# Financial Contagion: An Empirical Investigation of the Relationship Between Financial-stress Indexes of Australia and the US

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*A key departure in this study from many earlier studies is that, on the continuum of financial stress from nil to very high, both very high levels of stress and very low levels are seen as being harmful and potential harbinger of a financial-market crisis. Specifically, a surfeit of stress can act as a tipping point into crisis and a dearth of stress can encourage hubris and increase a nation's susceptibility to financial contagion from another nation; even one that is far removed by geographic and/or economic distance. This paper focuses on developing financial stress indices for the US and Australia using composite market indices, trade weight indices and yields on securities with different maturity dates. Monthly data from January 1989 to December 2011 was sourced from the Australian Bureau of Statistics (ABS), the Reserve Bank of Australia (RBA), the Federal Reserve Bank (FRB), the Bureau of Economic Analysis (BEA), the Federal Reserve Bank of St Louis website, Bank of Canada, Reserve Bank of New Zealand and Yahoo finance website. For purposes of this study the aggregate measures of stress consists of inverted yield spreads, volatility measures for market indices, volatility measures of trade weighted indexes, risk spreads, credit risk spreads and a measures of risk in the equity market.*

## INTRODUCTION

Recent global financial crisis (GFC) and the European Credit Crunch (ECC) demonstrated how countries that are different in their economic structure, with location differences and even without substantial economic links can be influenced in different degrees by the financial crisis in other countries pressurizing the global investors and policy makers searching for solutions to mitigate/avoid crisis forming due to the contagion effects. The GFC have enflamed fears of how financial contagion (see Allen and Gale 2000 for details on financial contagion) can rapidly inflict panic in even apparently vibrant economies and transform them from prosperity to crisis. While financial contagion risk constitutes a legitimate fear, its path and effects are so convoluted that they are often unpredictable *a priori* and may be driven more by the attributes of potential destination nations than those of the source nation.

**The Objective of the Study**

This paper accepts that, as discussed later, there is clear incontrovertible evidence of the existence of financial contagion; the issue being reviewed is, what conditions of. Domestic/trade and/or financial links with the source nation can make financial contagion a significant issue and/or an ancillary issue); what and when should national policy makers act to deflect, mitigate, or ameliorate the harm caused by financial contagion. The central aim of this study is to find out the use of financial factors to gauge the financial stability of an economy with particular emphasis on the risk factors for the contagion of financial distress from one country to another examining Australia and US in this empirical study.

A key departure in this study from many earlier studies is that, on the continuum of financial stress from nil to very high, both very high levels of stress and very low levels are seen as being harmful and potential harbinger of a financial-market crisis. Specifically, a surfeit of stress can act as a tipping point into crisis and a dearth of stress can encourage hubris and increase a nation's susceptibility to financial contagion from another nation; even one that is far removed by geographic and/or economic distance.

The rest of this paper is organized with: A literature review that gives special emphasis to foundation theories on the fundamentals of asset pricing and market performances; A review of financial stress in Australia and the US; A summary of the data gathering approach, research methodology/design and initial findings; A discussion of the index building approach and technique; A review of Granger Causality and this study's Granger outcomes; and A concluding discussion of the issues raised by this study's findings and how the issues raised might be addressed by future research.

## LITERATURE REVIEW

**Theoretical Background**

*Modern Portfolio Theory* (Markowitz, 1952), *Efficient Market Hypothesis (*EMH) developed by Fama (1970), *Capital Asset Pricing Model* (Sharpe, 1964) and the other theories that have, until recently, dominated the way investors and researchers evaluate market performance were unable to suggest the causes and potential remedies to these often contagion-driven panics. As the foundation theories of financial-market performance are based on assumptions that: risk is defined by volatility; investors act rationally; all available information is costless to gather and is incorporated into decisions effortlessly and seamlessly. Such assumptions have led to the axiom that security prices reliably and fairly reflect intrinsic value and, as a result, unexpected asset returns always follow a random walk. As a result, above-normal returns are always unpredictable. These long-run notions are confirmed by the *Theory of Arbitrage* (Fama, 1965; Ross (1976)) where short-run price deviation is quickly identified by rational investors who, in seeking to profit from it, rapidly normalizes it and returns the market to the long-run equilibrium. As a result, investment markets are expected to be efficient in the long run and the price of assets in those markets are expected to reflect their intrinsic value (Fama, 1965). Nonetheless, irrationality and repeated errors-in-judgment appeared periodically, mostly every 10-20 years, stressed financial markets, but the timing and magnitude of those *bouts* are difficult to predict (Ball, 2009). The financial market meltdown in 1987, the 1990 Japanese economic crisis; the 1994-1995 Mexican crisis (Kindleberger & Aliber, 2005; Mazumder & Ahmad, 2010); Asian financial crisis in 1997 and a subprime mortgage crisis in 2007 which led to a global financial crisis are among the many significant bouts of irrationality and recurring errors in judgment that continue to recur and that many researchers (including Fama & French, 1993 and 1996) have difficulty in explaining them within the framework promulgated  by the foundation-theories of finance. Keynes (1936, p. 148), in explaining equivalent recurrent events, noted that the "...practice of calmness and immobility, of certainty and security [of investor forecasts], suddenly breaks down ... [and is then] subject to sudden and violent changes".

**Behavioral Finance and Prospect Theory**

As researchers identified difficulties with the traditional paradigm (including investor behaviors seen as irrational) and searched for ways to explain those difficulties and *irrationalities*, they initiated the new sub-disciplines of *Behavioral Finance* (De Long, et al, 1990; Shelifer & Vishny, 1997) and *Prospect*

*Theory* (Kanheman & Tversky, 1979). Given that over the last few decades, repeatedly, many hundreds of billions of dollars were lost as the hubris of a *Bull Market* collapsed into the overly timorousness of *Bear Market*, it is important to draw from the new perspectives in finance, ways to identify the symptoms and patterns within the financial stress stages so that either the wild market swings can be moderated or prudent investors can avoid being dragged into losses by less prudent investors, or even profit by identifying the coming financial storm.

**Extant Indices of Financial Stress**

Financial stress is a feeling of unease that arises from fear of what may occur if one's income does not at least cover outgo; a fear, also, known as the Micawber Principle.[1] A financial stress index is a measure of the aggregated financial stress within a nation and is on a continuum ranging from a low indicative of a pending "bubble crisis", a high indicative of an imminent "crash crisis" (Illing & Liu, 2006), and a propensity to swing rapidly and with little warning from a bubble to a crash.

The goal of this study is to explore the use of economic and financial factors to gauge the financial stability of a country with particular emphasis on the risk factors for the contagion of financial distress from one country to another.

The evidence of financial market volatility, and episodes of financial crises (distress), suggests that financial markets are either inefficient or that the semi-strong market- efficiency exists in the long run and is punctuated by periodic bouts of inefficient hubris that can quickly switch to transpose inefficiency of being overly timorous.

This study concentrates on identifying what factors affect macro-finance stress and the risk of contagion between Australia and one of its longest and most prominent trade partners (the USA). This study uses the review of extant studies, the indices and Granger analysis to answer the following research questions:

  i)   What is the economic impact of financial stress in Australia?
  ii)  What are the risk factors for financial contagion?
  iii) What stress indicators should be part of a comprehensive index of financial stress in Australia?
  iv)  What is the value of using the proposed index to predict periods of financial distress in Australia?
  v)   What are the limitations of using a financial-stress index to forecast financial distress?

In order to achieve macroeconomic stability it is essential to closely monitor the economic environment and implement policies that safeguard against: on one hand, financial stress escalating into financial distress; and on the other, a dearth of stress that encourages investor hubris and leads to a *bubble and collapse* that precipitates financial stress. Wolf (2009) and Fox (2010) worry that economists, overly focused on the ideals and market conditions needed to achieve the elusive but notionally ideal *laissez-faire* of a strong-form efficient-market hypothesis (EMH), have failed to consider other more-workable options. A second-best, but highly achievable focus would be on the economic analysis needed to identify the *what and the when* of an intervention, to prevent/mitigate the distress of a pending financial crisis.

Siegel (2009) asserts that the EMH nurtured an environment where asset bubbles, poor policy controls, and engineering of malicious and complicated instruments thrived and subsequently led to the subprime mortgage crisis of 2007. Similarly, Krugman (2009) asserts that economists overlooked the reality of market imperfections and that securities can and often are incorrectly priced. Further, if securities were overpriced traders in the financial markets are human and investors are not always as rational as what is proclaimed by many economists. Behavioral models use other ways to explain stock-price anomalies including over and under reactions, herding behaviors, momentum strategies, investor overconfidence and firm-size bias (Barberisb et al., 1996; Daniel et al., 1998; Dremen & Lufkin, 2000; Chan, 2001).

EMH model, with its *laissez faire* ideology, does not encouragement policy makers to intervene, even when they realize that a market is slipping into distress. Specifically, this ideologically driven policy of *leaving markets to self-correct* inevitably increases the occurrence, length and depth of financial crises and associated distress.

Currently, little is known about the appropriate structure and content of a financial- stress index, or where the tipping-point(s) occur(s), what creates a risk of contagion, and, how to modify/regulate the financial markets to avoid or ameliorate the descent into the financial distress of a financial crisis.

**The Relationship Between Micro- and Macro-Financial Stress**

Financial stress can be experienced at a microeconomic or macroeconomic scale. The microeconomic school focuses on financial stress at the household and individual businesses scale; whereas, the macroeconomic school relates to financial stress at the national or regional economy scale. While these two scales can be interrelated, not every micro-level stress accumulates into a macro-scale stress. However, uncontrolled micro financial stress can have spill-over effect which often causes the stress at macro level vice versa. Given that these stresses accumulate on a systematic basis, the final outcome can be unexpected and unpredictable in both direction and magnitude.

Micro-finance stress: is "...the adverse economic or social outcomes associated with a household's [/business's] financial situation, including debt repayment problems, delinquency, bankruptcy and lack of discretionary income" (Worthington, 2006, pp. 2-3). Breunig and Cobb-Clark (2006) and Wesley Mission (2006) explain the different conditions that fuel the micro-level stress. Ehrhardt and Brigham (2011) explain the micro-stress with administrative, economic and financial factors. Lakonishok and Smidt, (1988) and French (1980) state how tax benefits can encourage excessive debt financing, which adds to micro-level financial stress. Dun and Bradstreet Credibility Corp (2012) show how extensive episodes of stress often culminate in bankruptcy, receivership or liquidation.

Macro-finance stress: definitions focus on how financial stress impacts on a national economy. This kind of stress can be defined in several ways, depending on the factors that triggered an episode of distress. Since these factors vary, depending on (among other things) political and economic characteristics, settling on a definition that will incorporate all characteristics of historical episodes of stress is difficult. Nevertheless, Hakkio and Keeton (2009) maintain that regardless of the origin of stress, financial stress generally results in the "...interruption of the normal functioning of financial markets". As noted earlier in this study, moderate levels of financial stress can act as a moderating influence on markets by discouraging the investor hubris that can lead to bubbles, contagion, and the distress of a financial crisis.

A more specific definition (proposed by Illing and Liu (2006)), suggests that macro-economic financial stress is the anxiety experienced by producers or consumers due to increased uncertainty and changing expectations of economic losses in the financial markets and institutions. Similarly, an episode of financial stress is understood as a period when a country's financial system is under pressure and the country lacks adequate resources to facilitate a quick transition out of an economic slump. Typically, countries under excessive financial stress can experience significant changes in commodity prices, a rapid increase in risk and/or uncertainty, limited liquidity, and fears about the health of the banking system (Balakrishnan, Danninger, Elekdag, & Tytell, 2009).

Interdependence: On one hand, Hakkio and Keeton (2009) point out that when financial markets are in distress, the savers are less willing to lend money unless they are provided with more security and/or a premium to compensate for increased risks of default. As a result, increased uncertainty at a macro-economic level can contribute to a credit crunch at the microeconomic level. On the other hand, Gramlich and Oet (2011) suggest that structural fragility in key financial and regulatory agencies can lead to and/or potentiate a crisis, as seen in the subprime mortgage crisis. Thus, while the notion of financial stress and financial crisis are closely related, they are not the same—an important distinction between the terms is that financial crises are found at the extremes of the financial stress continuum (Illing & Liu, 2003).

**The Importance of the Study**

There is extensive research on the impact of financial stress at the microeconomic level (Bray, 2001; Breunig & Cobb-Clark, 2006; Commonwealth Department of Family and Community Services, 2003; Marks, 2007; Wesley Mission, 2006; Worthington, 2006). However, the current high volatility in financial markets and the rising risk of contagion as globalization intensifies, make it ever more important

to identify and measure macro-level financial stress. As a result, building and calibrating an appropriate financial stress index, at the nation level, is an ever more vital element of maintaining the well-being of financial markets. Although there is much research on the factors that may contribute to financial stress and the distress of a financial crisis, there is little research on combining those factors into an appropriate and useful financial stress index.

**The Nature and Origin of Financial Stress**

Origin of the financial stress: Not all periods of stress are harmful as certain economic disturbances are linked to economic recessions or downturns while others have little impact. Consequently, financial stress can be used as a warning of an impending crisis; if the financial stresses are building from rising forces that result from a loss of confidence or other disturbances that are consistent with an impending down-turn and/or recession. Nevertheless, while an episode of financial stress often leads to a correction, it does not always translate into a financial crisis. The main issue of concern for analysts is the nature and origin of the financial stress and the volatility of the markets (e.g. a spark that is harmless in most times and/or places can lead to a conflagration, if it occurs in a tinder-dry forest). While researchers have identified many different contributing factors, their influence individually and in combination is not as well understood.

The IMF states that the probability of an economic recession depends on the degree to which house prices or aggregate credit rose before the episode of financial stress (International Monetary Fund (2008)) and identified a positive relationship between financial stress and large increases in housing prices or credit. The larger the increase in credit and house prices the more the financial stress and vice versa. Hakkio and Keeton (2009) assert that the depth and length of a subsequent recession depends on the extent to which firms and households reduce spending and cut costs. Moreover, the added push from structural weaknesses in the banking sector can often generate more severe economic downturns than the effects of securities or foreign-market-related stress. Illing and Liu (2006) suggest that countries with weak financial systems are a fertile ground for economic shocks to germinate into financial stress and on into financial crises.

Furthermore, Misina & Tkacz (2009) suggest that an absence of financial crisis in a country does not mean that it is safe from future episodes of financial distress. For example, seeming tranquility in an economy may mask rising stress levels, either via the slow, steady increase in financial imbalances over time or via rapid contagion from other economies. Thus, there is an onus on regulatory authorities to keep watch and intervene before an episode of rising stress matures into a full-blown crisis.

**Contagion**

Kaminsky and Reinhart (2000) see contagion as process by which "financial difficulties spread from one economy to another in the same region and beyond" via trade and financial linkages (p. 51). In an empirical investigation of the contagion process Hettihewa and Mallik (2005) examined co-integration between eight countries. It is difficult to determine if contagion at a regional level arises from mostly financial or from trade links because countries usually co-establish regional trade agreements and corresponding interbank linkages to facilitate the trade agreements (Caramazza, Ricci, & Salgado, 2004). The 1997 Asian financial crisis is an example of regional contagion that originated in Thailand and spread to neighboring Indonesia, South Korea, Philippines and Malaysia. Aggressive dealings by speculators convinced foreign lenders to cease all loans denominated in the rupiah, the ringgit and the won to minimize the impact of speculation. The ultimate effect of such Draconian actions was to slow the adjustments in the region, to starve the affected countries of foreign reserves, and to reduce their ability to service their foreign debt (Kindleberger & Aliber, 2005). Another variant of contagion, suggested by Calvo and Mendoza (1998), can develop even if linkages are absent or fully controlled. Specifically, it afflicts financial markets because of a herding behavior that may not be fully rational (Caramazza et al., 2004).

**Trade Theory, Globalization and Contagion[2]**

International trade has played a key role in the economic growth and development of any economy. For instance, Dornbusch, Fischer, and Samuelson (1977) developed a Ricardian model for a continuum of goods, based on the notion that comparative advantage is mainly driven by differences in technology across nations and that labor is the most relevant factor to consider in the analysis of comparative trade. Feenstra and Hanson (1996) used the Ricardian model to explore the relationship between wages and international trade in a capital based economy (the US), verses a labor based economy (Mexico). The study found that when the US outsourced labor, relative demand for non-production labor increased while demand for production labor decreased. Correspondingly, there was a drop in the wages of production workers and an increase in the labor rates of non-production workers. [3] Moreover, the relative demand for production workers rose in the labor intensive country with a corresponding upward pressure on labor rates. The resulting outcome was mixed with: On one hand, winners included Mexico (gaining from jobs creation), US companies (that minimized their production costs with cheaper offshore labor) and non-production staff in US (who realized an increase in their wages); On the other hand, losers included production workers in the US (who missed-out on jobs which were outsourced to other countries with employers preference shifting from the local market to the international ones unless employees were willing to take a significant pay-cut in order to keep their jobs) and sectors of the US market that service the US production workers. Theoretically, a utopian country with no trade or financial linkages with the rest of the world is safer from financial-stress contagion, but misses-out on the benefits of international trade. Conversely, a high dependence (i.e. an open small economy) means that a country is more susceptible to events in other countries. (see the United Nations Conference on Trade and Development (2008); Oxfam, 2002) for details). Thus, globalization multiplies the pathways for greater economic growth and for increased risk of economic recession. In effect, policies reducing trade barriers create opportunities for benefit to an economy and risks of harm (Hettihewa & Wright 2010; Stiglitz & Charlton, 2007). For instance, Gramlich and Oet (2011) state that the Greek crisis spilled into neighboring European countries via the increased structural fragility arising from linkages such as the interbank lending relationships, credit lines and solvency issues. Financial globalization now involves a network that facilitates quick transmission of economic shocks from one country to another. The dilemma that most countries find themselves in is optimizing the degree of financial integration so that they can enjoy an ease of trade, but minimize their exposure to contagion stress (Stiglitz, 2010).

Interdependent relationships are regarded as a technique of insuring a country against excluded from the benefits of foreign market changes (Daniels & Radebaugh, 1995). However, financially interdependent countries are more likely to share financial crises and countries who are more dependent than interdependent are more of a one-way pipeline (i.e. having to suffer any imported crises alone rather than passing some of the pain on to others). Thus, higher levels of dependence are associated with increased vulnerability to contagion. The vulnerability of a country to contagion of financial stress also depends on the degree to which a country depends on trade with other countries.

## AUSTRALIA'S TRADE RELATIONSHIP WITH THE US AND ITS EXPERIENCE WITH THE GFC

The U.S. has for decades been one of Australia's leading trading partners. According to the Ehrhardt and Brigham (2011), US was Australia's largest bilateral trading partner in 2010-11; US exported 36.3 billion dollars' worth of goods and services to Australia and imported 14.2 billion dollars' worth of products and services from Australia. "In 2010–11, the United States was also Australia's largest services trading partner and third largest merchandise trading partner" (p. 192). The main non-trade related links between the countries relate to national security through sharing of technological knowledge, training techniques and intelligence as per the 1951 ANZUS treaty. Since the establishment of the treaty the two countries have continued to engage in trade agreements that encourage liberal trade not only in the two countries but also in the Asia Pacific region (Ehrhardt & Brigham, 2011). Also, the current episode of GFC indicates that the impact of US subprime crisis had mammoth flow on effect on many countries

including Australia making it is vital for Australia to investigate the contagion effect between these two countries.

Australia has experienced a few episodes of volatility in its financial markets in the past few decades. Indeed many such episodes experienced in the Australian economy over its history can be seen as contagion driven financial stress. In a recent example, the GFC started in the US and affected global markets, including those in Australia. In recent decades, Australia has for a variety of reasons, been very effective in resolving economic downturns. Specifically, Australia has stable financial institutions with strong prudent regulatory measures that shielded it from the worst depredations of the GFC. The Australian Prudential Regulation Authority (APRA) facilitated strong regulation, close supervision and effective risk management of Australian banks which  nurtured a stable banking sector in Australia, as compared to many overseas countries.[4] Also, the Australian government took pre-emptive measures to ensure Australian banks had sufficient foreign currency at their disposal to prevent bank runs. Further, even after the GFC was well established, Australia enjoyed an extended economic boom, due (in large part) to the exports of its mining industries (Perlich, 2009). A more interesting question is: with its strong regularity standards and strong mining sector, how strong is Australia's capacity to resist global financial crisis? While, in answering this key question, it is essential to find out the contagion relationship with all the trading partners, this study takes a first step by looking into the contagion effect between the USA and Australia.

## DATA AND METHODOLOGY

### Background for Contagion Measures
Determining the impact of contagion related stress between two countries compared to that between few countries is a less complicated task. This study focuses on financial stress, and contagion of stress transmitted from one country to another. The main countries of interest are Australia and the United States. The US and Australia have a long history of trade and non-trade links that are aimed at cooperatively enhancing economic prosperity and national security. While in recent years, Australia has shifted much of its trade focus away from the US toward Asian countries (China in particular), it takes time for institutions that have developed over many decades to refocus. According to the Ehrhardt and Brigham (2011), "...the United States is ... [still] Australia's largest services trading partner and third largest merchandise trading partner". Also, the non-trade related links between the countries (national security via sharing of technological knowledge, training techniques and intelligence go back to the 1951 ANZUS treaty (Ehrhardt & Brigham, 2011). This study uses a quantitative approach to estimate financial stress in the USA and Australia and to examine whether financial stress in USA can be used to forecast financial stress in Australia.

Generally, a country has several trade partners and deciphering the impact of contagion related stress caused by each country could prove difficult. In order to do this, a researcher would not only have to construct a suitable financial stress index for each country but also provide a criterion for checking validity of the financial stress index. Illing and Liu (2003) suggest that a comprehensive measure of financial stress can be designed using a two-pronged approach that incorporates quantitative and qualitative analysis. The former entails the use of empirical criteria to measure the degree of financial stress experienced by each country while the latter utilizes expert surveys aimed at correctly diagnosing episodes of stress in a particular country. Once both factors have been considered the financial stress index of each trading partner can be estimated and the causality relationship examined in order to determine the degree of contagion stress transmitted from one country to another. This technique would ensure that empirical analysis for episodes of stress is supported by prevailing perceptions of economic stress in a particular country. The practicality of this technique is subject to availability of time and resources to conduct surveys in the countries of interest (if no secondary information is available) and construct financial stress indices for all trading partners. Researchers used a more pragmatic approach while examining financial stress in several countries (Cardarelli, Elekdag, & Lall, 2009; Duca &

Peltonen, 2011). Both constructed stress indices and checked whether they signaled historical episodes of financial stress; a similar method was employed in this research.

**Data Development and Variable Choice in the Model**

This paper focuses on developing financial stress indices for the US and Australia using composite market indices, trade weight indices and yields on securities with different maturity dates. Monthly data from January 1989 to December 2011 was sourced from the Australian Bureau of Statistics (ABS), the Reserve Bank of Australia (RBA), the Federal Reserve Bank (FRB), the Bureau of Economic Analysis (BEA), the Federal Reserve Bank of St Louis website, Bank of Canada, Reserve Bank of New Zealand and Yahoo finance website. For purposes of this study the aggregate measures of stress consists of inverted yield spreads, volatility measures for market indices, volatility measures of trade weighted indexes, risk spreads, credit risk spreads and a measures of risk in the equity market. The econometric packages used in the estimation process are: (1) Eviews 7 and (2) IBM SPSS Statistics 19.[5]

*Stress Index and the Variables*

Developing a plausible starting point for selection of stress variables requires careful consideration of historical episodes of stress or crises. Illing and Liu (2006) suggest that historical crises mainly originated in the banking sector and financial markets that comprise the foreign exchange, debt and equity markets. None of these sectors can be considered in isolation since problems in one sector can be transmitted to other sectors of the economy. Banking related crises are characterized by banking failures and often result from poor regulation or transmission of stress from other sectors. For instance, a steady increase in real estate prices in Japan led to a bubble that eventually burst in the 1990s leaving Japanese banks with large losses. Moreover, the currency crisis in 1997 left many banks in South Korea, Thailand and Malaysia bankrupt (Kindleberger & Aliber, 2005). These bank failures resulted from a sudden drop in real estate prices and depreciation of Asian currencies.

The main issue of concern for policy makers is: whether it is possible to anticipate banking crises using macroeconomic and financial sector data and avert a crisis or intervene before an episode of stress translates to a crisis in the banking sector. Demirguc-Kunt and Detragiache (1998, 2005) suggest that low GDP growth rates, high real interest rates and high inflation indicate increased vulnerability of an economy to a banking crisis. Furthermore, increased interbank linkages can help a developed countries hedge against credit risk associated with operating in a country. Demirguc-Kunt and Detragiache (1998) argue that increased integration of banks may be key to strengthening banks worldwide since entry of foreign banks encourages healthy competition and adoption of better banking regulation practices (p. 103). However, setting up these linkages will also increase the vulnerability of a country to financial-stress contagion, so countries should be careful when encouraging increased financial integration across borders. Hardy and Pazarbasioglu (1999) explored the further use of financial and economic indicators in 50 different countries with the aim of identifying suitable banking-stress indicators (e.g. the use of ratios that measure the relationship between banking deposits and GDP). However, many of the proposed variables are not provided at monthly frequency. For example, GDP data is only available on quarterly and annual basis. Originally, the difference between the Eurodollar interest rate (ED) and the Treasury bills interest rate (T) of a country is defined as the TED Spread however, recent studies also define the TED spread as the difference between the London Interbank Offered Rate (LIBOR) rate and treasury bills (Hammoudeh et al., 2011; Lee et al., 2007). This study focuses on the latter definition of the TED spread. The Australian TED spread is the difference between the 3-month LIBOR in Australian dollars and the 90-day bank accepted bills. Rising TED spreads indicate that banks are unwilling to lend to each other for fear of default loss (Hammoudeh, Chen, & Yuan, 2011).

Figure 1 shows the TED spreads for Australia and US. Both spreads indicate an increased reluctance by banks to lend to each other especially during the 2007 subprime crisis. Understandably, international banks were less inclined to lend to US banks compared to Australian banks as indicated by a larger spike in the TED spread.

**FIGURE 1**
**TED SPREADS FOR AUSTRALIA AND US**
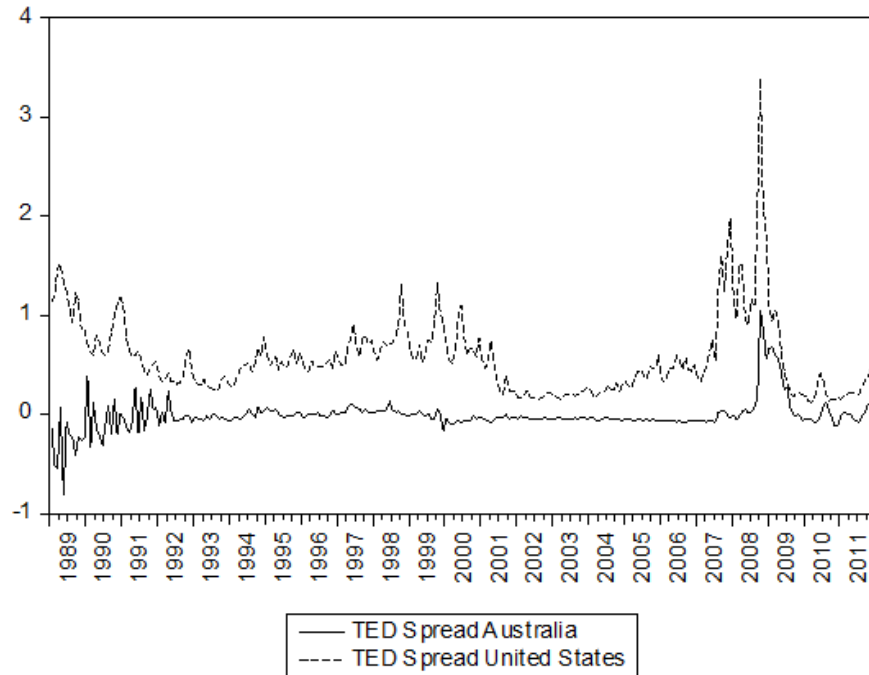


*Equity Market Stress*

Equity market crashes are characterized by plummeting of share prices. For instance, in the 1987 Black Monday share prices in the New York Stock exchange fell by about 33.33% over five trading days in October (Patel & Sarkar, 1998). Speculative forces that intensify during a financial crisis suggest that a country can never be immune to large drops in the share prices regardless of whether a country is an emerging economy or developed countries such as US and Australia. However, share indexes in emerging markets are more fragile and bound to experience larger share price losses compared to developed countries. Illing and Liu (2006) propose the use of a share value at t, indexed to the maximum share value for the review period (CMAX) to measure share volatility in a financial market. Following Illing and Liu (2006), this research adopts a CMAX measure for a period of two years.[6] The two year review period is a trade-off between using a longer period which would give better statistics and a shorter period which tends to minimize the change in share prices due to long-term trends.

The CMAX calculation can be expressed as shown in equation 1.

$$Cmax_t = \frac{I_t}{\max[I \in (I_{t-j}|j=n,n+1,n+2...T)]} \qquad (1)$$

$CMAX_t$ = share value at t, indexed to the maximum share value for the review period.
    $I_t$ = stock index value at time t.
    $t$ = moving time window during $j$.
    $j$ = review period (n to n+$T$).
    $n$ = start of review period.
    $T$ = end of review period.

Hence, the CMAX calculation for both, Australia and US financial stress indexes considers the value of the stock index at time t compared to the maximum value over the past two years.

Figure 2 shows the graphical representation of the computed CMAX for the Dow Jones and the All Ordinaries. As expected, the largest drop in the share indexes was experienced between 2008 and 2009; during the GFC, with the epicenter of the crisis (US) recording higher loss in value of the share index.

**FIGURE 2**
**CMAX GRAPHS FOR AUSTRALIA AND US**
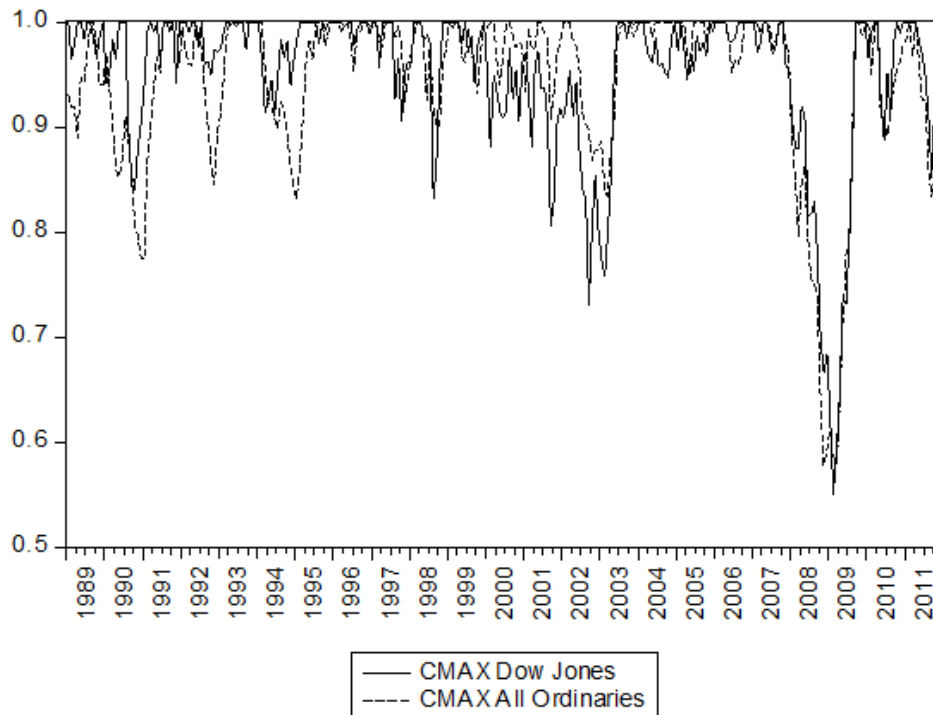


*Yield Spreads*

Consistent with Illing and Liu (2006), this research used the inverted spread between a long-term security and a short term security to measured interest rate shocks. Interest rates on a 10-year government bond were used to represent long-term securities in both countries, while yields on a 3-month treasury bill and a 90-day accepted bills were chosen as short-term securities in US and Australia respectively. The inverted spread was calculated by deducting the interest rate of the long-term security from the interest rate of the shorter-term security. The logic being long-term rates are the equilibrium rate and stress is experienced when the short-term rate surpasses the long-term ones. In addition to the yield spreads, this study will measure uncertainty in Australia and US debt markets using risk spreads. Following Illing and Liu (2006), based on the compatibility and risk of the neighboring trading partners, this study evaluates the uncertainty of Australian market considering the difference between yields on 90-day bank accepted bills in Australia and New Zealand. The uncertainty in the US market was calculated as the difference between US and Canadian 3 month treasury bills.

*Volatility in Stock Prices and Exchange Rates*

Stock prices and exchange rates tend to fluctuate more during periods of crisis compared to periods of no crisis. For instance, in 2008, Gujarati (2011) states that the US Dow Jones Index oscillated due to rising oil prices and the 2007 subprime mortgage crisis. More specifically, on 29 September 2008, the Dow Jones lost 777.7 points and subsequently swung upwards and downwards by more than 300 points for most of October 2008 (p.238). Such volatility in stock prices can be incorporated into a financial-stress index using a Generalized Autoregressive Conditional Hetero-skedasticity (GARCH) process (Bollerslev, 1986). In this study, GARCH models are used to capture volatility clustering exhibited in

stock prices and exchange rates using stock indexes and trade weighted indexes of both countries. The stock indexes for the Australian and US market include the All Ordinaries (AOrds) and the Dow Jones Industrial Average (DJ) indexes respectively. Both indexes were deemed representative, as they contained historical information of companies with the largest market capitalizations in the respective countries. The descriptive statistics of four series are contained in Table 1.

**TABLE 1**
**DESCRIPTIVE STATISTICS FOR STOCK AND TRADE WEIGHTED INDEXES**

|  | LNDJ | LNAORDS | LNATWI | LNUTWI |
|---|---|---|---|---|
| Mean | 8.384316 | 7.625621 | 4.132516 | 4.538750 |
| Median | 8.566813 | 7.712085 | 4.094345 | 4.525038 |
| Std. Dev. | 0.902329 | 0.694669 | 0.170700 | 0.155443 |
| Observations | 384 | 384 | 384 | 384 |

The natural log of Dow Jones stock index (LNDJ) reports a higher standard deviation in returns from the mean compared to the natural log of the All Ordinaries index (LNAORDS). Similarly, the natural log of US trade weighted index (LNUTWI) has higher standard deviation compared to the natural log of Australian Trade weighted index (LNATWI). This suggests that for the selected period the Australian market has enjoyed lower fluctuation in the share prices and exchange rates compared to the US.

Figure 3 shows the graphs for natural logarithm of each series from January 1980 to December 2011. To confirm this observation, the Augmented Dickey Fuller (ADF) tests developed by Dickey and Fuller (1979, 1981) were conducted on all series.

**FIGURE 3**
**GRAPHS OF STOCK INDEXES AND TRADE WEIGHTED INDEXES**
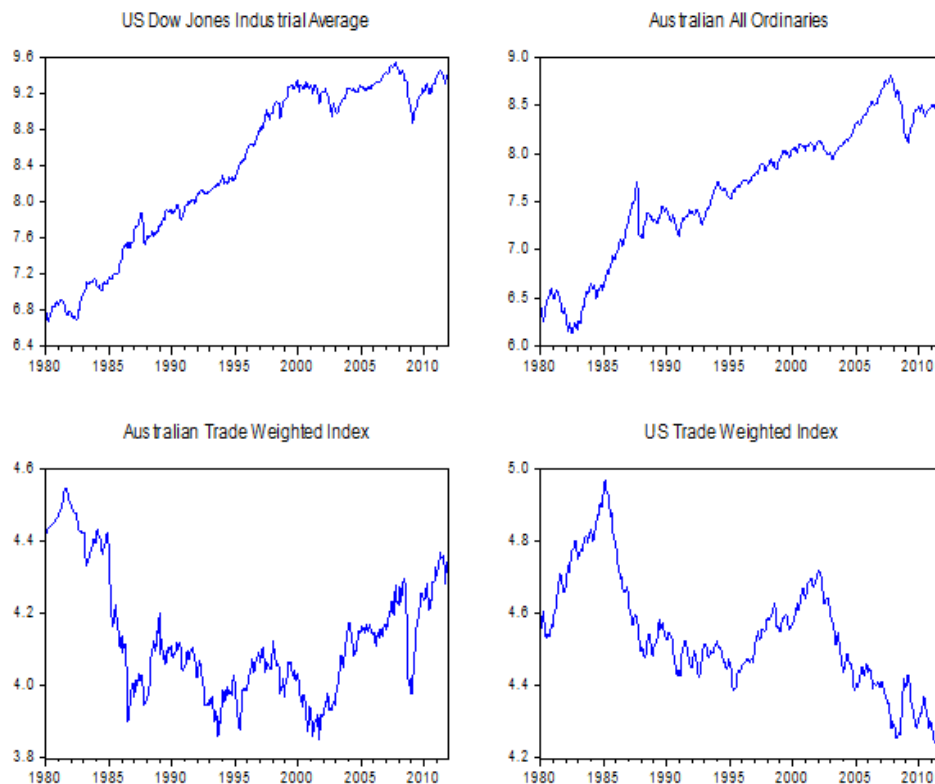
Because the stock index series trend upwards, a trend term is included in the ADF tests for these series. Therefore, the estimating regression for the ADF test[7] is as shown in equation 2.

$$\Delta y_t = \alpha + \beta t + \rho y_{t-1} + \gamma_1 \Delta y_{t-1} + \cdots + \gamma_p \Delta y_{t-p} + e_t \qquad (2)$$

$\Delta y_t$ = 1$^{st}$ difference of the stock index
   $\alpha$ = a constant term,
   $\beta$ = coefficient of the trend term
   $t$ = the trend term
   $\rho$ = the coefficient of the lagged stock index,
   $\gamma_1$ = coefficient of the 1$^{st}$ difference of the first lag of the stock index,
   $\gamma_p$ = coefficient of the 1$^{st}$ difference of the p$^{th}$ lag of the stock index,
   $e_t$ = error term

The trade-weighted indexes follow a random walk. the equation for conduction the ADF tests for these series excludes the trend term in equation 1:

$$\Delta y_t = \alpha + \rho y_{t-1} + \gamma_1 \Delta y_{t-1} + \cdots + \gamma_p \Delta y_{t-p} + e_t \qquad (3)$$

The number of lags (p) in equation 2 and 3 were determined using the Modified Akaike Information Criterion (MAIC) as proposed by Ng and Perron (2001). Table 2 contains the results of the ADF tests. As expected, all series are non-stationary at the level as each series contains a unit root. By contrast, the first difference of each series proves stationary at any level of significance. Therefore, the first difference of each series was used to estimate the GARCH models using the GARCH process developed by Bollerslev (1986).

**TABLE 2**
**UNIT ROOT TESTS USING ADF TEST (FOR MONTHLY DATA)**

| Variables | ADF test | |
|---|---|---|
| | **Level** | **First difference** |
| lnAOrds | -2.660 | -9.878*** |
| lnDJ | -1.218 | -6.819*** |
| lnUTWI | -1.239 | -5.045*** |
| lnATWI | -1.897 | -12.968*** |

* indicates that the Dickey-Fuller tau statistic is significant at the 10% (*), 5% (**) or 1% (***) level.

We start with a simple GARCH(1,1) or an AR(1)-GARCH(1) model before considering other GARCH models such as a GARCH (2,1) model and IGARCH models. The estimated AR(1)-GARCH(1) model can be written in equation form as shown in equation 4a & 4b.

$$y_t = \hat{\phi}_0 + \hat{\phi}_1 y_{t-1} + \hat{e}_t \qquad (4a)$$

$$\hat{\sigma}_t^2 = \hat{\alpha}_0 + \hat{\alpha}_1 \hat{e}_{t-1}^2 + \beta \hat{\sigma}_{t-1}^2 \qquad (4b)$$

Table 3 shows the estimated GARCH (1, 1) models for the four series using the ordinary least squares approach.

The GARCH (1, 1) model proves sufficient for the stock indexes as indicated by the highly significant GARCH parameter estimates. On the other hand, the GARCH (1, 1) model is a poor fit for the

trade-weighted indexes as the β coefficients associated with the variance are highly insignificant. In this case the use of a GARCH (2, 1) may be more suitable[8].

**TABLE 3**
**GARCH (1, 1) MODELS FOR STOCK AND EXCHANGE INDEXES**

|  | LNAORDS | LNDJ | LNATWI | LNUTWI |
|---|---|---|---|---|
| $\phi_0$ | 0.0055*** | 0.0069*** | 0.0008 | 0.0005 |
|  | (0.0017) | (0.0022) | (0.0015) | (0.0004) |
| $\phi_1$ | 0.1887*** | 0.0036 | 0.0373 | 0.3696*** |
|  | (0.0471) | (0.0632) | (0.0702) | (0.0312) |
| $\alpha_0$ | 8.66E-5* | 8.86E-5* | 0.0006*** | 0.0003*** |
|  | (4.59E-5) | (5.06E-5) | (0.0001) | (7.68E-5) |
| $\alpha_1$ | 0.1890*** | 0.0974*** | 0.2983*** | -0.0950*** |
|  | (0.0301) | (0.0319) | (0.0598) | (0.0101) |
| $\beta$ | 0.7714*** | 0.8659*** | 0.0354 | -0.0356 |
|  | (0.0442) | (0.0395) | (0.1366) | (0.2581) |

Robust standard errors in parentheses. * indicates that the coefficient is significant at the 10% (*), 5% (**) or 1% (***) level.

The GARCH (2, 1) process was used to estimate volatility in exchange rate. The estimated GARCH (2, 1) model is shown in equation 5a & 5b and its output shown in Table 4.

$$y_t = \hat{\phi}_0 + \hat{\phi}_1 y_{t-1} + \hat{\phi}_2 y_{t-2} + \hat{e}_t \tag{5a}$$

$$\hat{\sigma}_t^2 = \hat{\alpha}_0 + \hat{\alpha}_1 \hat{e}_{t-1}^2 + \hat{\alpha}_2 \hat{e}_{t-2}^2 + \beta \hat{\sigma}_{t-1}^2 \tag{5b}$$

**TABLE 4**
**GARCH (2, 1) MODELS AUSTRALIAN AND US TRADE WEIGHTED INDEXES**

|  | LNATWI | LNUTWI |
|---|---|---|
| $\phi_0$ | 0.0015 | -0.0007 |
|  | (0.0015) | (0.0008) |
| $\phi_1$ | 0.0440 | 0.3706*** |
|  | (0.0695) | (0.0386) |
| $\phi_2$ | -0.0019 | -0.0979* |
|  | (0.0534) | (0.0521) |
| $\alpha_0$ | 1.46E-5*** | 3.14E-5 |
|  | (3.44E-6) | (2.54E-05) |
| $\alpha_1$ | 0.2896*** | -0.0863*** |
|  | (0.0581) | (0.0077) |
| $\alpha_2$ | -0.2697*** | 0.1328*** |
|  | (0.0581) | (0.0290) |
| $\beta$ | 0.9657*** | 0.8436*** |
|  | (0.0140) | (0.1003) |

Robust standard errors in parentheses. * indicates that the coefficient is significant at the 10% (*), 5% (**) or 1% (***) level.

From the results, both indexes show highly significant variance coefficients. Notably, the Australian TWI shows persistent variance with $\alpha_1 + \alpha_2 + \beta = 0.9856$ compared to just 0.8901 for the US TWI. Hence, the GARCH (2, 1) model is deemed a suitable fit for the US trade weighted index and not the Australian trade weighted index. Rather, an IGARCH process is applicable for modeling persistent volatility in the Australian case (Robert & Bollerslev, 1986).

An IGARCH (2, 1) model is estimated by excluding the constant term ($\alpha_0$) from equation 5a and 5b and restricting the sum of $\alpha_1 + \alpha_2 + \beta$ =1.

**TABLE 5**
**IGARCH (2, 1) MODEL FOR AUSTRALIAN TRADE WEIGHTED INDEX**

|  | LNATWI |
|---|---|
| $\phi_0$ | 0.0036*** **(0.0004)** |
| $\phi_1$ | 0.0139 (0.0477) |
| $\phi_2$ | -8.78E-5 (0.0343) |
| $\alpha_1$ | 0.2798*** (0.0310) |
| $\alpha_2$ | -0.2079*** (0.0376) |
| $\beta$ | 0.9281*** (0.0136) |

Robust standard errors in parentheses. * indicates that the coefficient is significant at the 10% (*), 5% (**) or 1% (***) level.


Table 5 shows the resulting IGARCH (2, 1) which is a better fit for modeling exchange volatility compared to the GARCH (2, 1) model. Moreover, the IGARCH model has highly significant GARCH coefficients. Therefore, the IGARCH (2, 1) model is used to model the volatility of the trade weighted index.

**INDEX BUILDING TECHNIQUE**

Selecting a particular index building technique can prove difficult, as different researchers prefer different techniques to form a composite index. Some common techniques of index construction include Principal Component Analysis method (PCA), variance-equal weights technique, credit weights technique and transformation using sample Cumulative Distribution Functions (CDFs) (Federal Reserve Bank of St Louis, 2010; Hakkio & Keeton, 2009; Holló, Kremer, & Duca, 2012; Illing & Liu, 2006; Louzis & Vouldis, 2011). This study explores the use of the transformation of variables to CDFs method.

**Transformation of Variables to CDFs**
According to Illing and Liu (2006) the transformation of variables to CDF's method involves converting all variables to their sample CDF before constructing the index. Each variable is expressed in terms of a rank percentile that ranges from 1 to 100. The lowest values of a particular variable are assigned the value one and the highest are assigned the value a hundred. The composite index is computed by taking the arithmetic mean of the transformed variables.

**FSI of Australia**

The stress index for the Australia is computed by calculating the arithmetic average of the variables in equation 6.

$$AFSI = (IYSp + LnAORDS + LnATWI + RSp + CMAX_{AORDS} + TED)/6 \qquad (6)$$

Where, AFSI = Australian financial stress index.
IYSp = inverted yield spread.
LnAords = volatility for the natural logarithm of the All Ordinaries index.
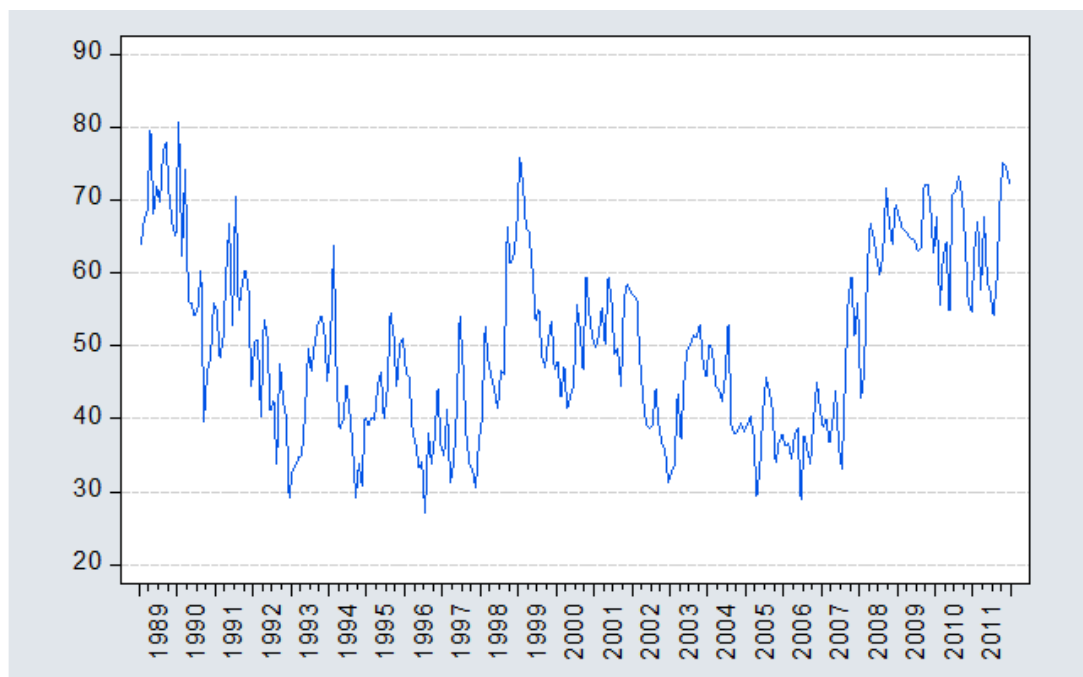LnATWI = volatility for the natural logarithm of the Australian trade weighted index.
RSp = Australian-New Zealand risk spread.
$CMAX_{AORDS}$ = risk of equity market loss based on the All Ordinaries share index.
TED = credit risk spread.

The resulting financial stress index (FSI) is shown in figure 4 and it depicts that for the three periods between 1989 and 1990, between 1998 and the early 1999 and from late 2008 to 2011 the FSI is greater than 70 with the highest level of historical stress estimated at about 80th percent in 1989 to 1990. A plausible cause of the indicated stress during this period is the Japanese crisis that occurred between 1989 and 1990 (Kindleberger & Aliber, 2005). Stress in 1998 is possible due to the contagion of the 1997 Asian crisis to Australian markets (Corsetti, Pesenti, & Roubini, 1999). The final episode of stress is possibly due to the 2007 GFC and the recent 2010 European Economic crisis.

**FIGURE 4**
**A COMPOSITE FINANCIAL STRESS INDEX FOR AUSTRALIA**



**FSI of US**

Similarly, the financial stress index for US can be obtained by calculating the arithmetic mean of the variables as shown in equation 7.

$$UFSI = (IYSp + LnDJ + LnUTWI + RSp + CMAX_{DJ} + TED)/6 \tag{7}$$

Where: UFSI =the US financial stress index; IYSp = inverted yield spread; LnDJ= the volatility for the natural logarithm of the Dow Jones; LnUTWI= the volatility for the natural logarithm of the US trade weighted index; RSp= the US-Canada risk spread; $CMAX_{DJ}$ =the risk of equity market loss based on the Dow Jones share index and TED=the credit risk spread.

The resulting financial stress index is shown in figure 5. From the graph indicates financial stress during late 1998 and late 2000 when the index exceeds the 70th percentile. The indicated distress in Dec/98 may be as a due to contagion of the Asian currency crisis. Alternatively, the indicated distress may also be due to the contagion of 1998 Russian crisis that led to the controversial but necessary bail out Long-Term Capital Management, a hedge fund company that lost "$550 million on August 21 2000" (Jorion, 2000; Pinto & Ulatov, 2010). The 2000 crisis may be indicative of the high-tech or dot-com crash, whereby the value of the Nasdaq fell by 40 percent (Illing & Liu, 2006). Contrary to what was expected, the constructed index reports mild levels of stress during the GFC, with the 65 percent in Mar/09 being the highest level recorded. This is lower than the stress levels recorded in the Australian market.

**FIGURE 5**
**A COMPOSITE FINANCIAL STRESS INDEX FOR UNITED STATES**
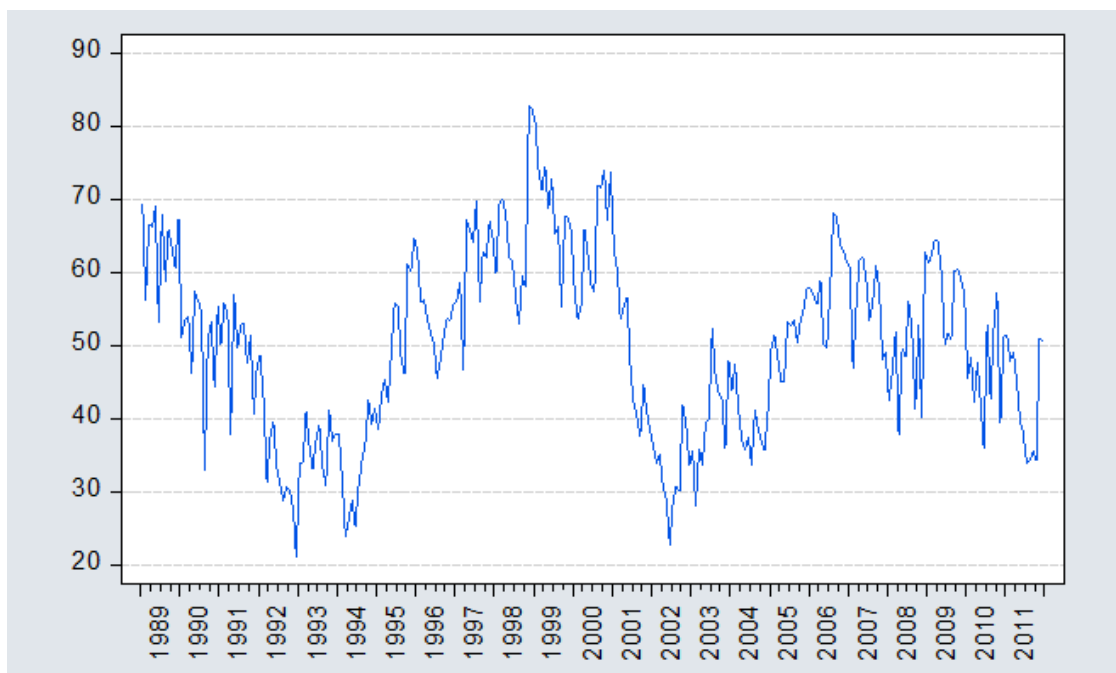


A plausible explanation for this is overreaction of the Australian financial market to news of the subprime mortgage crisis. Unfortunately, there is no way of confirming the exact cause of stress in the different markets using empirical means.

**GRANGER CAUSALITY RELATIONSHIP**

The financial-stress indexes were assessed to determine if the US-financial stress index is useful for forecasting financial stress in Australia. Specifically, we sought to determine whether: past values of the estimated financial stress in USA can be used to estimate the level of financial stress in Australia? This

Granger-causality relationship is of interest, given the historical episodes of financial stress crossing boarders (e.g. the GFC had global impacts) including those on developed countries (such as Australia). This question can be answered by performing Granger-causality tests on the estimated financial stress indexes (Granger, 1969).

By definition, Granger-causality tests were designed for stationary series. Yang (2000) suggests that if two series are non-stationary, the first difference can be used to transform them to the covariance stationary form required in Granger-causality tests. Furthermore, it is important to assess the co-integrative relationship between two non-stationary series. Dakurah, Davies, and Sampath (2001) state that using two non-stationary series that are integrated of the same order yet are not co-integrated could yield spurious causality regressions—a problem that could be fixed by taking the first difference of each series. Otherwise, if two series are non-stationary and co-integrated then the causality tests should incorporate the co-integrated relationship between the two variables (Dakurah et al., 2001; Yang, 2000). Graphical representations of both index in figure 4 and 5 indicate that both series are non-stationary. Unit root tests were conducted using the OLS equation 3 and the results of ADF tests are shown in Table 6. At a 5% level of significance, both stress indexes were found to contain a unit root. Conversely, the first difference of each index is stationary; thus each series is integrated of order one.

**TABLE 6**
**UNIT ROOT TESTS USING ADF TEST THE FINANCIAL STRESS INDEXES**

| Variables | ADF test | |
|---|---|---|
| | Level | First difference |
| *AFSI* | -1.677 | -21.683*** |
| *UFSI* | -2.658* | -24.304*** |

The Dickey-Fuller tau statistic is significant at the 10% (*), 5% (**) or 1% (***) level.

The co-integrated relationship between the Australian financial stress and the US financial stress can be evaluated by regressing UFSI on AFSI. The estimated OLS regression is:

$$\widehat{UFSI}_t = 37.384 + 0.256\widehat{AFSI}_t \tag{8}$$

The residuals $(e_t)$ for equation 8 follow a random walk as shown in figure 6 whereby the residuals are integrated of the first order $(e_t \sim 1(1))$. Hence, the two stress indexes are not cointegrated. Accordingly, the first difference of each series was used for the Granger-causality testing procedure.

**FIGURE 6**
**LINE GRAPH OF RESIDUALS**
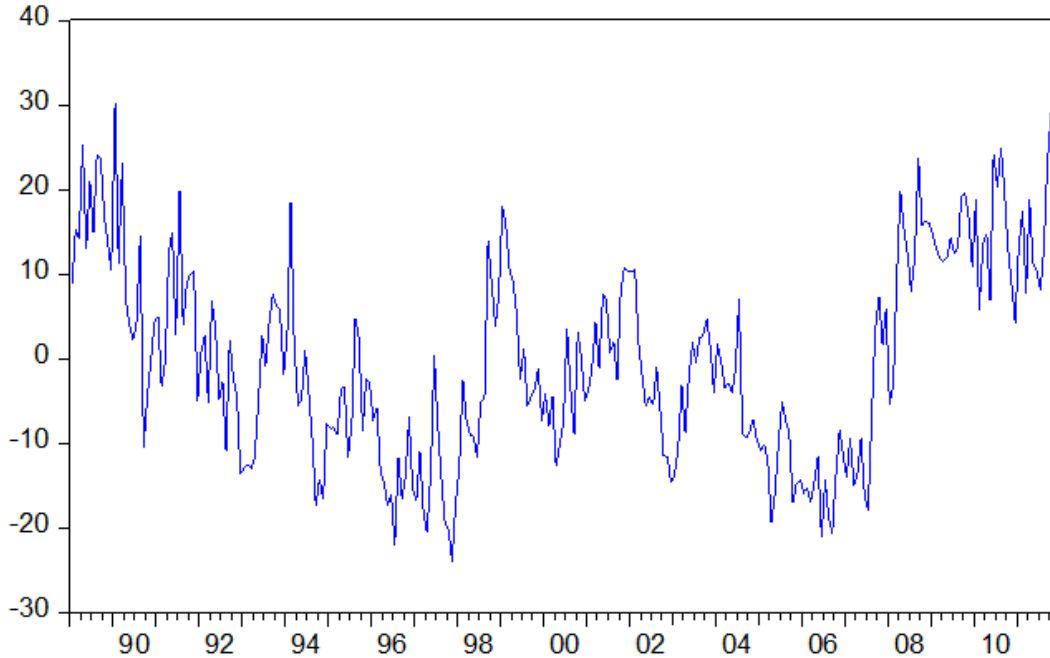


Usually, the bi-variate VAR model (shown in equations 9a and 9b) is used to test for Granger-causality when both series are stationary (Granger, 1969).

$$AFSI_t = \sum_{i=1}^{k} \beta_{1i} AFSI_{t-i} + \sum_{i=1}^{k} \beta_{2i} UFSI_{t-i} + u_t \qquad (9a)$$

$$UFSI_t = \sum_{i=1}^{k} \alpha_{1i} UFSI_{t-i} + \sum_{i=1}^{k} \beta_{2i} AFSI_{t-i} + v_t \qquad (9b)$$

However, given that the two stress indexes are integrated of order one and are not co-integrated, Toda and Yamamoto (1995) recommend the use of a VAR model of variables in the first difference form. Consequently, the Granger-causality equations applicable for this study are as shown in equations 10a and 10b.

$$\Delta AFSI_t = \sum_{i=1}^{k} \beta_{1i} \Delta AFSI_{t-i} + \sum_{i=1}^{k} \beta_{2i} \Delta UFSI_{t-i} + u_t \qquad (10a)$$

$$\Delta UFSI_t = \sum_{i=1}^{k} \alpha_{1i} \Delta UFSI_{t-i} + \sum_{i=1}^{k} \beta_{2i} \Delta AFSI_{t-i} + v_t \qquad (10b)$$

As Granger-causality tests are sensitive to the number of lags ($k$) included in the test, 5 tests were conducted to determine the appropriate number of lags to include in the VAR model. These five tests are the modified Likelihood Ratio (LR) test, the final prediction error (FPE), the Akaike Information Criterion (AIC), Schwarz Information Criterion (SIC) and the Hannan-Quinn Information Criterion (HQIC). All tests were conducted at a 5% level of significance and the results of the tests are included in Table 7.

## TABLE 7
## VAR LAG SELECTION TESTS

| Lag | LR | FPE | AIC | SIC | HQIC |
|---|---|---|---|---|---|
| 0 | NA | 1958.998 | 13.25594 | 13.28311 | 13.26686 |
| 1 | 53.74490 | 1642.373 | 13.07965 | **13.16114** | **13.11240** |
| 2 | 13.02638 | 1609.748 | 13.05958 | 13.19540 | 13.11416 |
| 3 | 7.290453 | 1612.900 | 13.06152 | 13.25167 | 13.13794 |
| 4 | **17.52852** | **1551.885** | **13.02293** | 13.26741 | 13.12118 |
| 5 | 4.138048 | 1573.830 | 13.03692 | 13.33574 | 13.15701 |
| 6 | 3.232229 | 1601.699 | 13.05441 | 13.40755 | 13.19633 |
| 7 | 3.636400 | 1627.275 | 13.07017 | 13.47764 | 13.23392 |
| 8 | 8.272690 | 1622.242 | 13.06696 | 13.52876 | 13.25254 |
| 9 | 6.864191 | 1626.189 | 13.06924 | 13.58537 | 13.27666 |
| 10 | 0.698703 | 1671.877 | 13.09678 | 13.66723 | 13.32603 |
| 11 | 3.182262 | 1701.177 | 13.11393 | 13.73872 | 13.36502 |
| 12 | 1.846032 | 1740.614 | 13.13660 | 13.81571 | 13.40952 |

*Note: * indicates the lag length selected by the test criterion*

The LR, FPE and AIC criterion recommend the inclusion of four lags while the SIC and the HQIC criterion recommend the use of one lag in the VAR framework. Accordingly, VAR models for Granger-causality were constructed using 4 lags; since most tests prefer this lag length. The results of the Granger-causality tests are given in Table 8.

## TABLE 8
## GRANGER-CAUSALITY TEST RESULTS (LAGS=4)

| Null Hypothesis | F-Statistic | Probability |
|---|---|---|
| ΔUFSI does not Granger Cause ΔAFSI | 1.881 | 0.114 |
| ΔAFSI does not Granger Cause ΔUFSI | 1.844 | 0.121 |

The results in Table 8 show that we fail to reject that null hypothesis at a 5% level of significance in both cases. Hence, there exists no causal relationship between the first differences of financial stress in the Australia and US markets. Moreover, past information of financial stress in the US provides no useful information for forecasting financial stress in Australia and vice versa.

**CONCLUSION**

As expected, given their relative economic sizes, the Granger-causality tests indicate that financial stress in Australia does not Granger-cause financial stress in the US. Given the relative importance of US trade to Australia, It is very interesting that the reverse is also true—that financial stress in the US does not granger-cause financial stress in Australia. These tests do not exclude the possibility that contagion from US financial stress, during the 2007 GFC, flowed into and caused financial stress in Australia. Nor does it indicate that either country is immune from financial crises episodes that occur in the other country. The inconclusive Granger-causality findings in this study suggest that Australian policy makers

cannot be confident in using information from US financial markets to predict financial stress and risk of a crisis in Australian markets, nor should they use that information fine-tune their policies.

Given the shifting trade focus in Australia, it was not entirely surprising that the results for financial stress in the US Granger-causing financial stress in Australia, were inconclusive—what is surprising is the apparent speed of financial institutions in Australia adjusting to the US losing trade-dominance over Australia. Given that trade dominance rises and falls over time, it may be interesting for financial and economic historians to evaluate the change in Australia's contagion risks with the US over period of decades and the implications for the rising trade-dominance of China for many countries (e.g. Australia, Latin American countries, and African countries).

Future research could explore inclusion of other financial stress indicators not considered in this research—e.g. other variables may prove useful as proxies for factors not available on a monthly basis. Alternatively other future research might explore the effects of using quarterly data instead of monthly data. Also, future research might explore the use of historical data within Australia, to forecast future episodes of financial stress. Further, the effect of Australia's stringent banking rules on financial contagion should be examined.

## ENDNOTES

1. As observed by Mr. Micawber (a Dickens's character):"Annual income twenty pounds, annual expenditure nineteen pounds nineteen and six, result happiness. Annual income twenty pounds, annual expenditure twenty pounds ought and six, result misery" (Dickens's (1850, Chapter 12)
2. Trade theory is discussed in this study to provide essential background for contagion, as it relates to financial stress. An extensive discussion of trade theories is out of scope of this study and is well covered in the literature.
3. Feenstra and Hanson (1996) found that outsourcing contributed to an increase in wages of non-production labour rates by about 31 percent in the 1980s.
4. See the House of Representatives Standing Committee on Infrastructure Transport Regional Development & Local Government, 2009.
5. Eviews7: User Guide (2009), Irvine: Quantitative Micro Software.
6. Patel and Sarkar (1998) designed CMAX to index the share price levels to their maximum value over a review period that is expressed in years.
7. The null hypothesis for all ADF tests is that $y_t$ has a unit root. In which case $\rho$ would be equal to zero. The null is rejected if the series does not contain a unit root or is stationary.
8. The ARCH Lagrange Multiplier tests for all series indicate that no ARCH left in the standardized residuals. Hence there is no need to estimate a GARCH (1, 2) model.

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