Financial Stress and its Impact on Economic Activity: Evidence from Jamaica

Celia Wallace*

Financial Stability Department
Bank of Jamaica

Abstract

This paper developed Financial Stress Indexes for Jamaica (JFSI) using monthly data from January 2005 to July 2013 for the equity, foreign exchange and money markets by utilizing a simple aggregation method, a market weighted approach and principal components analysis (PCA). All three indexes were successful in identifying historical periods of financial stress for Jamaica. In addition, deterioration in the indexes during periods of stress was mainly attributed to volatility in the stock and foreign exchange markets. However, the unweighted index exceeded other indexes during key periods and was chosen as the most appropriate measure of financial stress. In addition, OLS estimation was utilized to examine the effect of financial stress episodes, as measured by the unweighted index, on real GDP growth. Other variables captured in the estimation included the spread between loan and deposit rates, growth in the fiscal balance, the exchange rate and growth in net exports. Findings showed that following a financial stress episode, real GDP growth will moderately decrease three months into the future.

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* Celia Wallace is a graduate student in the Department of Economics, UWI, Mona Campus, Jamaica. This paper was written while Celia Wallace served as an intern in the Financial Stability Department at the Bank of Jamaica under the supervision of Mrs. Sherene Bailey-Tapper. The author is also grateful to the staff of the Financial Stability Department & the Research & Economic Programming Division for their useful comments and suggestions. The views expressed are those of the author and does not necessarily reflect the position of the Bank.

Table of Contents

1.0 Introduction ... 3
2.0 The Literature on Measuring Financial Stress ... 4
3.0 The Jamaica Financial Stress Index ... 8
3.1 Selecting the Variables for the Index ... 8
3.1.1 The Money Market Sub-index ... 9
3.1.2 The Equities Market Sub-Index ... 10
3.1.3 The Foreign Exchange Market Sub-Index ... 12
3.2 Creating the Index ... 13
3.2.1 Method 1: Aggregating the Variables ... 13
3.2.2 Method 2: Weighting the Index using PCA ... 14
3.2.3 Method 3: Weighting the Index using Market weights ... 15
3.3 Using the JFSI to Identify Historical Periods of Financial Stress ... 16
4.0 Estimating the Impact on Economic Activity ... 19
4.1 Regression Diagnostics ... 20
4.2 Regression Findings ... 22
5.0 Conclusion and Policy Implications ... 22
6.0 References ... 24
7.0 Appendix ... 26
Table A1: Description and Sources of Variables Used for the Index ... 26
Table A2: Descriptive Statistics for Index Variables ... 27
Table A3: Correlations Matrix for Index Variables ... 27
Table A4: Prinicpal Components Based on January 2005 to July 2013 ... 28
Table A5: Unit Root Tests for Regression Variables ... 28
Table A6: Descriptive Statistics for Regression Variables ... 28
Table A7: Correlation Matrix for Regression Variables ... 29
Table A8: OLS Results: Dependent Variable: R$GDPt$ ... 29
Figure A1: The $JFSI_{UNWEIGHTED}$, $JFSI_{PCA}$, $JFSI_{MARKET\ WEIGHTS}$ and Individual Components .. 30

1.0 Introduction

The Jamaican economy has experienced periods of economic downturn that can possibly be attributed to financial stress.[1] Based on the international literature, while not all periods marked by a continued slowdown in economic activity are caused by financial stress, there are many cases in which financial stress episodes have preceded such downturns. In recent years, research in advanced economies has been geared toward developing several indices that can be utilized to capture the effect that financial stress can have on a country's economic activity. Furthermore, one such indicator which has been developed is a Financial Stress Index (FSI).

Regarding Jamaica, several financial vulnerability indices have been introduced as shown by Milwoood (2012), Mingione (2012), Morris (2010) and Langrin (2002). Langrin (2002) developed an early warning system (EWS) for Jamaica to signal the development of future banking crises. He examined the aggregate sector rather than individual institutions to capture potential systemic vulnerabilities. Following this study, Morris (2010) developed an aggregate financial stability index to capture periods of financial instability, also using data from the banking sector. However, while Langrin (2002) and Morris (2010) used banking sector data only, Milwood (2012) developed a composite indicator of systemic stress (CISS) using data from the bond, money, equity and foreign exchange markets. The CISS was constructed using the Threshold Vector Autoregression (TVAR) process and was found to be effective when identifying stress in the financial markets. Mingione (2012) constructed a financial stress index that was useful in tracing financial stress which used macro and micro prudential indicators, as well as market and international variables. This paper proposes the development of a FSI, which is intended to augment the Bank's

[1] Financial stress can be defined as an interruption to the normal functioning of financial markets.

framework for financial stability assessment as well as aid in assessing the impact of financial stress episodes on economic activity.

The FSI developed in this paper for Jamaica follows a similar methodology to Cardarelli, Elekdag and Lall (2009), Illing and Liu (2003) and Rosenberg (2009). Like Milwood (2012) and Mingione (2012), the FSI constructed in this paper will involve aggregating domestic financial market data. Furthermore, two weighted indexes and an unweighted index will be developed. Additionally, there will also be an investigation of the impact of financial stress on economic activity.

The remainder of the paper is structured as follows. Section 2 discusses the literature on financial stress indexes. Section 3 provides the data description, methodology and performance of JFSIs constructed for Jamaica. Section 4 presents estimates of the impact of financial stress on economic activity while the conclusion and policy implications of the results are presented in section 5.

2.0 The Literature on Measuring Financial Stress

Subsequent to the global financial crisis which commenced in 2007, literature on measures of macro-financial vulnerability has vastly increased. In particular, a number of studies have focused on the development of financial stress indexes including Cardarelli *et al.* (2009), Illing and Liu (2003), Brave and Butters (2011), Oet, Eiben, Branco, Gramlich and Ong (2011), Kliesen and Smith (2010) and Hakkio and Keeton (2009). Nonetheless, of note is that much of the current literature on measures of macro-financial vulnerability pertains to advanced economies, and in some cases limits the applicability to developing countries.

The development of FSIs differs across authors according to variables used and the methods of estimation. Illing and Liu (2003), based on data for Canada, used variables from the banking sector and the foreign exchange market, debt and equity markets. To develop the index, Illing and Liu (2003) considered weighting the variables by using factor analysis, the cumulative distribution functions (CDFs) of the variables and credit-weighting analysis. They modeled stock prices and exchange rates using a GARCH procedure described by Bollerslev, Chou, and Kroner (1992) in a context where these two variables have historically exhibited changes in variances over time.[2] Hollo et al. (2010) described a holistic FSI as one that includes variables that span the entire financial system capturing information on the banking sector as well as the financial markets. Other studies have used a segment of these components. Cardarelli *et al.* (2009) developed and used FSIs (the Advanced Economy Financial Stress Index (AE_FSI)) to examine the main characteristics of financial stress episodes that were followed by periods of economic downturns using seventeen advanced economies with 113 episodes of financial stress over a thirty year period. Furthermore, they used three sub-indexes and seven components to derive their FSI and thus finding that banking stress that causes financial instability is more likely to cause a period of economic downturn. Similar to Illing and Liu (2003), the authors of the study modeled stock returns and exchange rates using the GARCH specification. The variables for the index were standardized and therefore were not weighted. They identified a period of financial stress as a point in time when the index is one standard deviation higher than its trend. The results specified that over half the episodes of financial stress that were followed by slowdowns or recessions were banking sector related.

Hakkio and Keeton (2009) developed a stress index for the Kansas City Federal Bank by using monthly data for 11 financial market variables over a 20 year period. To develop the stress index, they used principal components analysis (PCA) as was used for the FSI for Canada by Illing and

[2] Generalized Autoregressive Heterosckedasticity

Liu (2003). The Kansas City Federal Bank FSI was useful in identifying both past and future episodes of financial stress. Hakkio and Keeton (2009), like Cardarelli *et al.* (2009), analyzed the effects of the index on economic activity and found that the index was useful in anticipating changes in economic activity.

Balakrishnan *et al.* (2009) constructed the EM-FSI (Emerging Country Financial Stress Index) to capture how financial stress, transferred from advanced economies to emerging ones, stunt the growth of these upcoming economies. Balakrishnan *et al.* (2009) believes that financial stress is mainly associated with the health of the banking sector, liquidity droughts, increases in risk and or uncertainty and shifts in asset prices. The EM-FSI, like the AE_FSI, uses data from the banking, securities and exchange markets. These variables were aggregated into the EM-FSI using the method of variance-equal weighting. Like most of the literature of its kind, the EM-FSI was successful in identifying periods of financial stress.

Slingenberg and de Haan (2011) created a FSI using 30 variables from 13 OECD countries in an effort to predict future periods of financial stress. Furthermore, they also did a sensitivity analysis to check the robustness of their results. The main findings, while in line with Cardarelli *et al.* (2009), were such that the FSI constructed was not very useful in predicting financial stress. Also, there was a cross-country disparity in the predictive powers of the variables. Credit growth was the only variable that had predictive power for most countries.

Oet et al. (2011) developed a FSI for Cleveland using daily public-market data on the credit, equity, foreign exchange and interbank markets. They used a benchmarking methodology to compute and compare the FSI to other stress indexes and also to test its viability as an EWS. A credit-weighting method was used to assign the weights to the variables in the FSI. This method reassigned the weights as economic conditions changed. They found that the FSI has the ability to act as a filtering device for market distortions.

Rather than using PCA, Carlson, Lewis and Nelson (2012) standardized the variables for the index using a logit model. They used data that included market liquidity, risk pricing and uncertainty by employing 12 financial series. From this, they developed 3 sub-indexes then used a logistic regression model to determine how the variables would be weighted for the construction of the index. The FSI developed by Carlson et al. (2012) is employed as a tool to describe financial conditions rather than as a EWS measure.

Van Roye (2012) derived a financial market stress indicator (FMSI) for Germany using factor analysis. To estimate the impact on economic activity Van Roye (2012) used a TVAR model and found that if the indicator goes above the natural level then any additional stress in the financial sector will adversely impact economic activity.

Mingione (2012) designed a FSI for Jamaica using dynamic factor analysis in which the necessary and common factors were extracted using PCA, Two-Step and Quasi-Maximum Likelihood (QML) for 1998Q1:2012Q3. He used micro and macro prudential, market and foreign indicators to combine the 39 variables that best predict financial stress. This FSI was successful in identifying the major periods of financial stress, for example the impact of the financial sector crisis of the late 1990s on the domestic financial markets as well as the Jamaica Debt Exchange Programme (JDX). However it showed other periods of stress, such the impact of the US subprime crisis which commenced in 2008 and the period of substantial volatility in the domestic financial markets during the first quarter of 2003 as a period of calm for the economy.[3]

[3] See McFarlene (2010).

The literature suggests that a FSI should be able to capture financial market disturbances that will potentially have an effect on economic activity. Additionally, FSIs are useful tools that can aid in policy implementation and decision making. The consensus of the literature is that financial stress mainly emanates from the foreign exchange, debt and equity markets. Considering the literature, the Jamaica Financial Stress Index (JFSI) developed in this paper will utilize financial data from the money, equity and foreign exchange markets. [4] The index will be created using three methods. One version of the index will include the aggregation of normalized, unweighted variables. The other two methods involve the weighting of the variables using (i) principal components analysis (PCA) and (ii) using weights determined by the number of variables used to represent the financial market.[5] In all three cases any value that exceeds zero represents a stressful period. The unweighted index was found to be the most appropriate measure of financial stress and was utilized in estimating the impact of financial stress on economic activity.

3.0 The Jamaica Financial Stress Index

3.1 Selecting the Variables for the Index

For Jamaica, the JFSI was constructed using monthly data from January 2005 to July 2013 and includes seven variables. Furthermore, three sub-indexes were created to capture the different dimensions of financial stress. While it would have been desirable to use data from the 1990s to capture performance during the 1995 to 1998 Jamaican distress period, data was unavailable for all variables utilized in constructing the index. In addition, as discussed by Hakkio and Keeton (2009), market data variables chosen for inclusion in the three sub-indexes, the money and bond market sub index, the equity market sub-index and the foreign exchange market sub-index, capture

[4] See Cardarelli *et al.* (2009)
[5] See Sandhal (2011)

features of financial stress, such as investor uncertainty, in particular regarding the fundamental value of assets, investor willingness to hold risky assets as well as information asymmetry in the financial markets.[6]

3.1.1 The Money Market Sub-index

3.1.1.1 30-Day Spread (30-DayS)

The 30-day spread, measured as the difference between money market rates and Treasury Bills yields, was used to capture counterparty risk in the money market. The 30-Day spread included in the JFSI is computed as the difference between 30-day private money market rates and T-Bills of the same maturity as shown in *Equation (1)*.[7]

$$\mathbf{30 - \mathit{Day\ Spread} = 30\ \mathit{Day\ PMMR} - 30\ \mathit{Day\ T} - \mathit{Bill}} \qquad (\mathbf{1})$$

A positive value for this spread contributes to an increase (deterioration) in the JFSI and could potentially be a signal of default risk where banks fear that loans will not be repaid or possible liquidity risk challenges. According to Hakkio and Keeton (2009), the 30-day spread captures three possible aspects of financial stress, including potential flight to quality, flight to liquidity or asymmetric information that exists between buyers and sellers in the market.

3.1.1.3 The Term Spread (TermS)

The term spread, also referred to as the slope of the yield curve, was measured as the difference between the yields on short term and long term government issued securities. More specifically, the spread which is included in the JFSI is computed as shown in *Equation (2)*.

$$\mathbf{\mathit{TS} = \mathit{GOJ\ Domestic}\ 1\ \mathit{Year} - \mathit{GOJ\ Domestic}\ 20\ \mathit{Years}} \qquad (\mathbf{2})$$

[6] A description of the sources of the variables can be found in *Table A1* of the Appendix.
[7] Equivalent Treasury bill yields are calculated using the Equivalent Yield Formula.

A negative yield curve occurs when shorter term rates are higher than longer term rates, which could adversely impact financial institutions' profitability performance. Moreover, if the difference between the two rates is more than the average of the series then it is registered as an increase in the index

3.1.2 The Equities Market Sub-Index

3.1.2.1 The Financial Sector Beta (FSB)

The financial sector beta was calculated using changes in the banking, securities dealers and insurance sector data and the JSE main index.[8] The beta is computed based on *Equation (3)*,

$$\boldsymbol{\beta} = \frac{\boldsymbol{Cov(x, y)}}{\sqrt{\boldsymbol{Var(y)}}} \qquad (\mathbf{3})$$

where x is the year-on-year percentage change in the financial sector index and y is the year-on-year percentage change in the JSE main index. The beta of the financial sector was used to capture the risk of investing in the banking and insurance companies. It combines the volatility of the company's equity and its correlation with the main stock index.[9] A $\beta > 1$ means stocks in the banking sector are more volatile than those of the entire market. The higher the β, the higher the cost of equity and the more risk associated with the sector. However, since a $\beta > 1$ means a risky investment, it is expected that movements in the FSI will not be largely dependent on this beta as all monthly values are such that $\beta < 1$. All values such that $\beta < 0$ were entered as $\beta = 0$ to capture only the adverse effects to the banks and insurance companies. The beta of the financial sector increases when the stock prices of the banking, securities dealers and insurance sector are

[8] Data sourced from the Jamaica Stock Exchange.
[9] The correlation is calculated using a two month rolling variance and covariance of the data.

volatile. Therefore, any factor that causes such an increase will also cause a spike or deterioration in the index.

The financial sector index was computed by using market capitalization from the banking, securities dealers and insurance companies represented on the stock market using *Equation (4)*.[10]

$$\boldsymbol{New\ Index = \frac{\sum(Issued\ shares \times Market\ Price)}{Base\ Divisor}} \qquad (\mathbf{4})$$

The index was calculated for each month. In the cases where the number of shares issued changed for a company or a company enlisted or delisted from the stock exchange, a new base divisor was calculated using the formula outlined in *Equation (5)*.

$$\boldsymbol{New\ base\ Divisor = \frac{\sum New\ Market\ Capitalization}{Closing\ Index}} \qquad (\mathbf{5})$$

An increase in the financial sector index would suggest that the market value of these companies, on average, has increased.

3.1.2.2 Stock Market Decline (SMD)

Stock market decline was measured using monthly changes in the Main JSE Index and then negating these changes so that a fall in stock prices would translate to an increase in the JFSI. *Equation (6)* outlines the formula.

$$\boldsymbol{Stock\ Decline = -\left(\frac{Index_t - Index_{t-1}}{Index_{t-1}}\right)} \qquad (\mathbf{6})$$

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[10] Bank of Nova Scotia/Scotia Group Jamaica, Barita Investments Limited, Capital and Credit Merchant Bank, D.B.& G Ltd./Scotia DBG Investments, Dyoll Group, First Caribbean International , First Caribbean Inter. Bank Ja., First Jamaica Investments Ltd., Guardian Holdings Limited, Jamaica Money Market Brokers, Life of Jamaica/Sagicor Life Jamaica, Mayberry Investments Ltd., National Commercial Bank Jamaica Limited, Pan Caribbean Financial Services Ltd. Sagicor Investment Jamaica, Pan Jam Investments, RBTT Financial Holdings Ltd. and Sagicor Financial Corporation.

The stock market decline captures the effect that fluctuating stock prices will have on economic activity. It is expected that any stress episode in market activity that will cause stock prices to fall drastically will result in a spike in the JFSI.

3.1.2.3 Stock Market Returns Volatility (SMR)

Similar to the volatility in the foreign exchange market, stock market returns volatility was specified by using a GARCH (1,1) model on the monthly changes in the Main JSE Index. This series is predicted to capture the observation that asset prices exhibit volatility clustering in periods of uncertainty about the behaviour of investors (Cardarelli *et al.* 2009). An increase in the volatility of the returns in the stock market is expected to cause an increase in the index.

3.1.3 The Foreign Exchange Market Sub-Index

3.1.3.1 Volatility of the REER (REER)

REER volatility was derived using a GARCH(1,1) specification for the monthly changes in this variable (Bollerslev 1986). The general specification for this model is outlined below in *Equations (7) to (9).*

$$\boldsymbol{Y_t = a + \beta^{`} X_t + u_t} \tag{7}$$

$$\boldsymbol{u_t | \Omega_t \sim iid\ N(0, h_t)} \tag{8}$$

$$\boldsymbol{h_t = \gamma_0 + \delta_1 h_{t-1} + \gamma_1 u_{t-1}^2} \tag{9}$$

Volatility estimates which are derived from this model are intended to capture the uncertainty of investors about the value of the currency and about investment behaviours of other agents

(Cardarelli *et al.*, 2009). A rise in the volatility in the foreign exchange market is expected to increase the index.

3.2 Creating the Index

3.2.1 Method 1: Aggregating the Variables

Prior to creating the index, the variables utilized were normalized by adjusting for the sample mean and standardizing by the sample standard deviation. The formula used for normalizing each variable is represented in *Equation (10)*:

$$\boldsymbol{Normal\,Variable} = \frac{\boldsymbol{X_t - \bar{X}}}{\boldsymbol{std.dev}} \qquad (\mathbf{10})$$

The normalization method is employed because the variables for the index are different in their units of measurement. Normalizing the variables also allows for use in their un-weighted state when constructing the index. The normalized variables were aggregated to create the index. The index was transformed by representing each period as a proportion of the maximum historical value of the index to ensure that the values ranged between -1 and +1.

Sandhal *et al.* (2011) identified a financial stress episode as any period in which the value of the index exceeds three standard deviations for the sample period. However, Cardarelli *et al.* (2009) identified an episode of financial stress as one that is one standard deviation above its trend which is determined by the Hodrick-Prescott (HP) Filter. Stress episodes for the JFSI have been classified using similar ranges based on work by Oet et al (2011) (see *Table 1*).

Table 1: Classification of Stress Episodes	
Stress Episode	JFSI Classification
Grade 1(Below Normal Stress)	$-1 \leq JFSI < -0.5$
Grade 2 (Low Stress)	$-0.5 \leq JFSI < 0$
Grade 3 (Moderate Stress)	$0 < JFSI < 0.4$
Grade 4 (High Stress)	$0.4 \leq JFSI < 0.7$
Grade 5 (Significant Stress)	$0.7 \leq JFSI \leq 1$

3.2.2 Method 2: Weighting the Index using PCA

The literature describes several methods which can be used to weight the FSI. These methods include using equal weighting, equal variance weighting, using the PCA method and using cumulative distribution functions. The PCA method was utilized to identify the best possible combination of the components to generate the index. It involved uncovering structural relationships in time series data by identifying the eigenvectors and eigenvalues of the variance-covariance matrix of the dataset.[11]

In PCA, each observed variable series contributes one unit of variance to the overall variance in the dataset.[12] Furthermore, any component that displays an eigenvalue greater than 1 would be accounting for a greater amount of variance than had been contributed by only one variable. There are several criteria that determine the number of significant components to retain in the data. One criterion involves retaining components which have eigenvalues greater than 1. Researchers would also retain those components that account for at least 10.0 per cent of the proportion of the variance. The criterion used to retain the components for the JFSI is based on the cumulative percent of the variance. The idea is to retain enough components so that the cumulative per cent of the variance accounted for is at least 80.0 per cent.

[11] See Oet *et al*. (2011)
[12] Standardized variables were used.

After identifying the significant components, the PCA index was calculated using the normalized loadings of the first component generated from the analysis (*Table A4*). The PCA index was then transformed using the same procedure used in deriving the unweighted index. Stress episodes for the JFSI were classified using the previously identified ranges (see *Table 1).*

3.2.3 Method 3: Weighting the Index using Market weights

The market weighted approach was also examined and involved applying equal weighting to sub-components utilized in computing the index. The market weighted approach was also examined and involved applying equal weighting to sub-components utilized in computing the index (see *Table 2*). In addition, the variables utilized in the index are also normalized prior to applying weightings to the different subcomponents. The market weighted JFSI is transformed by representing each period's value such that the index values range from -1 to +1. Stress episodes were also classified using the same ranges as outlined for the unweighted and PCA weighted indexes (see *Table 1*).

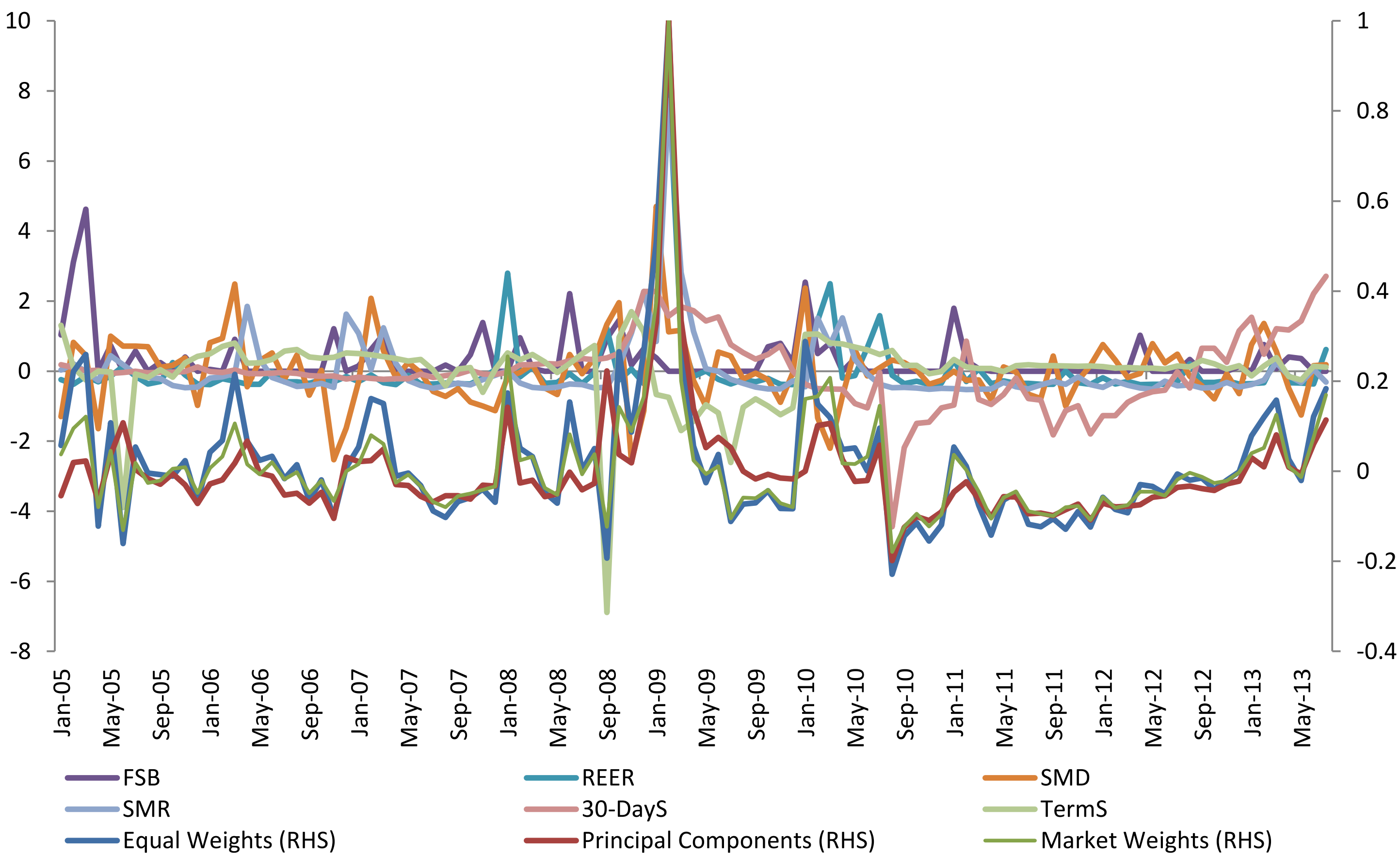
Table 2: Composition of JFSI using the Market Weighting Method

	Index Weight
Money Market	
Term Spread	16.7%
30-Day Spread	16.7%
	33.3%
Equity Market	
Financial Sector Beta	11.1%
Stock Market Returns	11.1%
Stock Market Decline	11.1%
	33.3%
Foreign Exchange Market	
Real Effective Exchange Rate	33.3%
	33.3%
Total	100%

3.3 Using the JFSI to Identify Historical Periods of Financial Stress

A general co-movement is identified in both the unweighted and PCA and market weighted indexes (see *Figure 1*). Furthermore, all three indexes have the highest correlations with the volatility in the stock market and the volatility in the real effective exchange rate (see *Table A2 & Figure A1*).[13] Furthermore, during periods of financial stress, these factors also peaked.

Figure 1: The JFSI$_{\text{UNWEIGHTED}}$, JFSI$_{\text{PCA}}$, JFSI$_{\text{MARKET WEIGHTS}}$ and Components[14]

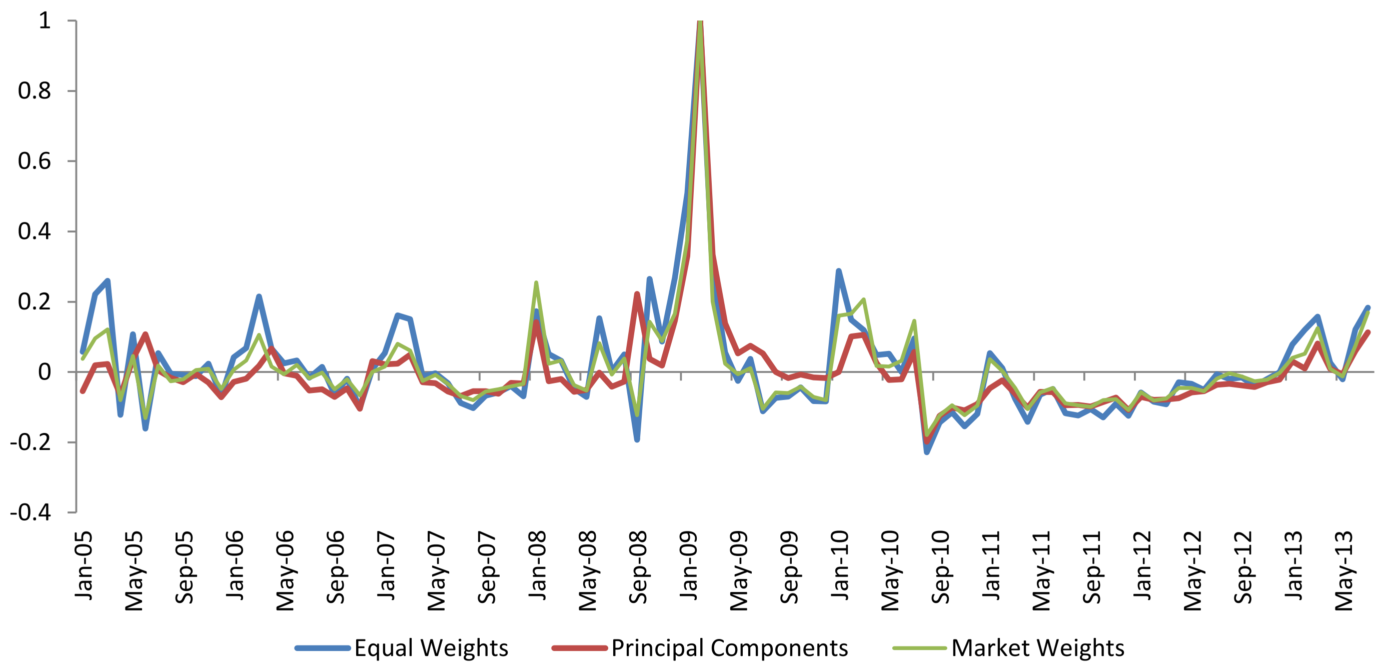


Nonetheless, over the period of analysis, all three indexes seemed to be closely correlated. While all the indexes identify the major periods of stress, the equally weighted and the market weighted index identified longer periods of stress and they both identified the same periods of stress.

[13] See *Figure A1*in Appendix for individual graphs of the indexes against each component.
[14] Only one graph was used because the components of the indexes are the same and therefore scale and distribution would not change.

Nonetheless, the equally weighted index was chosen as the preferred weighting method for Jamaica as it was found to be the most conservative in terms of its average across crisis periods. Stressful periods were identified as those that are sustained for at least four successive months. The indexes captured three key stress periods for Jamaica.[15]

Figure 2: The JFSI, three weighting methods



The first major period of financial stress identified by all three indexes is the recent global financial crisis period. The PCA index, however, started to show stress in the system from as early as September 2008, while the unweighted and the market weighted index started to deteriorate from October 2008.[16] In addition, the indexes peaked in February 2009 in the aftermath of the

[15] All three indexes identified the first quarter of 2006 as a period of stress, largely driven by sharp declines in the Main JSE Index largely reflecting the impact of weak earnings for a number of the companies listed on the stock exchange. In addition, the March 2007 quarter also represented a period of stress influenced by increased volatility in the foreign exchange market, weak stock market performance and declines in GOJ Treasury bill yields.

[16] This is prior to the crisis' full effect on the economy.

global financial crisis.[17] The global crisis fueled volatility in the foreign exchange market, particularly during the final quarter of 2008, reflecting investor uncertainty which translated to increased demand for foreign exchange by householders and domestic firms.[18]

The second key period of financial stress related to the Jamaica Debt Exchange Programme (JDX).[19] The equally weighted and market weighted indexes also spiked in January to July 2010 signaling the implementation and after effects of the JDX.[20] The performance in the indexes during this period largely reflected increased volatility in the foreign exchange and stock markets. As it relates to stock market, the JDX contributed to a reduction in profit margins for a number of financial institutions which influenced declines in the Main JSE index subsequent to the JDX.

The indexes also identified January to April 2013 as a key period of stress, largely reflecting the impact of the NDX programme. Similar to the JDX, the NDX was introduced to reduce public debt and government spending by allowing bond holders to switch current bonds for new bonds with lower interest rates and longer maturities. The NDX was associated with increased volatility in the foreign exchange and stock markets due to investor uncertainty during this period.

[17] All three methods of the deriving the index will be referred to collectively as they both identified the periods of economic stress.
[18] See McFarlane 2010.
[19] The JDX was launched on 14 January 2010 and involved investors voluntarily participating by surrendering old bonds and choosing new bonds according to specified rules. The financial settlement date was 24 February 2010 and on this date, new bonds were issued and accrued interest paid.
[20] The PCA index identified February to April 2010 as being stressful. However, due to the definition of a stressful period, this was not identified as one.

4.0 Estimating the Impact on Economic Activity

Given the potential impact of financial stress periods on economic activity, further work was done to estimate the nature of this relationship for the Jamaican economy. Monthly data was used covering the period January 2005 to March 2013. A model was estimated to test the impact of financial stress on economic activity. More specifically, the growth rate in real gross domestic product $(\boldsymbol{RGDP})$ was regressed against the unweighted JFSI index $(\boldsymbol{JFSI}_{(\boldsymbol{UNWEIGHTED})})$, the J$/US$ exchange rate $(\boldsymbol{XRATE})$, the interest rate spread between loans and deposits $(\boldsymbol{INTS})$, growth in the fiscal balance $(\boldsymbol{FB})$, growth in net exports $(\boldsymbol{NX})$, the unemployment rate $(\boldsymbol{UNEM})$ and household debt $(\boldsymbol{HH}(\boldsymbol{DEBT}))$. These variables were included because, based on the literature, they have the most pronounced impact on economic activity. Furthermore, the index was represented by a dummy variable, where successive stress periods were captured by 1, with zero otherwise.

Based on *a priori* expectations, the JFSI index is anticipated to have a negative impact on real output growth, that is, stress episodes are expected to weaken the growth in real output. On the other hand, increases in banking sector loans to households are assumed to increase this growth rate. This is partly because householders' purchasing power has increased which increases aggregate demand and hence real output. Increases in the interest rate spread will worsen the affordability of loans to borrowers and is expected to lead to slowdown the growth of real output. Depreciation of the Jamaican Dollar is anticipated to increase the competitiveness of Jamaican exports and potentially lead to an increase in $\boldsymbol{RGDP}$. The direction of the impact of the fiscal balance on real GDP can be argued from two opposite perspectives. A negative balance is indicative of expenditure exceeding revenue which means that resources are being pumped into the economy to stimulate growth in real output. Alternatively, as government revenue exceeds expenditure, this can fuel increases in spending and real output. Increases in the unemployment rate are postulated to decrease the growth rate of real output. Increases in net exports are also expected to stimulate growth in the economy.

4.1 Regression Diagnostics

Ordinary Least Squares (OLS) was used to determine the relationship between real GDP growth, the JFSI index dummy variable, household debt from the banking sector, the spread between loan and deposit rates, the exchange rate, the unemployment rate, growth in the fiscal balance and growth in net exports. The model is outlined in *Equation (11).*

$$\begin{aligned} \boldsymbol{RGDP_t} &= \boldsymbol{\alpha + \gamma_0 FB_{t-4} + \gamma_1 INTS_{t-5} + \gamma_2 HH(DEBT)_{t-4} + \gamma_3 NX_{t-12} + \gamma_4 \Delta UNEM_{t-1}} \\ &\quad \boldsymbol{+ \gamma_5 \Delta XRATE_{t-4} + \gamma_6 JFSI_{(UNWEIGHTED)t-3} + \gamma_7 \Delta RGDP_{t-1} + \gamma_8 \Delta RGDP_{t-2}} \\ &\quad \boldsymbol{+ \gamma_9 \Delta RGDP_{t-3}} \qquad (\boldsymbol{11}) \end{aligned}$$

The Augumented-Dickey Fuller (ADF) and Phillips-Perron (PP) tests for stationarity were used to determine if the eight variables for the regression contained unit roots. The results indicated that all variables, except two regressors, the unemployment rate and the exchange rate, were stationary (*see Table A5*).[21]

A number of robustness checks were also done to determine whether the model was correctly specified. Furthermore, tests for multicollinearity involving the variance inflation factors of the independent variables in the regression were less than 4, indicating the absence of multicollinearity.[22,23,24] The Breusch-Godfrey Serial Correlation LM Test showed that there is no

[21] The ADF and PP test were inconclusive for the dependent variable and therefore the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test for stationarity concluded that the variable was I(0).
[22] This is used to test the existence of multicollinear variables. The lags of the dependent variable that were used have high VIFs, however, this is not detrimental to the paper as this type of relationship is expected.

evidence serial correlation among the variables.[25] More specifically, the p-value of this test was greater than 5.0%, indicating that there is no evidence of serial correlation.

The Ramsey Reset test was used to check if the model was correctly specified and that the parameters were linear.[26] The results showed probability values greater than the 5.0 per cent level of significance, indicating that the null hypothesis of a model with linear parameters cannot be rejected. The White's test was used to determine if the errors were homoscedastic.[27] The null hypothesis was rejected signaling that the errors were heteroskedastic; as such the White's robust standard errors were reported in the regression results.

The errors in both models were also tested for normality. The Jarque-Bera statistic was used to determine this and the findings showed normality of the errors as the null hypothesis for this test was not rejected.[28] Furthermore, it is a necessary assumption that the error term, conditional on the independent variables, has a mean of 0. This was tested by checking the correlation between the residuals of the models and each of the independent variables. The correlation coefficient in each case was approximately zero, therefore, as desired; the error term in the model has a conditional mean of zero.

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[23] A VIF of 4 indicates that at least 75 per cent of that variable can be explained by other variables. If the VIF for the other variables were larger than the 4 then the model would have to be re-specified to eliminate or combine the variables that have such a strong relationship.

[24] While serial correlation does not affect the unbiasedness or consistency of the OLS estimators, it affects their efficiency.

[25] This tests the null hypothesis that there is no serial correlation among the variables. The test was run using two lags of the residual. A probability value greater that 0.05 is indicative of the absence of serial correlation.

[26] This tests the null hypothesis that the model in itself is correctly specified. That is, there are no relevant variables that are excluded and there are no irrelevant variables that are included.

[27] The White test for homoscedasticity tests the null hypothesis that the error term is homoscedastic. If the p-value on the F-statistic is smaller than the 5% level of significance then the null hypothesis is rejected to conclude that the variance of the error tem is not constant.

[28] The null hypothesis for this test is that of a normal distribution. If the probability value on this statistic is small enough to reject the null hypothesis then the distribution of the model is not normally distributed.

4.2 Regression Findings

Regression findings were generally consistent with a priori expectations. The JFSI index dummy, net exports, the interest rate spread and the unemployment rate have a lagged and negative effect on real GDP growth (see *Table A8*). That is, increases in these variables lower real GDP growth in successive months. Furthermore, as expected, household debt, growth in the fiscal balance and the exchange rate contribute to increases in real GDP growth. Of note is that there was an ambiguous sign for the growth in net exports. Based on the results of the model, a period of financial stress will cause a decline in real GDP growth of 0.07% three months into the future.

5.0 Conclusion and Policy Implications

This paper analyzes financial stress in Jamaica using monthly data from January 2005 to July 2013 for the equity, money and foreign exchange markets using a methodology similar to Cardarelli *et al.* (2009). The index was developed using six standardized variables and was constructed using three methods, the simple aggregation (equal weighting), market weighting and principal components approach, as a means of checking the validity and robustness of the analysis. All indexes were successful in detecting major historical periods of financial stress in Jamaica since 2005. However, the method of aggregation derived the index that was the most robust of the three and as such it was this index that was used to examine the impact of financial stress on economic activity using data from January 2005 to March 2013. In examining the impact of financial stress on economic activity, the index contributed to a fall in real GDP growth in three months following the stress period.

The JFSI can be a use tool for policymakers in detecting periods of financial stress was well as the possible impact on economic activity and as a consequence potential feedback effects which may emanate from a falloff in the growth in economic activity. The index can also be used as an early warning tool for policymakers as various dynamic simulation techniques can be used to forecast index values and identify future periods of financial stress.

Furthermore, based on the findings for both indexes, policies which limit volatility in the stock market foreign exchange markets will help to contain episodes of financial stress. Additionally, efforts to contain financial stress will help to increase the country's output.

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7.0 Appendix

Table A1: Description and Sources of Variables Used for the Index

Sub-Index	Component	Variables Used	Description	Source	Frequency
Equity Market	Financial Sector Beta	JSE Main Index Financial Sector Index	The FSB uses the covariance of the year-on-year percentage change of the financial sector index and the JSE main index divided by the 2- month variance of the year-on-year percentage change in the JSE main index. $\beta = \frac{Cov(x,y)}{\sqrt{Var(y)}}$	Jamaica Stock Exchange	Monthly
	Stock Market Decline	JSE Main Index	$Stock\ Decline = -\left(\frac{Index_t - Index_{t-1}}{Index_{t-1}}\right)$	Jamaica Stock Exchange	Monthly
	Stock Market Returns Volatility	JSE Main Index	GARCH (1,1) volatility of the monthly percentage change of the stock market index.	Jamaica Stock Exchange	Monthly
Foreign Exchange Market	Volatility of the Real Effective Exchange Rate	Real Effective Exchange Rate	GARCH (1,1) volatility of the monthly percentage change of the real effective exchange rate.	Bank of Jamaica	Monthly
Money and Bond Market	30-Day Spread	30 Day Private Money Market Rates 30 Day T-Bill	This spread is the difference between the 30 day private money market rates and the yield on the 30 day Treasury Bill. $30 - Day\ Spread = 30\ Day\ PMMR - 30\ Day\ T - Bill$	Bank of Jamaica	Monthly
	Term Spread	Domestic 20 year Government Bond Domestic 1 year Government Bond	Otherwise called the slope of the yield curve, the term spread is the difference in short and long term government rates. $TS = GOJ\ Domestic\ 1\ Year - GOJ\ Domestic\ 20\ Years$	Bloomberg	Monthly

Table A2: **Descriptive Statistics for Index Variables**

	$JFSI_{UNWEIGHTED}$	$JFSI_{PCA}$	$JFSI_{MARKET\ WEIGHTS}$	FSB	REER	SMD	SMR	30-DayS	TermS
Mean	0.019	-2.17E-11	0.010	0.106	-9.71E-12	9.71E-12	-2.91E-11	-2.91E-11	1.94E-11
Median	-0.011	-0.026	-0.012	0.109	-0.294	-0.044	-0.321	-0.041	0.148
Max	1	1	1	0.195	8.347	4.701	7.728	2.708	1.701
Min	-0.229	-0.198	-0.179	0.000	-0.385	-2.591	-0.522	-4.441	-6.886
Std. Dev.	0.154	0.129	0.133	0.028	1.000	1.000	1.000	1.000	1.000
Obs	103	103	103	103	103	103	103	103	103

Table A3: Correlations Matrix for Index Variables

	$JFSI_{UNWEIGHTED}$	$JFSI_{PCA}$	$JFSI_{MARKET\ WEIGHTS}$	FSB	REER	SMD	SMR	30-DayS	TermS
$JFSI_{UNWEIGHTED}$	1	0.823	0.964	0.323	0.694	0.439	0.746	0.507	0.171
$JFSI_{PCA}$		1	0.881	-0.042	0.855	0.307	0.859	0.543	-0.302
$JFSI_{MARKET\ WEIGHTS}$			1	0.191	0.864	0.310	0.788	0.403	0.135
FSB				1	-0.017	0.175	-0.015	0.034	0.017
REER					1	0.143	0.732	0.192	-0.125
SMD						1	0.066	0.087	-0.196
SMR							1	0.308	-0.016
30-DayS								1	-0.198
TERMS									1

Table A4: Prinicpal Components Based on January 2005 to July 2013

Principal Component	Value	Percentage				
PC1	1.951	0.325				
PC2	1.231	0.530				
PC3	1.030	0.702				
PC4	0.857	0.845				
	FSB	**REER**	**SMD**	**SMR**	**30-DayS**	**TermS**
Loadings:	0.030	0.612	0.220	0.615	0.388	-0.216

Table A5: Unit Root Tests for Regression Variables

	Augmented Dickey Fuller Levels (Differenced)			Phillips-Perron Levels (Differenced)			Order of Integration
Variable	**t-statistic**	**5% Critical Value**	**p-Value**	**t-statistic**	**5% Critical Value**	**p-Value**	
$RGDP$	-1.293	-1.945	0.180	-4.338	-1.944	0.000	I(0)
	(-7.339)	(-1.945)	(0.000)	(-3.136)	(-1.944)	(0.002)	
$HH(DEBT)$	-8.183	-3.456	0.000	-8.392	-3.456	0.000	I(0)
FB	-9.951	-1.944	0.000	-10.005	-1.944	0.000	I(0)
$INTS$	-4.846	-3.456	0.001	-4.576	-3.456	0.002	I(0)
NX	-15.894	-1.944	0.000	-17.071	-1.944	0.000	I(0)
$UNEM$	-2.614	-3.461	0.275	-2.804	-3.456	0.199	I(1)
	(-1.992)	(-1.945)	(0.045)	(-4.559)	(-1.944)	(0.000)	
$XRATE$	-2.263	-3.457	0.450	-1.830	-3.457	0.683	I(1)
	(-4.618)	(-1.944)	(0.000)	(-4.714)	(-1.944)	(0.000)	
$JFSI_{(UNWEIGHTED)}$	-5.971	-2.891	0.000	-5.971	-2.891	0.000	I(0)

Table A6: Descriptive Statistics for Regression Variables

	RGDP	$JFSI_{UNWEIGHTED}$	FB	HH(DEBT)	INTS	NX	UNEM	XRATE
Mean	0.000	0.434	0.141	0.505	0.157	0.025	11.556	78.396
Median	0.000	0.000	-0.368	0.508	0.157	0.007	11.428	85.620
Max	0.012	1.000	69.038	0.574	0.178	0.689	14.507	98.887
Min	-0.013	0.000	-48.580	0.283	0.108	-0.331	8.842	61.544
Std. Dev.	0.007	0.498	12.401	0.045	0.012	0.210	1.445	10.976
Obs.	99	99	99	99	99	99	99	99

Table A7: Correlation Matrix for Regression Variables

	RGDP	$JFSI_{UNWEIGHTED}$	FB	HH(DEBT)	INTS	NX	UNEM	XRATE
RGDP	1	0.031	0.067	-0.052	-0.022	-0.071	-0.188	-0.118
$JFSI_{UNWEIGHTED}$		1	0.160	-0.216	-0.191	-0.048	-0.071	0.152
FB			1	-0.021	0.122	-0.104	-0.018	-0.006
HH(DEBT)				1	0.486	-0.039	0.541	0.749
INTS					1	0.135	0.455	0.437
NX						1	0.013	-0.029
UNEM							1	0.665
XRATE								1

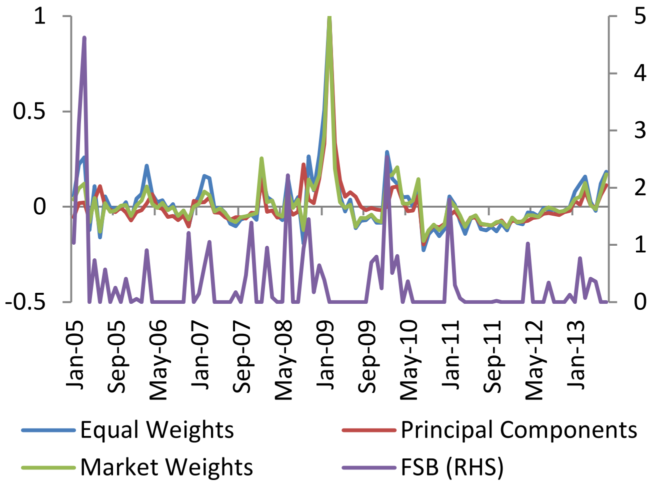
Table A8: OLS Results: Dependent Variable: $RGDP_t$

Variable	Expected Sign	Coefficients
$JFSI_{(UNWEIGHTED)t-3}$	(-)	-0.0007*
		(0.0004)
FB_{t-8}	(?)	4.01E-05***
		(8.49E-06)
$INTS_{t-5}$	(-)	-0.0174
		(0.0163)
$HH(DEBT)_{t-3}$	(+)	0.0023
		(0.0036)
NX_{t-12}	(+)	-0.0029***
		(0.0006)
$\Delta UNEM_{t-1}$	(-)	-0.0023***
		(0.0007)
$\Delta XRATE_{t-4}$	(+)	0.0002
		(0.0001)
$RGDP_{t-1}$	(?)	1.8480***
		(0.1002)
$RGDP_{t-2}$	(?)	-1.3583***
		(0.1652)
$RGDP_{t-3}$	(?)	0.4009***
		(0.0966)
$Constant$		0.0019
		(0.0023)
Adjusted R^2		0.9458
DW Stat		2.1314
F-Stat		151.0943
(p-Value)		(0.0000)

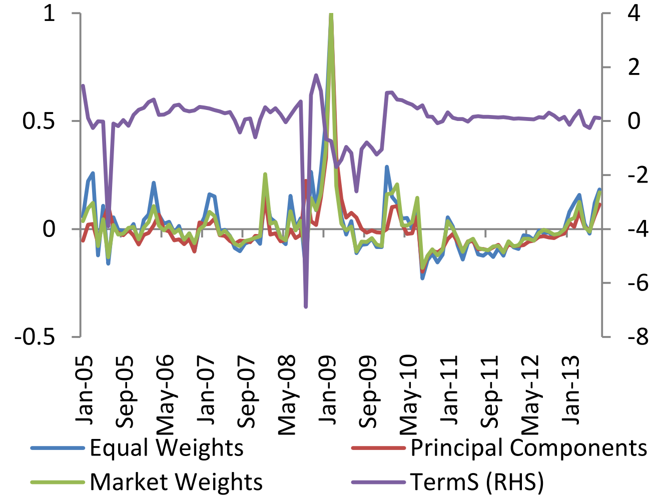
White's Heteroskedasticity Robust Standard errors are in parentheses.
(*) implies significances at the 10% level, (**) at the 5% level and (***) at the 1% level.

Figure A1: The $JFSI_{UNWEIGHTED}$, $JFSI_{PCA}$, $JFSI_{MARKET\ WEIGHTS}$ and Individual Components

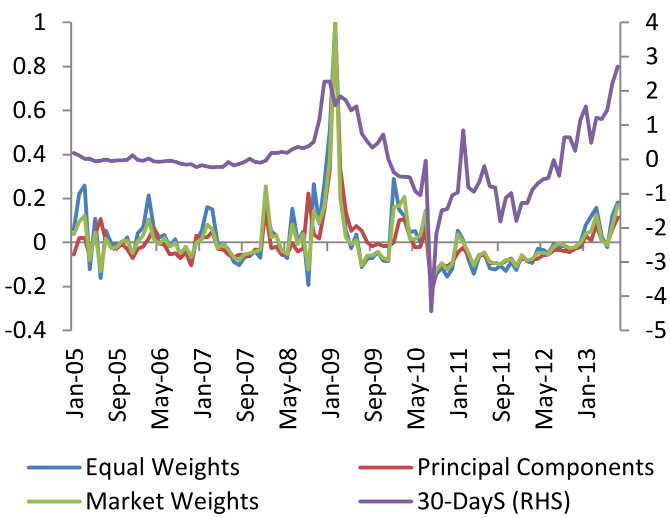
Graph 1: Financial Sector Beta



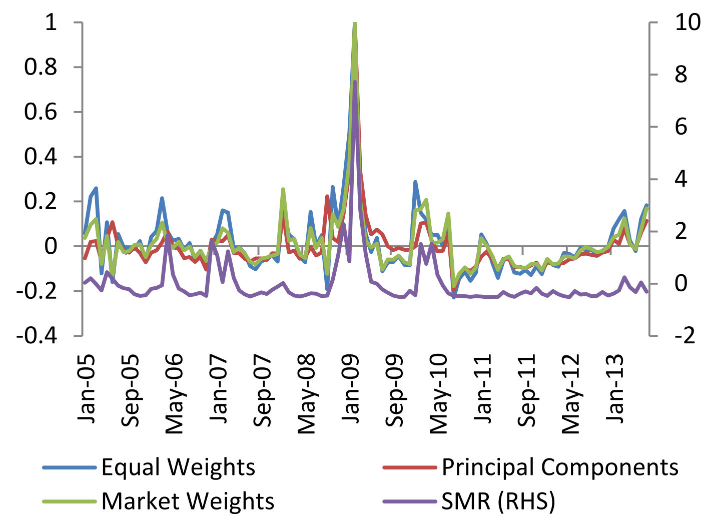
Graph 2: Term Spread



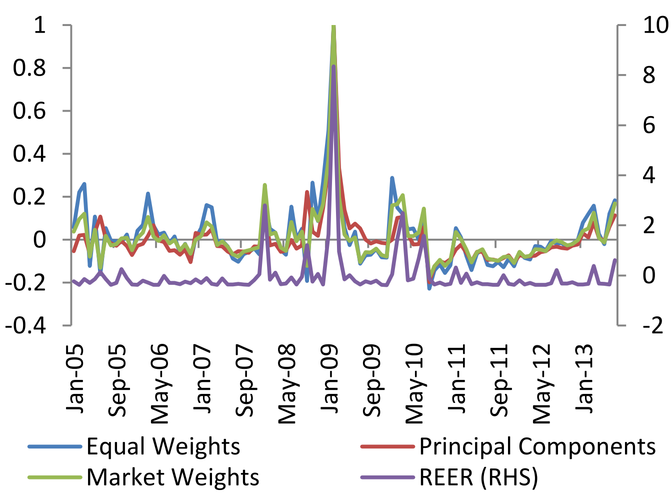
Graph 3: 30-Day Spread



Graph 4: Stock Market Returns



Graph 5: Real Effective Exchange Rate



Graph 6: Stock Market Decline