A Composite Indicator of Systemic Stress (CISS): The Case of Jamaica

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Outline

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Introduction

- Following the global financial crisis attention has shifted to the issue of systemic risk.
- Early detection of financial stress allows for expedient action to preserve financial stability.
- A single measure of stress illustrates the joint impact of several financial market developments.
- Aim:
  - To create a Composite Indicator of Systemic Stress (CISS) for Jamaica using the foreign exchange, equity, money and bond markets.
  - To identify any relationship between systemic risk and economic activity.

Literature Review

- Hollo, et al (2010, 2012) – Euroarea
- Cevik, et al (2011) – Turkey
- Morris (2010) – Jamaica

Composite Indicator of Systemic Stress (CISS)

- The CISS is a single measure of the current state of instability in the financial system reflecting the joint impact of activity in four markets.

- Indicators provide complementary information about the level of stress in each market segment.

CISS Composition

Market Segment	Indicator
Money Market	❖ **Realised volatility of the 30 day private market rate (monthly average of daily rate changes)** ❖ **Interest rate spread between the equivalent 180-day private money market rate (based on 30-day private money market rate) and the 180-day treasury bill rate**
Bond Market	❖ **Realised volatility of domestic GOJ bond with one year to maturity (monthly average of absolute daily yields)** ❖ **Realised volatility of domestic GOJ bond with three year to maturity (monthly average of absolute daily yields)**
Equity Market	❖ **Realised volatility of the main JSE index (absolute monthly log index returns)** ❖ **CMAX of the main JSE index (maximum cumulated index losses over a moving 1-year window)**
Foreign Exchange Market	❖ **Realised Volatility of JMD/USD (absolute monthly log of foreign exchange returns)** ❖ **Bid-Ask Spread (monthly foreign exchange bid-ask spread)**

CISS Indicators

- Preparing indicators for the CISS

- Recursive transformation of the variables by the empirical cumulative distribution function (CDF), $F_{n+T}(x_{n+T})$, as follows:

- $$trans_{n+T} = F_{n+T}(x_{n+T}) = \begin{cases} \frac{r}{n+T} \; for \; x_{[r]} \leq x_{n+T} < x_{[r+1]} \\ 1 \quad for \; x_{[r]} \geq x_{n+T} \end{cases} \qquad (1)$$

$trans_{n+T}$ represents the transformed stress indicators,
r represents the ranking number of each observation,
$x_{[r]}$ represents the r^{th} ranked observation of indicator x

- Transformed indicators for each market were aggregated into respective sub-indexes by taking the arithmetic average.

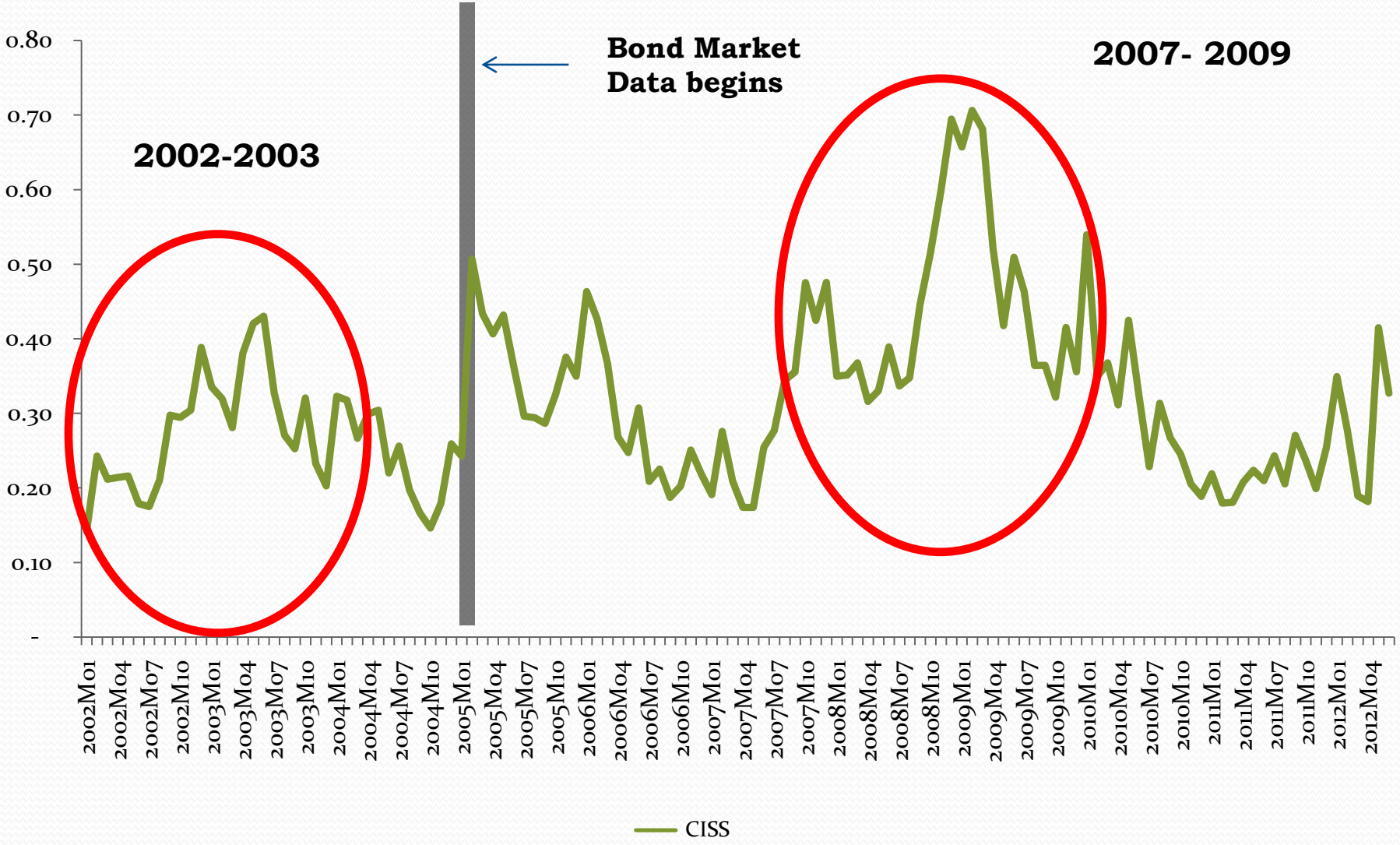
CISS Aggregation

$$CISS_t = \sqrt{(w \circ s_t) C_t (w \circ s_t)'} \qquad (2)$$

- with $w = (w_1, w_2, w_3, w_4)$ representing the vector of sub-index weights, $s_t = (s_{1,t}, s_{2,t}, s_{3,t}, s_{4,t})$ represents the sub-indices , and $w \circ s_t$ represents the Hadamard-product.
- C_t is the matrix of time varying cross-correlation coefficients $\rho_{ij,t}$ between sub-indices *i* and *j*:

$$C_t = \begin{pmatrix} 1 & \rho_{12,t} & \rho_{13,t} & \rho_{14,t} \\ \rho_{12,t} & 1 & \rho_{23,t} & \rho_{24,t} \\ \rho_{13,t} & \rho_{23,t} & 1 & \rho_{34,t} \\ \rho_{14,t} & \rho_{24,t} & \rho_{34,t} & 1 \end{pmatrix}$$

Figure 1: The CISS



TVAR Model

- Threshold vector autoregression (TVAR):
  - Theoretical model of the interactions of the CISS with the real economy.

- TVAR assumes regime switching where state transitions are triggered when an observed variable (e.g. CISS) crosses a certain threshold.

- The *A priori* expectation is that economic activity should be significantly lower when the CISS is at or above the estimated threshold level (high stress) than when it is below the threshold level (low stress).

TVAR Model cont'd

$$X_t = c^H + \sum_{i=1}^{p} \Psi_i^H X_{t-i} + e_t^H \quad \text{if } CISS_{t-d} \geq \delta \text{ (high stress)}$$

$$X_t = c^L + \sum_{i=1}^{p} \Psi_i^L X_{t-i} + e_t^L \quad \text{if } CISS_{t-d} < \delta \text{ (low stress)} \qquad (4)$$

where $X_t = (GDP_t, CISS_t)'$ represents the vector of endogenous variables real GDP growth and the CISS, respectively,

c^s, Ψ_i^s the vector of intercepts and the two matrices of slope coefficients for states s = H, L and lags i= 1,...., p .

$CISS_{t-d}$ is the threshold variable with $d=1$ representing the maximum threshold lag or delay foreseen.

The threshold parameter is δ and the vector e_t^s contains state-dependent regression errors .

Forecast Model

- Monte Carlo simulations (10 000 iterations) were used to provide a one-year forecast for the CISS.

$$CISS_t = c + \gamma * CISS_{t-1} + \alpha * m2_{t-4} + \beta * \inf_{t-4} + \varepsilon_t \quad (5)$$

- M2 growth and inflation were fitted to distribution functions based on historical values.

- A VAR model was then utilised to assess the relationship between forecasted CISS and forecasted real GDP growth.

Results

- Initial TVAR model unable to determine a threshold value for the CISS due to the limited number of observations above a suitable confidence level.

- Alternative methodology - An adjusted TVAR (involved separating the data into two regimes):

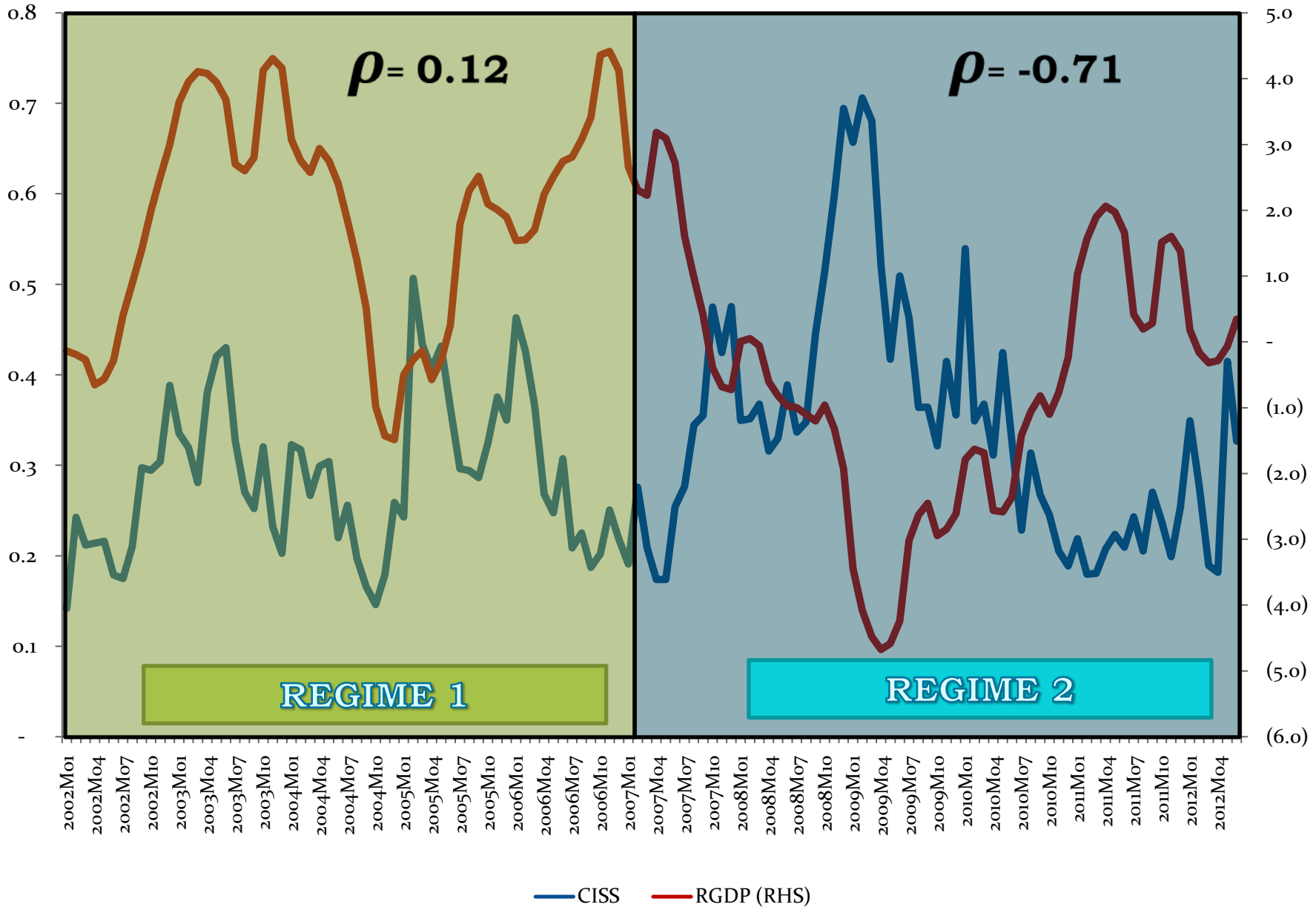
  - **Regime 1**: January 2002 and December 2006 (low stress)

    $$\mu = 0.29, \qquad \sigma = 0.09$$

  - **Regime 2**: January 2007 to June 2012 (high stress)

    $$\mu = 0.34, \qquad \sigma = 0.14$$

Figure 2: Interpolated Real GDP Growth alongside the CISS



Results cont'd

- **Regime 1**: No Granger causality between the CISS and real GDP growth.
- **Regime 2**: CISS was found to Granger cause real GDP growth.

Table 1: Granger Causality Test Results

	Regime 1: Jan 02 to Dec06 (Low Stress)		Regime 2: Jan 07 to Jun 12 (High Stress)	
	Chi-sq	p-value	Chi-sq	p-value
CISS →RGDP	0.420229	0.8105	41.78108	0.0000*
RGDP→ CISS	1.191723	0.5511	5.942491	0.2035

*Notes : *, **, *** indicates significance at the 10%, 5% and 1% level of significance, respectively.*

Response of lagged GDP to a one s.d. shock to the CISS in both Regimes.

Figure 3: Regime 1 - Low Stress

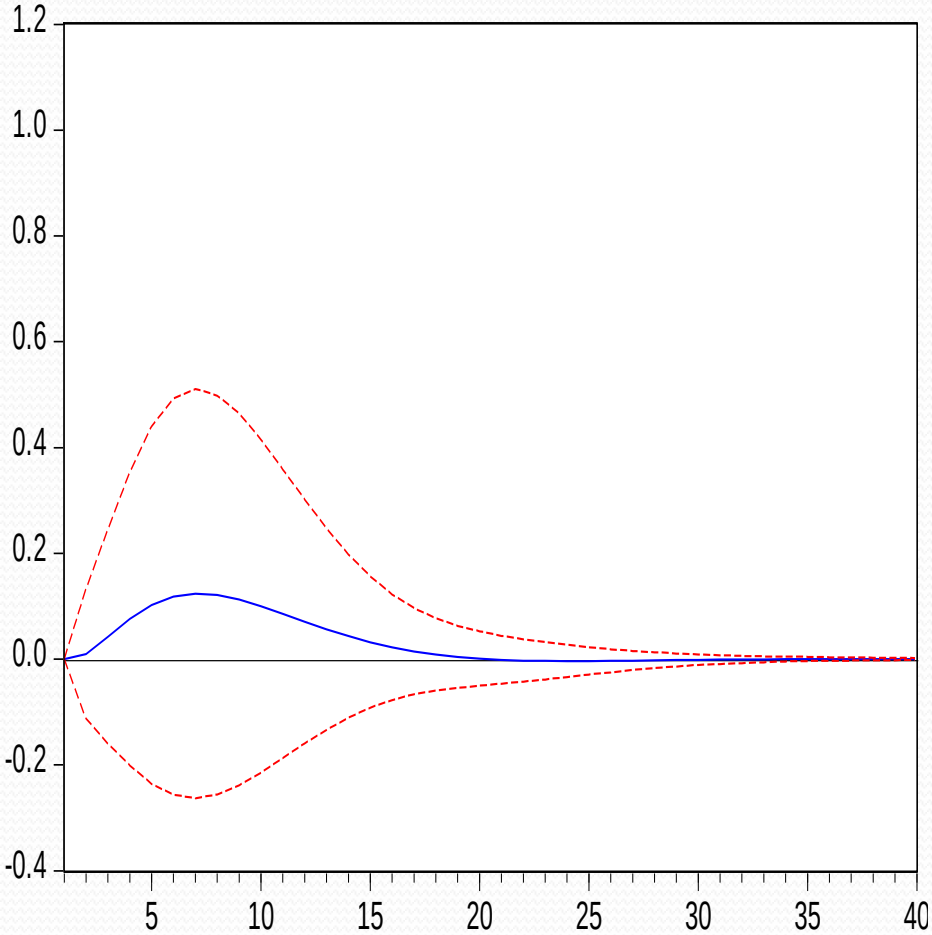
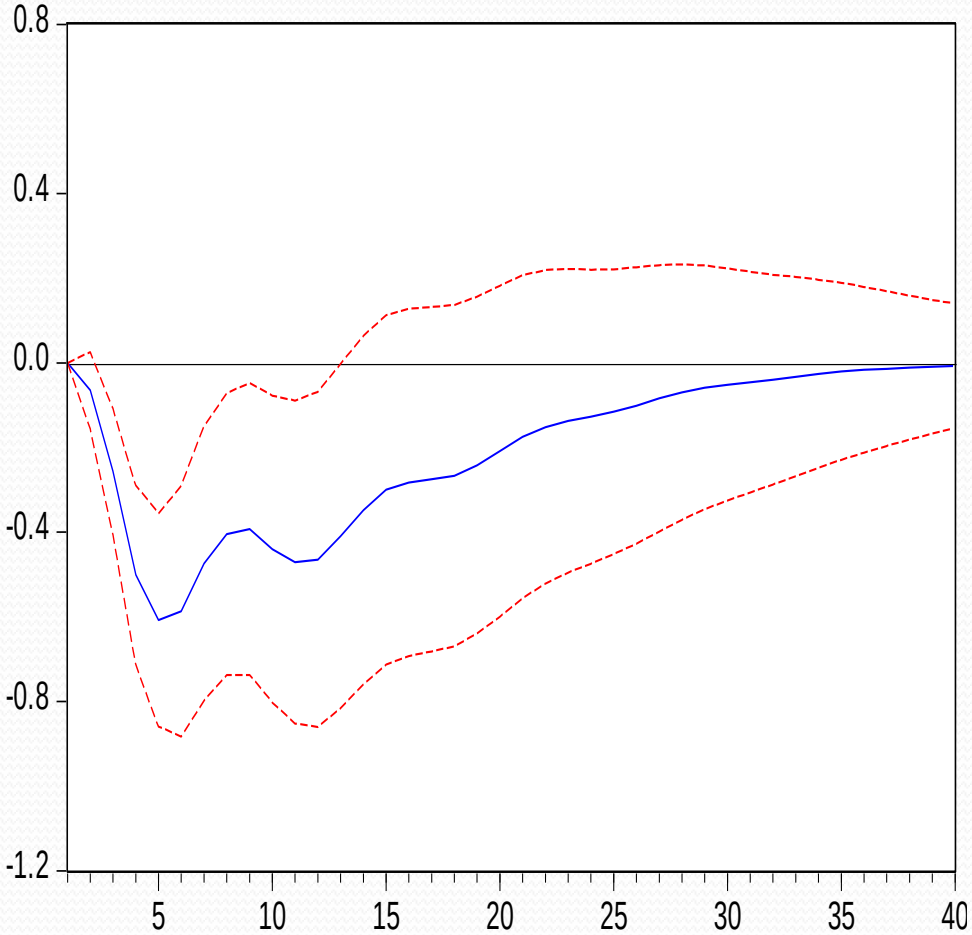


Figure 4: Regime 2 - High Stress



Results cont'd

Table 2: OLS Regression Results

$$CISS_t = c + \gamma * CISS_{t-1} + \alpha * m2_{t-4} + \beta * \inf_{t-4} + \varepsilon_t$$

Variables	Constant	$CISS_{t-1}$	$m2_{t-4}$	inf_{t-4}
Coefficients	0.043758	0.734449	-0.006941	0.004023
P-Value	0.0326**	0.0000***	0.0639*	0.0102**

*Notes : *, **, *** indicates significance at the 10%, 5% and 1% level of significance, respectively.*

Figure 5: One-Year Ahead Forecast of the CISS

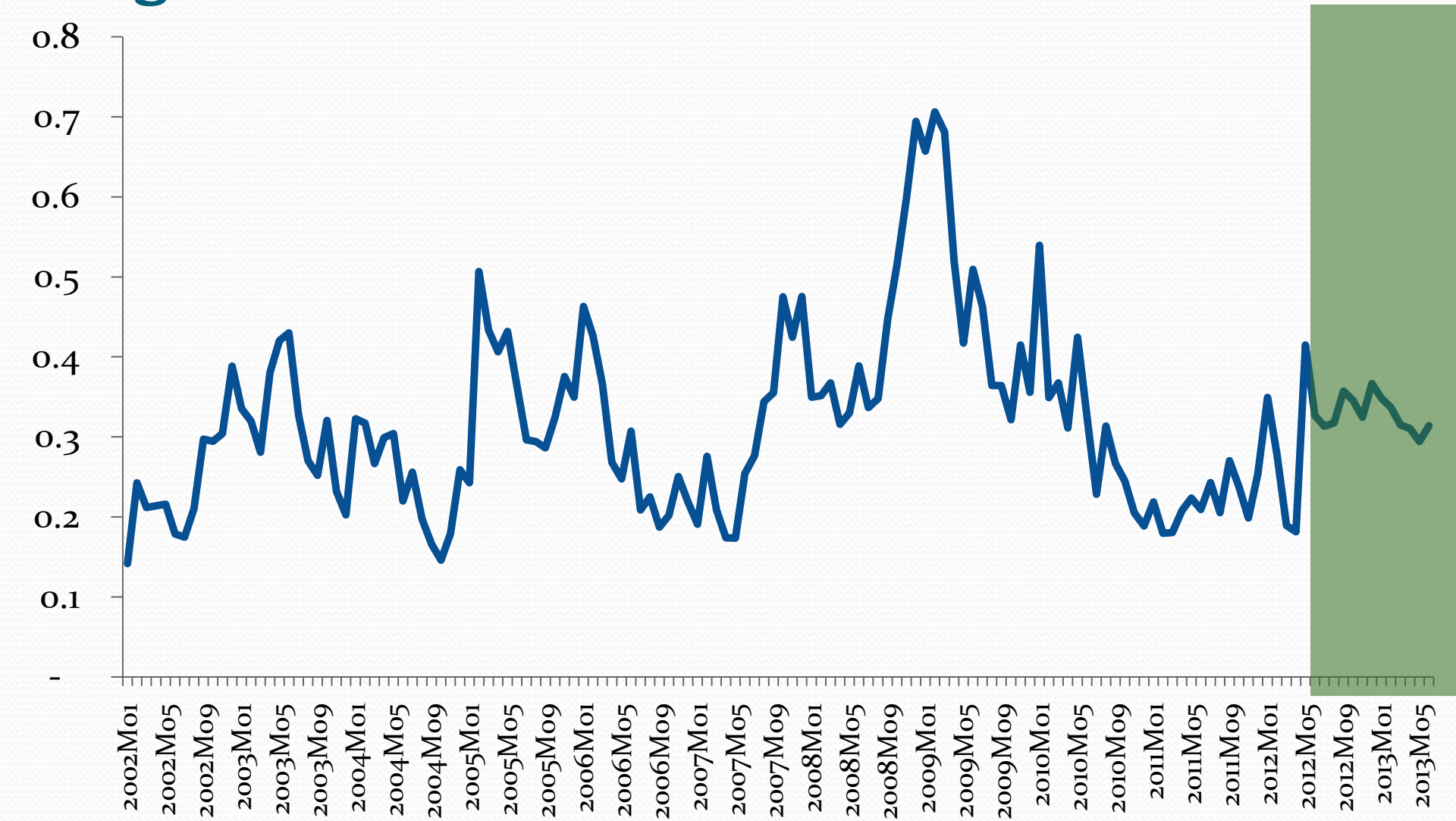
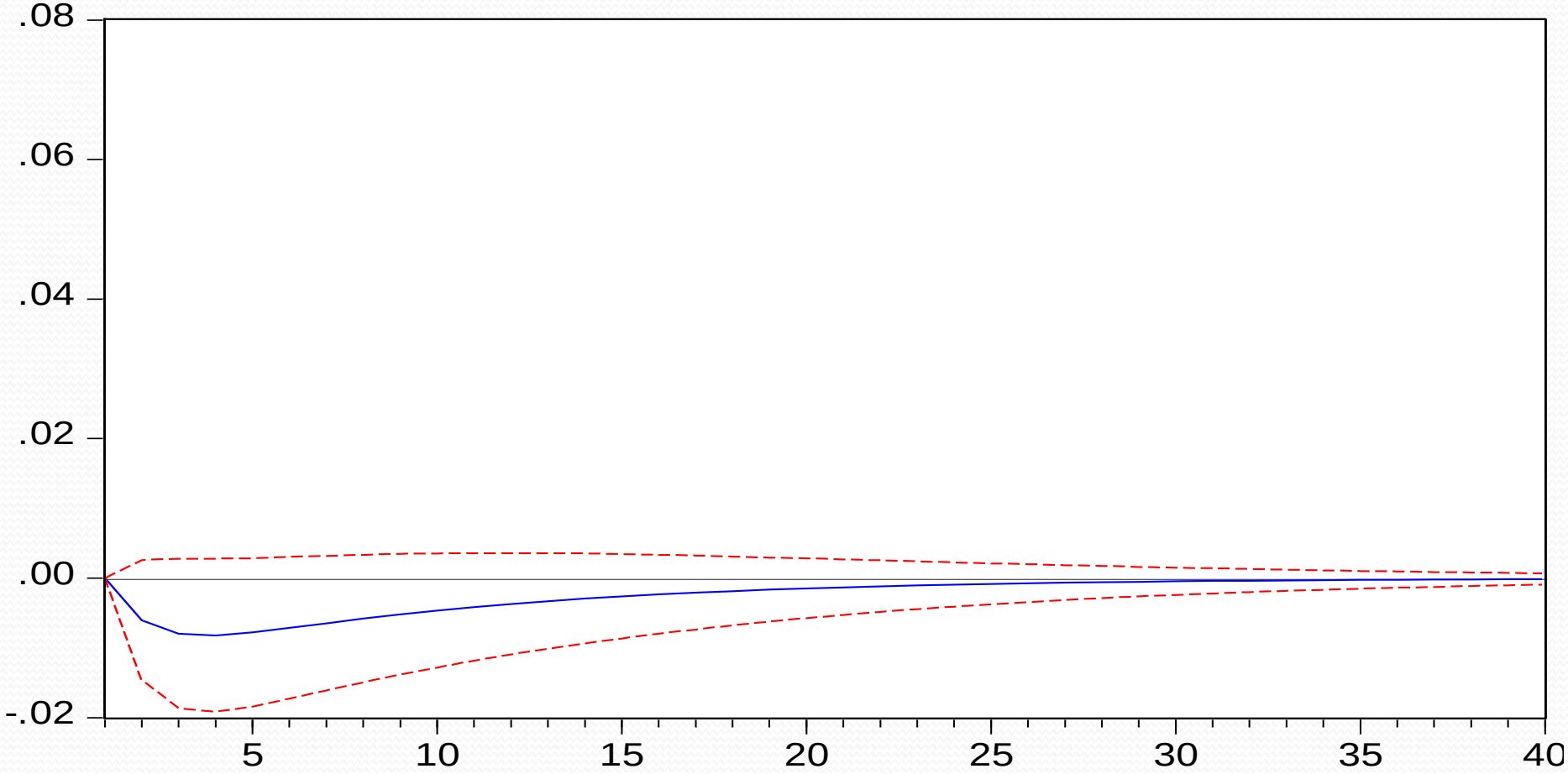


Figure 6: Response of lagged GDP to a one s.d. shock to the CISS with forecasted data



Conclusion

- The CISS was able to identify known periods of stress in the Jamaican financial system.
- Greater impact of the CISS on real GDP growth in regime 2 (high stress) relative to regime 1 (low stress).
- The relationship between the CISS and real GDP growth in regime 2 is forecasted to continue over a one-year period.

Policy Implications

- The CISS acts an early warning, stress testing and forecasting tool.
- The CISS is able to facilitate real-time updates enabling the authorities to respond in a timely manner to signals from the financial markets.
- Expedient action by the authorities would temper the effects of instability on the real sector.