INVESTIGATING THE RELATIONSHIP BETWEEN ECONOMIC FACTORS & BANK EFFICIENCY
THE CASE OF JAMAICA

Aroldo Moulton & Sherene Bailey-Tapper
Financial Stability Department
Bank of Jamaica

MOTIVATION

- In recent decades, financial liberalization and financial integration have featured as major forces impacting the performance of the banking sector worldwide. In this context, banking regulators and investors have placed increasing emphasis on efficiency or how effectively banks transform their inputs into various financial products and services .

- Furthermore, increases in banking sector inefficiency may not only raise the cost of services offered but also reduce the level of intermediation in the economy and impair economic growth.

- In addition, from a financial stability policy perspective, an efficiently operated banking system is expected to strengthen capital buffers and ultimately increase the safety and soundness of the financial system as well as increase consumer welfare by way of higher quality services and lower prices.

OBJECTIVES

- Derive efficiency estimates for Commercial banks in the Jamaican banking sector over the period 2000 – 2012 using a Translog cost function.

- Use OLS models to determine the impact of economic factors on the efficiency of Large and Small banks.

- A VEC model was also utilized to determine whether there is a long run relationship between the economic factors examined in the study and cost efficiency for the commercial banking sector.

- The study is intended to provide insight regarding the impact of economic policy on bank efficiency as well as the possible implications of these policies for consumer welfare.

OUTLINE

- Review of Existing Literature
- Technical Efficiency
- Trends in Efficiency
- Data
- OLS Results
- VEC Modelling Framework
- Impulse Response Functions
- Summary and Policy Recommendations

LITERATURE REVIEW

- In recent times, there have been investigations as to whether macroeconomic and institutional factors have an effect on the efficiency of the banking system.

- Craigwell et. al (2005) estimated efficiency scores for Barbadian commercial banks for the period 1979 to 1999 using the 2 most widely used approaches to bank efficiency measurement, namely the stochastic frontier approach, a parametric method and data envelopment analysis, a non-parametric method. The findings show that financial innovation is a significant determinant of bank efficiency, along with bank size, the loan to asset ratio and national income growth.

- Yildirim (2002) investigated the efficiency of the Turkish banking sector between 1988 and 1999, a period characterized by strong macroeconomic volatility. The results showed that efficient banks showed greater profitability. Additionally, he found that macroeconomic conditions had a profound influence on efficiency measures over the period examined.

TECHNICAL EFFICIENCY

- In the international literature, bank efficiency is largely measured using 2 main approaches – Data Envelopment Analysis and the Stochastic Frontier Approach. The Stochastic Frontier Approach is applied in this study and is a parametric method which involves banks' costs diverging from an efficiency frontier due to either random effects or inefficiency. This is a major advantage relative to the DEA approach where the entire deviation from the frontier is considered as inefficiency.

- Under the Stochastic Frontier Approach, the cost function is represented as:

$$\ln tc = f(y_i, p_i) + \varepsilon_i \qquad (1)$$

where: $\varepsilon_i = u_i + v_i$

y_i is the output of each bank (e.g. investments and loans)

p_i is the cost of input

v_i is statistical noise distributed normal $(0, \sigma_2)$

U_i is a an inefficiency measure which can follow a truncated or half-normal distribution and measures the individual firm's deviation from the efficient cost frontier

TECHNICAL EFFICIENCY

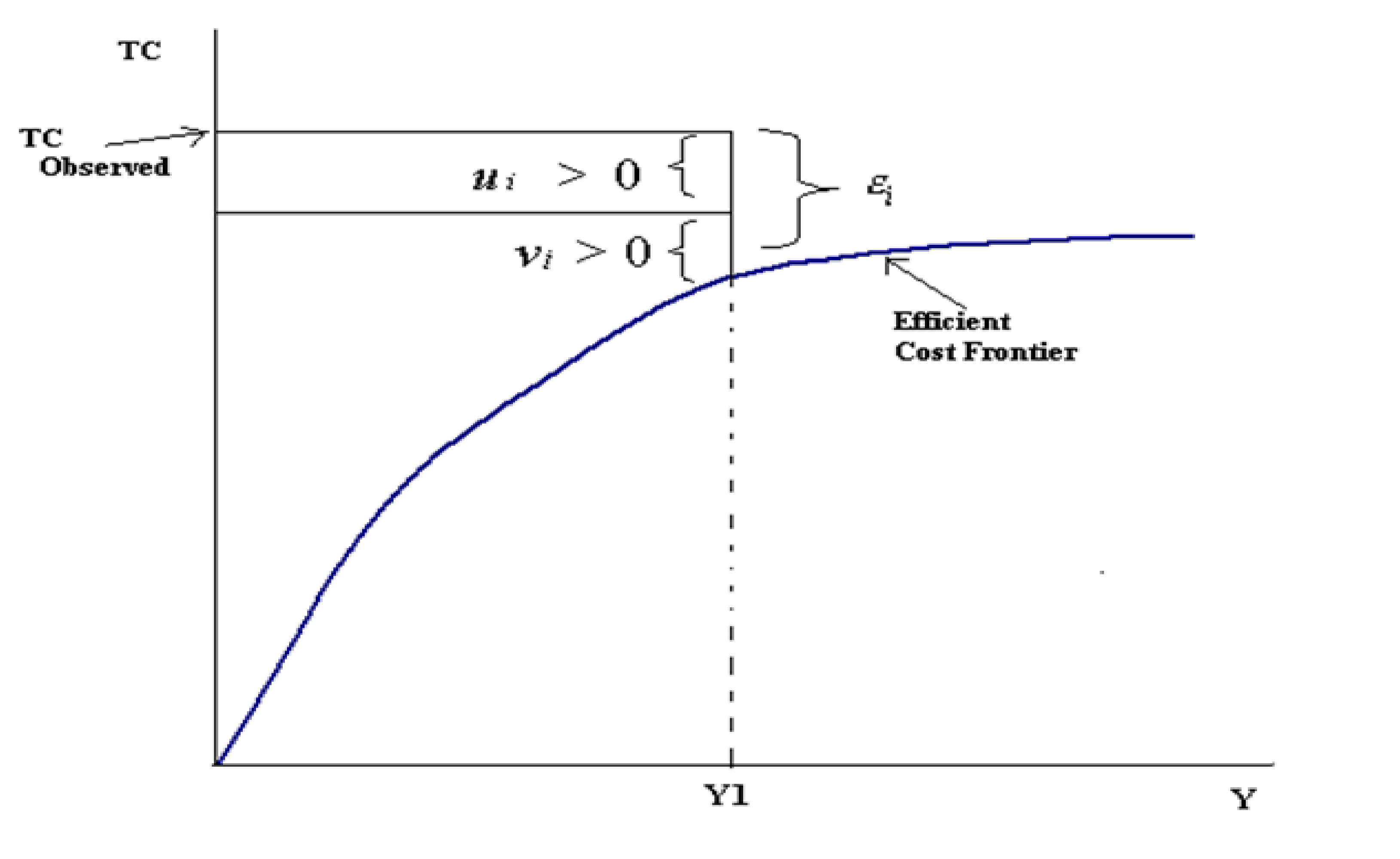


FIGURE 1: PICTORIAL VIEW OF STOCHASTIC FRONTIER APPROACH

TECHNICAL EFFICIENCY

- In evaluating the cost frontier for banks in Jamaica, the following translog cost function was employed:

$$\ln tc = \alpha_0 + \sum_{i-1}^{2} \alpha_i \ln(y_i) + \sum_{j=1}^{3} \beta_j \ln(p_j) + 1/2 \sum_{i=1}^{2}\sum_{k=1}^{2} \alpha_{ik} \ln(y_i)\ln(y_k) + 1/2 \sum_{j=1}^{3}\sum_{h=1}^{3} \beta_{jh} \ln(p_j)\ln(p_h) \qquad (2)$$

$$+ \sum_{i=1}^{2}\sum_{j=1}^{3} \delta_{ij} \ln(y_i)\ln(p_j) + \in$$

where:

y_i represents loans, the primary output in the framework

y_k represents all other earning assets, secondary outputs

p_i is the price of labour

p_j is the price of fixed capital

p_h is the price of borrowed funds

Efficiency Software Employed

- FRONTIER® Version 4.1 is an econometric software package which provides maximum likelihood and efficiency estimates for a variety of stochastic cost & production functions.
- Designed by Professor Timothy Coelli (Centre for Efficiency and Productivity Analysis - CEPA). The software is publicly available for download from the CEPA website.
- FRONTIER follows the following estimation procedure:
- First, ordinary least square estimates of the function are obtained. These OLS estimates are utilized as some of the starting values in the next step of the process which involves deriving maximum likelihood estimates.
- Maximum likelihood estimates and cost efficiency estimates are obtained using an iterative procedure (i.e. the Davidson, Fletcher & Powell Quasi-Newton Method).
- Cost efficiency estimates range over the interval , $[1, \infty]$ with a score of 1 indicating full efficiency. The amount by which the score deviates from 1 is a measure of technical inefficiency

MODEL PARAMETERS OF THE STOCHASTIC COST FUNCTION SPECIFIED IN EQUATION 2

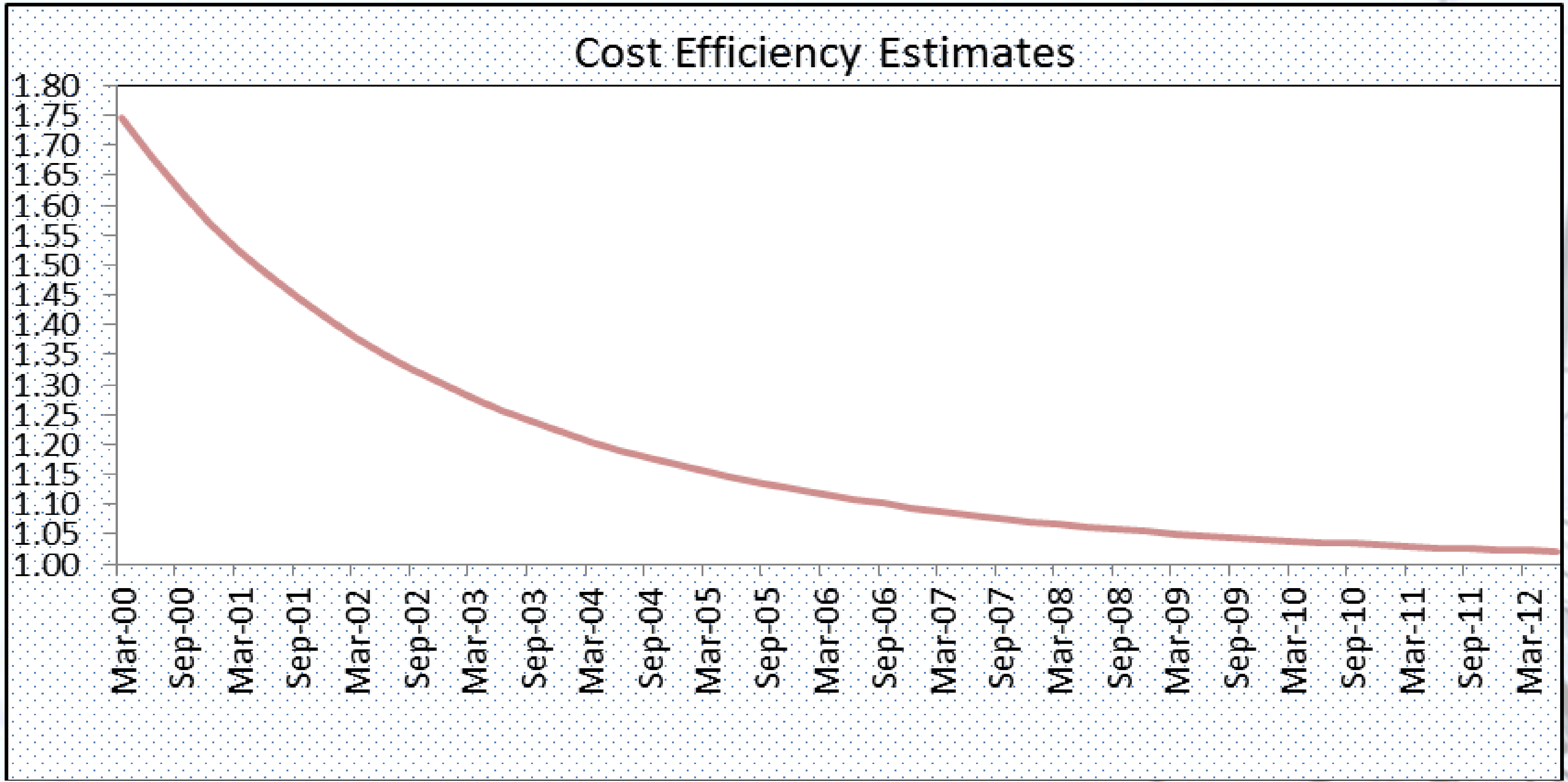
Variables	Coefficient	t-ratio
Dependent variable: ln(cost)		
Constant	1.79	1.51
ln(Y1)	0.22	1.08
ln(Y2)	*0.68	2.58
ln(P2*)	0.18	0.61
ln(P3*)	-0.3	-0.97
ln(Y1)ln(Y1)	*0.20	10.58
ln(Y1)ln(Y2)	*-0.38	-9.01
ln(Y2)ln(Y2)	*0.18	5.95
ln(P2*)ln(P2*)	-0.02	-0.48
ln(P3*)ln(P2*)	-0.02	-0.49
ln(P3*)ln(P3*)	*0.20	9.06
ln(Y1)ln(P2*)	*0.04	2.08
ln(Y1)ln(P3*)	*-0.05	-4.18
ln(Y2)ln(P2*)	-0.03	-1.48
ln(Y2)ln(P3*)	*0.08	3.73
log likelihood function value	223.22	

"*" Significance at 10% level

TRENDS IN EFFICIENCY ESTIMATES

COMMERCIAL BANKING SYSTEM

Figure 2



DATA

- Quarterly commercial banking system data covering the period March 2000 to June 2012 was used.

- Variables included in the study:
  - Average inefficiency estimates were calculated for the sector for each quarter over the period
  - Capital to total assets - a measure of capital adequacy
  - Non-performing loans to total loans ratio - a measure of loan quality
  - Growth in GDP, growth rate of nominal GDP
  - Inflation – measured using the 12-month point-to-point inflation rate
  - Interest rate spread - captured as the spread between loan and deposit rates
  - Herfindahl-Hirshman Index (HHI), which is a measure of concentration, was calculated as the sum of the squares of individual bank assets to total banking industry assets
  - Dummy variables representing the JDX Program and the global financial crisis

OLS RESULTS

Dependent Variable Cost Inefficiency (ΔCFX)

Variables	Expected Sign	Small Banks		Large Banks	
			Coefficients		Coefficients
CAPAD	(-)	ΔCAPAD	-0.36855** (0.14184)	ΔCAPAD	-0.11243*** (0.01416)
GDPR	(-)	ΔGDPR (1)	-0.03831* (0.02047)	ΔGDPR (1)	-0.00644*** (0.00220)
INT	(+)	ΔINT (2)	0.00425*** (0.00131)	ΔINT (2)	0.00030** (0.00015)
NPL	(+/-)	ΔNPL	0.39244*** (0.07995)	ΔNPL	0.38361*** (0.08636)
HHI	(?)	ΔHHI	-0.00007** (0.00003)	ΔHHI	-0.00002*** (0.00000)
INF	(+)	ΔINF (2)	0.00029** (0.00012)	ΔINF (3)	-0.00015*** (0.00004)
JDX		JDX	0.01865*** (0.00526)	JDX	0.00484** (0.00233)
GCRIS		GCRIS	0.00846*** (0.00303)	GCRIS	0.00389* (0.00195)
		C	-0.01964*** (0.00414)	C	-0.00619*** (0.00203)

Heteroskedasticity and Autocorrelation Consistent (HAC, Newey-West) Standard Errors are presented in parentheses beside the coefficients.
Δ represents the first difference of a variable; Numbers in parentheses represent the number of lags
*, **, *** indicate the 1%, 5% and 10 % level of significance respectively.

Vector Error Correction Model (VECM)

- Since the variables were integrated of the same order, a VEC model was used to capture the long run and the short run relationships among the variables. The model framework is outlined below:

$$Y_t = A_1 Y_{t-1} + A_2 Y_{t-2} + \ldots . + A_p Y_{t-p} + BX_t + \varepsilon_t \qquad (3)$$

Equation 3 was reformulated into a vector error correction form as shown below:

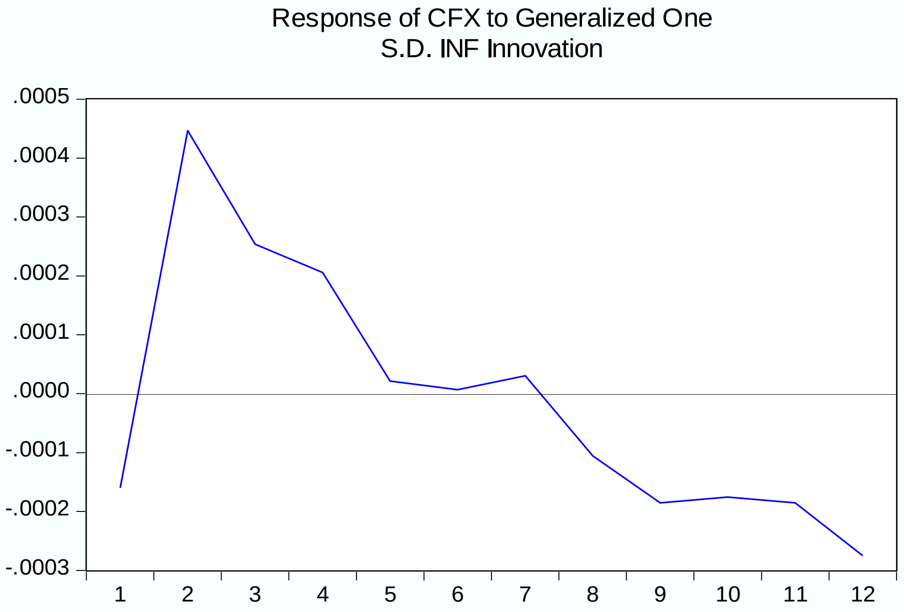
$$\Delta y_t = \Pi y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + Bx_t + \varepsilon_t \qquad (4)$$

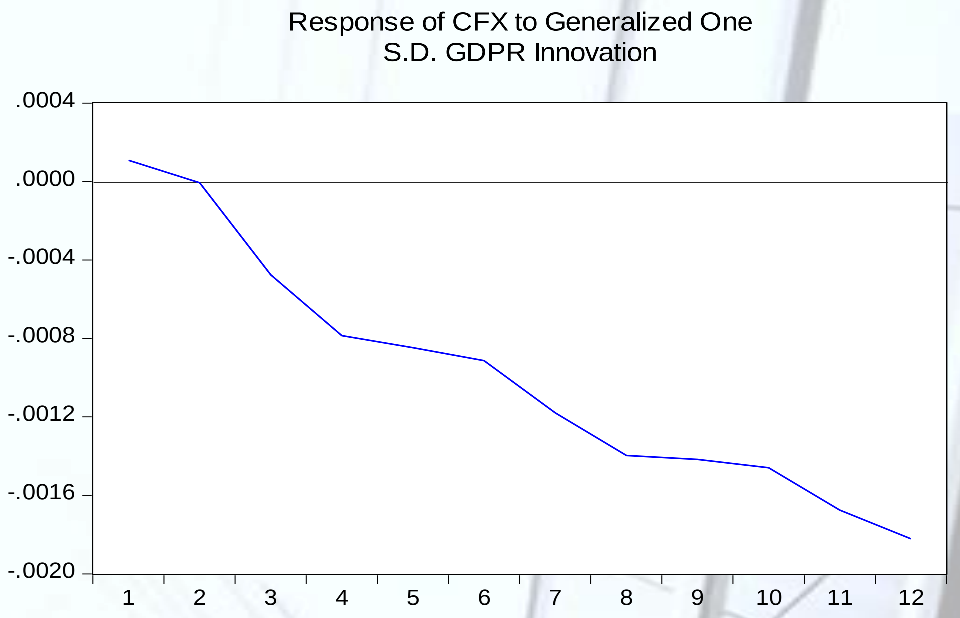
where:

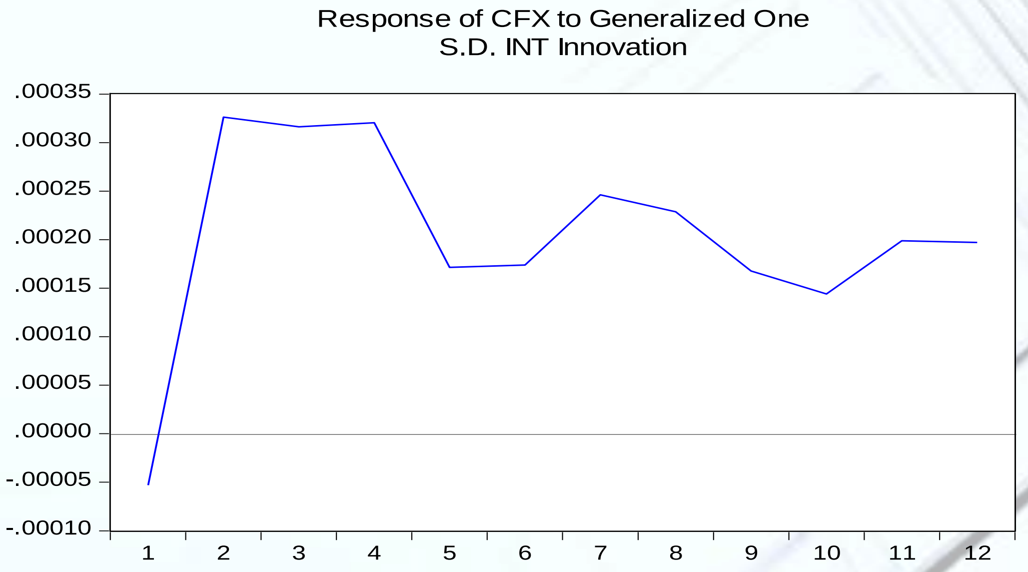
Π is a vector of endogenous variables

Y_t is a matrix with the parameters α and β

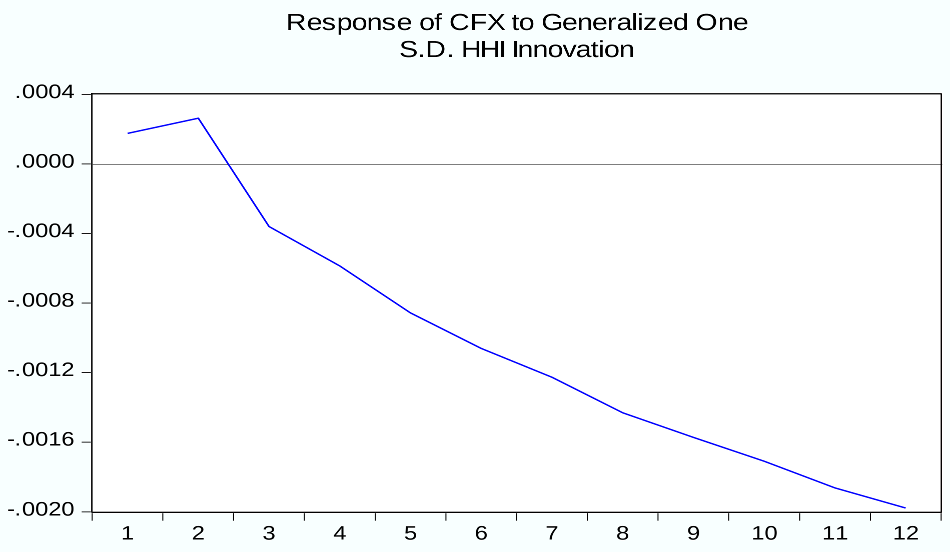
VEC MODEL IMPULSE RESPONSES

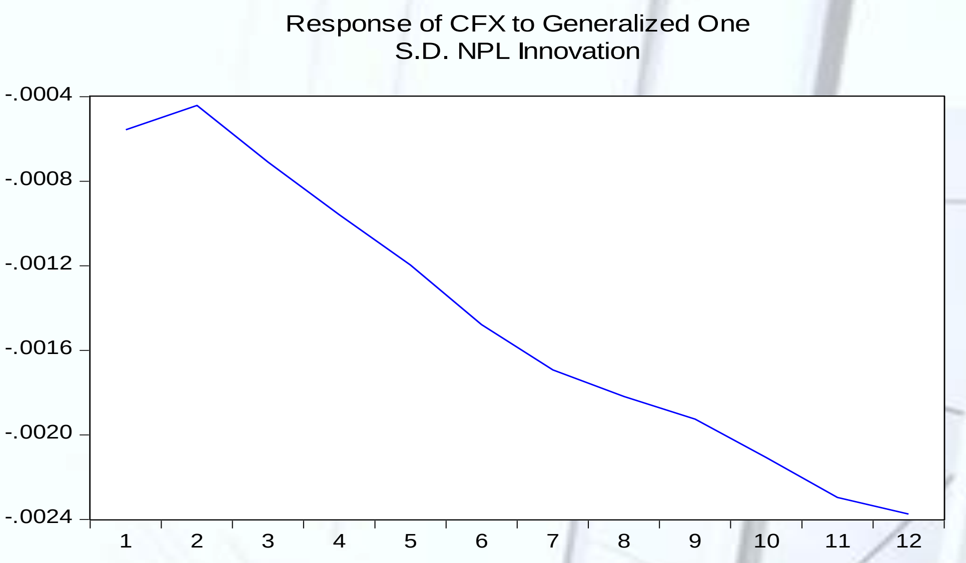


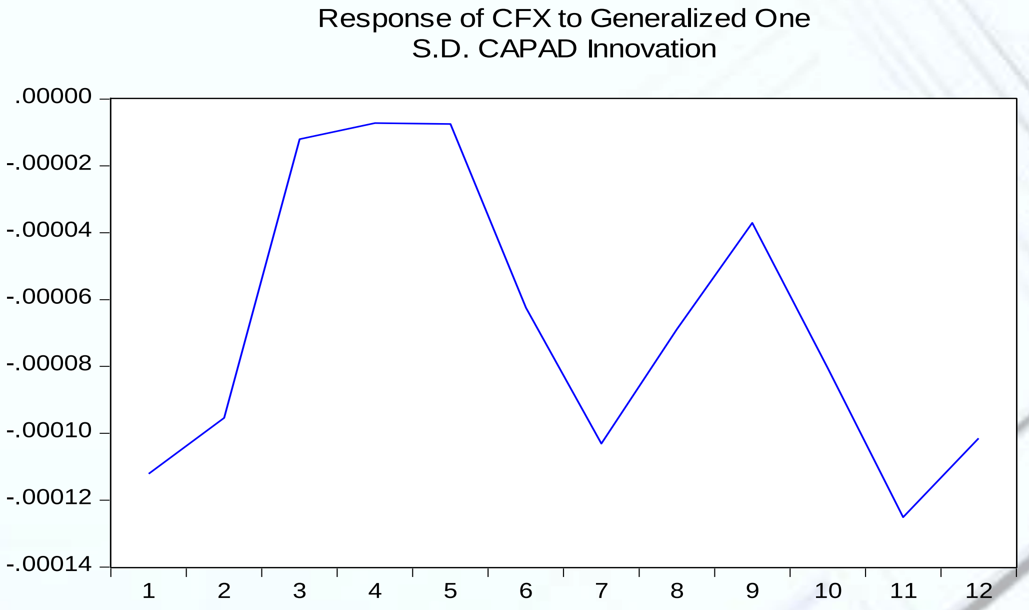




VEC MODEL IMPULSE RESPONSES







SUMMARY & POLICY IMPLICATIONS

- Findings for the VEC model showed, consistent with a priori expectations, lower interest rate spreads, declines in inflation and increases in GDP growth largely lead to improvements in cost efficiency.

- These findings are useful in informing policymakers of the potential implication of macroeconomic policy affecting these variables on the performance of banking institutions. In addition, cost efficiency is a useful input in assessing banking sector fragility.

- Furthermore, banks with higher capital to asset ratios exhibit improvements in efficiency i.e. promotes the adoption of capital standards by banks, as institutions with stronger capital base are better able to expand their activities safely, avoiding excessive risk taking and also face adverse developments.

- Also, improvements in loan quality ratio contribute to declines in inefficiency for the commercial banking sector. These findings support the continued monitoring of this ratio as well as other financial stability indicators by regulators in order to promote the performance and stability of the sector.

THANK YOU!