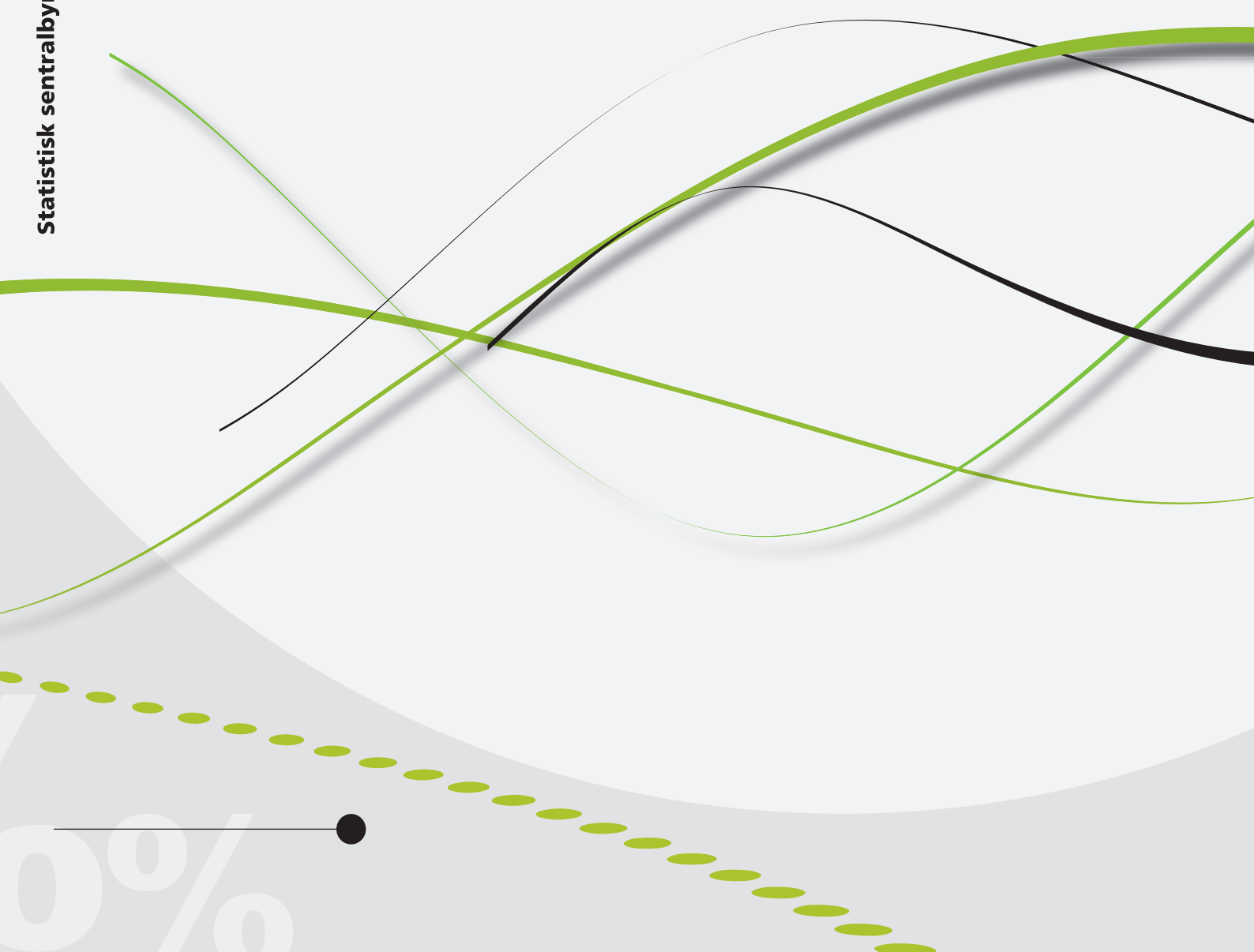
Rapporter
Reports
31/2012

Statistics Norway
Statistisk sentralbyrå

Robin Choudhury

Macroeconomic modelling in developing countries

An example from Malawi



Reports 31/2012

Robin Choudhury

Macroeconomic modelling in developing countries

An example from Malawi

Statistisk sentralbyrå • Statistics Norway
Oslo–Kongsvinger

Reports In this series, analyses and annotated statistical results are published from various surveys. Surveys include sample surveys, censuses and register-based surveys.

Published November 2012

ISBN 978-82-537-8519-6 (printed)
ISBN 978-82-537-8520-2 (electronic)
ISSN 0806-2056
Subject: 09.90

Print: Statistics Norway

Symbols in tables	**Symbol**
Category not applicable	.
Data not available	..
Data not yet available	…
Not for publication	:
Nil	-
Less than 0.5 of unit employed	0
Less than 0.05 of unit employed	0.0
Provisional or preliminary figure	*
Break in the homogeneity of a vertical series	—
Break in the homogeneity of a horizontal series	|
Decimal punctuation mark	.

Preface

Since 2004 Statistics Norway has participated in an institutional cooperation project between the governments of Norway and Malawi. The third phase of the project started in 2012 and is expected to end in 2014. One component within this capacity building program has been to develop a macroeconomic model for the government of Malawi.

Although a number of documents have been written about the model, none of them illustrates the special features that need to be recognized when building macroeconomic models in developing countries. The Report "Macroeconomic modelling in developing countries - An example from Malawi" discuss some of these characteristics and relate them to the modelling project for Malawi.

The author is grateful to Ådne Cappelen, Torfinn Harding and Bjørn Kjetil Getz Wold for valuable comments.

Statistisk sentralbyrå, 9 November 2012

Hans Henrik Scheel

Abstract

Macroeconomic modelling in developing countries has been going on for more than fifty years. Most models have been built by development partners to assist countries in macroeconomic management. Statistics Norway's modelling project in Malawi follows along the same line, but includes two other dimensions; one is a close link to a parallel project on constructing a national account, and the second is a strong emphasis on capacity building. A major component of the strategy to add capacity has been everyday on-the-job training. A small aggregated model for the Malawian economy was gradually implemented as a first step towards a more disaggregated model. Using the disaggregated model made it apparent that the new methodology was a huge improvement on previous efforts.

The choice of what type of model to develop was based on its intended use and considering available data. As Malawi has undergone IMF programs for a long time, one of the design criteria was to make the model useful for forecasts and analysis related to such programs. Another criterion was that the model should be useful in preparing the national budgets, an area in which it has already proved helpful.

Macroeconomic models in the Klein – Tinbergen tradition has been used to explain demand-oriented fluctuations and to deal with short-run instability of output and employment using mainly stabilisation policies. The model, however, has been criticised as it does not consider the supply – side and the incorporation of production relations. Neither does it adequately capture the role of the money market, relative prices and expectations. Most governments now accept that an improved supply-side performance is the key to achieving sustained economic growth without a rise in inflation. To forecast implications of supply-side policies, aggregate supply and the input factor market need attention. In the Malawi model (referred to as MalawiMod), demand for production factors is modelled by industry within a neoclassical Cobb-Douglas framework where intermediate goods, labour and capital are used as input factors for production.

Whether to go for large scale models or to keep it small and simple is a recurrent theme. When the Malawi model project started we opted for a "large" model, mainly because we wanted the model to cover the whole economy, including the public and the monetary sectors, but also because we wanted the input-output table to be the core of the model in order to keep close contact with the structure of the national accounts.

Developing economies have distinctive characteristics that must be recognized. In Malawi, e.g. households and companies are exposed to credit and foreign exchange rationing. Another characteristic is the large amount of smallholder farmers who practice a "safety-first" strategy, i.e. to produce enough food for own consumption and only then adopt a profit maximizing strategy. This must be addressed carefully and one must consider how to incorporate the implications of this into private decision rules. Also the government budget requires attention. Its composition, in particular, differs noticeably from industrial countries. MalawiMod calculates government revenues and expenditures, and any deficit is financed by an increase in domestic credit.

One of the most severe problems facing developing countries is to stabilise their external balances. It is reasonable to assume that developing countries like Malawi have little influence on prices of traded goods, and, in particular, often face exogenous terms of trade. We have linked the foreign and monetary sectors through the balance of payments identity, and assume any trade deficit to be offset and accumulated into net foreign assets.

The degree of development of the financial system is influential when deciding on how to model the monetary account. Malawi, and most developing countries, is characterized by immature financial institutions, making it difficult to model the link between the exchange rate, interest rates and capital mobility. This is of particular relevance when it comes to attract foreign capital to level out any current account deficit and to attract foreign direct investments.

Sammendrag

Makroøkonomisk modellbygging i utviklingsland har pågått i mer enn femti år. De fleste modeller har blitt laget av utviklingspartnere for å hjelpe land med makroøkonomisk styring. Statistisk sentralbyrås modellprosjekt i Malawi følger langs samme linje, men inkluderer to andre dimensjoner; en nær kobling til et parallelt prosjekt for å lage et nasjonalregnskap, og en sterk vekt på kapasitetsbygging. En viktig del av strategien for å øke kapasiteten har vært daglig opplæring på arbeidsplassen. En aggregert modell for den malawiske økonomien ble gradvis implementert som et første skritt mot en mer disaggregert modell. Ved bruk av den disaggregerte modellen ble det klart at den nye metodikken var en stor forbedring i forhold til tidligere forsøk.

Valget av hvilken type modell vi skulle utvikle ble basert på tiltenkt bruk og en vurdering av tilgjengelige data. Siden Malawi har gjennomgått IMF-programmer i lang tid, var et av designkriteriene at modellen måtte være nyttig for prognoser og analyser knyttet til slike programmer. Et annet kriterium var at modellen måtte være nyttig i utarbeidelsen av de offentlige budsjetter, et område hvor den allerede har vist seg verdifull.

Makroøkonomiske modeller innenfor Klein-Tinbergen tradisjonen har blitt brukt til å forklare etterspørselsbaserte svingninger og for å håndtere kortsiktig ustabilitet i produksjon og sysselsetting hovedsakelig ved hjelp av stabiliseringspolitikk. Modellen har imidlertid blitt kritisert for ikke å ta hensyn til tilbudssiden og å innlemme produktfunksjoner. Heller ikke pengemarkedets rolle, relative priser eller forventninger fanges opp i tilstrekkelig grad. De fleste regjeringer aksepterer nå at styrking av tilbudssiden er nøkkelen til å oppnå bærekraftig økonomisk vekst uten økning i inflasjonen. For å kunne forutsi konsekvensene av tilbudssidepolitikk, må samlet tilbud og faktormarkedet vektlegges. I modellen for Malawi (kalt MalawiMod), er faktoretterspørselen modellert etter næring innenfor et klassisk Cobb-Douglas rammeverk hvor innsatsvarer, arbeid og kapital brukes som innsatsfaktorer for produksjonen.

Hvorvidt en bør lage en ”stor” modell eller en “liten og enkel” er et tilbakevendende tema. Når prosjektet for Malawi startet bestemte vi oss for en ”stor” modell, hovedsakelig fordi vi ønsket at den skulle dekke hele økonomien, herunder offentlig og monetær sektor, men også fordi kryssløpstabellen skulle være kjernen i modellen for å holde strukturen nært det som brukes i nasjonalregnskapet.

Økonomier i utviklingsland har særtrekk en må ta hensyn til. I Malawi er for eksempel husholdninger og bedrifter utsatt for kreditt- og valutarasjonering. Et annet særtrekk er det store antallet småbønder som praktiserer en "sikkerhet først" strategi, det vil si å produsere nok mat til eget forbruk og først da iverksette en profittmaksimerende strategi. Slike særtrekk må settes på dagsordenen, og man må tenke igjennom hvordan man innlemmer konsekvensene av dette i husholdningenes og bedriftenes adferdsrelasjoner. Også de offentlige budsjetter krever oppmerksomhet, der spesielt sammensetningen skiller seg fra industrilandene. MalawiMod beregner offentlige inntekter og utgifter, og eventuelle underskudd finansieres av en økning i innenlandsk kreditt.

Et av de mest alvorlige problemer for utviklingsland er å stabilisere sine eksterne balanser. Det er rimelig å anta at utviklingsland som Malawi har liten innflytelse på prisene på de varer de handler internasjonalt, og at de ofte står overfor eksogent bytteforhold. Vi har knyttet sammen utenlandssektoren og monetær sektor via identitet for driftsbalansen, og antar at et eventuelt underskudd blir utlignet av og akkumulert i netto fordringer på utlandet.

Graden av utvikling av det finansielle systemet er viktig for hvordan man skal modellere monetær sektor. Malawi er, som de fleste utviklingsland, preget av umodne finansinstitusjoner, noe som gjør det vanskelig å modellere sammenhengen mellom valutakurs, renter og kapitalmobilitet. Dette er særlig relevant når det gjelder å tiltrekke seg utenlandsk kapital for å jevne ut eventuelle underskudd på driftsbalansen og for å tiltrekke seg utenlandske investeringer

Contents

1. Introduction

The use of macroeconometric models for forecasting and policy analysis has a long and interesting, but also turbulent, history. Jan Tinbergen is regarded as the pioneer as he developed the first macroeconometric model for the Dutch economy prior to World War II to assist the Dutch Central Planning Bureau in implementing their economic policies.

Macroeconometric modelling in developing countries also has a relatively long history. Persistent economic problems in many developing countries such as stagflation, trade and budget deficits, and enormous debt burdens led a significant number of developing countries to use macroeconomic models. See for example Ichimura and Matsumoto (1994) and Uebe (1995) for a list of macroeconometric models for a large number of countries.

The first macroeconomic model for a developing country was constructed by Narasimham (1956) for India under the supervision of Tinbergen. The earliest models were mainly small versions of the Tinbergen – Klein model capturing the demand side of the economy. The Economic Commission for Asia and the Far East (ECAFE, 1968) and the United Nations Conference on Trade and Development (UNCTAD, 1973) constructed macroeconomic models for about 40 developing countries to assist them in forecasting the foreign capital needs. These models were criticised on the basis of three major deficiencies, i.e. insufficient sample size, multicollinearity, and misspecification of the models (Shourie, 1972). In a response to this critique, Sastry argued that the UNCTAD models exhibit "a fair measure of stability and provide a reasonable basis for projections" (Sastry, 1975, p.158). In fairness to Shourie's criticisms, it should be pointed out that these deficiencies may not only be true in the context of developing countries, but also in the case of developed countries. Despite these problems, Sastry suggested that macroeconomic models can be useful if the value of the key parameters are checked and compared with those of other countries with a similar economic structure.

Bautista (1988) and Capros et al. (1990) have classified macroeconomic models into broad groups: macroeconometric models and CGE (computable general equilibrium) models. Further, according to Challen and Hagger (1983, pp.2-22) there are five varieties of macroeconometric models in the literature: the Keynes-Klein (KK) model, the Phillips-Bergstrom (PB) model, the Walras-Johansen (WJ) model, the Walras-Leontief (WL) model, and finally the Muth-Sargent (MS) model.

In developing countries the Keynes-Klein model is mainly used to explain the Keynesian demand-oriented macroeconomic fluctuations, and to deal with the problems of short-run instability of output and employment using mainly stabilisation policies. The basic Keynesian model has been criticised as it does not consider the supply-side and the incorporation of production relations. Neither does this modelling approach adequately capture the role of the money market, relative prices and expectations. As a response to these shortcomings the St Louis model was constructed by the monetarist critics in order to highlight the undeniable impacts of money on the real variables in the economy (Anderson and Carlson (1970), Valadkhani (2005)).

Also in Malawi there have been attempts to build macroeconomic models. When the MalawiMod was designed in 2003 the tool used to make forecasts for the Malawian economy was a model called MacSol (Macroeconomic Solution model), a simple model without any estimated behavioural equations. It used a top down approach distributing an exogenous growth rate for total GDP to the industries using their historic shares of total GDP. The model is no longer in use.

In the 1990's the then National Economic Council, with support from the United Nations Development Programme (UNDP), used a model called Threshold 21 (T-21) to prepare and analyze Malawi's Vision 2020 document[1]. The T-21 model aimed at providing a holistic picture of the economy, including factors such as health and education. The scenarios developed for the Vision 2020 document was made mainly by external consultants, and despite of many attempts the model was never used again and is considered defunct.

The use of MalawiMod will provide the foundation for analyses concerning the economic policy decision making process in Malawi. It will possibly be complimented with other tools where the Ministry of Economic Planning and Development (MEPD), the Ministry of Finance (MoF) and the Reserve Bank of Malawi (RBM), has expertise. The MoF does not use any formal model tool for their analyses related to, for instance, the preparation of the annual government budget, while the RBM has a financial programming model and some tools for inflation modelling. However, as of today, no other tool gives the same overall picture of the economy as the MalawiMod. In Chapter 2 we will give a brief introduction to the modelling project taking place in Malawi. In Chapter 3 we discuss some issues related to why this particular model was chosen. In Chapter 4 we discuss some special features related to model building in developing countries and how they have been put in place in MalawiMod. In Chapter 5 we discuss some aspects of interlinking the various accounts in some of the models typically used in developing countries, as well as in MalawiMod. Here we also briefly present some shocks to the model. In Chapter 6 we conclude.

[1] See the Millennium Institute's web page http://www.millennium-institute.org for more information.

2. The modelling project

2.1. Project set-up and motivation

The institutional cooperation project between the governments of Norway and Malawi is a capacity building program in the fields of statistics and planning. Moreover, the planning part of the project described here aims at developing a macroeconomic model for Malawi. The absence of a research culture in Malawi has left important committees such as the Economic Management Team and the National Accounts and Balance of Payments Technical Committee, without any scientifically based tools for discussing viable policy options. For instance, the government's position was somehow unclear, or ambiguous, on the impact on the domestic economy of the global economic downturn starting in 2007/8.

The project has completed two phases (2004-2012) of implementation and a third phase was started in 2012. The first phase of the project was associated with the "Malawi Poverty Reduction Strategy Paper" (MPRSP) and was designed to serve its need for information for the implementing government agencies, other national and international data users and the public at large. During phase two of the project focus was at the technical cooperation between the Malawian and Norwegian institutions to provide information needed for implementation of the government's overarching strategy, the "Malawi Growth and Development Strategy" (MGDS) replacing the MPRSP in mid 2006. The MGDS focused on stronger economic growth and development as a catalyst for poverty reduction. This phase aimed at bridging the gap in evidence based policy decision making in the country by expecting the government to employ the model for analysing its national planning and budgeting processes. The third phase of the project was proposed in order to gain experience, understanding of the system, and confidence for further adjustments and developments. During phase three it is expected that the Malawian institutions gradually will take full ownership and institutionalize the model and use it efficiently as a core input for national policy analysis.

2.2. Achieving the project goals

The overall goal of the planning project is to implement capacity in macro-economic modelling, and to facilitate the use of such tools by the Malawian government for forecasts and policy analysis on a regular basis. The main rationale behind this goal is to allow for a holistic approach to economic forecasting and analyses. Without a macroeconomic model the various institutions in Malawi will continue doing forecasts and analyses of the economy isolating their own field of activity. Further, where there are some attempts to analyse the whole economy, e.g. in the National Accounts and Balance of Payments committee, they do not have the tools to properly link the various sectors of the economy together, notwithstanding in a simultaneous way.

To achieve the goals of capacity building and lasting institutional memory a strategy must be in place. This strategy must be clearly communicated and manifested with all stakeholders. Moreover, the key elements of the strategy must be revised and any deviation dealt with. One of the key elements is everyday on-the-job training, i.e. to bring along the staff of the Malawian stakeholders in all aspects of model related work, spanning from routine updates of the database to analyses using the model to shed light on specific issues. So far this has proven to be a very efficient way of transferring knowledge and given enough time the technical advisor can gradually back out from the details of everyday work.

Prior to designing and building the macroeconomic model for Malawi we started with a stepwise introduction into modelling in general. This was carried out through training courses implementing small text book models, using the software chosen to handle the modelling system. Having gained some confidence the technical advisor and the model team continued to develop a small aggregated

model and its associated database for the Malawian economy. Not only was it aggregated in terms of the production side, but also a simplified fiscal and monetary framework was put into practice. This was the first step towards constructing a disaggregated model based on new national accounts data for Malawi, expected to become available sometime during 2006. The model was gradually expanded by endogenising variables with estimated econometric equations. At this stage, when interlinking the sectors of the economy, numerous meetings and workshops were arranged for the involved institutions to participate and propose alternative closure rules and to discuss their implications. In particular, discussing the link between the fiscal sector and the monetary sector caused many viewpoints and resulted in new insight among the participants. The final version of this aggregated model constituted some 100 equations.

The next step was to disaggregate the model incorporating the new input-output tables. This called for a different mindset among the involved institutions. Previous modelling efforts, as already mentioned, had been a top-down approach to forecasting, first estimating GDP outside the model and then distribute it to the industries. The new methodology based on a bottom up approach where GDP is found by summing value added by industry was a huge improvement and also contributed to new insight into the economy. This step had additional advantages; first, it created a closer link between the model builders and users (at the Ministry of Economic Planning and Development, the Ministry of Finance and at the Reserve Bank of Malawi) and the producers of the national accounts and the input-output tables (the National Statistical Office). Second, as the model evolved the interdependencies became clearer amongst the involved institutions. This has attracted attention and commitment to the modelling project, and contributes to a more holistic approach in producing forecasts and analysis.

To further increase sustainability of the project there has been attempts to gain a foothold in the academia in Malawi. Increased links to academic institutions is a way of ensuring continuity of modelling work, because the university provides the necessary training of staff likely to be recruited into the government ministries. The plan is to give regular lectures on the macroeconomic model at the university and to offer master student to use the model for their thesis.

All these steps are expected to contribute to anchor the macroeconomic model within the co-operating institutions. However, this alone, even if successfully implemented, will not be enough to secure that capacity has been built and that institutional memory has been added. There also has to be demands on the Malawian institutions involved with respect to their skills and commitment. To achieve the goals there has to be a clear understanding about the capacity already in place in the partner institutions. Although the level of skills varies across institutions and individuals, a general understanding is best obtained during workshops and especially when undertaking on-the-job training. In the case of Malawi there were not many surprises regarding the skills level. Moreover, as project participants have returned from master studies abroad we have noticed a more mature academic approach in contributing to the project.

We identified the turnover of personnel in the government system as one of the major risk factors to the project. As expected we have had our share, but not more than the project should be able to handle. Safeguarding against the risk of key personnel leaving office is difficult. However, general awareness, a positive reputation, and the model becoming more essential to the government will help moderate this risk. To better take new members aboard the model team, it has been a priority to create teaching materials and model related documents. Moreover, staff already trained is expected to give initial training to support newcomers.

2.3. Exit of the project

The exit strategy is an integral part of the project document. The macroeconomic modelling project is established for a fixed period of time and the full success may only be realised after the project has ended. The exit of the project is somewhat tied to the targets specified in the project document but is also constrained by a time-bound and available funding.

Targets are not always fully met during implementation of the model project. Usually, in order to get back on track, we either continue work to meet the target, delaying other project activities, or the technical advisor steps in to get the work done. In this project, targets are regularly monitored and evaluated so that we can predict what is being handed over. A minimum requirement for a responsible exit is that the local model group manages to maintain and use the model system without a technical advisor in place. As indicated above, the regular use of the model will gradually be taken over by the local model team before the technical advisor withdraws. Even though this does not mean leaving the model team all to themselves, it will require all their efforts to carry out everyday activities. During this phase Statistics Norway will be available for direct consultations, short-term visits, and of course there will be funds available for workshops and seminars.

3. Choosing a model

3.1. Use of the model

Choosing what type of model to build clearly depends on what it is going to be used for. In the project document, outlining the scope of the project, it is emphasized that a macroeconomic model will generate capacity within the government of Malawi for conducting macroeconomic simulations, which in turn will lead to reliable forecasts of key macroeconomic variables, and technically informed policy papers, contributing significantly to national economic forums and policy dialogue (NORAD, 2011). In general the intended application of the model is for regular forecasts and analyses. The forecasts are frequently updated; both in the event of changes in important assumption to the model but also as new statistics emerge.

As Malawi has a long history of undertaking IMF programs, one of the design criteria for the model was to make it useful for forecasts and analysis related to such programs. This implies, among other things, that the model is suitable for use in the process of formulating the government budgets, and has the interlinkages to the monetary sector for estimating the increase in the money stock as a result of any financing needs due to fiscal deficits. This also requires a proper modelling of the second round effects to keep track of the revenues from tax and subsidy policies. The project intends to establish model use as a routine when the government budget is prepared and reviewed. Enabling the government of Malawi to meet with the IMF with their own model based forecasts and analysis is a huge step forward, and, as the model documents are openly available, defines a framework for professional discussions.

Using the model has made it apparent that the new methodology is a huge improvement on previous efforts. It has contributed to new insight into the economy and created a closer link between the model team and the producers of the statistical input to the model. This, in effect, acts as a quality assurance system providing important feedbacks from users to producers of the statistics.

The model has been used to produce the scenario in the Macroeconomic Framework chapter in the MGDS 2 document. Here we also carried out model simulations to substantiate and underpin the analysis, in particular related to tax policies, import substitution and transport costs. Further, the model is intended to be an important tool in the annual review of the document.

3.2. Is big better?

During the recent decades the art and science of macroeconomic modelling has developed tremendously. These developments consist of improvements in computational capacity, new developments in econometric methods, new macroeconomic theories and advances in the quality and availability of the required data. The new generation of modellers should take advantage of these developments to build large scale macroeconomic models and conduct various econometric diagnostic tests.

However, it is also argued that analysis of the economy will be more difficult when there are numerous equations in the model, thus advocates of small scale modelling suggest that small models can explain the economy more efficiently. Their arguments are that one needs to "keep it sophisticatedly simple". It is "much easier to see the forest when the trees are fewer" (Bodkin and Marwah, 1988, p.301). Arguments from advocates and critics of large scale models can be found in Friend and Taubman (1964), Fair (1971, 1974), Kmenta and Ramsey (1981), and Klein (1989).

Klein (1999) argues that small models cannot capture the complex nature of an economy and this may result in misleading policy conclusions. In addition, Bodkin et al. (1991) state that a complete model often includes three sub components; national income, input-output and flow of funds. Thus a macroeconomic model becomes larger in size if the aim is to have a full model.

When the Malawian model project started we opted for a "big" model. We wanted the input-output table (then not yet finished) to be the core of the model. This disaggregation into 27 domestic industries, out of who 15 was also importing, caused many equations. We also model prices of intermediate inputs and all the 35 final demand components. We planned to link this core to the fiscal component, as well as to the foreign and monetary sectors.

While waiting for the new national accounts we had to use the data already in place. These data were compiled mainly from the Business Interviews and consequently biased towards the supply-side. But, they contained relatively consistent time series, starting from the late 1960's, which enabled us to estimate behavioural equations for consumption, prices, export and import. It should be noted though that in compiling these "national account" figures, consumption was derived as a residual, possibly containing miscalculation and other errors. Fiscal and monetary data are on a monthly basis and, although of dubious quality, quite up to date. Even though it was an aggregated model, we had all the relevant linkages between the main sectors of the economy (real, fiscal, foreign and monetary) in place, and, after all, many of the issues in econometrics and economic theory are more or less the same irrespective of the level of aggregation. As far as we know this was the first time these four components were put together in a simultaneous system in Malawi.

3.3. Are models useful?

The global economic crisis that emerged in 2007/8 has brought macroeconomic issues back to the forefront and has highlighted the importance of addressing uncertainty and robustness for both policymakers and modellers. Although one might claim that different theoretical framework amongst economists is the most fundamental source of uncertainty, there has been a significant convergence in economics in the direction of a common methodology based on firm micro – foundations. Since the 1990's and onwards there has been a growing interest in developing macroeconomic models having a transparent theoretical foundations, i.e. including long-run structural relationships suggested by economic theory, but also flexible dynamics that fit the historical time series data reasonably well (Intriligator et al., 1996, p.9). By no means does macroeconometric modelling at present appear to be weaker than before. The use of various models in formulating monetary and fiscal policy will continue to be an essential component of the policy procedures followed by central banks and finance ministries in both developed and emerging economies (Levine, 2009).

The Malawian institutions involved in the modelling project have been in need for a macroeconomic model. The MEPD are to provide strategic guidance, advice and technical support to government and other stakeholders on economic and development planning. Among its core functions is to carry out analysis and formulation of the country's economic development policies. Further, the MoF formulate fiscal policy and manage financial and material resources of the government of Malawi. The Reserve Bank of Malawi, with its independence from the government, has the full mandate to conduct monetary policy. They therefore have to ensure i.a. that fiscal developments are consistent with monetary developments. This new macroeconomic model has the potential to be a very useful tool for the involved institutions in conducting their directives. Moreover, using a scientifically based tool for their analyses will enable the government of Malawi to meet with international institutions such as the International Monetary Fund (IMF), the World Bank and other development partners on more equal terms.

Macroeconomic models are useful in structural analysis, forecasting and policy evaluation, provided they are subjected to some parametric tests prior to and after the release (Intriligator et al., 1996). The tests recommended, which are of paramount importance in evaluating the validity of macroeconomic models, are classified into tests for single estimated equations and test for the full model. Within the two categories are the standard measures, e.g. *t* and *F* tests to check for statistical significance, testing for the expected theoretical signs of parameters, and diagnostic and long-run stability tests. For testing the full model they propose dynamic tracking performance using some goodness of fit statistics. Moreover, before one start using the model, the model-builders must check if the dynamic response of the full model is acceptable (checking multipliers and characteristic roots) and in line with theoretical expectations.

According to macroeconometric model-builders, the implementation of the above-mentioned requirements usually settles the divergent opinions between modellers and critics. However, critics of macroeconomic models should recognise that, compared with the Vector Auto-Regressive (VAR) models and the calibrated Computable General Equilibrium (CGE) models, macroeconometric modelling still remains "the most promising approach to understanding macroeconomic behaviour generally and is the most likely approach to provide a really powerful policy tool" (Hall, 1995, p.975).

4. Aspects from the macroeconomic modelling perspective

Developing economies have several special features separating them from industrialised countries that need to be recognized, and should be addressed carefully when designing a macroeconomic model. In this section we discuss some of these from the macroeconomic modelling perspective and relate them to the modelling project for Malawi.

4.1. Real sector - accounting framework and behavioural equations

An obvious starting point in building any macroeconomic model is an accounting framework. However, the selections of relevant accounting relationships depends on what the model is supposed to shed light on, data availability, as well as the structure of the country's economy. There could, for example, be a "standard" accounting framework supplied with particular features such as alternative choices of disaggregation of production and consumption. Structural features of the labour market, e.g. a large informal sector might call for "non-standard" accounting. Further, the degree of development of the financial system will also be influential when deciding on how to model the monetary account.

When an aggregate accounting framework has been put in place, the next step is to give economic content to these relationships by adding suitable behavioural equations and equilibrium conditions. However, accounting relationships might need careful consideration because of behavioural equations. For example, developing countries are often exposed to credit and foreign exchange rationing, and we may need to incorporate the implications of this in private decision rules. Credit rationing will place liquidity constraints on aggregate consumption, and if consumers do not behave according to the permanent income hypothesis, due to credit constraints every period, a standard "real business cycle model" will fail to explain consumption. Also, because credit frequently is denominated in foreign currency, the recipient countries are exposed to foreign exchange risk. Foreign exchange constraints result in, amongst other thing, that (private) industrial enterprises are being held back from importing equipment and raw material requirements. Credit and foreign exchange rationing will also affect how other elements of the economy should be modelled, for instance investment, asset demand, export supply and import demand functions.

In the model for Malawi, we started with simple aggregated identities describing the four accounts. The real sector adds up GDP from the demand components of the economy. Total consumption is divided into private and government consumption. Private consumption is separated into "monetary" consumption representing the formal economy, and smallholder farmer's consumption. Monetary consumption is modelled as a function of real disposable income, no interest rate or wealth term is included. The interest rate did not give any significant explanatory effect on consumption, whilst the wealth was omitted because of lack of data. When we had more detailed information from the new national accounts we included consumption by non-profit institutions serving households (exogenous), and we introduced a linear expenditure system to distribute consumption to sub-categories. Although imposed, as is often the case, the estimated coefficient for real disposable income in the consumption function showed a very close relationship between change in real disposable income and change in consumption. This might be explained by the "myopic" behaviour one could expect from credit rationing discussed above.

The core of the model is the input-output tables (IOTs) derived from the national accounts. The input-output coefficients used in the model are calculated from the latest version of the IOT, which also defines the base year of the model.

Furthermore, the IOTs from 2002 to 2007[2] make up the bulk part of the data for the model. Moreover, it should be noted that we also have all the input into the economy separated into domestically produced and imports. This means we have detailed information on use of all input to the economy (domestic production and import); i.e. to intermediate use by industry or to final demand by component.

One particular feature, prevalent among most developing countries, is the large amount of smallholder farmers producing mainly rain-fed maize, groundnuts, roots and tubers for own use. Because many lack access to functioning input and output markets, it makes economic sense to produce maize despite its low value. There is evidence that most smallholder's practice a "safety-first" strategy to allocate household assets first to produce enough food for own consumption and only then adopt a profit maximizing strategy (Alwang et al., 1996). The food security constraint lowers household income, and its "removal" should allow smallholders to produce higher-value crops. This feature of a "food security constraint" can be modelled by applying a "safety-first" condition to the household's objective function (Alwang and Siegel, 2005). A very useful design of the IOT, also reflected in the model, is the separation of supply from the smallholder industry into "production for own use" and "production for market". This design is useful for analysing policies attempting to boost smallholders' production to the market.

The government sector plays an important role in developing countries. Its behaviour affects the real economy mainly through its revenue collection, spending, and employment. In the first aggregated model for Malawi public consumption was linked to the public wage bill and purchases of goods and services. In the disaggregated model public consumption is determined within the input-output block. It has a residual role in the sense that the level of private sector demand, for given government output, determines what is left for public consumption. Value added by the government industries are linked to their respective wage bills.

Modelling the links between the public and the real sector is not straightforward. This is mainly a problem arising from the use of data from different sources. In the MalawiMod we have defined government expenditures in a standard way making use of data both from the national accounts and the fiscal tables. From the national account we have records for government intermediate and final consumption, as well as investments. Moreover, from the fiscal tables we have interest payments, transfers, and "recurrent expenditures", the last-mentioned constituting a mix of intermediate use and final demand, and some elements that should be classified as investments. Despite problems aligning the data from various sources one must include this link in the model. In the MalawiMod we have incorporated a residual term in the equation for the government expenditures so that it reproduces its historical values in simulations.

Another feature of the governments in developing countries is the inflow of aid from abroad. In most cases these inflows are either budgetary support, i.e. grants and credit aimed at supporting the government budget, or project support aimed at specific projects. The money aimed for projects are recorded in the fiscal tables as "Development expenditures". These expenditures are neither separated accurately into consumption or investments, nor into public or private capital objects. In MalawiMod, as mentioned above, we use consumption and investment figures from the national accounts and have tried to extract it accordingly from the fiscal tables.

Trade has been recognized as a key element for sustainable growth in both developed and developing countries. Inspired by the gains from trade, many developing countries have adopted an export-oriented approach aiming at

[2] The 2008 and 2009 tables are about to be implemented.

improving internal and external balances and to intensify the efficiency of resource allocation (Berg and Krueger, 2003). This was also the case for Malawi when formulating its MGDS. Trade statistics for Malawi enable us to model exports and imports. In the first aggregated model version we estimated an import share equation and used a standard Armington equation for aggregate export demand. In the disaggregated model we use import coefficients from the input-output table together with an index for import shares to describe import behaviour by industry. For the exporting industries we have applied some guesstimates for the price and income elasticities and done some sensitivity simulations to verify their reasonableness. This will be followed up continuously as new data emerge to arrive at better and hopefully more stable elasticities. The explanatory variables associated with the price elasticity are the relative price between export and import, the latter used as a proxy for trading partner's price level. On the income elasticity we use a trade weighted index for the main trading partners' GDP (covering more than 90 percent of Malawi's export value averaged over the years 2000-2008).

4.2. External sector

One of the most severe problems facing developing countries is to stabilise their external balances, i.e. to reach and maintain a sustainable condition on their balance of payments (BoP). The important characteristics to keep in mind here are related to how they interact with the rest of the world, and how any difference in economic policies compared to developed countries might be dealt with from a modelling perspective.

Developing economies are likely to be more open to trade in goods and services than the major industrial countries. In this regard they are more like small industrial countries. Trade openness has increased over the years and has contributed significantly to developing countries' participation in the global economy. From 1990 to 2008, the share of exports from developing countries grew consistently faster than exports from developed countries or the world as a whole. For example, between 2000 and 2008 the volume of developing countries' exports almost doubled, while world exports increased by "only" 50 per cent (WTO's web page). However, behind the statistical aggregates we see that most of this export growth has taken place in Asia who grew from 10 percent of world export in 1990 to around 22 percent in 2008. Over the same period Africa's share of world export has been more or less constant at around 3 percent. This suggests, especially viewed against the relationship between trade and economic growth, that much more should be done to ensure a wider participation of developing countries in international trade. This should also be reflected in the economic modelling of these countries.

Another crucial feature of developing countries differentiating them from industrial economies is that more than half of their exports are agricultural and primary commodities. Such an export structure may have an enormous potential and needs to be modelled explicitly. Studies show that the world as a whole need to boost the agricultural output by 70% by 2050 to feed everyone. Meeting these targets will most importantly require increased efficiency, but also some expansion of land, in particular in Sub-Saharan Africa and Latin America (OECD, 2011). Figures from Malawi show that the value of agricultural export constituted more than 80 percent of total exports in 2006 (NSO, 2006). The main cash crop was tobacco constituting 61 percent, while tea, sugar and cotton constituted 15 percent. This also emphasise that proper handling of the export in the model is of paramount importance to analyse the effects from increased trade. Although the price and income elasticities are not properly estimated due to the short time series in the national account, it will enable us to undertake analyses related to trade.

Apart from highlighting the importance of modelling the trade properly, this also suggests that when designing a model one have to bear in mind what might be important in the future; although important now, export of tobacco might be going

down in the future due to changes in smoking behaviour while e.g. cereals and cotton might be on the rise. If one expects such a scenario one should try to cater for this while the model is still on the drawing-board although the industries may be rather insignificant at that time. When designing the model for Malawi we expected mining and quarrying to increase, both because of the development of the Kayelekera uranium mine, but also for the industry's potential in general. On this background we decided to model "Mining and quarrying" as a separate industry. Another example highlighting the importance of proper design is, as previously mentioned, the division of output from the smallholder industry into production for own use and for the market. This industry has a great potential for contributing to import substitution, as well as to increase the exports.

In the early days of using models for development policy work, much time was spent finding ways of modelling the behaviour of the foreign trade sectors. Modelling exports, imports, trade balance and balance of payments became important items on the agenda during the 1980's. Various approaches were tried and rejected, but a kind of consensus, assuming imperfect substitutability between imported goods and their domestic counterparts, was reached. The Armington assumption regarding imperfect substitutability (Armington, 1969) was extended to the modelling of exports as well, and was invoked by almost all modellers. To check the reasonableness of the imperfect substitutability assumption is important. There are areas where Malawian domestic production can substitute imports, notably in the agriculture, manufacturing and wholesale industries, but for those commodities of most importance, like fertiliser, medicines and fuel, these possibilities are negligible, at least in the short run.

To analyse policies addressing how to improve the weak balance of payments position in Malawi, which has led to exchange rate instability, we must emphasise how we implement the various components of the balance of payments in the model. Data for trade, factor services, the capital account, the terms of trade and donor inflows is in place. This makes the model useful for counterfactual analysis on e.g. how to encourage the diversification of exports, as the traditional exports like tobacco have not generated the desired level of foreign exchange recently. In the MalawiMod we have a link between the balance of payments and the central bank's balance sheet implemented by equating the balance of payments and the change in net foreign assets position of the banking system from the previous period. The banking system constitutes the monetary authorities (the Reserve Bank of Malawi) and the commercial banks. We have flexibility in the model whether to let any balance of payment imbalances be offset by the monetary authorities or the commercial banks. If we want to impose a current account target, the exchange rate, foreign reserves, or volume of imports will have to take the hit to achieve this. If import is to be controlled e.g. due to foreign exchange restrictions, some components of domestic demand must adjust for this to happen. This can be achieved through government spending limits or tax rate hikes.

As mentioned above many developing countries are recipients of development assistance. Malawi relies heavily on balance of payments support (budget support) from donors, which accounts for up to 80 percent of the country's development budget. Malawi has many programs with development agencies that, apart from the BoP support, finances projects by the means of grants and loans. The IMF, World Bank and the Department for International Development (DFID) in UK have been amongst the most important institutions assisting Malawi. It is important to try to mimic this characteristic into the models. There are many different arrangements but, regarding the balance of payments, it is basically grants or loans to support macroeconomic and structural adjustment programs. The Ministry of Finance, together with other key institutions, set up a financial plan in their annual budgets and medium term frameworks, which also displays their financial needs. This often serves as the basis for the budget support. It is important to capture these capitals flows in the model, both in the revenue side of the government budget, but also in

the transfers from abroad in the capital account of the balance of payments. The capital account is defined in the model for Malawi, accounting for grants, changes in foreign liabilities (commercial banks) and the net flow of credit to government from abroad.

4.3. Public sector

The public sector is another important component of a macroeconomic model that requires careful handling. In particular, the composition of the government budget differs noticeably between industrial and developing countries. The important role of the government in many developing economies is reflected through its structure and involvements in the economy. The public sector usually consists of a central government, local governments, specialized agencies, and public enterprises. Further, there are often financial institutions owned by the government. Adding to these characteristics, absorption of the central government in developing countries is smaller relative to output than in developed countries. Also the spending pattern differs between the two; while developing countries spend more of their budget on public services, defence, education, etc. developed countries spend more on health and substantially more on social security. In MalawiMod we have, according to the input-output table, divided government consumption in two groups; the central government (including defence), and health and education. They consume roughly half each of total government consumption.

How to deal with government owned enterprises is important, and should be discussed to some extent when the model is at the drawing board. These companies are involved in economic activities producing goods and services, but how they cover their costs varies. The solution is often given by the data. If statistics for public enterprises are classified and compiled into the government production activities it can be troublesome to separate it. In the first aggregated model we assumed them to be part of the business sector implying that the government sector was considered mainly a functional unit rather than an institutional sector. Principally this has not changed when we built the model based on the new national accounts, but we do have more details and proper classification of the government activities. The public administration, i.e. the central government is related to enterprises that cover a “small” portion of its costs from sales revenue. This is enterprises like the Malawi Revenue Authorities and Malawi Post Cooperation. It is important to have a transparent and easy-to-follow system for public enterprises, both regarding modelling aspects but in particular how the data is compiled. The classifications are likely to change over time, both as a result of changing standards for the System of National Accounts, and because of privatisation. Many developing economies have put into action extensive privatisation programmes in the last ten to fifteen years. The main reason is to promote economic growth and to reduce public sector borrowing requirements arising from unprofitable public enterprises. Furthermore, to receive loans and the all-important seal of approval from the IMF, which opens the door to other public and private credit, it is likely that Malawi must undertake market reforms like privatisation.

Other public enterprises operate in the market having most of their costs covered from sales income. Prices are often politically decided, and their failures to meet the costs, even though possessing a monopoly, are frequently attributed to the prices. In Malawi this is the case for the regional water boards and the Agriculture Development and Marketing Cooperation (ADMARC). For example ADMARC was directed to sell their maize at Malawi Kwacha (MWK) 60 per kilo in the 2009/10 season while the going market price was between MWK 45 and 52 (MEPD, 2010).

Tax collection in developing countries is hindered by limited administrative capacity and political constraints. This means that direct taxation plays a smaller role than in developed countries. In general, direct taxes, taxes on domestic goods

and services, and taxes on foreign trade account for roughly equal shares of total tax revenue in developing countries. In industrial countries income taxes account for the largest shares and taxes on foreign trade are negligible. In developing countries, the share of tax revenue raised from individuals is much higher than corporate income tax. However, some of these general observations do not seem to be the case for Malawi. In the fiscal tables for the financial year 2010/2011 direct taxes was about 44 percent of total tax revenue, while indirect taxes was about 46 percent. The remaining taxes came from taxes on international trade. Tax on individuals (Pay As You Earn, PAYE) was 53 percent, while company tax was 47 percent (Company Assessment 29 percent and Withholding tax 18 percent).

In the first aggregated model we used import value as the tax base for taxes on international trade, while the value added tax (VAT) was linked to private consumption. In the current model, based on the input-output table, we have records for VAT and product tax by all intermediate and final demand components. These figures, however, deviate somewhat from the tax revenues in the fiscal tables, but has proven to be very useful for analysing the annual government budget as the model take into account the second-round effects of tax rates on tax bases.

In MalawiMod we have emphasised the government's role. In short we calculate the revenues as the sum of tax revenue, other non-tax revenue and transfers from abroad to the government which is basically grants. Tax revenues are endogenous in the model. Product tax and VAT are determined from exogenous tax rates, weighted with tax coefficients from the IOT and applied to the relevant tax base (intermediate goods and final consumption). Direct taxes on households are linked to their gross income using a calibrated tax rate. The balance on the government budget is calculated as the difference between revenues and expenditures, and linked to the monetary sector in order to estimate the impact on the monetary variables.

4.4. Monetary sector

When designing a macroeconomic model the dynamic linkage related to monetary and exchange rate policy rules and the rest of the economy need to be highlighted. Inflation used to be a recurring feature of the Malawian economy, and consensus has been that its main cause has been the rise in money supply induced by fiscal deficits. Through various IMF programs, spanning more or less from the late 1970's until today, the inflation came down to single digits in 2007, partly because of fiscal measures combined with ceilings on domestic borrowing. However, due to the exchange rate instability and the resulting devaluation of the Malawian Kwacha in 2012, increased import prices put the inflation at more than 25 per cent in August 2012.

Also in developing countries there has been a disagreement among modellers with respect to the source of inflation. Basically this is about whether or not growth in money supply has a causal role. The non-monetarists view the source of inflation mostly as a result of sluggish relative productivity growth in agriculture, combined with politically fixed prices. The low productivity in the agricultural sector is often a result of poor land distribution and land ownership arrangements. Furthermore, the administered prices will often lead to downward price rigidities.

Exchange rate modelling requires special attention as well. In particular, one needs to identify special features such as "fixed" with rationing and simultaneous transactions in parallel markets when these are present. Moreover, the macroeconomic consequences of altering the peg (typically devaluation) and of the rules for moving the peg are of importance. The advocates of orthodox macroeconomic management assume substitution possibilities for imported inputs. This is often not the case in developing countries, so a policy of combining devaluation with tight fiscal and monetary policies might well result in stagflation

in the short-run with little or no improvement in the external accounts. Contractionary effects of devaluation may also destabilize the economy, and could be included as a theoretical possibility that may sometimes become a practical problem.

During the spring of 2011 there was a strong pressure on the Malawi Kwacha leading to a large difference between the official exchange rate and that of the parallel market. As currency was not available through the official channels businesses bought foreign exchange at the parallel market. The price they sometimes had to pay indicated that the MWK was 40-50 per cent overvalued. The parallel market prices transmitted into the economy and led to a general price increase. At this time the MalawiMod was used for forecasts related to the MGDS 2 document. In order to approximate these circumstances we had to overrule the real effective exchange rate in the model.

The debt overhang facing many developing economies, apart from how this influence on production and private investment decisions, can lead to currency substitution and informal financial markets on money demand. Many results show a strong link between high levels of indebtedness and unfavourable terms of trade among commodity-dependent countries. Further, results also show that the degree of openness has a significant influence on their external debt level (Swaray, 2005). The accumulation of foreign debt among less developed countries in the 1970's reached a crisis level in the 1980's. Many less developed countries have, since that time, declared serious debt crises. This led to debt rescheduling and debt forgiveness, culminating by the turn of the millennium. From 1999 to 2006 Malawi's external debt was between USD 2,500 and 3,200 million. In August 2006 Malawi reached the "completion date" for Heavily Indebted Poor Countries (HIPC), when most of its debt was forgiven (about USD 500 million remained). In June 2009, Malawi's external debt amounted to USD 712 million. Most of the debt is held by the government and the Reserve Bank of Malawi (81 and 19 percent in 2008 respectively), and the creditors are mostly multilateral organisations (88 percent in 2007) (Malawi Government, 2009). A well-known characteristic of African states is that government is the largest consumer of foreign exchange, in the context of debt service payments. This means that exchange rate depreciation magnifies the public sector net cash requirement and leads to a faster rate of monetary growth, thus resulting in further cyclic inflation.

Public domestic borrowing is the most common way for the government to finance its current spending. The interest rate on this debt is market determined in the sense that investors consider the risk-weighted return when making a decision whether to buy public debt or invest in other assets. In MalawiMod we endogenise the interest payments on this debt in a simple way by linking it to the debt stock. The link is the calibrated ratio between the interest payments and the average of the two latest year of debt. The public foreign debt is different. This is mostly some sort of development assistance with a low interest payment and a long term structure. The interest rate on this debt is exogenous by nature.

Foreign exchange reserves in Malawi have been under pressure for a long time. A goal has been to keep the reserves at least at a level equal to three months worth of imports. This is important in the case of a severe drought that inevitable will hit the country from time to time. This is not implemented as a restriction in the model but the number of months of import cover is a measure that is frequently reported.

When trying to model the monetary sector one should also bear in mind that financial markets in many developing countries are characterized by immature financial institutions. This is of particular relevance when it comes to attract foreign capital to level out any current account deficit, but also when analyzing policy impact on poverty reduction from macro to micro level. In the first model version we specified a number of important financial variables as exogenous. Most

importantly this related to the exchange rate and various interest rates. These variables are unquestionably related and may be described by a money market interest rate. Still, the question on how to model this money market rate will be left unanswered. The differences between short and long term interest rates on assets are also issues to be considered.

The major source of data used for the monetary sector is the monetary survey from the Reserve Bank of Malawi. It records the monetary authorities and the commercial banks' assets and liabilities and, on this basis defines the money stock. The main aggregate is the "broad money" defined by the sum of net foreign assets and net domestic assets. The foreign assets of the monetary authorities are mainly foreign reserves, whilst its major liabilities are with the IMF. For the commercial banks the foreign assets is mainly foreign currency denominated accounts (FCDA's).

4.5. The supply-side

To be able to forecast and analyse implications of supply-side policies, aggregate supply and the input factor market are aspects that need some further attention when building a model for a developing country. Most governments now accept that an improved supply-side performance is the key to achieve sustained economic growth without a rise in inflation. However, supply-side policy alone is not enough to achieve this growth; to fully utilise the productive capacity of an economy there must also be a sufficient level of aggregate demand.

Intermediate input plays an important role in the economy and is most commonly included in a model through an input-output framework. In general many think of developing countries as importing high-tech intermediate input and export final goods, although this stereotype might be somewhat valid for Asian countries, it is not true for African countries. In the agricultural producing countries in Africa imports of e.g. fertiliser are often significant. When it comes to practical modelling it is important to recognise that the exchange rate influences the economy's short-run supply curve because of the cost of intermediate inputs that are imported.

Although the labour market varies substantially across developing countries, the informal sector continues to play an important role in the determination of wages and employment in many of them. The large amount of smallholder farmers has widespread implication for how a macroeconomic model should be designed and need careful consideration. In longer term planning, when a country develops from subsistence farming to become more industrialised, this group will have a major impact on the supply-side of the economy through its labour supply. The labour market is particularly important for analyzing the poverty reduction implications of macroeconomic policies. E.g. in the short to medium term, the output from smallholders have a potential for contributing to an export led growth policy. Moreover, it is well known that developing countries often have hidden unemployment. What is less well known is that many developing countries' labour markets have a high degree of real wage flexibility (Horton et al., 1994). To model these markets one should opt for a detailed mix of flexibility and rigidity into each specific labour market, rather than generalise the behaviour across all labour markets.

Imports have indirect effects on human capital and policies directly aimed at increasing the human capital and to open up for trade will improve economic growth (Guisan and Exposito 2001). There are theoretical and empirical studies on how imports provide knowledge and technology transfer in a macroeconomic perspective (Keller, 2004). This should not be surprising as the use of imported intermediate goods implicitly involves the use of technology and knowledge embodied in them (Romer (1990), Grossman and Helpman (1991), Eaton and Kortum (1999, 2002)). During recent years there has been focus on attracting foreign direct investments into developing countries. Foremost to increase the

amount of physical capital, but also because of the positive effects it has shown to have on the human capital. These effects are difficult to estimate but they will in general show up in the total factor productivity term of the production functions.

In the first version of the model for Malawi demand for production factors was treated quite simple. Demand for intermediate use was assumed to be a fixed (although changeable) share of output, demand for capital (investments) was exogenous, and demand for labour was estimated at an aggregate level and distributed to the respective industries using fixed shares. In the current version of the model demand for production factors is modelled within a neoclassical Cobb-Douglas framework with production functions by industry using intermediate goods, labour and capital is used as input factors for production. We have made no attempts to describe changes in total factor productivity in terms of e.g. learning, health, etc., but have included a trend term to capture this in the factor demand equations. As previously mentioned we only have the necessary data spanning from 2002 to 2007 except for labour where statistics is almost non-existent for the private sectors. Investment is still exogenous but capital stock accumulation equations are implemented. Assuming producers minimize variable costs, and using national account information on cost shares in total output, we estimate the parameters related to relative prices in the factor demand equations. Further, we assume some costs of adjustments by adding a simple lag structure to the factor demand equations. We are awaiting a planned labour force survey that will provide more data and hopefully add more reliability to the coefficients put in place.

Total labour supply follows population growth. After demand from the private and government industries has been determined from the factor demand equations the balancing item is the large informal workforce, i.e. any unemployment is concealed within it.

Financial constraints, as we have mentioned before, is a widespread problem in developing countries. Considering the firms, costs and access to finance is among the top five problems they face (Hallward-Driemeier and Smith, 2005). An often ignored mechanism by which financial constraints can affect firms is working capital that is needed to cover costs of operations before revenue is received. For example, the farmer needs to purchase seeds and fertilizer before his crop is harvested. In the short run this may affect the supply-side as the cost of financing working capital increases the roles of the interest rate and the credit availability. Further, this would imply, for instance, that contractionary monetary policy may results in stagflationary effects in the short-run. Also, results show that under constraints, firms have to choose between factors in allocation of scarce cash, leading to countercyclical capital behaviour. Moreover, substitution between factors is driven by binding constraints and changes in output price and not by changes in relative factor prices (Chan, 2008).

5. Putting it all together

In the previous sections we have discussed features concerning various parts of a macroeconomic model for developing countries. We related these, both in the case of Malawi and in general, to the real, fiscal, foreign and monetary accounts. In this chapter we will have a look at some models used frequently in developing countries, and how they have dealt with the interlinkages. In addition, we will explain how this is done in the model for Malawi, and present a small example of use of the model.

Many developing countries have been evaluated and analysed using models; most famous is the Revised Minimum Standard Model (RMSM) of the World Bank and the Financial Programming Model (FPM) of the IMF. The RMSM is designed to project a country's external resource needs based on different assumptions for the (exogenous) GDP and export growth. It also describes the link between the BoP projections and the resulting external debt and debt servicing prospects. The model is meant to be a tool for forecasting small countries' economies and is built around the macroeconomic balances and quite detailed data on debt positions. The model is popular and frequently used by the World Bank because it is (assumed to be) usable across countries and therefore it is "minimum standard" in the modelling sense. The model is built for a conveniently simple recursive solution procedure.

Many key variables, including so called "Policy targets", e.g. planned value added growth by sector, growth of export, the exchange rate, and the planned growth rate of government expenditures, are input to the model. Further, it uses investment elasticities to sectoral GDP and the ICOR (Incremental Capital-Output Ratio) to determine investment by sector. One of the most attractive features of this model is that it is easy to understand and not data intensive. However, the RMSM is by many considered incomplete for development planning. The main critique, first pointed out by World Bank economists, is the inflexible prices, the insufficient disaggregation of the household sector, and that these types of models are designed for shorter terms than the horizon one would expect for development planning involving structural adjustments.

A second and third generation of the model was built to cope with this. The second version, called RMSM-X (X=extended), includes prices and features of the open economy. It also has added a fiscal and a monetary block. The third generation model (RMSM-XX) adds behavioural equations for the main macro variables. This version also describes relative prices and deals with the distributional dimension. This extension made the model more in line with many other models, but quite different from the original RMSM. As opposed to the two previous versions, RMSM-XX is solved simultaneously.

IMF programs has played an important role in many countries, including transition economies, and more recently, industrialised economies. The programs, and keeping to them, are critical elements in macroeconomic policies, and are requirements to get access to loans. The FPM of the IMF is designed to analyse short term macroeconomics, and is built around three identities; the central bank's balance sheet (monetary identity), the BoP constraint, and the government budget. One essential link is that between the BoP and the central bank's balance sheet, i.e. a monetary approach to the BoP is taken into account (Fischer, 1997).

One of the most important policy instruments used by the authorities to influence macroeconomic developments is the change in the size of the money stock (Barth et al., 2000, p. 152). The monetary identity, considered the most important identity in financial programming, makes it clear that the change in (the sum of) domestic credit and net foreign assets equals the change in money supply. The net foreign assets are usually measured in US dollars and converted to local currency using the exchange rate.

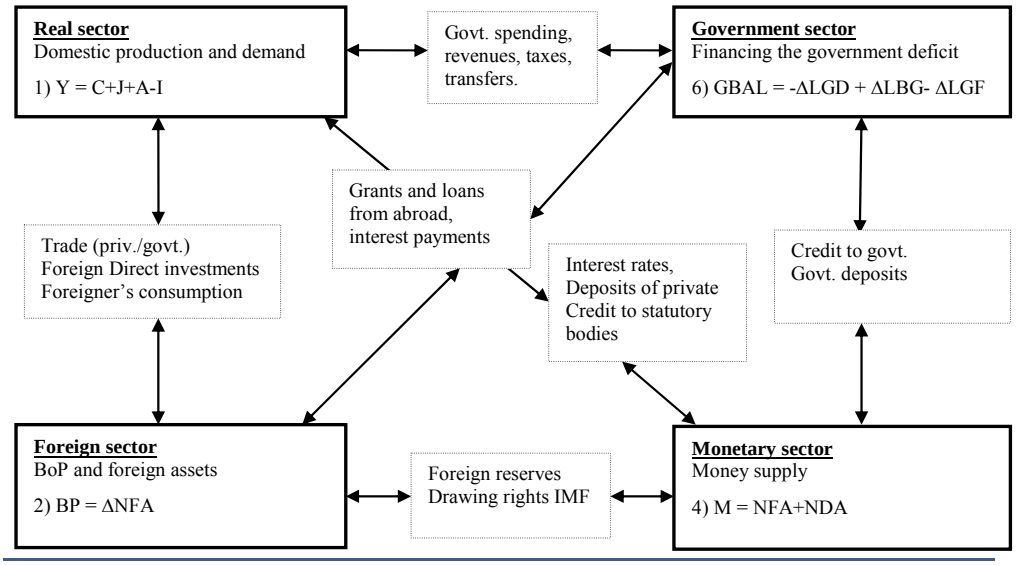
The IMF normally wants to control the money growth by introducing a ceiling on the net domestic credit as a condition for undertaking a program with a country. Often the IMF needs to bring inflation under control and use a monetary anchor, usually a target for central bank money, to achieve this. The monetary identity is linked to the government budget by assuming any budget deficit is financed by an increase in government borrowing, hence in the money supply. The main identities in the model are essentially the same as in the RMSM-X model. However, it should be noted that using a monetary aggregate as a target has its pros and cons. The rationale is that there exists a stable demand for the monetary aggregate that depends on the economic activity and the price level. But, money demand has been unstable in many countries limiting its usefulness as an indicator for monetary policy. Also, the monetary aggregate versus e.g. GDP tend to grow as a result of financial development and more macroeconomic stability (Masson, 2006). In Malawi the GDP/broad money ratio has risen from 0.16 to 0.20 over the period 2002 to 2007.

The process of coming up with a Poverty Reduction Strategy Paper (PRSP) in developing countries created a new demand for a more simplistic modelling framework. As mentioned above, the IMF's FPM and the World Bank's RMSM-X, taking the two important determinants of poverty, economic growth and relative prices, as exogenous, made them unsuited to evaluate the impact of policies on poverty. More complicated models, such as disaggregated computable general equilibrium models, come closer to capture these poverty impacts, but they are very data intensive and difficult to master in the short time-frame of the PRSP process. To deal with the PRSP the World Bank came up with a technique linking a simple static computable general equilibrium model with household survey data. The model represents a compromise between the two approaches. It is simple to estimate, learn and use (like the RMSM-X and FPM), but captures the links between macroeconomic policies and shocks and poverty in a way that is both consistent with economic theory and faithful to the structural characteristics of the country. This model is called the 123PRSP Model (the acronym stands for one country, two sectors, and three commodities). The model has been developed and used by teams from Mauritania and Zambia in their PRSP process (Devarajan and Go, 2003).

MalawiMod has more than 700 equations, with a simultaneous block containing some 510 equations. It captures the linkages described above but lacks a "poverty module" linking the macroeconomics to the households. In Figure 1 we have illustrated the relationships between the four accounts in the model of the Malawian economy. In the block for the real sector output and prices are determined together with the trade variables. The link to the government sector goes through government revenue and spending, taxes and transfers.

As Malawi has undergone many IMF programs we wanted to implement the important link between the government sector and the monetary sector. In the box representing the government sector in Figure 1 their balance (GBAL) is derived from the difference between government revenues (including grants) and expenditures. We let any government deficit be financed by an increase in domestic credit (LGD), i.e. credit to the government from the monetary authorities. Out of Malawi's total domestic debt stock at MWK 172.7 billion (end of 2009) about 57 percent were T-bills and T-notes (39 and 18 percent respectively) held by the Reserve Bank of Malawi. About 29 percent were held by commercial banks. Alternatively we can assume the government borrows from abroad (LGF), but we have let this to be exogenous. If one chooses to have a fixed value of the government budget balance due to say financing restrictions or targets on domestic borrowing, parts of government spending can be made endogenous in order to meet that target.

Figure 1 Interlinkages in the macroeconomic model for Malawi



Although an increase in government spending will result in an increase in the net domestic credit to the government, the dependence upon imports in government spending will also affect the net foreign assets (NFA). As we have mentioned above, government is the largest consumer of foreign exchange. This effect is captured through the input-output table, and is represented in Figure 1 with the link between the government sector and the foreign sector.

Classical trade theories argued that a trade balance should be zero in equilibrium. By studying trade statistics one can see that this is rarely the case. This led to a debate whether the equilibrium assumption was violated or not, and how to deal with this in practical modelling. The most common way to handle the non-zero trade balance was simply to exogenise it, assuming the trade imbalance was matched by the saving-investment imbalance. This, however, does not seem to be reasonable for the less developed economies with imperfect capital markets. In Malawi, the nominal interest rate on savings account currently (August 2012) range between 6 and 7 percent while the inflation rate is around 25 percent implying a negative real interest rate giving a disincentive to savers. Commercial banks' lending rate, however, is around 20 percent. Neither is the financial market in Malawi very well integrated to the international market. Recent information reveals that foreign portfolio investors are scared away from the capital market in Malawi due to i.a. shortage of foreign exchange, and unstable electricity supply. If foreign investors are unsure whether they can repatriate their dividends they will probably not enter the market in the first place. Rather than being attracted by higher interest rates, foreign investors are more concerned about the stability of the general economy, in particular with respect to inflation and exchange rate.

The Mundell-Fleming model (see Mundell, 1963) has since long been the work-horse of open economy industrial country models. It assumes endogenous terms of trade determination, with the domestic economy completely specialized in the production of a good over which it exerts significant market power. Neither this model seems to be entirely adequate to describe the situation on the ground in Malawi. To a certain extent it is reasonable to assume that developing countries like Malawi have little influence on prices of traded goods, and, in particular, often face exogenous terms of trade. In MalawiMod we have, for most of the industries, assumed that export prices are given at the world market. However, for the industries "Smallholders production for market", "Mining and Quarrying" and "Wholesale and Retail trade" we have included a domestic cost component (variable unit costs) to determine the export price.

The import price equations are where the exchange rate enters the model. Import prices are modelled by industry as either entirely given by the world market price, or also to include a domestic cost component according to the "pricing to market" hypothesis (Krugman, 1986). The foreign sector is linked with the monetary sector through the BoP identity. We assume a trade deficit is offset and accumulated into the net foreign assets of the commercial banks.

It is important, in general, to bring attention to the fundamental question on how monetary and fiscal policies affect availability of credit to the private sector. In particular if the bank lending channel for monetary transmission is effective, and to what extent a decline in government financing needs results in more loans accessible for private sector and households. Like in many developing countries, the traditional channels, i.e. interest rate, bank lending and asset prices are impaired in Malawi (Mishra et al., 2010). However, fiscal restraint will, in the model, lead to less government financing needs and make more credit available for the private sector.

The link between the real sector and the monetary sector works through the interest rate faced by consumers and companies, which is affected by the policy rate. Also, credit from the monetary authorities to the statutory bodies, i.e. state owned enterprises, creates a link between the two accounts.

Box 1 Some stylised shocks to the macroeconomic model for Malawi

This box reports some stylised shocks to the macroeconomic model for Malawi to illustrate particular aspects of uncertainty around the projections for the MGDS 2 document. In working towards its goal to reduce poverty, one of the government policies is to transform Malawi from an "importing and consuming economy to a producing and exporting economy". The two alternative scenarios simulated, both separately and combined, are:

Import substitution: Malawi has a history of trade deficit. In this simulation it is assumed that Malawi manages to achieve some import substitution. Import shares are assumed to have a half percentage point lower growth rate than in the baseline.

Reduced transport costs: Transport costs contribute significantly to the price facing the Malawian consumers on imported goods. In this simulation it is assumed that the new Nsanje inland port and the Shire-Zambezi waterway will reduce transport costs. Specifically it is assumed that this will lead to an increase in export volume by about 2 percent, and that import prices will be reduced by 2 percent.

As it appears from table 1, import substitution will increase GDP by 1.3 percent after 5 years. GDP continues to increase because the import shares are reduced gradually. The current account improves by 0.6 percentage points of GDP. For the sector importing most, "Manufacturing, other", import volume decreased by 1.2 percent (MWK 3.2 billion) after five years. Further, our results suggest that reduced transport costs will have similar effects on both GDP and the current account. The main driver behind the increase in GDP is the export volume. The combined effects are shown in the third column.

Table 1 Import substitution and reduced transport costs – Effect on key variables

	Import substitution			Reeduced-tran sport-costs			Ccombined		
	Year			Year			Year		
	1	3	5	1	3	5	1	3	5
GDP[1]	0,3	0,8	1,3	0,9	1,0	1.1	1.2	1.8	2.4
Current Account[2]	0,1	0,4	0.6	0.3	0.4	0.5	0.4	0.8	1.0

[1] Percent difference from baseline.
[2] Percentage point of GDP difference from baseline

Although statistics on the various accounts may be quite consistent internally, there have been some problems when they are modelled in a simultaneous system. In particular the link between the BoP and the monetary sector is difficult. The BoP statistics is settled against the change in net foreign assets of the monetary survey, and is generating large residuals in the model (the "Errors and omissions" in the BoP table). Also the link between the government expenditures and the real side is problematic. As mentioned above we need to put in place a residual term to balance the equation for the historic data. This is a general problem when interlinking the various sectors of the economy and one need to pay attention on how these residual terms are extracted throughout the forecasting period as they might have major impact on the outcome of model simulations.

6. Conclusions

In designing a macroeconomic model for developing economies it is important to define the intended application of the model, investigate the data availability, and to gain knowledge about the structure of the economy. There are features concerning developing countries' economy that call for a different model compared to industrial countries. In particular this concerns the modelling of private sector behaviour in the case of credit and foreign exchange rationing, but also how the government finance any budget deficit. In the attempt to forecast key economic figures one should strive to depict the links among the macroeconomic accounts, preferably in a simultaneous system. These interlinkages are affected by features concerning developing countries. In particular the importance of the public sector, the problems related to the balance of payments, and the immature financial markets.

The smallholder farmers will often have a major impact on the supply-side of the economy through its labour supply. A macroeconomic model must incorporate an appropriate mechanism to integrate this group into the ordinary labour force.

The recent year's attention towards poverty reduction and the associated need for an instrument to translate macroeconomic forecasts and simulations into microeconomic information suggests that a model for developing countries include a module for this purpose. This link to the micro level can be based on e.g. household surveys containing information on demography, poverty groups, age groups, etc. This will allow the user of the model to analyze the effect of macroeconomic developments and policy on the poverty level. Also of interest is to analyse to what extent high economic growth reduce poverty. For a long time evidence has existed that high rates of growth not always translate into welfare gains for the population as a whole (see for example Fishlow, 1972).

References

Alwang, J. and P.B. Siegel (2005): Poverty Reducing Potential of Smallholder Agriculture in Zambia: Opportunities and Constraints, Africa Region, Working Paper Series No. 85. The World Bank Washington, DC, USA.

Alwang, J., P.B. Siegel and S. Jorgensen (1996): "Seeking Guidelines for Poverty Reduction Policies for Zambia," *World Development*. Volume 24, No. 11, pp. 1711-1723.

Anderson, L.C. and Carlson, K.M. (1970): A Monetarist Model for Economic Stabilisation. *Federal Reserve Bank of St. Louis Review* 52(4), pp. 7-25.

Armington, Paul S. (1969): "A Theory of Demand for Products Distinguished by Place of Production", IMF Staff Papers, Vol.16, pp. 159-176.

Barth, Richard and William Hemphill, with contributions from Irina Aganina, Susan George, Joshua Greene, Caryl McNeilly, and Jukka Paljarvi (2000): *Financial Programming and Policy: The Case of Turkey*, IMF Institute, International Monetary Fund: Washington DC 2000.

Bautista, R.M. (1988): Macroeconomic Models for East Asian Developing Countries. *Asian-Pacific Economic Literature* 2(2), pp. 1-25.

Berg, A. and A. Krueger (2003): Trade, Growth, and Poverty: A Selective Survey. IMF Working Paper 03/30.

Bodkin, R.G. (1988): A Survey of Non-Dutch European Macroeconometric Models: Some International Perspective. In Challenges for Macroeconomic Modelling (W. Driehuis, M.M.G. Fase, and H.D. Hartog, eds.). Amsterdam: Elsevier Science Publishers.

Bodkin, R.G. and Marwah, K. (1988): Trends in Macroeconomic Modelling: the Past Quarter Century. *Journal of Policy Modeling* 10(2), pp. 299-315.

Bodkin, R.G., Klein, L.R., and Marwah, K. (1991): *A History of Macroeconometric Model-Building.* Aldershot: Edward Elgar.

Brooks, J., G. Dyer and E. Taylor (2008): "Modelling Agricultural Trade and Policy Impacts in Less Developed Countries", *OECD Food, Agriculture and Fisheries Working Papers*, No. 11, OECD publishing, © OECD. doi:10.1787/228626403505

Cappelen, Å., R. Choudhury, H. Kamwana, C. Msowoya, W. Munyenyembe and A. Palamuleni (2006): The 2007/8 Malawi Budget - Macroeconomic implications, Documents 2007/14, Statistics Norway. http://www.ssb.no/emner/09/90/doc_200714/doc_200714.pdf.

Cappelen, Å., R. Choudhury and T. Harding (2006): A small macroeconomic model for Malawi, Documents 2006/3, Statistics Norway. http://www.ssb.no/english/subjects/09/90/doc_200603_en/doc_200603_en.pdf.

Capros, P., Karadeloglou, P. and Mentzas, G. (1990): An Empirical Assessment of Macroeconometric and CGE Approaches in Policy Modelling. *Journal of Policy Modelling* 12(3), pp. 557-585.

Challen, D.W. and Hagger, A.J. (1983): Macroeconometric Systems: Construction, Validation and Applications. London: Macmillan.

Chan, Rosanna (2008): "Financial constraints, working capital and the dynamic behavior of the firm," MPRA Paper 27153, University Library of Munich, Germany, revised Aug 2010.

Devarajan, S. and D. S. Go (2003): "The 123PRSP Model", in F. Bourguignon and L.A. Pereira da Silva (eds.), *Evaluating the Poverty and Distributional Impact of Economic Policies: Techniques and Tools,* Washington D.C.: World Bank.

Diebold, F. (1998): The Past, Present and Future of Macroeconomic Forecasting. *Journal of Economic Perspectives* 12(2), pp.175-192.

Eaton, Jonathan and Samuel Kortum (1999): "International Patenting and Technology Diffusion: Theory and Measurement," International Economic Review, 40, pp. 537-570.

ECAFE (1968): *Feasible Growth and Trade Gap Projections in the ECAFE Region*. Bangkok: Economic Commission for Asia and the Far East.

Fair, R.C. (1971): A Short-Run Forecasting Model of the United States Economy. Lexington: Health.

Fair, R.C. (1974): An Evaluation of a Short-Run Forecasting Model. *International Economic Review* 15(2), pp. 285-304.

Fischer, Stanley (1997): Applied Economics in Action: IMF Programs. AEA Papers and Proceedings, Vol. 87 No. 2, May 1997.

Fishlow, Albert (1972): "Brazilian size distribution of income", Papers and Proceedings of the American Economic Association, Vol. 62 (May).

Friend, I, and Taubman, P. (1964): A Short Run Forecasting Model. Review of Economics and Statistics 46(3), pp. 229-36.

Grossman, G. M. and Helpman, E., (1991): *Innovation and growth in the global economy*. Cambridge, Massachusetts, MIT Press.

Guisan, M.C. and Exposito, P. (2001): Economic Growth of African and Asia-Pacific Areas in 1951-99. *Applied Econometrics and International Development* 1(2), pp. 101-125.

Hall, S. (1995) Macroeconomics and a Bit More Reality. *The Economic Journal* 105(431), pp. 974-88.

Hallward-Driemeier, M. and W.P. Smith (2005): "Understanding the Investment Climate," *Finance and Development*, 2005, *41*, 40.

Horton, Susan, Kanbur, R. and Mujmdar, D. (1994): "Overview" in *Labor Markets in an Era of Adjustment*, eds. Horton, S., R. Kanbur & D. Majundar, Washington D.C.: The World Bank.

Ichimura, S. and Matsumoto, Y. (eds.) (1994): *Econometric Models of Asian-Pacific Countries*. New York: Springer-Verlag.

Intriligator, M.D., Bodkin, R.G. and Hsiao, C. (1996): *Econometric Models, Techniques, and Applications*. New Jersey: Prentice Hall.

Jorge, A. and Salazar-Carrillo, J. (1988): "*New perspectives on Debt Crisis*", *Economic Impact,* 65, pp. 49-53.

Keller, Wolfgang (2004): "International Technology Diffusion." *Journal of Economic Literature* 32 (3), 752-782.

Khan, Haider A. (2004): Assessing Poverty Impact of Trade Liberalization Policies: A Generic Macroeconomic Computable General Equilibrium Model for South Asia, ADB Institute Discussion Paper No. 22. Asian Development Bank.

Klein, L.R. (1989): Development and Prospects in Macroeconometric Modelling. *Eastern Economic Journal*. 15(4), pp. 287-304.

Klein, L.R. (1999): Economic Stabilisation Policy: Pitfalls of Parsimonious Modelling. *Journal of Quantitative Economics* 15(2): (special Issue on Macroeconomics Policy Modelling).

Kmenta, J. and Ramsey, J.B. (eds.) (1981): *Large Scale Macro-Econometric Models*. Amsterdam: North-Holland.

Krishnamurty, K. and Pandit, V. (1996): Exchange Rate, Tari? and Trade Flows: Alternative Policy Scenarios for India. *Indian Economic Review* 31(1), pp. 57–89.

Krueger, A. (1987): "Debt, Capital Flows and LDC growth", *Economic Impact*, 60, 6-11.

Krugman, Paul R. (1986): Pricing to Market When the Exchange Rate Changes. NBER Working Paper No. w1926. Available at SSRN: http://ssrn.com/abstract=278027

Levine, Paul (2009): Lecture on "Monetary Policy in an Uncertain World: Probability Models and the Design of Robust Monetary Rules" September 14, 2009, Karachi.

Narasimham, N.V.A. (1956): *A Short-Term Planning Model for India*. Amsterdam: North-Holland.

Malawi Government (2009): Report on Public External and Domestic Debt Sustainability Analysis in Malawi, December 2009.

Masson, Paul (2006): "Anchors for monetary policy", in "Central banks and the challenge of development", Bank for International Settlements, Basel, Switzerland, May 2006.

MEPD (2010): Annual Economic Report 2010, Ministry of Development Planning and Cooperation.

Mishra, Prachi, Montiel, P. J. and Spilimbergo, A. (2010): "*Monetary Transmission in Low Income Countries*", IMF Working paper (WP/10/223).

Mundell, Robert A. (1963): "Capital mobility and stabilization policy under fixed and flexible exchange rates". *Canadian Journal of Economic and Political Science* **29** (4): 475–485. Reprinted in Mundell, Robert A. (1968). *International Economics*. New York: Macmillan.

NORAD (2011): "Institutional Cooperation between Norway and Malawi in Statistics and Planning - Appraisal of Phase Three", Aid Strategy and Development Economics Department, Oslo, Norway March 2011.

NSO (2006): Malawi Trade Statistics, National Statistical Office of Malawi.

OECD (2011): A Green Growth Strategy for Food and Agriculture - Preliminary Report, May 2011.

Romer, Paul (1990): "Endogenous Technological Change," Journal of Political Economy, 98(5), pp 71-102.

Sastry, V. K. (1975): The Use of Macroeconomic Regression Models of Developing Countries: A Comment. *Oxford Economic Papers* 27(1), pp. 156-165.

Shourie, A. (1972): The Use of Macro-Economic Models of Developing Countries for Forecasts and Policy Prescription: Some Reflections on Current Practice. *Oxford Economic Papers* 24(1), pp. 1-35.

Swaray, Raymond B (2005): "*Primary Commodity Dependence and Debt Problem in Less Developed Countries*". Applied Econometrics and International Development. AEID. Vol. 5-4 (2005) 131.

Uebe, G. (ed.) (1995): World of Economic Models: A Catalogue of Typical Specifications of Economic Models. Aldershot: Avebury.

UNCTAD (1968): *Trade Prospects and Capital Needs of Developing Countries*, United Nations Conference on Trade and Development, New York: United Nations.

Valadkhani, Abbas (2005): Macroeconometric Modelling: Approaches and Experiences in Developing Countries. *Applied Econometrics and International Development* (AEID). Vol. 5-1 (2005).

B

Return to:
Statistisk sentralbyrå
NO-2225 Kongsvinger

From:
Statistics Norway

Postal address:
PO Box 8131 Dept
NO-0033 Oslo

Office address:
Kongens gate 6, Oslo
Oterveien 23, Kongsvinger

E-mail: ssb@ssb.no
Internet: www.ssb.no
Telephone: + 47 62 88 50 00

ISBN 978-82-537-8519-6 (printed)
ISBN 978-82-537-8520-2 (electronic)
ISSN 0806-2056

Price NOK 150.00 VAT included

ISBN 978-82-537-8519-6
9 788253 781594

Statistisk sentralbyrå
Statistics Norway

Statistics Norway

31/2012

Macroeconomic modelling in developing countries

Design: Siri Boquist