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Implications of voluntary reductions in energy-related emissions for the environment and economic welfare in Malawi: An environmental general equilibrium approach

by

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Submitted in partial fulfilment of the requirements for the degree of

Ph.D. in Environmental Economics

in the

Department of Agricultural Economics, Extension and Rural Development

Faculty of Natural and Agricultural Sciences

University of Pretoria

South Africa

July 2010



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DEDICATION

To my parents, Geoffrey Timothy Maxon and Dinah.



DECLARATION

I, the under signed, hereby declare that this thesis, which I submit for the degree of PhD in Environmental Economics at the University of Pretoria is my own work and has not been previously submitted for a degree at another university.

BENJAMIN MATTONDO BANDA

JULY 2010

ACKNOWLEDGEMENTS

I am deeply thankful to my supervisor, Professor Rashid Mekki Hassan who generously nurtured my academic life from the time I joined the Environmental Economics programme at the University of Pretoria. I would like to acknowledge with gratitude his helpful insights and guidance throughout the course of my work. I am also indebted to two anonymous external reviewers whose comments greatly improved the quality of this research. Any remaining errors and omissions, including but not limited to technical inaccuracies and typographical errors are all mine.

I am grateful for financial support from the Centre for Environmental Economics and Policy in Africa (CEEPA), the African Economic Research Consortium (AERC) and the EU Capacity Building Programme at the University of Malawi. I would also like to thank my employer, the University of Malawi, for granting me leave to pursue post-graduate studies at the University of Pretoria.

I have benefited a lot from the wonderful atmosphere in the Department of Agricultural Economics, Extension and Rural Development. I would like to specifically thank Professor Johan Kirsten, Head of Department, for his visionary leadership and guidance. I am also grateful to Prof. Charles Machethe, The Chairperson of the Graduate Committee, for his guidance and support. I would also like to acknowledge with thanks the support from Ms. Daleene du Plessis and all the staff at CEEPA.

I would also like to acknowledge with great appreciation my family who supported me throughout my studies. I have been blessed with love and unconditional support from my wife Talumba and my sons, Liam Mwatama and BJ. I will always treasure the friendship, comfort and encouragement received from fellow students and colleagues. I am particularly indebted to Patrick Birungi, James Juana, Ted Nakhumwa, Jethro Zuwarimwe, Sanaa Abusin, Grace Tomoka, Choolwe Haankuku, Glwadyes Gbetibouo, Orefi, Chumi, Deressa, Mesfin, Yemmane, Charles Nhemachena, Sincengile, and Davison Chikazunga.

Finally, I thank God for giving me all that I have.

Implications of voluntary reductions in energy-related emissions for the environment and economic welfare in Malawi: A computable general equilibrium approach

By

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ABSTRACT

This study estimates an energy sector model consisting of interfuel substitution model and an aggregate energy and non-energy input demand system that incorporates short-run and long-run structural adjustment parameters. The study finds that all fuels in the energy aggregate are Morishima substitutes and that there are significant sectoral variations in magnitude of the elasticities. This indicates that economic instruments should be considered for energy policy but such policies should take into account not only differences in technology used across sectors but also the systematic distribution of costs when the relative prices of fuels change. Estimates of long-run elasticities for aggregate input demands indicate that energy-capital input ratios adjust faster than labour-capital input ratios. This suggests that investment policy should take into consideration tradeoffs between environmental gains and employment implicit in the production structure of the Malawian economy as both capital and labour demands have dynamic interactions with energy in the long-run with potential significant cumulative impacts on the environment.

Using results and gaps noted from the partial equilibrium analysis, the study also evaluated general equilibrium impacts of reducing fossil and biomass fuel use by production activities while investing in more hydroelectricity. The results show that carbon emissions and forest resource depletion due to energy use, respectively, can be reduced by imposing environmental taxes aimed at inducing a shift from biomass and fossil fuels to hydroelectricity. More significantly, there are at least three dividends from inducing a shift in the energy mix in that

the economy can attain GDP at least equal to the value before imposition of environmental taxes in addition to reducing carbon emissions and deforestation. Further, redistributing the environmental tax revenues to reduce direct taxes on households leads to better income distribution. These findings have direct policy relevance to the contemporary challenges to sustainable development under the added burdens of climate change. Most importantly is what developing countries can do to strategically position themselves in global agreements on financing for climate change adaptation and mitigation.

The general equilibrium estimate of direct environmental cost associated with the use of fossil and biomass fuels is close to the moderate estimate of social cost of deforestation in the National Environmental Action Plan (NEAP). This is significant because in the absence of estimates of damages of secondary impacts of both carbon emissions and deforestation, the optimal energy tax as inferred from the general equilibrium model corresponds to the annual growth rate in the economy's energy intensity. In addition, since short-run to medium term environmental impacts are critical when data on secondary damages are unavailable, it would be prudent to target growth in intensities of use of fuels that contribute to the economy's footprint on the environment. The study also proposes alternatives to carbon emission taxation that could complement the current legislation on land use by agricultural estates.



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GLOSSARY OF ACRONYMS

AES	Annual Economic Survey
AGE	Applied General Equilibrium
BEST	Biomass Energy Strategy
Btu	British Thermal Units
CGE	Computable General Equilibrium
CH ₄	Methane
CO ₂	Carbon Dioxide
COMESA	Common Market for Eastern and Southern Africa
COP 15	The 15 th Conference of Parties of the United Nations Framework Convention on Climate Change
DEA	Data Envelopment Analysis
EMA	Environment Management Act
ESCOM	Electricity Supply Corporation of Malawi
FAO	Food and Agriculture Organisation
GDP	Gross Domestic Product
Mega	M = 10 ⁶
GHG	Greenhouse Gas
GLS	Generalized Least Squares
GNP	Gross National Product
GoM	Government of Malawi
HSSW	Harberger, Scarf, Shoven and Whally
IEA	International Energy Annual of the US Department of Energy
IEP	Integrated Energy Policy
IFPRI	International Food Policy Research Institute
IHS	Integrated Household Survey
ISIC	International Standard Industrial Classification
Kg	Kilogram
KLE	Capital-Labour-Energy
LPG	Liquid Petroleum Gas
MAC	Marginal Abatements Cost

MACC	Marginal Abatement Cost Curve
MAREP	Malawi Rural Electrification Programme
MES	Morishima Elasticity of Substitution
MKW	Malawi Kwacha (Currency)
ML	Maximum Likelihood
MSG	Multisector Growth Model
N ₂ O	Nitrous Oxide
NEAP	National Environmental Action Plan
NEC	National Economic Council
NECO	National Electricity Council
NEP	National Environmental Policy
NFP	National Forest Policy
NO _x	Nitrogen Oxides
NSO	National Statistical Office
PMS	Poverty Monitoring System
RBM	Reserve Bank of Malawi
RES	Allen Relative Elasticity of Substitution
SADC	Southern African Development Community
SAM	Social Accounting Matrix
UNFCCC	United Nations Framework Convention on Climate Change
VNRC	Village Natural Resources Committees