and its trading partners. Results indicate that most of the markets which are highly correlated with Australia are its major trading partners. We conduct panel regression analysis to investigate whether trade intensity has any impact on the stock market correlations between Australia and its trading partners. The results show that trade intensity significantly and positively affect the correlations of Australia with its major trading partners. Thus, the results confirm our hypothesis that trade intensity drives stock market interdependence between Australia and its trading partners.

Keywords: Bilateral trade linkages; stock market interdependence; AGDCC
GARCH models, time series models

JEL codes: C32; G01; G15

* Corresponding author: Email: sudharshanreddy.paramati@griffithuni.edu.au;

** The revised and final version of this paper has been published in 'Applied Economics' Journal (2015). This paper can be cited as: Paramati, S.R., Gupta, R. & Roca, E. (2015) "Stock market interdependence between Australia and its trading partners: does trade intensity matter?" Applied Economics (available online): DOI: 10.1080/00036846.2015.1047088

1. Introduction

Over the last three decades, policy makers of both developed and developing nations have undertaken various measures to eradicate the barriers to the flow of resources across national boundaries. This has significantly contributed to the globalization of financial markets across the world. With increasing globalization, investors are more aware of global opportunities, and the accessibility of these markets has substantially increased. This provides considerable incentive for investors to look for international investment opportunities. Therefore, research into co-movements (or correlations) between equity markets is very important for portfolio managers who wish to diversify their portfolios into other markets for higher risk-adjusted returns. An understanding of the degree of stock market interdependence is also very important to enable policy makers to formulate appropriate policies to determine the flow of resources between national boundaries.

Recently, researchers have begun to explore what economic fundamentals determine stock market interdependence. There are limited numbers of studies on the issue to date, and the studies which have been undertaken provide either contradictory or inconclusive evidence. Findings from few studies suggest that trade linkage is the most significant economic determinant of stock market interdependence ([Chen and Zhang, 1997](#); [Bracker et al., 1999](#); [Pretorius, 2002](#); [Beine et al., 2010](#) and [Wälti, 2011](#)). In contradiction to these evidences, other studies argue that bilateral trade linkages between countries have no effect on their stock market linkages (Elyasiani et al., 1998; Gupta and Guidi, 2012). Some empirical studies also attempt to investigate the stock market long-run relationship

and direction of causality between Australia and its major trading partners. It is important to mention that these empirical studies have also brought mixed results (Roca, 1999; Shamsuddin and Kim, 2003; Hatemi-J and Roca, 2007; and Kazi, 2008)

The primary motivation of this study is that previous studies which examine the degree and manner of interdependence between Australia and its trading partners have several flaws. For instance, these studies do not empirically test the relationship between stock market correlations and trade linkages, but conclude that trade either is important or is not important for stock market interdependence. These studies also largely rely on the assumption that bilateral trade relations among the countries drive their stock market co-movements. None of these researchers has systematically analysed the short run dynamics in a time-varying framework of this interdependence, based on the AGDCC GARCH model. This model has the advantage of capturing the asymmetric and asset-specific news impact on correlations over time. In addition to these, it is also important to understand whether increasing economic integration among the countries have any effect on their stock market linkages. This knowledge is particularly important to policy makers and practitioners for taking appropriate economic policies and investment decisions, respectively. Thus, these unaddressed issues, contradictory evidences and its significance motivate us to undertake a systematic investigation between the stock markets of Australia and its trading partners.

This study therefore addresses this important gap in the context of Australia and its trading partners. We aim to investigate the extent and manner of stock market interdependence between Australia and its trading partners and examine whether

this is affected by their trade intensity. Based on trade intensity, we classify Australia's trade partners into major (Japan, China and the USA), medium (Germany, Malaysia, Indonesia, Thailand and India) and minor (Sri Lanka, Greece and Portugal)¹. We examine the long-run (cointegration)² relationship between the stock markets of Australia and its major, medium and minor trading partners using multivariate cointegration methodology. However, this is not the main focus of the study and it is only for our preliminary understanding of long-run relationship among these markets. Particularly, we estimate dynamic time-varying conditional correlations between the stock markets of Australia and its trading partners by employing AGDCC GARCH models. We then empirically examine the relationship between the stock market correlations and the intensity of bilateral trade linkages using panel regression models.

The results of this study have interesting findings. First, our preliminary results on stock market long-run relationship show that the Australian stock market is cointegrated only with its major trading partners. Second, the results on time-varying correlations indicate that an average Australian stock market has higher correlations with its major trading partners. Finally, panel regression results display that trade intensity significantly and positively affect the correlations of Australia with its major trading partners. Hence, the findings of this study confirm our hypothesis that trade intensity drives stock market interdependence between Australia and its trading partners. These findings contribute to the body of

¹ Australia's bilateral trade linkage with its partners and a detailed discussion about the classification of the markets is provided in Section 3.

² Cointegration is a statistical tool that measures the linear relationship between two non-stationary variables (Engle and Granger, 1987). If we find a cointegration relationship between two or more variables, this implies that they share a common stochastic trend and move together in the long-run.

knowledge on stock market interdependence and trade linkages in the context of Australia and its trading partners and also have important practical and policy implications. Knowledge of the linkage between Australian stock market and its trading partners would be helpful to Australian investors in their quest to find international diversification for their portfolios. This knowledge would also provide an indication of the contagion or spill over risks, and therefore would be important to policymakers in formulating strategies to contain these risks.

The rest of the paper is organized as follows: Section 2 presents the theory of stock market interdependence and intensity of bilateral trade linkage between Australia and its trading partners. Section 3 describes the econometric methodology which is used in this study to estimate time-varying correlations and to explore the relationship between trade linkages and return correlations. Section 4 documents the nature of data and preliminary statistics. Section 5 discusses the empirical results of the study, and finally, the conclusion and contributions of the study are presented in Section 6.

2. Literature Review

The issue of stock market integration has been of interest among academia, policy makers and practitioners for many years due to the significant effect it has on flow or reallocation of resources. Researchers have begun to explore whether economic integration (bilateral trade) between the countries has any impact on their stock market relationship. One stream of researchers argues that higher economic integration between countries can have substantial influence on their stock market correlations and cointegration relationships. While, other stream of researchers argues that economic integration has no impact on their stock market relationship.

These findings indicate either contradictory or inconclusive. We therefore provide critical literature review on stock market interdependence and trade linkages.

Trade linkage and stock market interdependence: In general

A number of studies in the literature document that the bilateral trade linkages between countries can have significant influence on their stock market interdependence. For instance, the relationship between financial markets' interdependence and bilateral trade linkages in the Pacific basin markets is examined by [Chen and Zhang \(1997\)](#). Their findings show that bilateral trade linkages between the countries have a significant influence on the stock market correlations. Authors document that the financial markets of countries which have stronger economic ties tend to move together. [Bracker et al. \(1999\)](#) report that macroeconomic factors such as trade, stock market size differential, real interest differential, geographic distance and time trend are significantly associated with the degree of stock market integration over time. Another study by [Pretorius \(2002\)](#) examines the determinants of stock market co-movements in ten emerging stock markets. This study uses both cross-section and time-series models for the empirical analysis and uses sample data from 1995 to 2000. The results of the cross-section analysis show that only the bilateral trade and the industrial production growth differentials are statistically significant variables for explaining stock market correlations. This study also finds similar results for time series analysis. A study by [Johnson and Soenen \(2003\)](#) shows evidence that higher trade linkage between the Latin America and the USA has strongly contributed for their stock market co-movement.

The direct foreign trade linkage between the countries has considerable influence on developing cross-country linkages and markets throughout the world ([Forbes and Chinn, 2004](#)). [Chambet and Gibson \(2008\)](#) investigate the relationship between bilateral trade linkages and financial market integration. These authors find that financial markets are more integrated among countries which have a homogeneous trade structure. Their analysis further suggests that the increase in openness of foreign trade between countries may positively contribute to higher financial market integration. Further, authors argue that financial markets are more segmented among nations which have restricted their foreign trade openness. [Walti \(2005\)](#) examines the macroeconomic determinants of stock market synchronization in fifteen industrialised countries using data from 1973 to 1997. The results of this study show that trade, financial integration and the similarity of economic structure can positively contribute to stock market synchronization. As other studies by [Calderon et al. \(2007\)](#) and [Frankel and Rose \(1998\)](#) document, close trade linkages lead to an increase in the correlation of business cycles.

The bilateral indicators of economic integration have any impact on the stock market correlations of 40 developed and emerging markets for the period 1970-1990 is examined by [Morgado and Tavares \(2007\)](#). The empirical results of this study show that bilateral trade intensity has a significant positive effect on stock market correlations. Similarly, [Tavares \(2009\)](#) finds that higher trade linkages between countries can increase their stock market co-movements. The recent studies by [Wälti \(2011\)](#) and [Beine et al. \(2010\)](#) argue that international trade is considered to promote synchronization of the business cycle across countries, which can then effect the degree of stock market interdependence.

Some other studies argue that bilateral trade linkages between countries have no impact on the cointegration relationship of their stock markets. For example, a recent study by [Gupta and Guidi \(2012\)](#) investigates the long-run relationship between India and its major trading partners using the daily data on the closing price indices for the period of August 31st, 1999 to June 17th, 2009. Empirical results from the cointegration models suggest that there is no long-run relationship between India and its major trading partners. Similarly, [Elyasiani et al. \(1998\)](#) investigate the interdependence and association between Sri Lanka and its major trading partners. Their results reveal that these stock markets are segmented rather than being interdependent.

Trade linkage and stock market interdependence: In the context of Australia

Since last two decades researchers have begun to explore whether bilateral trade linkages between Australia and its trading partners have any impact on the interdependence of their stock markets. Some studies document that bilateral trade linkage among Australia and its trading partners have significant impact on their stock market co-dependence. For instance, [Shamsuddin and Kim \(2003\)](#) explore the long-run relationship between Australia and its two major trading partners, i.e., Japan and the USA, using weekly data. The empirical results of this study show that there was a long-run relationship between these markets up until the time of the Asian financial crisis. However, results suggest that following the crisis, there was no evidence of a cointegration relationship among these markets. Another study by [Kazi \(2008\)](#) investigates the long-run relationship between the stock markets of Australia and its major trading partners (the UK, the USA, Japan, Canada, Germany and France) using annual data from 1945 to 2002. The evidence

from this study confirms the long-run relationship between Australia and its major trading partners.

However, some other studies find contradictory results. For example, a study by [Roca \(1999\)](#) explores the price linkages between the equity market of Australia and its major trading partners (the USA, the UK, Japan, Hong Kong, Singapore, Taiwan and Korea). This study uses weekly data from December 27th 1974 to December 8th 1995, and the findings show no evidence of a long-run relationship between Australia and its trading partners. Similarly, [Hatemi-J and Roca \(2007\)](#) investigate the equity market interactions between Australia and its major trading partners (Japan, the USA, the UK, Hong Kong, Singapore Taiwan and Korea). The authors employ a bootstrap causality test with leveraged adjustments to explore the causal relationship between Australia and its trading partners. The findings of this study show no significant long-term causal linkages in the pre- and post-crisis periods of Asia. Further, results show low correlations between Australia and its trading partners. Based on these results, the authors suggest that Australian investors can benefit by diversifying their portfolios into these markets.

Our review of the existing literature on stock market interdependence in the context of Australia and its trading partners reveal that these studies also brought mixed results as the general literature. Further, studies on Australia and its trading partners have several weaknesses. For instance, the previous studies relied on the assumption that trade linkages among the countries drive their stock market co-dependence. These studies have not demonstrated the time-varying conditional correlations between the stock markets of Australia and its trading partners. These studies also not empirically tested the relationship between bilateral trade linkage

and stock market correlations. Therefore, these unaddressed issues and contradictory results motivate us to undertake a systematic investigation in the context of Australia and its trading partners.

Bilateral trade

A number of studies in the literature argue that international trade is believed to foster business cycle synchronization across the countries, and therefore affect the level of their stock market interdependence (Wälti, 2011; and Beine et al., 2010). A study by [Wälti \(2011\)](#) provides an interesting argument that the effect of bilateral trade operates through both the demand and supply side of economies. On the demand side, an increase in aggregate demand of country X will lead to more imports from country Y, thus increasing the output of country Y, which induces business cycle synchronization across the countries. On the supply side, the author argues that the influence of international trade may be ambiguous, as it depends on the nature of the various countries and their industrial structures. Another study by Pretorius (2002) argues that through the exports and imports of goods and services between two countries can have significant influence on their stock market co-movements.

In this study, we measure the intensity of bilateral trade linkage between Australia and its trading partners using the following approach:

$$Z_{ij,t} = \frac{X_{ij,t} + M_{ij,t}}{X_{i,t} + M_{i,t}} \quad (1)$$

Where Z_{ij} indicates the intensity of bilateral trade linkage of country i with country j and t is the time period, X_{ij} indicates total exports from country i to

country j while M_{ij} shows total imports of country i from country j and $X_i + M_i$ denotes total exports and imports of country i .

Intensity of trade linkage between Australia and its trading partners

Table 1 provides the percentage of Australia's bilateral trade (exports and imports) linkage with its trading partners for the period of 1993 to 2013. We classified Australia's trade partners into major, medium and minor, based on the intensity of their trade linkages³. The table shows that among the major trading partners, Australia's trade linkage is increasing only with China, while with Japan and the USA, it is declining. It is noteworthy to mention that Australia's trade relationship with China has significantly increased from 4.2% in 1993 to 28.15% by 2013. In contradiction to this, its trade association with the USA is rapidly declining from year to year. Similarly, in the case of medium trading partners, Australia's trade association with Germany and Indonesia it is slightly decreasing, while with Malaysia, Thailand and India it is increasing over time. Australia's trade relations with its minor trading partners are marginally changing over the period. From this table, we can observe that Australia's trade relations with China have significantly increased from the time of the GFC onwards, that is, particularly from 2008. Further, this table shows that in the year 2013, Australia shares 48% of its total trade only with its three major trading partners. This indicates that how strongly these economies are interdependent.

³ To classify Australia's major, medium and minor trading partners, we use Australia's average bilateral trade with its trading partners from 1993 to 2013. The countries that have an average bilateral trade of 15% to 11%, 4% to 2% and 0.12% to 0.07% are considered to be Australia's major, medium and minor trading partners, respectively. The rationale for selecting these ranges is to show significant distance in terms of trade intensity among these groups. Bangladesh falls under the category of minor trading partners; however we have excluded this country from our analysis due to unavailability of stock price data for the given sample period.

[Insert Table 1 Here]

3. Methodology

The aim of this study is to examine the extent and manner of stock market interdependence between Australia and its trading partners and examine whether this is affected by trade intensity. For our preliminary understanding of stock market linkage, we explore the long-run relationship between Australia and its major, medium and minor trading partners, using the multivariate cointegration methodology⁴. As shown in Figure 1, we first estimate time-varying dynamic conditional correlations between these markets using the AGDCC GARCH approach. Finally, in order to investigate whether trade intensity is significantly affecting stock market correlations, we employ panel regression models.

[Insert Fig.1 Here]

Asymmetric Generalized DCC GARCH Model

To examine the time dynamics in the correlations of pairwise stock returns (Australia and each of its trading partners) we use the asymmetric generalized dynamic conditional correlation (AGDCC) GARCH model. The results of this model will convey whether stock markets are becoming more or less interdependent over time. The higher the correlations between the markets, then the lower will be the diversification opportunities for investors and vice versa. This methodology was initiated by Engle (2002), who was the first author to introduce a new class of M-GARCH model, which is known as DCC-GARCH. This is an important model for measuring the time dynamics in correlations. However, to

⁴ First we apply two unit root tests such as ADF (Dickey and Fuller, 1979) and PP (Phillips and Perron, 1988) to confirm that all the variables are integrated of order I (1) and then we apply Johansen (1991, 1995) multivariate cointegration test on the stock prices of Australia and its major, medium and minor trading partner markets to explore the long-run relationship.

allow for series-specific news impact and conditional asymmetries in correlations, we use the modified version of the DCC model i.e. the AGDCC GARCH of Cappiello et al. (2006)⁵. This AGDCC GARCH model is also a better model for capturing the heterogeneity that is present in the data series. This model can be represented through the following equation:

$$Q_t = (\bar{P} - A'\bar{P}A - B'\bar{P}B - G'\bar{N}G) + A'\varepsilon_{t-1}\varepsilon'_{t-1}A + G'n_{t-1}n'_{t-1}G + B'Q_{t-1}B \quad (2)$$

Where Q is the correlation matrix; A, B and G are $k \times k$ parameter matrices, and $n_t = I[\varepsilon_t < 0] \circ \varepsilon_t$, ($I[\cdot]$ is a $k \times 1$ indicator function which takes the value of 1 if the argument is true and otherwise 0, while " $\circ$ " indicating Hadamard product), $\bar{N} = E[n_t n'_t]$. If the matrices of A, B and G are replaced by scalars, then asymmetric DCC model can be obtained as a special case of the AGDCC model. In the same way, if matrix $G = 0$, then generalized DCC is a special case of AGDCC. The expectations are infeasible for $\bar{P}$ and $\bar{N}$ are replaced with sample analogues, $T^{-1} \sum_{t=1}^T \varepsilon_t \varepsilon'_t$ and $T^{-1} \sum_{t=1}^T n_t n'_t$, respectively.

Panel regression model

To empirically examine the relationship between bilateral trade linkages and stock market correlations of Australia and its major, medium and minor trading partners, we utilize panel regression models. For this purpose, we use the conditional correlations of the stock returns of Australia and its trading partners as the dependent variable, and the bilateral trade intensity as an independent variable. More specifically, we construct panel data for Australia's major, medium and

⁵ There are also other models for estimating time-varying correlations between the stock market returns such as; DCC, ADCC, GDCC and etc., however, this model has advantage over other models, particularly to incorporate both asset-specific news impact and asymmetries in the correlations which other models do not.

minor trading partners separately. This is to identify whether higher trade intensity is significant for stock market interdependence. Further, in the analysis we also use two control variables which are exchange rates (local currency against the Australian dollar) and inflation differentials (calculated based on CPI) and two dummy (1 for crisis and otherwise 0) variables to represent the AFC (Asian financial crisis) and GFC (global financial crisis). The panel regression model is described as follows:

$$Corr_{it} = C + \beta_1 BTI_{it} + \beta_2 ER_{it} + \beta_3 ID_{it} + \beta_4 AFC + \beta_5 GFC + \nu_t \quad (3)$$

where *Corr* is the conditional correlations of the pairwise stock market returns; *C* is the constant variable; $\beta_1, \beta_2, \beta_3, \beta_4$ & β_5 are the coefficients of the respective variables; *BTI* is the bilateral trade intensity; *ER* is the exchange rates; *ID* is the inflation differential; the *AFC* and *GFC* are the dummy variables for identifying the impact of the crises on the stock market correlations; ν is the error term; and finally *i* and *t* represent cross-section and time period, respectively.

Hypothesis

Based on the review of the theoretical and empirical literature that we have conducted, the majority of the studies indicate that trade linkage significantly affects stock market linkages. Hence, we hypothesise that markets with greater (lower) trade intensity will be more (less) interdependent with Australia. In this regard, we expect that Australia would be cointegrated and highly correlated with its major trading partners and that trade intensity would have a statistically

significant impact on the correlations between Australia and its major trading partners.

4. Data and preliminary analysis

Data

To investigate the long-run equilibrium relationship and dynamic time-varying conditional correlations we use weekly (Wednesday)⁶ closing price data on MSCI indices for Australia, Japan, China, the USA, Germany, Malaysia, Indonesia, Thailand, India, Sri Lanka, Greece and Portugal for the period from January 6th, 1993 to April 23rd, 2014⁷. The selected indices for this study are denominated in local currency⁸ to avoid the problems associated with exchange rate fluctuations. There are also several other advantages to use data in local currency instead of a common currency. For instance, Mink (2010) argues that stock price data in the local currency can truly reflect the supply and demand forces that are present in that national stock market. Further, the author suggests that by converting data into a common currency (e.g. the Australian dollar) we may miss out on the true picture of the stock market dynamics, and hence it would be inappropriate to do this. In addition, when stock returns are converted into a common currency. The results are significantly driven by exchange rate fluctuations which then contribute to biased results.

⁶ We select week day as a Wednesday to avoid beginning of the week effect and end of the week affect on stock prices.

⁷ Weekly data causes fewer problems because of the non-synchronous trading and short-term correlations due to noise. Therefore, in this study we use weekly closing price data for the empirical analysis. The selection of the sample size is based on the availability of data.

⁸ Several studies in the literature use local currency denominated stock price indices for measuring stock market integration and to investigate the affect of economic integration on the stock market interdependence, e.g. Bracker, et al. (1999), Phylaktis and Ravazzolo (2002) and etc.

Similarly, Mierau and Mink (2013) argue a practical possibility that when two non-synchronous stock returns are changed into a common currency, and if both currencies at the same time appreciate or depreciate against this common currency, this will then indicate that the stock returns are seem to be synchronous, while in reality they are not. Therefore, authors suggest that to avoid these problems, it would be a good idea to use the returns in local currency to focus on correlations across the markets, rather than across currencies. The data on above indices are collected from DataStream. For our empirical analysis all the indices data are converted into natural logarithms.

To investigate whether the intensity of bilateral trade linkages matters for stock market interdependence, we constructed panel data for Australia's major, medium and minor trading partners separately which will suggest whether higher trade linkage between countries has an effect on their stock market correlations. For this purpose, we use quarterly data from the 1st quarter of 1993 to the 4th quarter of 2013 on the following variables: the pairwise stock return correlations that is Australia and each of the trading partners (weekly average of the last month of each quarter), the intensity of bilateral trade, exchange rates (local currency against the Australian dollar), inflation (based on the consumer price index, CPI) differentials⁹ and two dummy variables that are representative of the AFC and the GFC¹⁰. The bilateral trade data are collected from the Australian Bureau of

⁹ The last month of each quarter data is used for intensity of bilateral trade, exchange rates and inflation differentials in the analysis. To avoid model misspecification, we have used exchange rates and inflation differential variables as the control variables in the models.

¹⁰ The AFC period is considered to be from the 4th quarter of 1997 to the 4th quarter of 1998 while the GFC period is considered to be from the 4th quarter of 2007 to the 1st quarter of 2009. The selection of the crises periods is based on the closing stock price index movements. For instance, we consider the start of the crisis period to occur when the majority of the indices start declining and we treat the end of crisis period as being when the majority of the indices starting rising.

Statistics (ABS), while data on exchange rates and inflation differentials are obtained from the International Financial Statistics (IFS)¹¹. Before the application of the panel regression econometric model, only the exchange rate data is converted into natural logarithms and all other variables are in their original form¹².

Preliminary statistics

Table 2 reports the summary statistics of the weekly stock index returns of Australia and its trading partners¹³. This table shows that all the indices have positive mean returns except for those of Japan, China and Greece¹⁴. The highest mean returns were acquired by Indonesia (0.240) and India (0.200). Among all the markets, China (0.375), Malaysia (0.274), Thailand (0.259), Sri Lanka (0.249) and Indonesia (0.221) have the maximum mean returns. The minimum mean returns indicate that all the markets have gone through negative returns. The standard deviation is higher for China (0.048), Thailand (0.045), Greece (0.044), Indonesia (0.043) and Sri Lanka (0.040) while the lowest standard deviation is exhibited by Australia (0.021), the USA (0.023), Portugal (0.027) and Japan (0.029). Thus, the former group of markets are more volatile while the latter are less risky. Further, our analysis indicates that all of the markets display negative skewness with the exception of China, Malaysia, Thailand and Sri Lanka, and have higher kurtosis values. The results of the Jarque-Bera test for normality show that the null

¹¹ We collected exchange rates data on local currency against the US dollar from IFS, and then we converted these data into local currency against the Australian dollar, since our focus is on Australia and its trading partners.

¹² Since correlations and inflation differentials are in percentages, while the intensity of bilateral trade is in proportion to total trade, therefore we have not converted these variables into natural logarithms.

¹³ Returns are calculated using natural log of continuously compounded rates of returns for all the indices.

¹⁴ Mean returns are multiplied by 100.

hypothesis of normal distribution is rejected at a 5% significance level for all the indices, which indicates that the return series are not normally distributed¹⁵.

[Insert Table 2 Here]

Table 3 presents the results of unit root (ADF and PP) tests. The results of ADF and PP tests suggest that the null hypothesis of unit root is not rejected for the log prices at levels. We then apply unit root tests on the log first differences and the null hypothesis of a non-stationarity is rejected at 5% significance levels for all the indices. This therefore indicates that all the indices have the same order of integration, i.e., $I(1)$. Hence, these results suggest that there may be a long-run relationship between Australia and its trading partners.

[Insert Table 3 Here]

Analysis of long-run equilibrium relationship between the stock markets

We test the cointegration or long-run equilibrium relationship between the stock markets of Australia and its major, medium and minor trading partners using the natural log of weekly closing price indices data. The long-run relationship between these markets is explored by employing Johansen multivariate cointegration approach and the results of this test are presented in table 4. The cointegration test results demonstrate that the Australian stock market is cointegrated only with its major trading partners¹⁶. Hence, these results indicate that the higher bilateral trade linkage between the countries may have played an important role for their stock market long-run equilibrium relationship. However, in the following section, we empirically confirm whether higher bilateral linkage has any impact on stock

¹⁵ This indicates that GARCH-based models, such as the AGDCC model can estimate better correlations between two market returns than conventional correlation models.

¹⁶ We have added the USA index as a control market to the medium and minor trading partner groups, however there is no change in the results.

market correlations using panel regression models. Based on these results we accept the hypothesis that higher trade linkages among the countries lead to their stock market long-run relationship. Our cointegration test results are similar to those of [Kazi \(2008\)](#); [Shamsuddin and Kim \(2003\)](#) who found a long-run relationship between Australia and its major trading partners. Although, our approach is significantly different from these previous studies, for example, we have used more than 20 years data and we have classified markets into major, medium and minor based on the intensity of trade linkage with Australia. Therefore, our study results are more robust than previous studies.

[Insert Table 4 Here]

5. Empirical results

In this section, we provide the empirical results of the study. First, we examine the degree of interdependence between the stock markets of Australia and its major, medium and minor trading partners using correlation analyses based on unconditional and conditional models (using AGDCC GARCH models). We then investigate the impact of bilateral trade intensity on the stock market correlations of Australia and its trading partners by employing panel regression models. The empirical results of these models are presented and discussed in the following sub-sections.

Overview of stock market linkage between Australia and its trading partners based on unconditional correlations

We first provide an overview of the stock market linkage between Australia and its trading partners using the natural log of continuously compounded rates of returns. Table 5 presents unconditional correlations, which indicate that Australian stock

market has higher correlations (0.519) with its major trading partners and has lower correlations (0.326) with its minor trading partners, as a group. This suggests that higher trade intensity leads to higher stock market correlations. Similarly, we also provide pairwise unconditional correlations. These results demonstrate that the Australian stock market has higher correlations with Germany (0.59), the USA (0.58) and Japan (0.541) and has lower correlation with Sri Lanka (0.123). These unconditional correlation results suggest that the Australian stock market, largely, has higher correlations with its major trading partners and has lower correlations with minor trading partners. We further investigate the significance of these unconditional correlations and found that all the correlations are statistically significant at 1% level. Given the limitations of unconditional correlations, we undertake further rigorous analysis. In this regard, we conduct cointegration and DCC analyses between the stock markets of Australia and its trading partners. The results of these models are presented in the following section.

[Insert Table 5 Here]

Stock market linkages based on conditional correlations

The dynamic time-varying interdependence between the stock markets of Australia and its trading partners is explored using conditional correlation models. We applied AGDCC GARCH model, based on [Cappiello et al. \(2006\)](#), which uses a two-step estimation procedure. As shown in the descriptive statistics, the data is characterised by non-normalities and hence, the use of a GARCH-based model would be advantageous. This AGDCC model stands out from all other DCC models as being a robust model to capture time dynamics in the return correlations, as it incorporates the asset-specific news and asymmetries in the analysis. The

purpose of measuring the time-varying correlations is to understand the degree of linkage between the stock markets of Australia and its trading partners over time. Further, with this analysis we can identify the impact of Asian and global financial crises on stock market correlations. This is also an important issue to research because it has not been addressed in the previous studies which have explored the stock market linkage between Australia and its trading partners.

Table 6 reports the conditional correlations of the Australian stock market with its major, medium and minor trading partners. These correlations confirm that Australia has higher correlations (0.494) with its major trading partners (as a group) and has lower correlations (0.287) with its minor trading partners (as a group). We also present Australia's average conditional correlations with each of its trading partners. This indicates that, on average, Australia has higher correlations with Germany (0.573), the USA (0.549), Japan (0.498) and China (0.437) while its lowest correlation is with Sri Lanka (0.110).

Further, in Figure 2 we present Australia's time-varying conditional correlations with each of its trading partners. These graphs show that Australian stock market correlations with all of its trading partners are time-varying and are mostly increasing over time period with the exception of Germany, Sri Lanka and Portugal, where correlations are almost stagnant. These correlations also indicate that the impact of the AFC on stock market correlations is almost negligible. However, the recent GFC has had a significant influence on stock market correlations, with the exception of that of Sri Lanka. This has resulted in higher stock market interdependence during the period of the GFC. Our analysis further suggests that, following the GFC, correlations between the Australian stock market

and its trading partners have substantially declined. However, in most cases correlations are still higher than during the pre-GFC period. These pairwise conditional correlations give an indication that the Australian stock market correlations with its trading partners may have been driven by their bilateral trade linkages, as the results show that, on the whole, Australia has higher correlations with its major trading partners. Hence, we accept the hypothesis that higher trade linkages lead to higher stock market interdependence. However, to confirm this empirically, we test this hypothesis using the panel regression models, and the results are presented in the next section.

[Insert Table 6 Here]

[Insert Figure 2 Here]

The empirical relationship between bilateral trade and stock market correlations

The aim of this section is to empirically investigate the relationship between the intensity of bilateral trade linkages and stock market correlations of Australia and its trading partners using panel regression models. To avoid model misspecification, we use two control variables in the analysis, and these are exchange rates and inflation differentials. In order to identify the impact of the financial crises on stock market correlations we have used two dummy variables that represent the AFC and the GFC. The panel regression analysis is carried out separately for major, medium and minor trading partners. The empirical results of these panel regression models are reported in Table 7¹⁷.

[Insert Table 7 Here]

¹⁷ In the panel regression analyses all the variables are stationary and have no multicollinearity problem.

As the panel regression results show, the intensity of the bilateral trade linkages between Australia and its major trading partners has significant influence on their stock market correlations. These results indicate that if one unit of bilateral trade linkage increases between Australia and its major trading partners, then their stock market correlations will increase by about 93% of it. Further, our analysis shows that the GFC also has substantial impact on the correlations of Australia and its major trading partner markets. The panel regression results of medium trading partners show that the intensity of bilateral trade linkages has no effect on their stock market correlations. However, the results show that both the AFC and the GFC have significant influence on these stock market correlations. In the case of minor trading partners, none of the variables is statistically significant.

Our panel regression analysis confirms our hypothesis that trade intensity drives stock market interdependence between Australia and its trading partners. Our study results are similar to those of [Chen and Zhang \(1997\)](#); [Pretorius \(2002\)](#); [Forbes and Chinn \(2004\)](#); [Chambet and Gibson \(2008\)](#); and [Tavares \(2009\)](#) who argue that bilateral trade linkages between countries can significantly increase their stock market interdependence. However, our study is different from previous studies as we argue that having modest or weak trade linkages (our classification of markets into major, medium and minor) between countries has no effect on their stock market correlations.

6. Conclusion

The issue of stock market integration has been of interest among the policy makers, practitioners and academia for many years due to the effect it has on the flow of resources. There are several studies examined the stock market integration.

Although, only few studies explored what economic fundamentals determine stock market linkages. Evidence from these studies is either contradictory or inconclusive. For instance, some studies argue that trade linkage is the most significant economic determinant of stock market co-movements; while other studies document that trade relations have no effect on stock market linkages. In the context of Australia and its trading partners also we found mixed results.

This therefore motivates us to systematically investigate the extent and manner of co-movement or interdependence between the stock markets of Australia and its trading partners by taking into account the intensity of their trade linkages. We hypothesise that markets with greater (lower) trade intensity will be more (less) interdependent with Australia. For our preliminary understanding of the market linkage, we first examine the long-run relationship between the stock markets of Australia and its major, medium and minor trading partners. We then explore the time-varying conditional correlations between these markets. Finally, we empirically investigate the relationship between trade intensity and stock market correlations, and also address the impact of the Asian and global financial crises on these correlations.

The results on our preliminary analysis of long-run relationship show that the Australian stock market is cointegrated only with its major trading partners. This result confirms our expectation that strong bilateral trade linkages are important for the long-run relationship between the stock markets of trade partners. Our primary results from the dynamic conditional correlations of the AGDCC GARCH model show that the correlations between the Australian stock market and its trading partners are time-varying and increasing, in most cases, over the time period. This

analysis also shows that correlations have significantly declined in the post GFC. The results of panel regression models suggest that there is a significant relationship between trade intensity and the stock market correlations of Australia and its major trading partners. These findings indicate that higher bilateral trade linkages lead to higher stock market co-movements. In addition, our findings reveal that the GFC has had a significant impact on the correlations of Australia with its major and medium trading partners. The impact of the AFC on stock market correlations is limited to medium trading partners. This might be due to the fact that among the five medium trading partners, four are from Asia.

Our empirical results suggest that strong economic integration between countries can have considerable influence on their stock market correlations and cointegration relationships, particularly in the context of Australia and its trading partners. Our results are similar to those of [Chen and Zhang \(1997\)](#), [Pretorius \(2002\)](#), [Forbes and Chinn \(2004\)](#), [Tavares \(2009\)](#), [Beine et al. \(2010\)](#) and [Wälti \(2011\)](#) who document that higher trade linkages lead to higher stock market interdependence.

In spite of that, our study is significantly different from previous studies as we adopted different approaches. For example, 1) the previous studies concluded that trading partners have higher stock market interdependence but have not clearly distinguished trading partners such as; major, medium and minor. This study addresses this gap by classifying markets into major, medium and minor based on the intensity of their trade linkage. 2) The previous studies have not used the AGDCC GARCH model to measure time-varying correlations, and we find that this is a robust model for estimating correlations as it incorporates asymmetries

and asset-specific news impact on the correlations. 3) Further, in this study we use a large data set which covers more than 20 years, which significantly improve the reliability of the results. Given the advantages of our study, these results make important contributions to the body of knowledge and are also valuable for policy makers and portfolio managers. From the standpoint of policy makers, these results give a good understanding of trade linkage and stock market interdependence. The understanding of return correlations among the markets is important for portfolio managers when making appropriate decisions about diversification of their portfolios into other markets for higher risk-adjusted returns.

References

- Beine M., Cosma A. and Vermeulen R. (2010) The dark side of global integration: Increasing tail dependence, *Journal of Banking & Finance*, **34**, 184-192.
- Bracker K., Docking D.S. and Koch P.D. (1999) Economic determinants of evolution in international stock market integration, *Journal of Empirical Finance*, **6**, 1-27.
- Calderon C., Chong A. and Stein E. (2007) Trade intensity and business cycle synchronization: Are developing countries any different?, *Journal of International Economics*, **71**, 2-21.
- Cappiello L., Engle R.F. and Sheppard K. (2006) Asymmetric dynamics in the correlations of global equity and bond returns, *Journal of Financial econometrics*, **4**, 537-572.
- Chambet A. and Gibson R. (2008) Financial integration, economic instability and trade structure in emerging markets, *Journal of International Money and Finance*, **27**, 654-675.
- Chen N-f. and Zhang F. (1997) Correlations, trades and stock returns of the Pacific-Basin markets, *Pacific-Basin Finance Journal*, **5**, 559-577.
- Dickey D.A. and Fuller W.A. (1979) Distribution of the estimators for autoregressive time series with a unit root, *Journal of the American statistical association*, **74**, 427-431.
- Elyasiani E., Perera P. and Puri T.N. (1998) Interdependence and dynamic linkages between stock markets of Sri Lanka and its trading partners, *Journal of Multinational Financial Management*, **8**, 89-101.
- Engle R. (2002) Dynamic conditional correlation: A simple class of multivariate generalized autoregressive conditional heteroskedasticity models, *Journal of Business & Economic Statistics*, **20**, 339-350.
- Engle R.F. and Granger C.W. (1987) Co-integration and error correction: representation, estimation, and testing, *Econometrica*, **55**, 251-276.
- Forbes K.J. and Chinn M.D. (2004) A decomposition of global linkages in financial markets over time, *Review of Economics and Statistics*, **86**, 705-722.
- Forbes K.J. and Rigobon, R. (2002) No contagion, only interdependence: Measureing stock market comovements, *The Journal of Finance*, **57**, 2223-2261.
- Frankel J.A. and Rose A.K. (1998) The endogeneity of the optimum currency area criteria, *The Economic Journal*, **108**, 1009-1025.
- Gupta R. and Guidi F. (2012) Cointegration relationship and time varying comovements among Indian and Asian developed stock markets, *International Review of Financial Analysis*, **21**, 10-22.
- Hatemi-J A. and Roca E.D. (2007) Equity market price interdependence based on bootstrap causality tests: evidence from Australia and its major trading partners, *Applied Financial Economics*, **17**, 827-835.
- Johansen S. (1991) Estimation and hypothesis testing of cointegration vectors in Gaussian vector autoregressive models, *Econometrica*, **59**, 1551-1580.
- Johansen S. (1995) Likelihood-based inference in cointegrated vector autoregressive models, *New York*.

- Johnson R. and Soenen L. (2003) Economic integration and stock market comovement in the Americas, *Journal of Multinational Financial Management*, **13**, 85-100.
- Kazi M.H. (2008) Is Australian stock market integrated to the equity markets of its major trading partners?, *International Review of Business Research Papers*, **4**, 247-257.
- Lin, C.H. and Cheng, W.H. (2008) Economic determinants of co-movement across international stock markets: the example of Taiwan and its key trading partners, *Applied Economics*, **40**, 1187-1205.
- Mierau J.O. and Mink M. (2013) Are stock market crises contagious? The role of crisis definitions, *Journal of Banking & Finance*, **37**, 4765-4776.
- Mink M. (2010) *Is Contagion in the Eye of the Beholder?:* De Nederlandsche Bank.
- Morgado P. and Tavares J. (2007) Economic Integration and the Co-movement of Stock Returns. CEPR Discussion Papers.
- Phillips P.C. and Perron P. (1988) Testing for a unit root in time series regression, *Biometrika*, **75**, 335-346.
- Phylaktis K. and Ravazzolo F. (2002) Measuring financial and economic integration with equity prices in emerging markets, *Journal of International Money and Finance*, **21**, 879-904.
- Pretorius E. (2002) Economic determinants of emerging stock market interdependence, *Emerging Markets Review*, **3**, 84-105.
- Roca E.D. (1999) Short-term and long-term price linkages between the equity markets of Australia and its major trading partners, *Applied Financial Economics*, **9**, 501-511.
- Shamsuddin A.F. and Kim J.H. (2003) Integration and interdependence of stock and foreign exchange markets: an Australian perspective, *Journal of International Financial Markets, Institutions and Money*, **13**, 237-254.
- Tavares J. (2009) Economic integration and the comovement of stock returns, *Economics Letters*, **103**, 65-67.
- Walti S. (2005) The macroeconomic determinants of stock market synchronization, *Journal of International Banking Law*, **11**, 436-441.
- Wälti S. (2011) Stock market synchronization and monetary integration, *Journal of International Money and Finance*, **30**, 96-110.

Fig.1: Structure of methodology

Fig.2: Time-varying conditional correlations (AGDCC)

Table 1: Percentage of Australia's bilateral trade with its major, medium and minor trading partners

Year	Major Trading Partners			Medium Trading Partners					Minor Trading Partners		
	Japan	China	USA	Germany	Malaysia	Indonesia	Thailand	India	Sri Lanka	Greece	Portugal
1993	21.985	4.172	14.585	3.640	2.083	2.420	1.612	1.063	0.101	0.070	0.077
1994	21.140	4.657	14.663	3.853	2.383	2.269	1.690	1.017	0.153	0.052	0.078
1995	19.131	4.688	14.324	4.231	2.541	2.505	1.845	1.107	0.110	0.064	0.088
1996	16.589	5.148	14.798	3.713	2.523	3.084	1.777	1.151	0.185	0.080	0.093
1997	16.778	5.182	14.573	3.436	2.652	3.364	1.773	1.385	0.149	0.078	0.088
1998	16.528	5.175	16.164	3.889	2.449	3.073	1.572	1.523	0.158	0.083	0.093
1999	16.104	5.681	15.684	3.771	2.750	2.616	1.933	1.167	0.151	0.086	0.108
2000	16.331	6.635	15.003	3.164	2.917	2.460	2.101	1.128	0.163	0.136	0.091
2001	16.224	7.447	13.864	3.387	2.701	2.969	2.071	1.346	0.179	0.088	0.096
2002	15.342	8.586	14.039	3.620	2.509	2.945	2.287	1.384	0.156	0.191	0.117
2003	15.092	9.810	12.601	3.919	2.693	2.884	2.460	1.814	0.106	0.081	0.110
2004	15.014	11.172	11.610	3.683	3.083	2.672	2.637	2.529	0.114	0.076	0.083
2005	15.460	12.718	10.400	3.422	2.914	2.463	3.034	2.779	0.091	0.084	0.070
2006	14.629	13.494	10.196	3.061	2.812	2.634	3.101	2.970	0.075	0.060	0.059
2007	14.029	14.823	9.455	3.133	2.944	2.456	3.454	3.018	0.065	0.076	0.062
2008	15.837	15.078	8.661	2.995	2.889	2.121	3.454	3.423	0.073	0.059	0.043
2009	13.830	19.717	8.023	3.075	2.691	2.190	3.994	4.155	0.072	0.052	0.037
2010	13.987	22.113	7.228	2.797	2.884	2.221	3.817	4.165	0.073	0.045	0.035
2011	13.995	23.228	7.181	2.642	2.669	2.310	3.109	3.573	0.074	0.036	0.034
2012	13.644	23.973	7.593	2.697	3.004	2.284	3.077	3.021	0.068	0.040	0.033
2013	13.111	28.146	6.737	2.654	2.920	2.111	3.237	2.365	0.071	0.036	0.031
Average	15.942	11.983	11.780	3.371	2.715	2.574	2.573	2.195	0.114	0.075	0.073

Note: Taiwan is also Australia's medium trading partner but we have not included this country due to unavailability of data on control variables.

Table 2: Summary statistics

None	40.517**	40.175	0.046	27.373**	24.159	0.018
At most 1	13.144	24.276	0.609	9.191	17.797	0.573
At most 2	3.953	12.321	0.718	3.825	11.225	0.656
At most 3	0.128	4.130	0.769	0.128	4.130	0.769
Medium trading partners (Germany, Malaysia, Indonesia, Thailand & India)						
None	90.430	95.754	0.110	36.908	40.078	0.109
At most 1	53.522	69.819	0.482	22.628	33.877	0.559
At most 2	30.894	47.856	0.672	14.197	27.584	0.809
At most 3	16.697	29.797	0.662	9.435	21.132	0.796
At most 4	7.261	15.495	0.548	5.358	14.265	0.696
At most 5	1.903	3.841	0.168	1.903	3.841	0.168
Minor trading partners (Sri Lanka, Greece & Portugal)						
None	34.692	47.856	0.464	20.581	27.584	0.302
At most 1	14.111	29.797	0.834	9.749	21.132	0.768
At most 2	4.362	15.495	0.872	4.099	14.265	0.849
At most 3	0.263	3.841	0.608	0.263	3.841	0.608

Note: ‘**’ denotes rejection of null hypothesis of no cointegration at 5% significance level.

Table 5: Unconditional correlations

Markets	Correlations	t-test	Prob.	Group correlations
Major trading partners				
Australia – Japan	0.541	21.415***	0.000	0.519
Australia – China	0.437	16.175***	0.000	
Australia – USA	0.580	23.735***	0.000	
Medium trading partners				
Australia – Germany	0.591	24.423***	0.000	0.412
Australia – Malaysia	0.333	11.760***	0.000	
Australia – Indonesia	0.365	13.041***	0.000	
Australia – Thailand	0.402	14.641***	0.000	
Australia – India	0.368	13.189***	0.000	
Minor trading partners				
Australia – Sri Lanka	0.123	4.115***	0.000	0.326
Australia – Greece	0.418	15.301***	0.000	
Australia – Portugal	0.438	16.120***	0.000	

Note: unconditional correlations are estimated using log returns.

Table 6: Time-varying conditional correlations (AGDCC)

Markets	Correlations	Group correlations
Major trading partners		
Australia – Japan	0.498	0.494
Australia – China	0.437	
Australia – USA	0.549	
Medium trading partners		

Australia – Germany	0.573	
Australia – Malaysia	0.346	
Australia – Indonesia	0.332	0.392
Australia – Thailand	0.387	
Australia – India	0.322	
Minor trading partners		
Australia – Sri Lanka	0.110	
Australia – Greece	0.357	0.287
Australia – Portugal	0.394	

Note: The above correlations are average.

Table 7: Panel regression results

Dependent variable: Conditional correlations									
Variable	Major trading partners			Medium trading partners			Minor trading partners		
	Coefficient	t-Statistic	Prob.	Coefficient	t-Statistic	Prob.	Coefficient	t-Statistic	Prob.
Constant	0.363	17.715**	0.000	0.386	44.346**	0.000	-0.005	-0.400	0.689
Trade intensity	0.932	6.491**	0.000	-1.054	-0.574	0.567	4.772	0.355	0.723
Exchange rates	0.188	1.831	0.068	-0.057	-0.597	0.551	-0.007	-0.669	0.504
Inflation differentials	0.002	1.310	0.191	0.005	4.301**	0.000	0.000	0.322	0.747
AFC	-0.031	-1.020	0.309	0.073	2.050**	0.041	0.027	1.267	0.206
GFC	0.135	4.716**	0.000	0.199	6.552**	0.000	0.003	0.147	0.883

Note: ‘**’ denotes significance at 5% level;

Trading partners, major (Japan, China & the USA), medium (Germany, Malaysia, Indonesia, Thailand & India) and minor (Sri Lanka, Greece & Portugal);

AFC and GFC stands for Asian financial crisis and global financial crisis, respectively.