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CAPACITY BUILDING IN ECONOMIC MODELLING AND FORECASTING FOR

EAC CENTRAL BANKS

TABLE OF CONTENTS

LIST OF ACRONYMS AND ABBREVIATIONS

ARCH: Autoregressive Conditional Heteroscedasticity

ARDL: Autoregressive Distributed Lag

ARMA: Autoregressive Moving Average

BNR: Banque Nationale du Rwanda (National Bank of Rwanda)

BRB: Banque de la République du Burundi

CBK: Central Bank of Kenya

CECM: Conditional Error-Correction Models

CLRM: Classical Linear Regression Model

DSGE: Dynamic Stochastic General Equilibrium

EAC: East African Community

EGARCH: Exponential Generalized Autoregressive Conditional Heteroscedasticity

GARCH: Generalized Autoregressive Conditional Heteroscedasticity

GJR: Glosten, Jagannathan, and Runkle

GMM: Generalized Methods of Moments

MAC: Monetary Affairs Committee

NAIRU: Non-accelerating Inflation Rate of Unemployment

SRO – EA: Sub-Regional Office for Eastern Africa

SVAR: Structural Vector Autoregression

UNECA: United Nations Economic Commission for Africa

VAR: Vector Autoregressive Model

VECM: Vector Error Correction Model

EXECUTIVE SUMMARY

This report presents findings on need assessment in Modelling and Forecasting in East African Central Banks. This assessment has been commissioned by the Monetary Affairs Committee (MAC) of East African Community and the United Nations Economic Commission for Africa, Sub Regional office for Eastern Africa (henceforth UNECA/SRO–EA).

Modelling and forecasting training program is designed to provide adequate skills to the staff of EAC Central Banks in Economic Analysis, Modelling and Forecasting.

Modeling and forecasting are key instruments in monetary policy formulation and implementation. Indeed, monetary policy is conducted in a forward-looking manner. For its efficiency, there is a need of assessing trends and developments in the domestic economy and external environment as well as the simulation and evaluation of the impact of monetary policy over the medium term. In other Words, There is a need for a Central Bank to have a clear understanding on its monetary transmission mechanisms. This is realized through macro econometric models based on the reality of the economy.

As EAC is deepening and widening its regional integration, capacity building in Modelling and Forecasting in EAC Central Banks will contribute to have good understanding about dynamics of economies in the region and then contribute to the implementation of the EAC Monetary Union which is scheduled in 2012.

Different visits in the five EAC Central Banks have been carried out to collect data on needs in terms of Modelling and Forecasting. Findings from the need assessment show that there are significant gaps between EAC Central Banks related to qualified staff in these two areas. The assessment shows gaps on existing potentials in the five central banks. Some of them implemented catch up programme in quantitative methods to compensate limited skills, especially in econometrics[1]. Additional internal trainings at national level remain necessary.

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[1] The "Banque de la République du Burundi" has organized an internal training programme on econometrics in 2008. This is a good prerequisite for another internal training at advanced level.

Based on different topics proposed by the five EAC Central Banks, a joint training module has been proposed.   Modelling and Forecasting Program are widely used in sectors different from Central Banks. This study recommends extending the training programme to staff from institutions like ministries of Finance and economic planning, Institutes of Statistics, as well as other Research institutions. Given the complexity of this task and a required follow up process, the training should be organized on a gradual and periodic basis.

1. Background

The East African Community (EAC) is a regional organization formed of Kenya, Tanzania, Uganda, Rwanda and Burundi. It is implementing integration programs on economic, social and political areas. The Treaty of the establishment of the EAC was signed in November 1999 and came into force in July 2000. Under the Treaty, Partner States undertook to establish among themselves a Customs Union, Common Market, subsequently a Monetary Union and Ultimately a Political Federation. So far the EAC has a Customs Union which came into force in 2005. Burundi and Rwanda joined the process later. Currently the EAC Partner States have signed the Common Market Protocol and its implementation is planned to start on June 2010. To further expedite the pace of integration, the Summit of EAC Heads of States has decided on the need to fast track the establishment of an EAC Monetary Union by 2012.

Early in March 2010, Ministers of Finance and Economic Planning of EAC have adopted road map for the East African Monetary Union.

This EAMU projects has been elaborated by Central Banks governors, Secretary Generals, and general directors of financial markets agencies, insurance and pension agencies, National Bureaus of statistics, General Attorneys, Banks associations under the general coordination of the Ministries of EAC.

In this framework, the negotiations on EAMU and East African Central Banks protocols are expected to start in 2011 and conclude in twelve months.

In the same line, the study on the proposed EAC Monetary Union conducted by European Central Bank and a team from EAC secretariat, including national experts from the five EAC central Banks has identified the gaps in EAC partner states in terms of capacity building related to the implementation of Monetary Union, including capacity building in economic modelling and forecasting.

Both, the Monetary Affairs Committee (MAC) meeting held in Kigali Rwanda on May 2009 and the Governors of Central Banks meeting organized in Nairobi in June 2009 recognized the need for EAC Central banks to build their capacity in economic modelling and forecasting. A special committee comprising of heads of Research Departments in EAC Central Banks was formed and tasked with preparing the Terms of

Reference for the capacity building program. The 12th MAC meeting of Governors requested the National Bank of Rwanda to take the lead in organizing the training program. Accordingly, the Rwanda National Bank, jointly with the EAC secretariat, request UNECA/SRO-EA to assist them in this task.

2. Objective of the study

The overall objective of the capacity building program is to develop adequate capacity of EAC Central Banks to effectively manage monetary policies, monitor performance and build accurate expectations of the regional Economies.

The objective of this first step study is to identify needs in the five Central Banks in terms of modeling and forecasting and propose appropriate training modules. Modeling and forecasting are key instruments in monetary policy formulation and implementation It allows Central Banks to identify and measure strength of different monetary transmission mechanisms and provide technical support to different monetary policy actions.

To achieve the objective, a visit in the five EAC central banks was carried out within two weeks. The consultant met Heads (and staff members) of Research departments for discussion. Although the needs in terms of training in Modelling and Forecasting seem to be common in all EAC central Banks, there are however some specific needs identified in particular central banks.

The main objective of the proposed training programme is to build the Central Banks' capacity to handle quantitative techniques to analyse financial data, understand the mainstream financial models and forecast financial variables. In other words, the training programme aims to give participants a sound knowledge of the key modern econometric techniques commonly used in the finance literature. The programme also aims to provide hands-on training in the use of one of the main econometric packages, like EViews; PCGIVE, Stata and RATS.

3. Needs in training program

3.1 BURUNDI

Modelling and Forecasting are often referring to the econometric approach. The planed training on "Modelling and Forecasting" is focusing on econometric analysis and applied econometrics. The Bank of the Republic of Burundi (BRB) has huge gaps of staff specialised in econometrics. To this end, the needs in capacity building of the BRB may be grouped into two categories namely enrichment of the training and capacity building.

1. **Proposed training enrichment**

Organized on short terms period, the training would not facilitate the development of different economic theories and the review of basic statistics.

BRB proposes to receive a training starting with a brief overview of the theory and practical exercises. It should mainly focus on:

> Inflation

> Monetary aggregates

> Exchange rates and

> Banking liquidity

2. **Capacity building**

The Bank needs to train a good number of senior staff in modelling and forecasting so to build their analytical skills. BRB has a small group of staff with relatively advanced basis in econometrics. They have benefited from the internal training in econometrics organized in 2008.

The Bank has expressed the crucial need to organize another internal training in modelling and forecasting before joining the pull of colleagues from other EAC central Banks. To this end, BRB needs assistance from partners like UNECA to fill this gap.

More precisely, the training would focus on two main topics:

▪ introduction to statistical analysis

- Single and multiple regression models

- Introduction to Stationarity, unit roots and cointegration.

3. 2 KENYA

The Central Bank of Kenya provided more detailed proposal in terms of training. The table below summarizes the needs formulated by Central Bank of Kenya with justification of each suggested topic.

N°	COURSE/ACTIVITIES	Possible topics	JUSTIFICATIO N
1	**Basic econometrics**	• Linear regression analysis -Assumption of the least squares method -violation of assumptions • System of equations	• Introduce /Review basic econometrics techniques and their applications in economic analysis and decision making in a central bank • There are many staff members who may not have done formal econometric courses or even if they have done, they need to be updated on the basic principles.
2	**Time Series Econometrics**	• Stationarity / unit roots analysis • testing unit roots • Cointegration analysis; -Engle-Granger 2 step procedure -Engle-Granger and Yoo 3 step procedure -analysis of response characteristics -Johansen cointegration framework -analysis of structural VAR, VECM etc	• Provide tools for empirical work using time series data • Facilitate awareness of how staff in research department can use and apply time series econometrics techniques in a central bank setting.
3	**Cross-Section and survey methodology**	• How to conduct surveys • Data coding and entry • Binary choice models -linear probability model -logit and probit	• To enable the central bank research staff take advantage of available individual-level data sources • Introduce a range of micro econometric techniques useful in drawing insights from

N°	COURSE/ACTIVITIES	Possible topics	JUSTIFICATIO N

		model
		
		• Multinomial choice models
		   -Multinomial logit/probit
		
		   -Conditional logit
		
		   -Nested logit
		
		• Sample selection and truncated models
		-Heckit model
		
		-Tobit
		
		• Etc.
			individual-level data that is useful for enabling CBK achieve its objectives
			• Possible areas of immediate use:
			  o Understanding dynamics of inflation from Kenya Household Integrated Budget Survey (KHIBS) of 2006
			  o Understanding factors driving access to financial services using the Financial Access survey of 2006
			  o Analysing other survey data carried out by the bank e.g. bank supervision
			  o Immediate application to each researcher's own agenda

4	**Panel Econometrics**	• Basic panel data analysis
		-One-way error components
		
		-Two way error components
		
		-Testing hypotheses
		• Dynamic panel
		• Nonstationary panel
			• To communicate the skills necessary to understand and assess the applications of panel data analysis reported in literature
			• To provide panel data econometric skills necessary to analyse a variety of research and policy issues confronting central banks.
			• Possible areas of immediate use:
			  ▪ Analysing the behaviour of a panel of commercial banks in Kenya with regard to monetary policy
			  ▪ Analysing any issue which requires data that has both cross-section and time dimension i.e. panel

N°	COURSE/ACTIVITIES	Possible topics	JUSTIFICATIO N
5	**Macro econometric Modelling**	• Building a macro model • DSGE models	• To communicate the skills necessary to build a macro econometric model • To provide skills for using a macro econometric model for policy simulations and forecasting • This training is necessary since standard econometric courses do not expose researchers to issues regarding macro econometric models.

3.3. RWANDA

National Bank of Rwanda provided a detailed and comprehensive program which can constitute a model of the final training module. Apart providing the contents of the proposed topics, BNR shows also the description of the proposed training, the aims and the expected program outcomes.

1. DESCRIPTION OF THE TRAINING PROGRAMME

This short training programme for the BNR focuses on the key statistical techniques relating to the analysis of financial data in order to understand the mainstream financial models and to forecast financial variables that are central to policy making decisions for Rwanda. The module covers financial time series modelling, time series econometrics as applied in finance, financial economics, securities and investments. Theoretical as well as practical issues are considered.

2. AIMS OF THE TRAINING PROGRAMME

The training programme aims to equip participants with a sound knowledge of the key modern econometric techniques commonly employed in the finance literature, specifically for financial modelling and forecasting.

3. EXPECTED PROGRAMME OUTCOMES

Upon successful completion of training programme, participants should be able to:

(a) Apply and explain the standard procedures for model-building in economics and finance, including the empirical testing of finance models and forecasting of financial variables, which are central to policy making in Central Bank;

(b) Demonstrate application of univariate time series modelling and forecasting using ARMA models;

(c) Show the application of multivariate modes, with emphasis on VAR models as well as finance models that feature simultaneous equations;

(d) Test for unit root and cointegration in modelling long-run relationships in finance;

(e) Discuss and demonstrate the main techniques used in modelling and forecasting volatility, with emphasis on the class of ARCH models and extensions such as GARCH, GARCH-M, EGARCH and GJR formulations.

4. Outline & lecture plan for the training programme

TOPIC 1:   Model building with the Classical Linear Regression Model

Diagnostic testing, including parameter stability; Violations of the CLRM assumptions; General-to-specific modelling; Applications and examples.

TOPIC 2:   Univariate Time Series Modelling and Forecasting

Standard models of stochastic processes (white noise, moving average and autoregressive processes); ARMA processes and building ARMA models; Forecasting in econometrics; Application: Inflation Forecasting.

TOPIC 3:   Multivariate Models

Estimation techniques for simultaneous equations models; Vector autoregressive (VAR) models; Causality testing; Impulse responses and variance decompositions

Applications: Monetary transmission mechanisms

TOPIC4: Unit Root & Cointegration in Modelling Long-run Relationships

Stationarity and unit root testing; Cointegration: Engle-Granger and Johansen techniques; Equilibrium correction or error correction models

Applications: Estimation of Money demand function, modelling inflation.

TOPIC 5:   Modelling and Forecasting Volatility

Non-linearity in financial time series; the class of ARCH models; Generalised ARCH (GARCH) models; Extensions to the basic GARCH model such as GARCH-M, EGARCH and GJR (TGARCH) formulations; Volatility forecasting using GARCH-type models.

TOPIC 6:   Conducting Empirical Research in Banking & Finance

Revision of the key techniques;

Design and conduct of an empirical research papers;

Presentation issues.

3.4. UGANDA

The needs formulated by Bank of Uganda are more specific and want to deal with the practical approach. To this end, the following topics have been identified as the priority of the Bank of Uganda:

❖ Data exploration methods;

❖ Conditional Error Correction Models under the ARDL approach;

❖ Granger Causality Tests in Conditional Error-Correction Models (CECM) under the ARDL approach;

❖ Multiple Equation Analysis – Dealing with systems of equations (Solving estimated systems of equations), calibrating system of equations, forecasting using systems of equations and performing single and multivariate simulations;

❖ Structural VAR models and their application in Central banking;

❖ Bayesian VAR models;

❖   Fan charts (Win Solve);

❖   Macro econometric modelling;

❖   Forecasting using macroeconomic models and linear stochastic models (AR,MA and ARMA/ARIMA models);

❖   Seasonality tests in economic time series;

❖   Structural breaks and model selection: tests for structural breaks, Empirical evidence on structural breaks and their implications for an analysis for NAIRU, technology and monetary policy shocks;

❖   Panel Data Econometrics: Unit root tests, cointegration tests.

3.5 TANZANIA

The needs formulated by Bank of Tanzania are not different from what have been proposed by other Central Banks. The following topics have been identified as the priority of the BOT:

1. Approaches to Forecasting

Simple and Naive Methods;   Model Based Forecasting; Macroeconomic Model Building; Numerical Analysis and Forecasting; Numerical Simulations; Fun charts projections; Econometric Forecasting.

2. Econometrics Training Needs

Data Analysis;   Unit root tests, co-integrating tests, etc;   Estimating Structural Models; Two stage least square estimation and multiple equations estimations;   Generalized Methods of Moments (GMM);   Forecasting with Structural Models;   Time Series Econometrics: Univariate Time Series Analysis;   Structural Vector Autoregression (SVAR);   Co-integration and Vector Error Correction Models (VECM).

3. State Space Models: Kalman Filtering Techniques

4. Proposed training module for the EAC central banks

1. Introduction

Based on different topics proposed by the five EAC Central Banks, a joint training programme in modelling and forecasting is proposed as follow:

These modules are proposed to be used during the short training programme of staff from EAC Central Banks as recommended by the last MAC meeting held in Kigali, in May 2009.

3. Methodology

The methodology should be based on:
- ❖ Formal training, practical exercises, computer-based simulations and the frequent use of case studies based on real-life business situations.
- ❖ The topics should be designed to be practical for attendees and their workplace.
- ❖ The contribution of Participants should be highly encouraged.
- ❖ The lecturer would be available throughout the entire course for additional guidance, if required.

4. Expected programme outcomes

Upon successful completion of training programme, participants should be able to:

(a) Apply and explain the standard procedures for model-building in economics and finance, including the empirical testing of finance models and forecasting of financial variables, which are central to policy making in Central Banks and for EAC economies.

(b) Demonstrate application of univariate time series modelling and forecasting using ARMA models;

(c) Show the application of multivariate models (modelling and forecasting), with emphasis on VAR models as well as finance models that feature simultaneous equations;

(d) Test for unit root and cointegration in modelling long-run relationships in finance;

(e) Discuss and demonstrate the main techniques used in modelling and forecasting volatility, with emphasis on the class of ARCH models and extensions such as GARCH, GARCH-M, EGARCH and GJR formulations.

5. Outline and Lecture Plan for the Proposed Training Programme

TOPIC 1:   Basic Econometrics

- A brief overview of the classical linear regression model;

- Diagnostic testing, including parameter stability;

- Violations of the CLRM assumptions

- General-to-specific modelling

- Applications and examples

- Generalized Methods of Moments (GMM)

Case Study: Use of E-Views on Model building with the CLRM

TOPIC 2: Univariate Time Series Modelling and Forecasting

- Standard models of stochastic processes (white noise, moving average and autoregressive processes);

- ARMA processes and building ARMA models;

- Forecasting in econometrics with application to some EAC Countries.

Case Study: E Views: estimation of an ARMA model, Forecasting of inflation by using an ARMA model (use data from one of the five EAC countries)

TOPIC 3:   Multivariate Models

- Estimation techniques for simultaneous equations models

- Vector autoregressive (VAR) models

- Causality testing

- Impulse responses and variance decompositions

- Structural VAR models and their application in Central banking
- Bayesian VAR models

Case study: Use of E-Views on Multivariate Modeling and forecasting.

1. Identification of monetary policy transmission mechanism
2. Inflation Forecasting

TOPIC 4: Unit Root & Cointegration in Modelling Long-run Relationships

- Stationarity and unit root testing

- Cointegration: Engle-Granger and Johansen techniques

- Equilibrium correction or error correction models

- Seasonality tests in economic time series
- Structural breaks and model selection: tests for structural breaks, Empirical evidence on structural breaks and their implications for an analysis for monetary policy shocks. Use here RATS for example.

Case Study: Estimation of Money demand; test of stability of money multiplier

TOPIC 5:   Modelling and Forecasting Volatility

- Non-linearity in financial time series

- The class of ARCH models

- Generalised ARCH (GARCH) models

- Extensions to the basic GARCH model such as GARCH-M, EGARCH and GJR (TGARCH) formulations

- Volatility forecasting using GARCH-type models

- **Approaches to Forecasting**

✓ Simple and Naive Methods

✓ Model Based Forecasting

✓ Macroeconomic Model Building

✓ Numerical Analysis and Forecasting

✓ Numerical Simulations

✓ Fun charts projections

Case Study: Modelling and Forecasting Volatility; Fun charts to have projections on inflation.

Topic 6: Cross-Section and survey methodology

- How to conduct surveys
- Data coding and entry
- Binary choice models
    - linear probability model
    - logit and probit model
- Multinomial choice models
    - Multinomial logit/probit
    - Conditional logit
    - Nested logit
- Sample selection and truncated models
    - Heckit model
    - Tobit

Topic 7: Panel Econometrics

- Basic panel data analysis
    - One-way error components
    - Two way error components
    - Testing hypotheses
- Dynamic panel
- Nonstationary panel

8. SUMMARY

Modelling and Forecasting Program should provide technical background for financial decisions. It should have a wide range of fundamental analytical and forecasting skills, required to interpret national and regional economies.

The reality found in EAC central Banks confirms that the training in Modelling and Forecasting is necessary. It would facilitate the harmonization of financial analysis within the EAC Central Banks and the implementation of the EAC Monetary Union scheduled for 2012.

The heads of research department in respective EAC Central banks are welcoming the initiative proposed by UNECA to provide such kind of training. They reaffirm interest to attend and benefit from this training to improve their capacities, where they exist, in terms of modelling and forecasting in macroeconomic and financial analysis. As the

EAC is deepening and widening its regional integration, the harmonisation of macroeconomic and financial analysis would address the gaps in interpretation of national and regional economy. To formulate the contents of training module, it has been agreed that the assessment of needs in this area within the five Central Banks of EAC countries would provide relevant information in elaborating the training module. In the visit, each of the central banks provided its priorities in terms of training. We harmonize them and design a proposal on a common training module.

9. RECOMMENDATIONS

The EAC Central Banks have different levels in applied macroeconometrics. Some of them do not use econometric tools in formulating their financial and macroeconomic analysis.

In an era of sound regional integration and harmonization, the use of a common method in financial analysis would help policy makers of the Community to take decisions based on harmonised and homogeneous data. To this end, all EAC Central Banks need to be on the same line in macroeconomic and financial analysis. It is in this context that the following recommendations need to be considered:

- ✓ Besides the common training formulated in the present report, each Central Bank needs a particular training following its specific needs. For banks with big gaps in terms of econometrics analysis, it should be better to plan preliminary training before joining the regional session.

- ✓ The common training would be more practical than theoretical. The case study of each participating country would provide a good example of practice of the theory.

- ✓ As the Modelling and Forecasting Program is not a particularity of Central Banks alone, it is recommended to involve other institutions concerned by the topics (e.g. Ministries of Finance, Institutes of Statistics, etc.)

- ✓ Due to the complexity of the training in Modelling and Forecasting, this kind of training should be organized periodically in order to make sure that the previous training has achieved positive results.

Appendix 1. List of contacted Persons

N°	Country	Institution	Name of contacted Person	Position	Address	Phone number	E-mail
1.	Rwanda	National Bank of Rwanda (BNR)	Dr. Kigabo Rusuhuzwa Thomas	Chief Economist	P.O Box 531 Kigali -Rwanda	+250 788303633	thkigabo@yahoo.fr
2.	Burundi	Banque de la République du Burundi (BRB)	Mr. Sota Bonaventure	Directeur Responsable du service des Etudes	P.O Box 705 Bujumbura - Burundi	+257 79910367	sotabon@yahoo.fr
			Mr. Audace Niyonzima	Deputy Director Monetary & Financial Market Department		+257 79970126	aniyonzima@brb-bi.net
			Mr. Joseph Bahizi	Head of Monetary & Financial Market Department		+257 77733230	jbahizi@brb-bi.net
3.	Uganda	Bank of Uganda	Dr. Adam Mugume	Assistant Director Head, Modelling &Forecasting Division	P.O Box 7120 Kampala - Uganda	+256 772416058	amugume@bou.or.ug
			Mr. Francis Leni Anguyo	Head, Large Macroeconometric Modelling Section Research Department		+256 774224565	fanguyo@bou.or.ug
4.	Tanzania	Bank of Tanzania	Dr. Kamili Alphonce Kombe	Deputy Director, Research	P.O Box 2939 Dar es Salaam Tanzania		kakombe@hq.bot-tz.org
5.	Kenya	Central Bank of Kenya (CBK)	Mr. Charles G. Koori	Director of Research Department	P.O Box 60000-00200 Nairobi - Kenya	+254 722235583	kooricg@centralbank.go.ke
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