European Commission

JRC TECHNICAL REPORTS

STAGE_DEV

A variant of the STAGE model to analyse developing countries

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2017

EUR 28627 EN

Joint Research Centre

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JRC Science Hub
https://ec.europa.eu/jrc

JRC104686

EUR 28627 EN

PDF ISBN 978-92-79-69103-4 ISSN 1831-9424 doi:10.2760/90737

Luxembourg: Publications Office of the European Union, 2017

How to cite this report: Aragie, E., H. Dudu, E. Ferrari, A. Mainar Causapé, S. McDonald and K.Thierfielder; S*TAGE_DEV - A variant of the STAGE model for developing countries*, EUR 28627 EN; doi:10.2760/90737

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Abstract

This document provides a description of the comparative static version of STAGE_DEV single-country computable general equilibrium (CGE) model, which is a variant/development of the STAGE 2 single country CGE model.
This model embeds several new distinctive features which make this version tailored for the ex-ante impact analysis of national policies in developing countries.
The model is designed for calibration using a reduced form of a Social Accounting Matrix (SAM) that broadly conforms to the UN System of National Accounts, which for the purpose of this study has been enriched with relevant satellite accounts.

1. Introduction

The European Commission (EC), and in particular the Commission's Directorate-General for International Cooperation and Development (DG DEVCO), are responsible for decisions about external aid and its allocations to third countries, and for deciding on sensitive positions in specific situations, e.g., declaration of a food crisis situation. These decisions and positions should be based on evidence and systematic and replicable analyses. Such evidence-based policy decisions depend on the availability of reliable data and economically consistent models; but a lack of reliable data and incomplete economic models limit the capacity of the Commission to make, and defend, evidence-based policy decisions.

The Joint Research Centre (JRC), the Commission's in-house science service, is committed[1] to close knowledge gaps that limit the capacity to provide reliable analyses to support policy formulation and follow up for decision making purposes. Providing support to DG-DEVCO, by enhancing information systems, policy and economic analyses and scientific advice on selected topics concerning sustainable agriculture and food and nutrition security, are central to this commitment.

The framework of this commitment identifies the Economics of Agriculture Unit (JRC.D.4) of the Sustainable Development directorate as responsible for developing scientific tools for *ex-ante* policy analysis at the whole-economy level. As part of this remit, a variant of a single-country STatic Applied Computable General Equilibrium (CGE) model[2] (STAGE) (McDonald, 2007) was designed to address developing country specific issues. The model - STAGE_DEV - was developed in cooperation with academic experts.

The STAGE_DEV model incorporates a series of additional behavioural relationships that better account for economic relationships in developing countries, in particular the least developed and Sub-Saharan African (SSA) countries. The reason for engaging on the development of the STAGE_DEV model was a degree of dissatisfaction with existing single-country CGE models, including STAGE 2, in the context of developing countries. In particular, the developers were concerned about the representation of the dual roles of semi-subsistent (agricultural) households as non-separable producers and consumers, the assumption that the functional distribution of income was exogenously defined, structural rigidities in developing economies, including un/underemployment, the use of time for activities outside the ‘production boundary’, e.g., fetching water, a simplistic modelling of labour markets and migration. Some of the additional behavioural relationships are novel and original; some are novel but not original and some are neither novel nor original, i.e., they implement behavioural relationships found in other models.

Some of the additional behavioural relationships are derived from previous variants of the STAGE model produced over a number of years.[3] Others build on promising solutions that have arisen in recent years.[4] Aragie and McDonald (2014) developed a STAGE application to Ethiopia with the introduction of Home Production for Home Consumption and measuring unemployment at household level. Ferrari *et al*. (2014) presented an analysis on time use

[1] In accordance with the Administrative Arrangement (AA) JRC №33272-2013-10 DEVCO 325-863 between DG Development and Cooperation – Europeaid (DG DEVCO) and DG Joint Research Centre (DG JRC).

[2] STAGE is part of the integrated Modelling Platform for Agro-economic Commodity and Policy Analysis (iMAP) (M'barek et al., 2012 and M'barek and Delincé, 2015) established in 2005 in JRC-IPTS-AGRILIFE (former name for JRC.D.4) with the idea of building up a platform to host agro-economic modelling tools financed by the European Commission, to maintain and develop a policy support-oriented platform that disposes of a number of partial equilibrium (PE) and computable general equilibrium (CGE) models.

[3] Collaborators on these variants who are not co-authors of this report include Cecilia Punt and Melt van Schoor (University of Stellenbosch), Sandra Polaski (formerly at the Carnegie Endowment for International Peace and the ILO) and Dorothee Flaig (OECD).

[4] Many of these were consolidated in Ariage (2015).

in Kenya related to water in which labour/leisure trade off was introduced into the STAGE model.

The rest of the report is organised as follows. Chapter 2 provides an overview of the main behavioural features added to generate STAGE_DEV and provides explanations of the economic characteristics that the new developments address. Chapter 3 details the new model developments, in particular: nested utility function, modelling home production for home consumption (HPHC), labour-leisure trade off, domestic migration and factor market segmentation Chapter 4 describes the organisation of Social Accounting Matrix (SAM) and data requirements to calibrate and model the newly developed modules of the model. Chapter 5 concludes and puts the basis for future research.

2. Aspects of CGE Model Addressed

While some aspects of CGE models have progressed substantially over the last 40 years, e.g., the modelling of energy and imperfect competition, other aspects concerned with economic development and income distribution remain similar to those found in early models. The developments incorporated within the STAGE_DEV model represent one approach towards enhancing the modelling of development and income distribution in developing countries, by incorporating into the model insights that derive from the basic needs and human development literature, the role of prices in the determination of welfare and the long literature on peasant households, e.g., Chayanov (1966)[5] and Ellis (1993). The developments start from the recognition of certain stylised facts about developing economies and the available data systems:

1. Home production for home consumption (HPHC): for many rural and/or poor households HPHC is an important determinant of welfare. National accounts should include imputed values for HPHC in household accounts but unless HPHC is separated from consumption of marketed commodities the price system for both in CGE models will be misspecified.
2. Utility functions and attributes: standard utility functions, e.g., Cobb Douglas, Constant Elasticity of Substitution (CES), and Stone-Geary (i.e., Linear Expenditure System LES), assume the elasticity of substitution between different commodities, e.g., food, transport and energy, are the same. But as consumption data become more disaggregated so this assumption becomes less realistic.
3. Underemployment: unemployment is (arguably) a social construct that does not exist in the vast majority of poor/developing economies, given the absence of 'unemployment benefits'. In developing economies, underemployment is manifest as low marginal productivities of labour, economic activities outside the production boundary of the System of National Accounts (SNA) and households sharing incomes.
4. Heterogeneity of labour: labour is heterogeneous with inherent skills that can be adapted to the needs of different activities/industries. The classification of labour by occupation, which is common and linked to the classification scheme of the International Labour Office (ILO), is not appropriate within the economic logic of the economic modelling of labour mobility. Rather, such economic models, including CGE models, prefer (logically) labour to be categorised according to the characteristics that determine the ability of labour to transition between activities.
5. Migration: populations in all economies are mobile, and the mobility of populations is often greater where an absence, or lack, of social welfare nets requires people to move to gain incomes. Some migration will be temporary, e.g., seasonal relocation for harvests and/or during periods of slack labour demand in a household's locale, such that a household remains in its original locale; or permanent in the sense that a household, or some of its members, relocates to a new locale.
6. Functional distribution of income: the functional distribution of income depends on the assets owned by households in each locale and the use of those assets. Thus, the functional distribution of income is variable and will change as households migrate and the labour market evolves, in terms of the demand for labour by different activities, and the degree of underemployment.

The relevance of these aspects of developing economies is reviewed briefly below to provide a context within which the model developments can be assessed.

[5] Chayanov (1888-1939) represented the culmination of research into peasant economics in Russia from the 1860s until the late 1920s. Much of this research, especially that in post revolution Russia, was unknown in the West before the 1960; hence the publication date.

2.1 Home production for home consumption (HPHC)

Home Production for Home Consumption (HPHC) accounts for a large proportion of consumption 'expenditures' by rural households in developing economies. Estimates indicate that HPHC accounts for greater than 50% of the value of consumption by rural households in many developing and least developed economies; the less developed an economy the greater the proportion of HPHC in consumption expenditures. This characteristic of economies is fully recognised in the SNA; statisticians are expected to impute the value of HPHC when compiling national accounts. HPHC should be valued at basic prices, which in the context of agricultural producers is equivalent to farm gate prices, while purchased (market) commodities are valued in purchaser prices, i.e., basic prices plus trade and transport margins plus any unrebated commodity taxes, e.g., Value Added Tax (VAT) and General Sales Taxes (GST). However, in most Social Accounting Matrices (SAMs) the expenditures by each Representative Household Group (RHG) on each commodity are recorded without distinguishing between the expenditures on HPHC and market commodities, which means that the associated rates for trade and transport margins and commodity taxes are misspecified.

Consequently, if changes in economic circumstances, due to policy changes and/or other changes produce changes in the determinants of basic prices, trade and transport margin rates or commodity tax rates, the responses by RHGs will be distorted, and the resultant welfare implications will be inaccurate.

HPHC also has implications on the production side of economies. CGE, and other economic models, assume strong separability, whereby agents make optimising decisions over production and consumption independently. But HPHC strongly implies that production and consumption decisions are interdependent because the household is simultaneously the producer and consumer. CGE models, and their underlying databases, rarely recognise this reality; producers are usually defined with respect to their principal products, or, occasionally, technology characteristics. HPHC requires that each RHG is also a productive activity, which simultaneously relaxes the assumption of strong separability and requires factor market clearing at the level of each productive activity and its associated RHG.[6]

2.2 Utility functions and attributes

Most utility functions used in CGE models assume common elasticities of substitution between all commodities; in terms of the common Stone-Geary/Linear Expenditure system (LES) this amounts to the presumption that the marginal budget shares are constant.[7] This specification of utility functions is appropriate when the commodity accounts are highly aggregated but is less and less appropriate as the commodity accounts in the databases for CGE models are increasingly disaggregated. It can be argued that RHGs are more willing to substitute between the components of broad commodity groups, e.g., food and services, than they are between broad commodity groups. This is in essence an application of the general approach to utility functions proposed by Lancaster (1971) wherein consumers' preferences are for the attributes provided by commodities rather than the commodities themselves. This pattern of substitution possibilities has been widely recognised on the production side of CGE models but not on the consumption side. One way to accommodate this aspect of consumer preferences is to use a system of nested utility functions that allow for different elasticities of substitution between different groups of commodities.

The recognition of HPHC requires, by definition, the use of utility functions that allow for different elasticities of substitution between different groups of commodities. RHGs that

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[6] The characteristic of non separability in decision-making by peasant households is a core aspect of the literature on peasant economies.

[7] This assumption does not apply when using AIDS or AIDADS utility functions, but translogarithmic functions introduce other difficulties.

engage in HPHC will face the option of consuming the commodities they produce, valued at basic prices, or selling their variant of a commodity they produce, valued at basic prices, for another variant that is available on the market, valued at purchaser prices. The differences between variants of the 'same' commodity may be between the characteristics of the specific commodity (taste), dimensions of modern (high yielding) varieties and/or of time and place (limitations of storage technologies may mean it is better to store value in money terms rather than commodity terms). Moreover, changes in market conditions – taxes and trade and transport costs – may be important; if taxes and/or trade and transport cost decline then the opportunity cost of the market variant will fall and consumers will have an incentive to reduce the consumption of the HPHC variant in favour of the market variant.

2.3 Underemployment

Unemployment as commonly defined in developed market economies – by a so-called 'claimant count' – does not exist in the vast majority of developing economies. What is observed in developing countries is better described as underemployment, which may be manifest in multiple forms. In CGE models model underemployment, if included, is modelled under the assumption that the marginal product of surplus labour is zero and that surplus labour can be used for other purposes with no adverse implications for output.[8]

Observations of rural households in developing countries may, at certain times of the year, suggest the existence of surplus labour while observations of the same households at another time, e.g., harvest, weeding and sowing, may suggest full employment. In such circumstances, the (implicit) wage rates may be very low, but moving labour to employment by other activities will reduce output; thus, an assumption of zero marginal products is not appropriate.[9]

Moreover, CGE models and their databases define output by reference to the SNA's production boundary, i.e., output for which unambiguous prices can be defined. But, there are a wide range of economic activities that take place outside the production boundary, e.g., care of children, the sick and aged adults, cooking, etc.[10] Consequently, it is highly unlikely that transferring labour from domestic activities to those within the production boundary will have no implications for households, either by reducing the output of domestic activities or reducing "leisure" time.

Simplistic presumptions that the marginal product of surplus labour is zero, or that there is full employment, show themselves questionable and not able to capture the critical distinction between activities within and outwith the SNA's production boundary.

Similarly, the assumption of an upward sloping labour supply curve with respect to specific labour factors is simplistic, not grounded in economic theory[11] and ignores the fact that decisions about labour supply, in the institutional logic of CGE models, are taken by the household institutions, i.e., RHGs, and not by factors.

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[8] In the STAGE model, among others, this characterisation is modelled by specifying an unemployment rate that is greater than or equal to zero and then using an endogenous regime switching setting.

[9] This characteristic of peasant households implies the sharing of incomes within households. Income sharing within households is a core aspect of the literature on peasant economies.

[10] There is an extensive literature on the problems associated with the valuation of production outwith the SNA's production boundary (see Chadeau (1985 and 1992) and OECD (2002)). Essentially, the problems can be distilled down to the fact that valuing such production at opportunity cost and market prices produces substantially different values, which means that the prices are ill defined.

[11] The references to the wage curve literature to justify this formulation do not take note of the qualification by Blanchflower and Oswald that explicitly rejects this interpretation the wage curve.

The approach taken in the STAGE_DEV model assumes that each RHG also has a paired activity that produces leisure using ONLY labour provided by the paired RHG, i.e., the costs associated with any additional labour being drawn in to the labour market, but does not preclude the model being specified so that in addition, each RHG does have surplus labour with zero marginal productivity.

One important consequence of this approach is a need to recognise that the determinants of the functional distribution of income are not fixed. Specifically, if RHGs shift labour between activities within and outwith the production boundary and between leisure and productive activities the quantities of labour sold will change. Consequently, the determinants of the functional distribution of income will be a variable defined by the quantities of labour sold.

2.4 Heterogeneity of labour

Standard CGE models assume that each labour category is homogenous and that any differences in the wage rates paid by activities to each type of labour that 'perfectly' reflect differences in labour productivity, are solely attributable to differences arising from the activity.[12] Thus, when labour is reallocated from one activity to another, CGE models will, if there are differences in implied labour productivity, record an increase or decrease in the supply of effective labour, i.e., a *de facto* productivity gain or loss. This is a restrictive assumption. For instance, an 'unskilled' worker employed in agriculture as a tractor driver is assumed to be inherently identical to an 'unskilled' worker employed in a service activity as a cleaner, whereas they are, arguably, more likely to be heterogeneous. When data on the values and quantities of each type of labour employed by each activity are available, they demonstrate large differences in wage rates that are difficult to attribute solely to differences across activities, while at the same time displaying limited differences in the wage rates across groups of activities, e.g., agriculture, food processing, heavy manufacturing, etc.

Moreover, it is a common practice to classify labour according to its occupation, e.g., agricultural and shop workers, in line with the ILO classification scheme; such a method of classification exacerbates these problems since the presumption of homogeneity precludes workers transitioning between categories.[13]

The STAGE_DEV model includes an assumption of imperfect factor mobility between (user defined) groups of factors. The method used is a generalisation of the method reported in Flaig, *et al*., (2013a and b), which is a development of method reported in McDonald and Thierfelder (2009) to simulate the mobility of labour for the ILO and Carnegie Endowment for International Peace.

The actual method is a hybrid. Labour of type *l*1 is assumed to be perfectly mobile between the activities in group *a*1, but is imperfectly mobile between labour of type *l*1 employed in activity *a*2. In addition, labour of type *l*1 can transition into labour of type *l*2, both within groups of activities and between groups of activities. The user defines which transition pathways are open, and hence those that are closed, when setting up the model. The force/incentive that induces labour to transition from one state into another are **changes** in relative wage rates; the responsiveness of different labour categories to changes in relative wage rates is defined by the magnitude of supply elasticities.

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[12] CGE models that extensively use the Armington 'insight' to encompass the implications of heterogeneity of commodities within a category typically ignore heterogeneity within factor categories.

[13] Some databases, e.g., GTAP prior to v9, create labour categories that are aggregates of occupational categories. This amounts to an assumption that aggregating heterogeneous categories produce homogenous categories!!! McDonald, et al., (2016) explore some of the implications of this assumption.

The method allows the tracking of employment in terms of natural units – person hours – and efficiency units – the quantity of services provided. But it does require the user to actively address the issues associated with changes in the quantities of natural and effective units of labour and to define the ease with which labour types can transition; for all of which there is limited empirical evidence even though logic, and simulation results, indicate that the effects are likely to be non-trivial.

Furthermore, this method involves an evolution of the patterns of labour ownership as labour owned by RHGs transitions between labour categories, and consequently the functional distribution of income also needs to evolve, i.e., needs to be model as variable.

2.5 Migration

Populations in all economies are mobile, and the mobility of populations is often greater where an absence, or lack, of social welfare nets requires people to move in order to gain incomes. In the STAGE_DEV model the key institutional presumption is that 'households' migrate between RHGs. Some migration will be temporary, e.g., seasonal relocation for harvests and/or during periods of slack labour demand in the household's locale; in such instances household's do not migrate although some labour supplied by those households will work in different locale, i.e., the household remains in its original RHG. When migration is permanent, it is assumed that the household relocates to a new RHG; or some of its members form new households that relocate to a new RHG.

The actual method for permanent migration assumes that migration involves some households within RHGs leaving their original RHG and relocating in another RHG, e.g., rural-urban migration involves households leaving a rural RHG and entering an urban RHG. The user defines which transition pathways are open, and hence those that are closed, when setting up the model. The force/incentive that induces households to migrate from one RHG to another are **changes** in relative household incomes and the responsiveness of different RHGs to changes in relative incomes is defined by the magnitude of supply elasticities.

As households move from one RHG to another RHG, it is assumed that the factors owned by the households that migrate also move to the new RHG. It is assumed that the composition of households, in terms of demographic profiles and factor ownership, that move are the same of those in the RHG that they leave. Thus the quantities of factors owned by source and destination RHGs will evolve, and consequently so will the functional distribution of income. Note how these assumptions mean that the pattern of the demographic profiles and factor ownership by source RHGs do not change due to migration alone while those of the destination RHGs do change.

2.6 Functional distribution of income

The functional distribution of income depends on the assets owned by households in each RHG, i.e., their endowments, and the use of those assets. In many single country CGE models the functional distribution of income is represented as a matrix of parameters that reflects the shares of factor incomes, usually after tax and depreciation, received by each RHG in the base transactions data. This might be an acceptable approximation when factor types are homogenous and there is full employment. Relaxing either of those strong assumptions stretches the credibility of this assumption.

In the STAGE_DEV model, not only are the assumptions of factor homogeneity and full employment not imposed, but households are allowed to migrate between RHGs. Thus the functional distribution of income needs to be modelled as variable and will change as households migrate and the labour market evolves in terms of the demand for labour by different activities and the degree of underemployment. It is important to note that the functional distribution of income will be variable if any one of these three features exists in a CGE model; hence while this feature has been reported last it does underpin much of the prior discussion.

Furthermore, once any form of dynamics is introduced into a CGE model, the evolution of the demographic profiles and factor ownership by RHGs must become a central part of the model formulation. Once this feature of economic development and change is acknowledged, it is essential that the evolution of the functional distribution of income is incorporated in the model if the model is to provide meaningful insights about the evolution of the distribution of income and the welfare.[14]

3. STAGE_DEV: model developments

The STAGE model is a single country CGE model that that employs the approach to CGE modelling described by Dervis *et al*., (1982). More specifically, the implementation of this model, using the General Algebraic Modeling System (GAMS) software, is a direct descendant and development of models devised in the late 1980s and early 1990s, particularly those models reported by Robinson *et al*., (1990), Kilkenny (1991).

To properly model agriculture and food security issues in the frame of CGE models, a model should depict key structural characteristics of the economy and of the agricultural sector. The most relevant issues in the developing countries, in particular sub-Saharan African countries, are the dual role of semi-subsistent agricultural households, which play the non-separable dual role of producers and consumers, the modelling of subsistence consumption expenditures and structural rigidities in economies, especially labour market and factor segmentation; high un/underemployment, particularly in rural areas; high use of time for productive activities outwith the SNA production boundary, e.g., fetching water; substantial population and labour force migration, etc.

The starting point for the development of the STAGE_DEV model is the STAGE 2 (McDonald, 2015) CGE model: a consolidation of a series of developments of the STAGE 1 model (McDonald, 2007). The specific behavioural relationships embedded within the STAGE 2 model are reported in a technical document (McDonald, 2015) and user guide is available to guide users through the structuring of the databases and the configuration of a running version of STAGE 2.

It is useful to highlight some of the key developments embedded in STAGE 2. First, STAGE 2 allows for modelling of multi-product activities using various assumptions; fixed proportions of commodity outputs by activities with commodities differentiated by the activities that produce them, varying output mixes by activities in response to changes in the (basic) prices of commodities, and domestically produced commodities that are differentiated by source activity or are homogeneous, i.e., undifferentiated by source activity. Second, the (value added) production technologies are specified as a three level nested series of Constant Elasticity of Substitution (CES) function. Third, the functional distribution of income is endogenously determined through the specification of the ownership (domestic and foreign) of factors used within the economy as a series of variables. Fourth, trade and transport margins between factory and dock gate and the consumer are levied on domestic consumption. And fifth, household consumption expenditure is represented by Stone-Geary utility functions.

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[14] Migration and transition of labour types between categories could be modelled as part of the updating process in recursive dynamic CGE models. In that case the functional distribution of income can be represented by a matrix of parameters that are also updated between solutions. But such a method cannot be used to circumvent changes in distribution associated with un/underemployment. Similarly, it is difficult to assume that labour can be modelled as a quasi-fixed factor that can only transition between solutions.

3.1 Modelling compound/nested LES-CES utility functions

Constant Elasticity of Substitution (CES) and Linear Expenditure Systems (LES) are two of the most widely used utility functions to represent the household consumption in economy-wide models. Researchers interested in modelling developing economies have extensively used the LES, derived from Stone-Geary utility functions. This function is considered the most appropriate functional form for modelling consumption behaviours of households in developing countries since it allows subsistence consumption expenditures. Indeed, in most developing countries, there are substantial numbers of very poor consumers at, or close to, their subsistence consumption. Under Stone-Geary preferences household consumption is made of two components: subsistence and discretionary consumption. The amount of household budget spent on discretionary demand is a residual component of household consumption budget and committed expenditure on subsistence demand. Subsistence (minimum) consumption is calibrated using estimates of the income elasticity and the Frisch parameters (defined as the negative of the ratio of a household's consumption expenditures and the supplementary income). A perceived weakness with the Stone-Geary (and all Cobb-Douglas type) utility functions is the limitations on the elasticities of substitution between commodities. Consequently, CES utility functions have been used frequently because of the greater degree of flexibility in the setting of the substitution elasticities.

The use of single-level demand systems is common in CGE modelling, where modellers adapt a single stage CES or LES. However, there are distinct potential benefits of introducing a multi-stage nesting structure. Multi-stage nested functions have the advantages of assigning different elasticity of substitution values at different stages of the nest, and the possibility to introduce different functional forms at each stage of the nest. In rare cases of multi-stage demand modelling, modellers tend to impose multi-stage CES functions. The use of LES-CES nesting is uncommon, but it does allow modellers to exploit the benefits of both CES and LES functions by introducing the more realistic assumptions about the behaviours of different households.

For a developing country Stone-Geary is preferable since it allows for subsistence consumption expenditures, which is arguably a realistic assumption when there are substantial numbers of very poor consumers. Nevertheless, the assumption that households define subsistence consumption requirements at the level of the individual commodity, however disaggregated the commodity accounts are in the data/model, is both highly restrictive and unrealistic. It is realistic, however, to assume that households (of all sorts) have subsistence consumption requirements across 'broad' commodity groups with common attributes, e.g., food, while within those commodity groups households may elect to substitute between components (natural commodities) of the 'broad' groups, e.g., between different grains (wheat, rice, etc.) and between vegetable and meat commodities.

CES functions are one of the most widely used functional forms for demand modelling. For example, Iorwerth and Whalley (2002) and Ferri, et al. (2005) used CES utility functions to combine own and market consumption in a different context (beyond the System of National Accounts (SNA) boundary using data on household time allocation). It also allows key parameters to be incorporated with some degree of flexibility while remaining analytically tractable.

The introduction of nested CES and LES utility functions with LES at the top level, involves substitution between 'broad' commodity groups, subject to subsistence consumption constraints on these 'broad' groups, while at the lower level households are willing and able to substitute between the component commodities that make up the 'broad' commodity groups. This may be particularly advantageous in the context of very poor households for whom large shares of consumption expenditures are concentrated on basic commodities.

Consumers are not highly concerned about the sources/types of components of a composite as long as the composites satisfy some basic requirements. Hence, it is justifiable to assume CES utility function at the lower stage of the nest. In technical terms, the use of the CES function at the lower stage of the consumption nesting is to determine optimal combination of elements/commodities getting into the nest as arguments. For illustrative purposes, assume there are 15 commodity types which can be grouped to five closely related commodity groups: grains, meat products, food commodities, manufacturing, and services. Each of the three natural commodities are aggregated at the lower nest using CES demand systems to form the five composite commodity groups at the bottom of the upper nest. The optimal combination of the respective natural commodities in a composite commodity is determined by their relative prices through a first-order condition for optima.

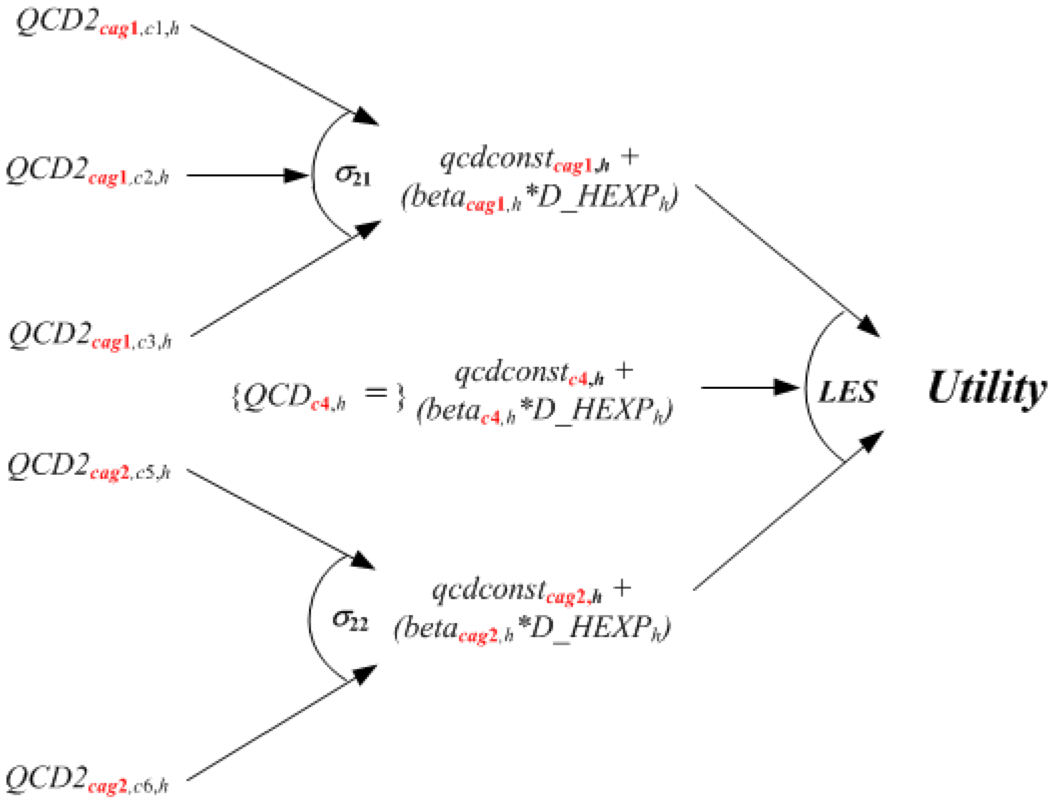
Nevertheless, households need to ensure that some subsistence requirement of each composite commodity is satisfied in their overall consumption bundle. This is best captured by LES demand systems. LES demand systems are assumed at the top nest of the consumption relationship, where composite commodities are aggregated to form household utility. The optimal combination of each of the composite commodity in household consumption depends on the subsistence consumption, and the relative prices of composite commodities, given household's expenditure.

The data requirement for extending the usual single stage consumption structure to a two stage LES/CES nesting structure has no implication for additional transactions data in the Social Accounting Matrix (SAM) although there are requirements for additional exogenously defined substitution elasticities.

3.1.2 Behavioural relationship

Households are assumed to maximise utility subject to nested CES and Stone-Geary (aka LES) utility functions. The nested (CES-LES) utility functions have a linear expenditure system (LES) defined over a mix of natural and aggregate commodities. This is illustrated in quantity terms in Figure 1 where the subscript '*cag#*' indicates an aggregate commodity and the subscript '*c#*' a natural commodity. The underlying logic is that each household demands subsistence quantities of certain aggregate commodities, e.g., food, energy, etc., but not necessarily of all natural commodities, e.g., meat, gas, etc. Thus, the LES utility functions for each household are defined over a mix of aggregate and natural commodities demands for which there are subsistence quantities (*qcdconst*) and marginal budget shares (*beta*) of discretionary household consumption expenditures (*D_HEXP*).

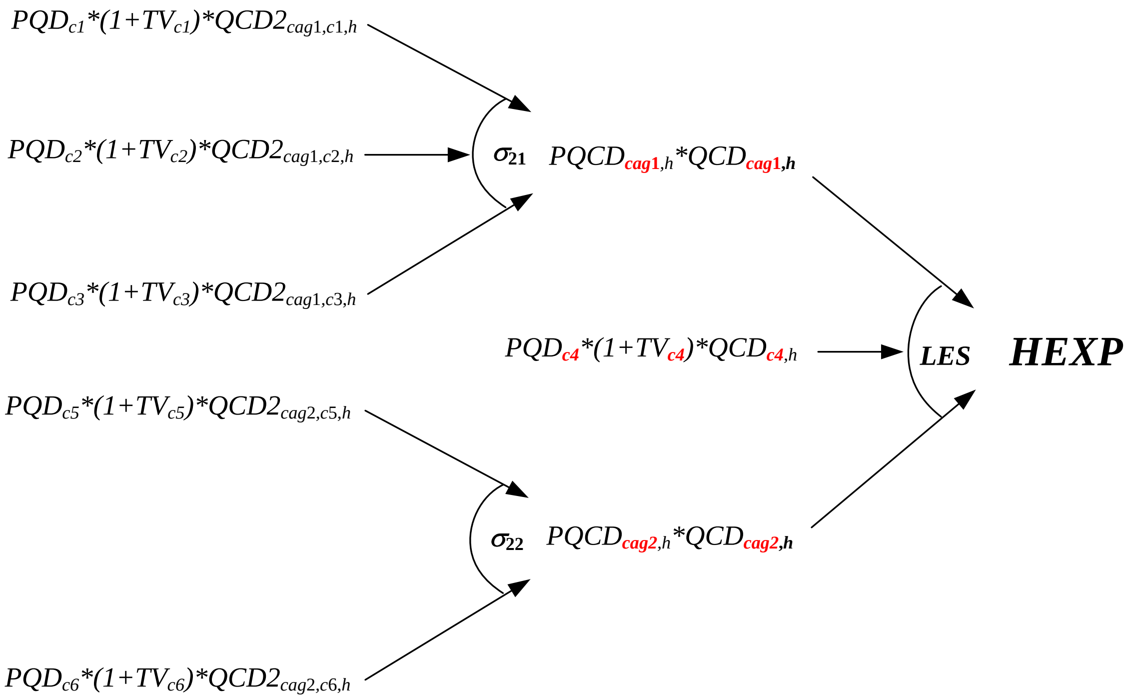
Figure 1: Utility Functions in Quantities



The aggregate commodities are CES aggregates of various natural commodities that are demanded to generate the aggregate. Since each RHG, *h*, has different preferences, as disclosed by the data, the quantities of each commodity, *c*, used to generate an aggregate, *cag*, differ and hence the demand for each commodity (*QCD*2) has three arguments/indices. As illustrated in Figure 1 the system is general in the sense that any number of commodities can be used to generate each aggregate and there can be any mix of aggregates and natural commodities in the LES.

The Law of One Price (LOOP) must however be retained. Thus despite the demand for commodities by each household depending on *c* and *h* the prices paid are only determined by the commodity *c*. However, since the mix of commodities in each aggregate commodity varies by household because the quantities of each natural commodity, the weights, are different for each household. Consequently, the aggregate prices (*PQCD*) are indexed on both the aggregate commodity, *cag*, and the RHG, *h*. This is illustrated in Figure 2 where the components of the transaction values are identified.

Figure 2: Utility Functions in Transaction Values



The CES utility function for the *c*-commodities, i.e., $QCD_{cag,h}$, is

$$QCD_{cag,h} = a_{cag,h}\left[\sum \delta_{c,h} QCD_{c,h}^{-\rho_{cag,h}}\right]^{\frac{-1}{\rho_{cag,h}}} \qquad [1]$$

where each element *cag* is a composite of natural commodities *c* that are consumed by RHG *h*; ρ is substitution parameter (or functional exponent) between the natural commodities in each composite, which is aggregate commodity and household specific; α is a shift parameter, and δ measures the expenditure share for consumption spending on commodity *c* as computed from the RHG's consumption pattern for a base year.

Optimal commodity prices, given the utility function in [1], are derived from the partial differentials of the utility maximisation problem and follows:

$$PQD_{ci} = a_{cag,h} PQD_{cag}\left[\sum \delta_{ci,h} QCD_{ci}^{-\rho_{cag,h}}\right]^{-1} * \left[\delta_{ci,h} QCD_{ci}^{-\rho_{cag,h}-1}\right] QCD_{ci,h} \qquad [2]$$

where PQD_{ci} are prices of the natural commodities *ci* that enter into the production of *cag*, and PQD_{cag} is price of the composite commodity $QCD_{cag,h}$. Note that only the first order conditions are required in the model since the purpose in the lower nest is only to determine the optimal distribution of commodities in the consumption basket.

In the upper nest, the consumer is assumed to combine composite and natural commodities to generate utility from the consumption of commodities according to LES demand systems derived from Stone-Geary utility function. Since the consumption basket of a typical household constitutes more than two composite commodities, it is desirable to specify *n*-argument LES demand function at this nest. The *n*-argument LES demand function is

$$PQD_{cles} * QCD_{cles,h} = PQD_{cles} * \gamma_{cles,h} + \beta_{cles,h}\left(HEXP_h - \sum_{cles=1}^{n} PQD_{cles}\gamma_{cles,h}\right) \qquad [3]$$

where $HEXP_h$ is the expenditure of each household; $\beta_{cles,h}$ is the marginal budget share or relative contribution of each commodity to utility after subsistence has been achieved; $\gamma_{cles,h}$ represents the quantities of subsistence/minimum consumption of each commodity below which physical consumption cannot fall; and other variables are as defined above.

In a Stone-Geary utility function household consumption demand consists of two components; 'subsistence' demand (*qcdconst*) and 'discretionary' demand, and the equation must therefore capture both elements. This can be written as two equations:

$$QCD_{cc,h} = \frac{\sum_h \left(\left(PQD_{cc} * (1+TV_{cc}) * qcdconst_{cc,h} \right) + \sum_h beta_{cc,h} * \left(\begin{array}{l} HEXP_h - \sum_c \left(PQCD_{cag,h} * qcdconst_{cag,h} \right) \\ -\sum_c \left(PQD_{cc} * (1+TV_{cc}) * qcdconst_{cc,h} \right) \end{array} \right) \right)}{\left(PQD_{cc} * (1+TV_{cc}) \right)} \qquad [4]$$

$$\forall ccesn(cc)$$

and

$$\begin{aligned} QCD_{cag,h} * PQCD_{cagc} = & \left(qcdconst_{cc,h} * PQCD_{cc} \right) \\ & + beta_{cag,h} * \left(\begin{array}{l} HEXP_h - \sum_{cag} \left(PQCD_{cag,h} * qcdconst_{cag,h} \right) \\ -\sum_{ccesn} \left(PQD_{ccesn} * (1+TV_{ccesn}) * qcdconst_{ccesn,h} \right) \end{array} \right) \end{aligned} \qquad [5]$$

where the first equation relates to 'natural' commodities that directly enter into the LES utility function and the second equation relates to 'aggregate' commodities that enter into the LES utility function. The discretionary demand is defined as the marginal budget shares (*beta*) spent on each commodity out of 'uncommitted' income, i.e., household consumption expenditure less expenditure on 'subsistence' demand. In this system of nested utility functions, the commodities in the LES utility function are defined as 'broad' commodity groups, e.g., food, clothing, utilities, etc., that are aggregates of 'natural' commodities or 'natural' commodities that are deemed sufficiently distinctive as to justify the assumption that they are characterized by having a distinct 'subsistence demand. The set *cles*(*cc*) is therefore defined to encompass natural commodities, that enter into the LES utility functions, and the LES function is calibrated accordingly. Because the prices of the aggregate commodities are defined differently – *PQCD*, which is a weighted average of the prices of 'natural' commodities (*PQD*) inclusive of VAT. If the user wants to assume Cobb-Douglas utility functions for one or more households, this can be achieved by setting the Frisch parameters equal to minus one and all the income elasticities of demand equal to one (the model code includes documentation of the calibration steps). This is the case for relatively rich households where the operation of the utility function will not reduce demand below subsistence demand.

The second level of the utility functions is defined with CES preferences. The quantities of the aggregated commodity groups that are demand by each household ($QCD_{cag,h}$) are defined in the top level (LES) utility function and therefore only the first order conditions are required to determine the optimum combinations of natural commodities. This is presented as a standard FOC for a CES function, i.e.,

$$QCD2_{cag,cc,h} = QCD_{cag,h} * \left(\frac{\left(\left(PQD_{cc} * (1+TV_{cc}) \right) * accd_{cag,h}{}^{-\rho^{cd}_{cag,h}} \right)}{\left(PQCD_{cag,h} * \delta^{cd}_{cag,cc,h} \right)} \right)^{\left(-1 / \left(\rho^{cd}_{cag,h} + 1 \right) \right)} \qquad [6]$$

$$\forall cces(cc)$$

which has been calibrated for shift, share and elasticity parameters based on the initial data and the, exogenous imposed, substitution elasticities that are aggregate commodity and household specific.

3.2 Modelling home production for home consumption (HPHC)

The household sector, whether the component is recorded in the national accounts or outside the boundary of national accounts, is considerable in most economies, developed and developing alike. Factors ranging from high transaction costs, commodity and factor market imperfections, to perceived differences between own produced and marketed commodities/factors are indicated in the literature as some of the causes of Home Production for Home Consumption (HPHC). In situations where households act as producing units consuming part or all of their output, the failure to account for this behaviour may have serious impacts on simulation results and associated policy proscriptions (Tiberti, 2011; Kuiper & van Tongeren, 2005; Taylor and Adelman, 2003); this is due to misrepresentation of the difference in price formation processes between HPHC and marketed commodities.

A decision by a researcher to incorporate HPHC in the model for analysis has implications for both the database and the model's functional relationships. The modelling implications are related to behavioural specifications on consumption decisions, production relationships, factor allocation decisions, and factor market clearing mechanisms. Apart from the required model development to account for the implied changes in behavioural specifications, it equally requires adjusting the structure of the SAM so that it can accommodate the actual economic and institutional relationships in accounting for HPHC. Additional satellite accounts on factor ownership by institutions in the SAM, mainly labour ownership by households, are also required.

The first step in incorporating HPHC involves expanding the structure of a SAM by adding information on HPHC. This requires including extra rows and columns, which are different in structure, to the commodity and activity accounts. As taxes and high trade and transport margins are causes of HPHC, by creating wedges between basic/producer and purchaser prices, especially SAMs that intend to account for HPHC need to incorporate detailed information on margins and commodity taxes. While commodities consumed at home are valued at basic prices (excluding margins and commodity prices), marketed commodities are valued at purchaser/market prices (including margins and commodity prices). The gap between basic and purchaser prices is considerable in most low-income countries.

The database implications of incorporating the dual roles of households in a non-separable fashion in economy-wide CGE models requires a more detailed account of factor and resource ownership to integrate explicitly households' production with their resource endowments. Production for own use depends largely on own factor availability and in most low-income areas the factor market is distorted or non-existent (Lamb and Worthington, 2003; Lambert and Magnac, 1998). The need to record ownership of labour by households arise because the use of own labour on a household's activity should be constrained to its labour endowment. Also, unless labour ownership is recorded and modelled at household level, it will not be possible to trace labour transitions between household and non-household activities.

Beyond the database implications, the recognition of consumption of own produced commodities requires extending model relationships that capture the consumption behaviour of households such that the consumer decides the utility maximising combination of HPHC and marketed commodities subject to the budget constraint. The inclusion of own account commodities in the consumption bundle of a typical household complicates the consumption behaviour specifications in CGE models and requires imposing a multi-stage demand nesting where appropriate functional forms are considered at each stage of the nest thereby accommodating the nature of commodities and the type of households being modelled.

Likewise, the explicit consideration of households as producing units makes the production and factor allocation process in CGE models less straightforward. Under situations where households are treated as just consumers, production and factor use entirely follow profit maximisation subject to market determined factor costs and commodity prices, i.e., the decisions over factor allocations and consumption decisions are strongly separable. However, bringing household production, consumption and factor supply into the picture requires defining factor supply and factor market clearing conditions at the household level such that own factor use by the household activity is constrained by its factor supply. The household and non-household activities are free to employ factors from the factor market following the profit maximisation procedure if functioning labour markets exist.

3.2.1 Behavioural relationship

The modelling of HPHC requires the use of nested demand systems because consumption involves a mix of own account and marketed commodities that are differentiated by time, place and cost despite having broadly the same attributes. Moreover, since a household cannot produce all types of the commodities it consumes, there will be some commodities that have to be supplied solely by the market; in which case the commodity will have only a marketed counterpart. Then lower nest combines home produced and marketed commodities, which are the same but differentiated commodities, using CES aggregation function to generate composite commodities. In the upper nest, the household maximises utility following either LES or CES utility functions to form utility.

It is tempting to follow the practice of using single level LES utility functions for modelling the relationship between home-produced and marketed commodities that are notionally identical, as in Arndt et al. (1999) and Tarp (2002). The use of single level LES functions could be justified by the assumption that households market their produce only once they satisfy subsistence consumption levels, which may be likely in semi-subsistence economies, but this does not allow households to make substitutions between closely related commodities, e.g., wheat and rice, that are both home produced, in response to changes in market prices.

Hence, CES functions are used to aggregate HPHC and marketed commodities at the lower nest of the commodity demand tree and LES functions are used at the upper level. The critical distinction when considering HPHC, as compared to the generic case consider above, is in the determination of the aggregate commodity groups and the natural commodities included in each aggregate. In fact, this is relatively straightforward: natural commodities are paired according to whether a specific commodity is home produced or purchased on the market. Thus, for instance home produced wheat would be paired with marketed wheat to produce aggregate wheat, and home produced flour would be paired with marketed flour to produce aggregate flour. Thereafter the operation of the nested utility functions is identical to the generic case detailed above.[15]

[15] There is an argument when modelling HPHC for the use of a three-level nesting system wherein the home produced and marketed variants of commodities are included at the bottom (third) level,

It transpires that the modelling of output mix decisions by multi-product activities as price responsive, the inclusion of trade and transport margins (already included in STAGE 2) and the endogenous specification of the functional distribution of income are sufficient for the modelling of Home Production for Home Consumption once two, or more, -level nested utility functions are included in the model. Then, provided the database is structured to capture transactions by semi-subsistent households and production activities and the model is appropriately configured, the model has the necessary information to represent HPHC in a restricted manner.

The restrictions placed on a more complete representation of HPHC are that the segmentation of factor markets at the level of institutions/households means that a behavioural response by semi-subsistent households is muted. Namely, households are constrained to employ the factors they own within the same labour market segment despite changes in (relative) factor prices. This is necessary because factor market clearing conditions must be satisfied at the level of the individual institution/household IF the model is to include non-separability in its key behavioural relationships.[16]

3.3. Modelling the labour-leisure trade off

Many of the CGE models currently employed for economic analysis and labour supply focus on the portion of a household's and/or individual's time in employment, with the implicit assumption that the supply of labour is fixed at this level. In some analyses this assumption has been relaxed by the assumption that there is a pool of unemployed labour that can be drawn upon, at zero marginal cost, according to the demand for labour of that type. In the former case the labour supply curves are assumed to be vertical, while in the latter case the labour supply curves are assumed to be horizontal. Regimes switching versions of these polar assumptions are implemented using Mixed-Complementarity (MCP) formulations of GAMS based CGE models.

However economic theory argues that the supply of labour depends on some trade-off between utility derived from leisure and consumption, which is a function of wage income from labour time. In the institutional context of a CGE model, with its assumption of a unitary household, the relevant utility function is defined at the level of the household/RHG. This requires considering the household's 'full time supply' which comprises of leisure time and work; this approach allows the substitution (trade-off) between labour and leisure in labour supply determination. Apart from the argument that labour supply depends on the trade-off between leisure and consumption/work, accounting for labour/leisure trade-off is relevant since outcomes of economic analyses tend to depend on the mechanism governing the allocation of 'full time endowment' between leisure and work (Goettle *et al*., 2009), and the trade-off between the two major uses of time is the major cost of adjustment/response costs (Britz *et al*., 2014).

Incorporating labour/leisure trade-off means that the consumption basket of a typical household comprises of goods, services, and leisure, i.e., household utility is defined at 'full consumption' levels rather than only on commodities, which is the custom in most economy-wide models. This is because leisure is treated as a 'commodity' produced by the household at home using leisure time as input, and the leisure produced is entirely consumed within the household itself.[17] The household's allocation of full consumption

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while the second level combines commodities to produce 'broad' commodity groups and the top level is an LES.

[16] Typical single country CGE models, e.g., the IFPRI standard, PEP and STAGE 1 models include an organisation of factor markets and factor ownership that impose strong separability on the operation of the factor markets.

[17] Leisure as defined in this instance implicitly includes domestic activities that produce commodities outwith the SNA production boundary as well as 'pure' leisure. As such it involves an implicit presumption that commodities produced by domestic production outwith the SNA

between leisure and demand for goods and services is an important factor that influences labour supply and attaches opportunity costs to any decision to change labour supply.

The labour/leisure trade-off is not the same for all groups of households and individuals facing a labour supply decision; it depends on observed and unobserved characteristics of each agent. For example, retired people will not have same labour/leisure trade-off as those in the working age group; self-employed persons' labour-supply decision should differ significantly from the one made by employees; and certainly, unemployed people have a different labour/leisure trade-off compared with employed. The incorporation of the trade-off between labour/consumption and leisure is crucial for accounting for these empirical observations.

Incorporating the labour/leisure trade-off increases the policy relevance of the resultant data and model by:

1. representing the actual labour supply and consumption decision rules of households, and
2. allowing for a wide range of policy options to experiment.

Labour and commodity tax policy, and environmental analyses are some of the policy experiments that can be conducted more effectively in situations where the trade-offs are recognised. The level and consequences of distortions caused, such as, by new taxes on labour incomes, can be examined using such models and databases. Taxes on labour income can distort the labour/leisure trade-off by making leisure time more attractive than labour time; or in other words such taxes can make the consumption of commodities more expensive relative to the consumption of leisure. Bringing the labour/leisure trade-off can also have great use for environmental policy analysis to identify appropriate environmental policies that can raise revenue while reducing distortions in labour incomes. It also finds applicability on analysis of sustainable development and food systems in a world increasingly constrained by the growing challenges of food availability.

3.3.1 Upward Sloping Labour Supply Curves

In recent years a number of models have included 'upward sloping labour supply curves' that are notionally justified by reference to the wage curve (see Blanchflower and Oswald, 1995, for a summary). Thus, for instance, variants of the IFPRI standard model include a behavioural relationship that allows the supply of each factor/labour type to increase/decrease as the factor/labour prices increase/decrease. This behavioural relationship mimics the empirical evidence that underpins the wage curve hypothesis but introduces 'manna from heaven' to the model; specifically, an increase in factor/labour supply has no opportunity cost. This implies that the utility foregone by the labour added to the labour supply is zero, which means there is no opportunity costs, i.e., its marginal cost is zero but it only enters the labour market at a positive price.

The wage curve literature by Blanchflower and Oswald (1995) is careful to avoid the interpretation associated with the use of upward sloping labour supply curves in the CGE literature

> *"The evidence given in The Wage Curve does not offer support for the idea that the negative correlation between pay and unemployment is explained by a labor [sic] supply function. The book argues that the demand and supply framework is the wrong way to think about the labor [sic] market. As Robert Solow's 1989 lectures at Berkeley suggest, there may be something special about labor as a*

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production boundary are valued at opportunity costs; this presumption is not without its own accounting problems.

commodity, and therefore about the labor [sic] market itself (p.3, Solow 1990)." (Blanchflower and Oswald, 1994).

Hence while the application of upward sloping labour supply curves may provide some reflection of the empirical evidence its behavioural and theoretical foundations are dubious and the wage curve literature does not provide theoretical justification for its use.

Moreover, none of the known models that include upward sloping labour supply curves endogenise the functional distribution of income. Specifically, the functional distribution of income is controlled in these models though matrices of parameters that embody the implicit presumption that the (proportionate) changes in factor supplies are identical across all RHGs.

3.3.2 Behavioural Relationships

The standard STAGE model does not require the inclusion of additional behavioural relationships to account for labour-leisure trade-offs. It does however require changes to the definition of the commodity and activity accounts and to the factor use (*factuse*) and factor ownership (*factinsw*) matrices and extensions to the SAM transaction matrix, and modifications to the factor/labour market clearing equations.

The commodity accounts must be extended to include leisure commodities that are household specific, i.e., one additional commodity (leisure) for each representative household group (RHG) in the database. Similarly, the activity accounts must be extended to included leisure activities that are household specific, i.e., one additional activity for each representative household group (RHG) in the database, and only use labour supplied by the paired household in production. Each of these leisure activities produces a single leisure commodity that can only be consumed by the paired RHG and only uses labour supplied by the paired RHG.

The factor ownership matrix must be extended to include all labour available to each RHG for activities within the (SNA) production boundary, i.e., labour sold on the labour market, the original definition, plus labour used to produce leisure.[18] By definition the amount of labour used to produce leisure defines the amount of labour used by the paired activity to produce the amount of leisure commodity demanded by the paired RHG. The standard logic of CGE models dictates that the price of each leisure commodity is defined by the costs of its production, i.e., the costs of the household labour used in its production. By definition the opportunity cost of labour used in the production of leisure is the marginal wage income foregone; hence the transaction values in the SAM database for labour used in leisure activities are the wage rates for each labour type times the quantities of labour used to produce leisure. Since in this context leisure time is time foregone from the labour market, within the production boundary, by members of the RHGs its valuation avoids the complication associated with defining the production boundary. Specifically, leisure time can only be provided by those persons that enjoy the leisure and the opportunity cost of the time and its market price are identical, and therefore leisure can be given a price and hence valuation.

Thereafter the model treats leisure as another commodity that enters each RHG's utility function. If the model is shocked so that the costs of producing leisure increase relative to other commodities, then the demand for leisure would decrease and the clearing of labour markets would result in more labour being supplied to the market and hence increases in the production of non-leisure commodities. Similarly, a shock that decreases the costs of producing leisure would cause the supply of labour to the market to decline.

[18] This statement contains an implicit presumption that labour is strictly segmented between activities within and without the SNA's production boundary. This is self-evidently an abstraction/approximation, for instance households can reduce the time costs of food preparation by purchasing pre-prepared food products thereby releasing labour for activities within the production boundary.

The key change to the market clearing conditions for the factor markets are that the factor quantities supplied by each institution for the production of leisure (*FSIL*) must be defined so as to be activity, and its paired RHG, and factor specific This is defined in [7] where the mapping (*map_hh_alei*) pairs leisure activities (*alei*) with RHGs (*hh*). Then the market clearing condition for the factor supplies by institution (*FSI*) and the demand for factors by non-leisure activities (*FD*) and leisure activities (*FSIL*) is specified in [8].

Factor Market Clearing Block Equations

$$\sum_{insw} FSI_{insw,f} = \sum_{alein} FD_{f,alein} + \sum_{insw} FSIL_{insw,f} \qquad \forall alein(a) \text{ and } f\left(ff\right). \qquad [7]$$

$$FSIL_{insw,f} = \sum_{a\$map\_hh\_alei(insw,a)} FD_{f,a} \qquad \forall alei(a) \text{ and } f\left(ff\right) \qquad [8]$$

There is however no reason to suppose that the proportionate changes in the amount of labour time devoted to leisure and non-leisure activities will be identical across households. Even if the elasticities controlling the operation of the RHGs utility functions are the same there are differences in the levels of household incomes and preferences, i.e., there will be differences in the shift and share parameters of the utility functions. Thus the presence of a labour-leisure trade-off means that the labour/factor supplies by institution (*FSI*) will be endogenously determined variables and hence the functional distribution of income should change. This is achieved by endogenously determining the shares of factor supplies (*FSISH*) in equation [9] and then defining in [10] the factor incomes distributed to institution (*INSVA*) as the product of the shares of factor supplies and the distributed factor incomes (*YFDISP*).

Factor Block Equations

$$FSISH_{insw,f} = {FSI_{insw,f}} \Big/ {\sum_{insw} FSI_{insw,f}} \qquad [9]$$

$$INSVA_{insw,f} = FSISH_{insw,f} * YFDISP_{f} \qquad [10]$$

It is important to note that the extension of the SAM (transaction) database contains an implicit redefinition of GDP. The standard expenditure measure of GDP (C(consumption) + I(nvestment) + G(overnment) + X(exports) – M(imports)) is implicitly extended to include the value of leisure consumed. But leisure is outside of the System of National Accounts' (SNA) production boundary. Thus users must be careful to define GDP and extended GDP separately. Similar issues apply to the use of money metric welfare measures (EV) and absorption.

3.4. Household Migration

Migration in response to changes in socio-economic conditions and relative magnitudes of pull and push factors between places of origin and destination has been one of the oldest practices of human beings, and has continued to be so. Demographic, health, environmental, and economic shocks and intervening factors (such as access to finance, existence of networks, and political and policy variables) have caused migration in greater or lesser numbers over millennia. Several studies (Khan, 2008; Stifel and Thorbecke, 2003; Nana and Poot, 1996) have been conducted to examine the migration impacts of economic opportunities and constraints caused by changes in economic policies such as trade liberalisation, changes in agricultural support programs, sectoral policy biases. Changes in socio-economic policies are almost inevitable and evolve overtime making the prospects of migration a reality, as long as the changes will put economies in a transitional disequilibrium and alter sectorial and spatial income distribution.

It is important to recognise that household migration can take multiple forms. The simplest distinction is between external and internal migration, where external migration refers to migration across national boundaries and internal migration refers to migration/relocation within national boundaries. External migration requires the use of a global model if the determinants of migration are to be fully endogenised. This has been achieved in the GMIG (Walmsley *et al*, 2007) and the GLOBE_MIG (McDonald *et al*., 2009) models. Internal migration is in the tradition of Harris and Todaro (1970) wherein the primary interest has concentrated on the subject of rural-urban migration. The STAGE_DEV model is concerned with internal migration only. The model uses behavioural relationships that are a development of those in the GLOBE_MIG model and the migration pathways are general, i.e., migration can take place between and within rural and urban locations, and hence is a generalised form of the traditional focus on rural-urban migration.

Modelling this old practice of mankind in response to policy and external shocks is a complicated undertaking since shocks affect migration outcomes in a variety of ways. The income dimension is among the complex ways through which changes in socio-economic variables might affect migration decisions, and the discussion here focuses on this dimension. Following the neoclassical theory of migration, e.g., Harris and Todaro (1970), it is assumed that individuals/households decide to migrate from places of origin to destination if their relative (expected) incomes/wages change; existing differences in incomes are assumed to reflect non-accounted factors. Also, while other models migration is an individual's decision, migration is more of a household decision where members of the household make collective decisions with the objective of maximising/optimising the household's utility (objective function).

Hence, unlike the classical approach of relying on individual wage rates as a decision tool, the household's average, or per capita income, which includes all income sources such as transfers and remittances, is assumed to be used to make migration decisions. It is further assumed that households will decide to migrate permanently to new locations (geographically) as long as the changes in relative average incomes are permanent, with a possibility of return migration or a second round migration if the newly established equilibrium is destabilised, although this is beyond the time horizon of a static model.

In a similar fashion, as the case of labour mobility across segmented labour markets (discussed below), constant elasticity supply functions are used (Walmsley *et al*., 2007; McDonald and Thierfelder, 2009; McDonald *et al*., 2009). The approach adopted here is a development of the factor mobility functions developed in McDonald and Thierfelder (2009) where physical units of labour are allowed to transit across regions and/or skill types according to constant elasticity labour supply functions; so-called labour mobility functions. This method was used by Polaski *et al*., (2009), refined and developed by Flaig *et al*., (2013a) and further generalised by McDonald *et al*., (2015) to examine, respectively, gains from trade in Brazil, labour market segmentation between Palestine and Israel, and calibration biases in trade policy analyses. Following the justification for treating migration as a household decision vis-à-vis an individual decision, the decision is based on average incomes here rather than wage rates as in factor mobility functions.

Household migration affects factor distribution since labour moves together with household migration. The existence of labour migration, as households migrate, means that a new definition for factor supply at representative households group (RHG) level is needed to incorporate the alterations in factor distribution by each household involved in the migration either as origin, destination or both. Thus, importantly, as each household migrates so the matrix of factor ownership by each RHG updates to reflect the transition of factors from one RHG to another. This ensures that the functional distribution of income and the factor supply by institution variables are endogenous.

3.4.1 Behavioural Relationships

The typical approach to modelling households, one of the institutions, is to assume that representative household groups (RHG) are rigidly segmented and that each RHG receives a fixed share of factor incomes generated domestically and received from abroad. The first part of the assumption requires that households are not allowed to migrate, while the second part carries the implicit presumption that any changes in factor supplies by RHGs changes the supply of each factor by each RHG equiproportionately. Neither of these assumptions is necessarily an accurate reflection of reality and, at the same time, imposes restrictions that require households to NOT change behaviour in response to economic signals. The STAGE_DEV model allows RHGs to relocate/migrate in response to changes in economic signals, e.g., changes in relative RHG incomes, and when they do so transfer their factors from the RHG they leave to the RHG they join. The model is coded so that the functional distribution of income changes as RHGs migrate.

The inclusion of the assumption of household migration across types of household relaxes the restrictive assumption of rigid segmentation of RHGs. The behavioural assumption is that the incentives for a RHG to migrate are changes in the relative returns to different RHGs, i.e., only economic incentives are embodied within the behavioural assumption. Thus, if RHGs in one segment experience a RELATIVE increase in income to the RHGs in all other segments there will be incentives for households to relocate/migrate to the RHG that receives an increase in RELATIVE income: relative incomes (*YMIGR*) are defined in [11]. There are two important things about this relationship: first it is assumed that all other influences on the location decisions of RHGs are unchanged and second that the user needs to specify the set (*map_insw_inswp*) that defines the pairs of RHGs between which households can migrate[19].

Institution Migration Block Equations

$$YMIGR_{insw,inswp} = \frac{\left[\sum_f INSVASH_{inswp,f}\right]}{\left[\sum_f INSVASH_{insw,f}\right]} \qquad \forall map\_insw\_inswp_{insw,inswp} \qquad [11]$$

[19] Thus, the user can limit the migration possibilities to rural-urban pathways or and other pathways, including
urban-rural.

$$FSIM\_I_{f,insw,inswp} = FSIA_{insw,f} * \left(\frac{YMIGR_{insw,inswp}}{YMIGR0_{insw,inswp}} \right)^{etahh_{f,insw,inswp}} - FSI0_{insw,f} \quad . \qquad [12]$$

$$\forall map\_insw\_inswp_{insw,inswp}$$

$$FSIM\_I_{f,insw,inswp} = FSI0_{insw,f} - \sum_{inswp\$(notsameas_{inswp,insw})} FSIM\_I_{f,insw,inswp} \qquad [13]$$

$$\forall inswmig_{insw} \textbf{ AND } FSI0_{insw,f}$$

$$FSI\_I_{insw,f} = \sum_{inswp\$inswmig_{insw}} FSIM\_I_{f,insw,pinsw} \qquad [14]$$

$$\forall inswmig_{insw} \textbf{ AND } FSI\_I0_{insw,f}$$

Given these changes in relative incomes and elasticities of migration (*etahh*), which are factor and institution pair specific, the quantities of households moving between RHG pairs for each institution (*FSIM_I*) can be determined [12] by a constant elasticity of supply function and their summation across institutions produces the supply of each factor by each institution (*FSI*) in [14]. There is also a need to ensure that no additional households are created; this is achieved by a constraint equation that ensures that for each household moved from one segment only one household is created in the paired segment [13].

The endogeniety of the functional distribution is ensured by the fact that the functional distribution of income depends upon the shares of factors supplied by different institutions (*FSISH*), which is a function of the supply of factors by institutions (*FSI*), which is defined in Eqn [14]. Since both of these are endogenous variables the functional distribution of income is endogenous.

An important behavioural assumption on STAGE_DEV is that RHGs are assumed to make the migration decision before making the factor mobility decision. Hence in the migration equation [12] the constant supply elasticity functions operate on the base level of the factor supplies by the relevant institution/RHG (*FSI*0). This is in fact defined as *FSIA*, which is equal to *FSI*0, but provides the ability to update *FSIA* in the update statements between solution periods in a recursive dynamic setting.

3.5. Factor Market Segmentation

Accounting for factor market conditions is crucial for understanding poverty and income distribution implications of policies and programmes since factor incomes and how they are affected by policy and economic changes are the main drivers of changes in income distribution. The evidence indicates that the socio-economic impacts of economic shocks depend on the structure of factor markets and the speed with which factors can reallocate in response to shocks, which to some extent depends on the degree of factor mobility. In the simple textbook case some factors are categorised as more mobile than others: land and natural resources being the least mobile with labour the most mobile and capital somewhere in between. In theory, for homogeneous and perfectly mobile factors, *ceteris paribus*, there will be an equalisation of factor returns across activities, while for less mobile factors returns to notionally identical factors may differ.

In many CGE models the factor markets are considered to be unified and operate smoothly, with factors that are perfectly mobile across uses. This implies that factors are homogenous and that there are no restrictions and costs involved with the transition of factors between activities. However, factor markets, especially labour markets, differ from other markets, such as commodity markets, due to their structural complexity and specificity (Jakstiene, 2010), where the role of institutions (such as government policies), socio-economic-political factors (such as working conditions) are crucial in characterising markets. Hence, the assumption of unified labour markets does not explain, *inter alia*, the empirical observations of:

1. persistent rural (agricultural) - urban (non-agricultural) wage differentials,
2. farm vs off-farm wage disparity, and
3. continuing urban-rural migration caused by forces other than skill differentials.

Traditionally, differences in skills and investments in skill developments are considered as the sole causes of differences in wage rates. Hence differences in wages paid to labour are assumed to be attributable solely to differences in skill level, technology and factor ratios, e.g., capital-labour ratios. Nevertheless, empirical observations indicate that labour types within the same classification category receive substantially different wage rates in different activities and these differences are difficult to reconcile solely by appeal to differences in technology and factor ratios.

It is this failure of the classical approach to labour markets that led to the emergence and use of a segmentationalist view to factor markets. Ryan (1984, cited in Leontaridi (1998)) defined labour market segmentation as 'the failure of the labour market to treat its participants even-handedly, in that it accords significantly different opportunities to otherwise comparable people'. The acknowledgment of segmented factor markets is of crucial significance in the case of developing countries where factor market segmentation is facilitated by several compounding factors. In most of these countries, there are deep-rooted non-economic barriers that prevent mobility of factors between sectors and segments. These barriers are crucial for the existence of segmented labour markets since the existence of complete inter-sectorial mobility means equalisation of wages between sectors/segments.

Unlike the ideal outcome of unified factor markets, under segmented factor markets, the factor market within a national economy is recognised not to be single and unified and that it is perceived to be a set of non-competing market segments where the underlying operations with regard to wage levels, job security and working conditions differ across segments due to institutional and other barriers. While some jobs are structurally low paying jobs with limited or no opportunity for on job skill development, others are better paying with higher returns to skill developments. Moreover, even if there could be some mobility between markets/segments in response to changes in factor returns subject to the degree of each factor's mobility as represented by its elasticity of mobility/transformation, it is usually the case that mobility between segments is restricted to the extent that the wage differentials between the segments are, at least partially, maintained. Segmentation also implies that the factor market clearing condition is defined for each segment; hence, there are *n* market clearing conditions for *n* segments each with separate employment and wage setting mechanisms. At equilibrium, the economy-wide supply of each specific factor is equal to the sum of the demand for that factor by each employing sector, plus factors currently unemployed.

While it has been recognised that many labour markets are organised in segments, there is no general consensus on how to define and organise the segments. The number of segments adapted is also a matter of empirical choice open to each respective context. Crudely modellers can follow one or more of three approaches for incorporating segmented factor markets in economic models:

1. by disaggregating each factor by its characteristics, e.g., education, gender, race, migration status, and by geography, e.g., rural vs urban;
2. by the sector of employment, e.g., agriculture vs non-agriculture, and
3. by some combination of the two.

The activity of employment is related to 'industrial characteristics' and is used in much of the labour market literature; it involves the feature of the employing activity, e.g., 'core' vs 'periphery' activities, and the nature of the product market for the activity's output. It also focuses on the nature of the demand for labour services since labour demand is a derived demand from the activity output.

Conventionally CGE models have adopted one or more of three approaches to factor mobility in applied economic models, each factor is classified:

1. perfectly mobile; or
2. perfectly immobile; or
3. 'sluggish'.

The first two approaches derive from standard economic theory. Perfectly mobile factors respond to changes in the factor market by reallocation, instantly and costlessly, across activities until the factor prices are 'equalised'.[20] If a factor is perfectly immobile, the classic short run case, then returns to the factor varies across activity. The 'sluggish' classification, used in the GTAP family of models (Hertel *et al*., 2007)[21], amounts to an assumption of imperfect mobility where a factor partially reallocates with the extent of reallocation being determined by the elasticity of transformation of a constant elasticity of transformation function. Thus the three 'standard' alternatives could be classified by the implied elasticities of transformation: infinite, zero and greater than zero but less than infinite. Intuitively the presumption of imperfect mobility is attractive since it allows for a range of response rates according to differences in factor characteristics that may better represent the operation of labour markets. In a CET formulation of imperfect factor/labour mobility the response depends on the elasticity of transformation with structural features, such as factor heterogeneity, high transaction costs and inefficient factor markets, captured by the mobility elasticity. The higher the mobility elasticity, the easier labour moves between sectors.

But the adoption of the 'sluggish'/CET function approach implies that the reallocation of labour in response to changes is in terms of some form of efficiency units (Flaig *et al*., 2013a), which suggests that the equilibrium condition in the labour market should be defined in efficiency units; not in head counts. However, for studies that are concerned with the physical movement of people/workers, defining labour supply in head counts is more appropriate. One approach to this issue was developed by McDonald and Theirfielder (2009) where physical units of labour are allowed to transit across regions and/or skill types according to constant elasticity labour supply functions; so-called labour mobility functions. This method was used by Polaski *et al*., (2009), refined and developed by Flaig *et al*., (2013a) and further generalised by McDonald *et al*., (2015) to examine, respectively, gains from trade in Brazil, labour market segmentation between Palestine and Israel, and calibration biases in global trade policy analyses.

The logic behind the use of labour mobility functions is relatively simple. Databases that include transactions and quantity data for factor demand transactions reveal that the wage rates for each type of labour differ markedly across the sectors within which they are employed, which runs counter to the presumption that labour is homogeneous within each type category, i.e., wage rates are not equalised. Another common characteristic of these databases is that the wage rates for each type of labour are relatively common across groups of related sectors, e.g., agriculture, food processing, manufacturing, etc. The regularity of these data indicates that there is likely to be a degree of heterogeneity within each labour category. Moreover, empirical evidence from studies of South Africa and Israel have demonstrated that the traditional approach of assuming labour that relocates to another sector adopts the productivity of labour in the destination sector can lead to large productivity gains that dominate the results of policy analyses. Labour mobility functions assume that each type of labour is segmented across different

[20] The precise interpretation of 'equalised' will be clarified below.
[21] Typical applications use the 'sluggish' option with respect to the operation of the land market, but there are no reasons why it cannot be applied to labour markets; the model code allows the user to make such a choice.

categories of sectors, in the extreme case each sector is its own segment, and that labour mobility between segments is imperfect but within segments mobility is perfect. The roles of structural features such as high transaction costs and lack of efficient factor markets on factor mobility are captured by the mobility elasticity. The higher the mobility elasticity, the easier labour moves between segments.

This however leaves the issue of the productivity of labour that moves from one segment to another underdetermined. The polar extremes may be defined in terms of whether labour that transitions is measured in terms of physical/quantity units, i.e., the labour that transitions takes the productivity of labour already in that segment, or efficiency units, i.e., the labour that transitions takes the productivity of labour in that segment that it leaves. This leads to issues of how the calibration of the labour units is handled within the model

3.5.1 Production and Calibrating CGE Model

At a basic level there two alternative ways of calibrating the quantities of factors in the production functions used in CGE models: the use of value quantities, the so-called Harberger convention, and physical quantities. In some CGE models, including STAGE, the choice of method used is data driven; if the database contains physical quantity data for factors then factors can enter the model in terms of physical quantity units; if not they are measured in value units. The explanation of the method below will adopt this general specification.

Factor demands by activities can be written as

$$QFD_{f,a} = FACTUSE_{f,a} \qquad [15]$$

where $QFD_{f,a}$ is the demand for factor f by activity a and $FACTUSE$ is a matrix of factor quantities. Then, assuming no unemployment, for simplicity, the supply of factors (QFS) is defined as

$$QFS_f = \sum_a QFD_{f,a} \ . \qquad [16]$$

The factor paid prices by each activity (WFA) as reported in the database can then be calibrated as

$$WFA_{f,a} = \frac{SAM_{f,a}}{FACTUSE_{f,a}} = \frac{\left(WFA_{f,a}.QFD_{f,a}\right)}{FACTUSE_{f,a}} = WF_f.wfdist_{f,a} \qquad [17]$$

where $SAM_{f,a}$ is the transactions values reported in the database, which in this case is assumed to be a SAM.[22] If a factor is homogenous and there is no activity specific heterogeneity then a factor price will be identical for all activities[23]. However, if there is any factor and/or activity specific heterogeneity factor prices will vary across activities. This can be represented by decomposing WFA into two components: and average price for the factor (WF), which can be set equal to one without loss of generality, and a factor activity specific distribution factor ($wfdist$).[24]

[22] Since the transactions data for all CGE models can expressed in terms of a SAM this assumption is not restrictive.
[23] In terms of a SAM and the Law of One Price (LOOP) all entries in a row a SAM should have the same price, otherwise the price terms in the calibrated model will be underspecified.
[24] It is common practice to scale the physical quantity units so that the average prices of factors (WF) are close to one and the variations in prices across activities ($wfdist$) are centred on one. This was particularly important with earlier generation solvers that were sensitive to ranges of prices.

If the observed transactions in the SAM are equilibria and factors are paid the values of their marginal product, as defined by a standard first order condition (FOC) for a CES function

$$WF_f.wfdist_{f,a} = PVA_a.QVA_a.\left[\sum_f \delta_{f,a}.QFD_{f,a}^{-\rho_a}\right]^{-1}.\delta_{f,a}.QFD_{f,a}^{-\rho_a-1} \qquad [18]$$

where *PVA*/*QVA* are the price and quantity of value added and $\delta_{f,a}$ and ρ_a are the share and elasticity parameters; then differences in factor prices (*WFA* and *wfdist*) can be interpreted as differences in the observed productivities of the factors in different uses (activities). Given the (neoclassical) production functions used in CGE models the differences in a factor's price across activities can be derived from differences (heterogeneity) in the factor used by the activity and/or differences in the factor ratios in the activity specific technologies. In reality given the aggregation used in CGE models it would be reasonable to assume that factor heterogeneity and technology differences will be a defining feature of these models.

If physical quantity data are not present, which, for instance, is the very common, e.g., for models calibrated using the GTAP database, then the Harberger convention is adopted, i.e.,

$$\begin{aligned} VFD_{f,a} &= SAM_{f,a} \\ VFS_f &= \sum_a VFD_{f,a} \end{aligned} \qquad [19]$$

where $VFD_{f,a}$ is the demand for the factor *f* in activity *a* and VFS_f is the supply of factor *f* measured in value quantities. Then, by definition, the factor paid price by each activity ($WFA_{f,a}$) is calibrated as

$$WFA_{f,a} = \frac{SAM_{f,a}}{SAM_{f,a}} = \frac{\left(WFA_{f,a}.VFD_{f,a}\right)}{SAM_{f,a}} = \frac{\left(WF_f.wfdist_{f,a}.VFD_{f,a}\right)}{SAM_{f,a}} = 1 \qquad \forall f,a$$

[20]

and $QFD_{f,a}$ and $VFD_{f,a}$ can be used interchangeably in the FOC. Note that, by definition, WF_f and $wfdist_{f,a}$ are equal to one for all factors and activities. Thus, the implicit assumptions underpinning the Harberger convention are that factors are homogenous and there are no activity-specific technology attributes that impact on the prices paid for a factor by an activity. In other words, the units of the value quantities can be defined as factor:activity specific efficiency units.

In terms of calibration it is not critical which quantity units are used since either will by definition, be consistent with the initial equilibrium. The issue is what happens in the event of a shock that induces factor reallocations in accordance with the FOC; in fact this depends solely on the interpretation of $wfdist_{f,a}$ when factor quantities are measured in physical and value units.[25] When physical quantities are used the interpretation of $wfdist_{f,a}$ is that ALL differences in factor prices across activities are activity specific, whereas when value quantities are used all differences are factor specific. Thus, when a factor moves to a new activity it either adopts the 'productivity' of the factors currently used by the activity, the physical quantity case, or it retains the 'productivity' it had in the activity from which it originated. In reality, an expectation may be that realised productivity is somewhere between these two alternatives; Flaig *et al.*, (2013b) addresses this issue.

[25] Note the normalisation of *WF* as equal to one in the case where physical quantities are used.

The full employment market clearing conditions in [16] and [19] are also important. When factor quantities are in physical units the market clearing condition is straightforward since the units are unambiguous, e.g., person hours. When factors are measured in value/efficiency units the units are not as transparent since one physical unit of a factor in one activity can be equivalent to more, less or the same number of physical units in another activity.

In either case the transition between equilibria will have productivity/endowment effects on the economy.[26] In the case of physical units, the movement of a factor to a higher/lower activity specific productivity will increase/decrease the average productivity of that factor, while in the case of value units the movement of a factor to an activity with higher/lower factor specific productivity will decrease/increase the average productivity of that activity. If quantity data are available, it is a relatively simple task to derive estimates of the activity level and economy wide productivity effects of factor reallocations.

3.5.2 Factor Mobility Functions and the Functional Distribution of Income

The standard assumption in labour mobility/migration frameworks is that factor incomes are distributed to households in fixed proportion, an assumption which requires that (McDonald, 2010): i) labour is fully employed, and ii) that each household's endowment of labour is fixed. However, as labour is allowed to transition from one skill type to the other or across employment types, the fixed share assumption is no longer feasible and any transition will have important implications on the functional distribution of income. This problem can be resolved by replacing the matrix of fixed share coefficients that controls the functional distribution of income by a matrix of variables that tracks changes in the supply of each labour type in each segment.

3.5.3 Behavioural Relationships

The typical approach to factor supply and demand is that factors are rigidly segmented so that the supply of a factor is fixed, either at the current level of demand, i.e., full employment, or at some level that is greater than the current demand so as to allow for unemployment of that type of factor. This presumption of rigid segmentation is restrictive and as such does not allow for the possibility that labour can transition, to a greater or lesser extent, between the segments in response to changes in the factor market, with or without job specific training. For instance, tractor operators, in agriculture, may readily transition into JCB operators, in construction. Moreover, the common option of classifying labour by levels of skill, e.g., skilled, semi-skilled and unskilled, involves the implicit assumption that all labour of a specific type receives the same average wage rate when within each type of labour there is likely to be a range of wage rates about the average. Thus it may be that lower paid skilled workers may be willing to take employment as semi-skilled workers if average wage rates for skilled workers decline relative to those of semi-skilled workers.

[26] Note that the endowment effect in the GTAP model's welfare decomposition is solely attributable to increases/decrease in the (value) quantities of factors employed.

$$WMOBR0_{f,fp,insw} = \frac{\left[\left(\sum_a WF_{fp} * WFDIST_{fp,a} * FD_{fp,a} \right) \Big/ \sum_a FD_{fp,a} \right]}{\left[\left(\sum_a WF_f * WFDIST_{f,a} * FD_{f,a} \right) \Big/ \sum_a FD_{f,a} \right]} \qquad [21]$$

$$\forall map\_fmig\_fmigp_{f,fp} \ \textbf{AND} \ FSI\_I0_{insw,f} \ \textbf{AND} \ FSI\_I_{insw,fp}$$

$$FSIM\_F_{f,fp,insw} = FSI\_I_{insw,f} * \left(\frac{WMOBR_{f,fp,insw}}{WMOBR0_{f,fp,insw}} \right)^{etaff_{f,fp,insw}} - FSI\_I_{insw,f} \ . \qquad [22]$$

$$\forall map\_fmig\_fmigp_{f,fp} \ \textbf{AND} \ FSI\_I0_{insw,f} \ \textbf{AND} \ FSI\_I_{insw,fp}$$

$$FSIM\_F_{f,f,insw} = FSI\_I_{insw,f} - \sum_{fp\$\left(notsameas_{fp,f}\right)} FSIM\_F_{f,fp,insw} \qquad [23]$$

$$\forall fmig_f \ \textbf{AND} \ FSI\_I0_{insw,f}$$

$$FSI_{insw,f} = \sum_{fp\$ fmig_{fp}} FSIM\_F_{fp,f,insw} \qquad \forall fmig_f \ \textbf{AND} \ FSI0_{insw,f} \qquad [24]$$

These differences in average wage rates are reflected in the fact that labour of the same type are paid at different wage rates according to the activity in which they are employed. This is evident in any CGE model for which there are data for both the transactions values and quantities of labour employed by different activities and are reported as differences in the values of $WFDIST_{f,a}$. Where such data are available it is not uncommon to find that skilled agricultural workers are paid less than semi-skilled manufacturing workers. Such an observation implies, within the logic of CGE models and the labour classification scheme that the labour market is not operating efficiently. Such an observation is justified by some combination of assuming that there are non-rewarded preferences that explain the differences in average wages and/or that the differences are entirely due to activity specific attributes, i.e., the maintained assumption is that the labour classification scheme encompasses all differences in characteristics of the labour types. But it does mean that any reallocations of labour in simulations can and does result in changes in the average productivity of labour, which is equivalent to changing the factor endowments in the model.

The inclusion of the assumption of factor mobility across types of labour relaxes this restrictive assumption by assuming that types of factors can transition into other, specified, types in response to changes in the relative rates of return to factor (*WMOBR*); these are endogenous changes that are computed in Eqn [21]. Given these changes in relative rates of return and elasticities of mobility (*etaff*), which are factor pair and institution specific, the quantities of factors moving between factor pairs for each institution (*FSIM_F*) can be determined [22] and their summation across institutions produces the supply of each factor by each institution (*FSI*) in Eqn [24]. There also a need to ensure that no additional factors are created; this achieved by a constraint equation that ensures that for each unit of a factor moved from one segment only one unit of a factor is created in the paired segment [23].

Note however that the mobility of factors is defined in [22] by reference to the numbers of factors supplied by each institution AFTER household migration, i.e., *FSI_I*, and not by reference to the amounts of factors supplied in the base period (FSI0). This reflects the presumption that household migration takes place before factor mobility decisions and ensures that in the solution the variables are all endogenous.[27] Similarly equation [23] is also based on the post migration factor supplies *FSI_I*, rather than the base quantities, *FSIM_F*.

The endogeniety of the functional distribution is ensured by the fact that the functional distribution of income depends upon the shares of factors supplied by different institutions (*FSISH*) that is a function of the supply of factors by institutions (*FSI*). Since both of these are endogenous variables the functional distribution of income is endogenous.

[27] Since the solutions are simultaneous this is not critical but it does simplify exposition and model clarity.

4. A Social Accounting Matrix (SAM) for STAGE_DEV

The STAGE_DEV model is designed for calibration using a reduced form of a Social Accounting Matrix (SAM) that broadly conforms to the United Nations System of National Accounts (SNA).

A SAM is a consistent data framework that collects the data of national income, product accounts, input-output table, and reflects the monetary flows between institutions in an economy. A SAM is a square matrix representing in a comprehensive, flexible, and disaggregated way all the transactions of a socioeconomic system. It reflects the processes of the generation of income by activities, of production, and the distribution and redistribution of income between institutional groups. The various interdependencies in the economic system are recorded as the actual and imputed transactions and transfers between the agents in the system.

The genesis of a SAM relies on the pioneering work on social accounts of Sir Richard Stone in the 1950s and 1960s; Stone created an integrated system of national accounts and defined most of the conventions that are currently followed by statistical agencies in the development of their SAMs. Pyatt and Thorbecke (1976) formalised the SAM as a framework for economic analysis and planning. SAMs were first used to study developing economies in the late 1970s (see Pyatt and Round (1985)).

4.1. An Introduction to Social Accounting Matrices

The guiding principles of a SAM are the concept of the circular flow and the requirements of double entry bookkeeping. The concept of the circular flow demonstrates how a SAM is distinct from Input-Output Tables (IOT) and Supply and Use Tables (SUT).

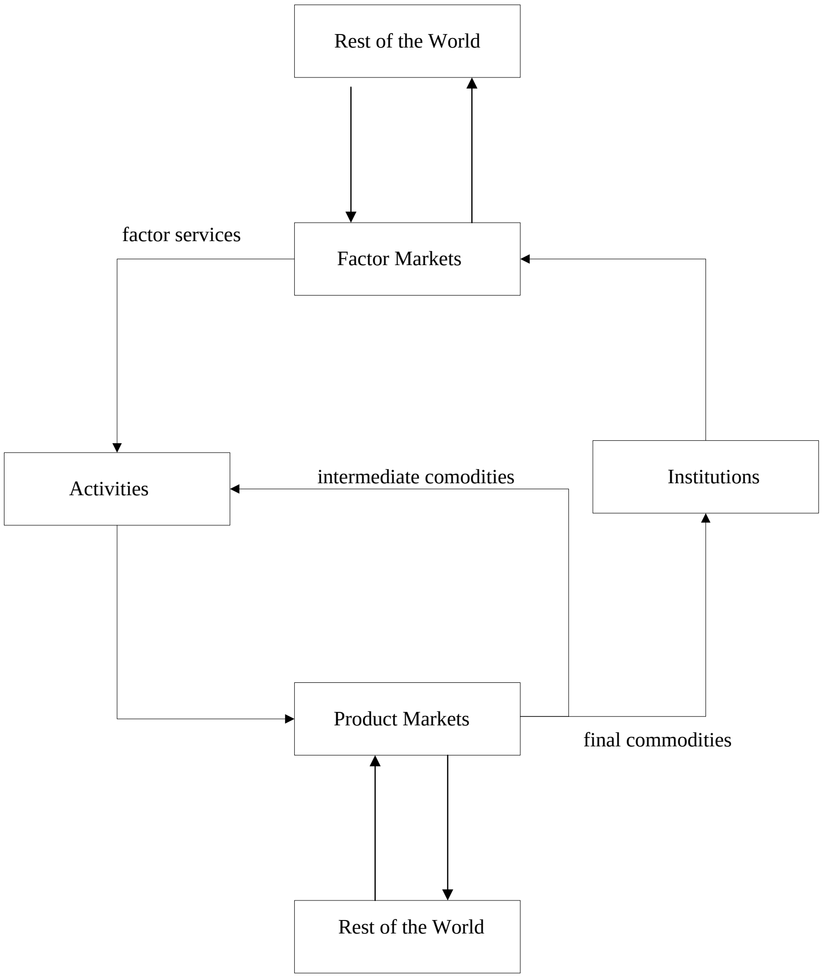
The Circular Flow

The concept of a circular flow represents a vision of economic systems. Going one way around the circular flows involves tracing out the flow of goods and services while going the other way around traces out the flows of funds (Figure 3). The arrow heads in Figure 3 indicate the direction of physical flows with associated flows of funds going in the opposite directions. Assume initially that the economy is closed and hence the Rest of the World agents/accounts can be ignored. Institutions (a term that encompasses households, non-profit organizations, government, investment, etc.) sell the factor services they own in factor markets where activities (producers, industries, firms, etc.) are the purchasers. This generates flows of funds, incomes, to the institutions, which can be used to fund purchasers of final commodities (goods and services) by the institutions on product markets. The activities realise part of their incomes from the sale of final commodities; the remainder of their incomes are realised from the sale to other activities of intermediate commodities on the product markets. Hence, a circular flow is generated between institutions and activities are linked via factor and product markets.

Opening the economy to the Rest of the World is then a simple extension of the system. Institutions can sell their factor services to domestic or foreign activities, while activities can source factor services from domestic or foreign institutions. Similarly, domestic institutions can source final commodities from domestic or foreign activities, while domestic activities can source intermediate commodities from domestic or foreign activities.

The circular flow is somewhat more complicated, although the principles remain simple. Figure 3 (deliberately) does not illustrate certain transactions. There are usually multiple transactions between institutions; these include savings (transactions between the investment account and other institutions), direct taxes (transactions between government and other institutions) and transfers (transactions between institutions and between domestic and foreign institutions). Also excluded are representations of various taxes levied on commodities and activities. Whilst such transactions are important, and are often the instruments through which policies are implemented, none alter the basic principles of the circular flow.

Figure 3: A Simple Circular Flow



An important distinction exists between IOTs, SUTs and SAMs, which can be intuitively explained by reference to the illustration of the circular flow in Figure 3. A SAM captures the full circular flow whereas IOT and SUT only capture part of the circular flow. Specifically, IOT and SUT do not record details of the interactions in factor markets - there are no links between factors and institutions. Consequently, IOT and SUT do not provide information about how institutions generate the incomes, through interactions on factor markets that enable them to fund expenditures on product markets. In addition, IOT and SUT do not record the transactions between the various institutions in an economic system, or between the various components of an economic system and the rest of the world except for commodity transactions.

A SAM is an extension of an IOT or SUT; it extends the information about inter-industry transactions to include more detailed information on institutions and factor markets. A SAM records details of transactions during the period for which it is constructed – current account transactions – and does not record details of the historical transactions that determine the stocks of factors etc. - capital account transactions. The description here will assume that inter-industry transactions are recorded in the form of SUTs.

Structure of a SAM

An illustration of the structure of an archetypal SAM is provided in Table 1; however, it needs to be recognised that the concepts underpinning a SAM are extremely flexible and can support a plethora of structures.

A SAM is a square matrix in which each agent/account has both a row and a column. The expenditures/payments/out-goings for each account are recorded as column entries while the incomes/receipts/in-comings for each account are recorded as row entries. As such a SAM is a form of single entry bookkeeping where each entry is a transaction, i.e., each entry has both price and quantity dimensions, which identifies both the source and destination of the transaction. Accordingly, the expenditures by each account must be exactly equal to the receipts: hence the respective row and column sums for a SAM must equate Moreover, it will provide that information in a manner that is consistent with the aggregate accounts for the system. Thus, in the context of an entire economy, a SAM will contain not only the information provided by the national accounts but also further details on the transactions between various groups of agents within the system. A SAM is an efficient and, ultimately, simple way to record economic transactions.

Typically, a SAM is constructed with 6 types of account and each type may contain numerous accounts:

- Commodity (or product) accounts
- Activity (or production/industry) accounts
- Factor accounts
- Institutional accounts
- Capital accounts and
- Rest of the World accounts.

The SAM in Table 1 identifies 3 categories of domestic institutional accounts; private households, (incorporated) enterprises and government. Each of these can have numerous sub accounts as can the other types of account. Also, note that while Table 1 follows a common ordering of types of account the actual ordering is irrelevant to the information content.[28]

Ultimately the ability to understand the information content of a SAM is a product of experience, and a description of the structure of a SAM can only serve as a starting point. Thus, while Table 1 is a reasonable illustration of SAMs used to calibrate economic models it is not an exhaustive illustration. In part this reflects the fact that there is no deterministic structure for a SAM, although all SAMs must conform to a series of principles. This explains why it can be difficult to interpret some SAMs; the structure chosen for a SAM may be one with which the reader is not familiar.[29]

The description of the SAM in Table 1 proceeds in the order of the accounts. The cells that include a '0' entry are those for which such an entry rarely, if ever, makes economic sense, whereas those left blank may have entries but they are not included in this description.

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[28] Arguably the reason for starting with the commodity accounts stems from the notion of 'consumer sovereignty', which implies that production activities supply outputs in response to consumption choices. But given the circular flow the ordering of arguments has little or no meaning. For instance, many SAMs originating in the USA, or derived by practitioners inspired by US practice, start with activity accounts.

[29] Indeed, the SAM structure in Table 1 relates back to the structure implicit to the SNA of 1968 and departs from the structure advocated by the SNA of 1993. One way to simplify the process of understanding a SAM with an unfamiliar structure is to re-order the accounts into a structure with which the reader is familiar.

Table 1 Structure of a typical Social Accounting Matrix

	Commodities	Activities	Factors	Households	Enterprises	Government	Capital	Rest of World	Account Total
Commodities	Marketing Margins	(Combined) USE Matrix	0	Household Consumption		Central Government Expenditure	Investment Expenditure	Exports of Goods & Services	Commodity Demand
Activities	SUPPLY Matrix	0	0	0	0	0	0		Production
Factors	0	Remuneration of Factors	0	0	0	0	0	Factor Income from RoW	Incomes to Factors
Households	**0**	0	Distribution of Factor Incomes	Inter Household Transfers	Distribution of Enterprise Income	Transfers to Households	0	Remittances from RoW	Household Income
Enterprises	0	0	Distribution of Factor Incomes			Transfers to Enterprises	0	Enterprise Income from RoW	Enterprise Income
Government	Commodity Taxes	Production Taxes	Factor Taxes	H'hold Income Tax & Other payments to Government	Ent'prise Income Tax & Distributed Enterprise Income		0	Transfers from RoW	Government Income
Capital	0		Depreciation	Household Savings	Enterprise Savings	Government Savings	Stock Changes	Capital Account Balance	Savings
Rest of World	Imports of Goods & Services	0	Factor Payments to RoW	Remittances to RoW	Enterprise Payments to RoW	Current transfers to RoW		0	Imports of G&S and Transfers to RoW
Totals	Commodity Supply	Cost of Production	Expenditure on Factors	Household Expenditure	Enterprise Expenditure	Government Expenditure	Investment Expenditure	Exports of G&S and Transfers from RoW	

Source: own elaboration.

4.2 Basic structure required for Developing country SAMs

4.2.1 Commodity accounts

The commodity accounts are easily understood by starting with the row accounts. The row entries identify the purchases (transactions) by the agents in the columns on commodities (in the rows); note that entries are transactions and therefore record values and not quantities. Thus, the row entries quantify the distribution of commodity demands between intermediate and final demand where final demands are disaggregated across different institutions, the capital account and the Rest of the World (exports). Notice how the Rest of the World (RoW) is simply another account, i.e., exports are incomes to the RoW. Total incomes to the commodity accounts are therefore given by the row sums that quantify the value of demand for commodities in the system. Transactions in the commodity account rows are valued at purchaser prices (see section 4 for details on the system of prices).

Ex post the toal demand for commodities must equal the supply of commodities, i.e., the row and column totals equate. But for any period, the demand for and supply of commodities may not equate due to the drawing down or increasing of stocks; this accommodated by including an account for stock changes as a sub account in the capital account.[30]

The supply of commodities in value terms includes domestic production (part of the Supply matrix and valued at basic prices), imports (valued at basic prices, i.e., carriage, insurance and freight (*cif*) paid), duties paid on imports and any other taxes on commodities paid by domestic agents, e.g., General Sales Taxes (GST), VAT,[31] excise duties plus the trade and transport costs associated with the domestic marketing of commodities. The commodity accounts therefore trace out the sources of commodities supplied to the system and the destinations of commodities once they are in the economic system.

A complication exists with the entry for (domestic) marketing margins in the commodity:commodity sub matrix. This sub matrix records the trade (wholesale and retail) and transport costs associated with transferring commodities from producers to purchasers within the economy. Thus, trade and transport margins, commonly referred to as marketing services, are part of the costs of supplying commodities to the system, i.e., entries in the column accounts, but also part of the demand for commodities, i.e., commodities of used to produce the services and are therefore entries in the row accounts. The sum of the entries in this sub matrix must be zero, which indicates that at least one entry will be negative, i.e., a demand. The negative entry, or entries, arise because the supply of marketing margins must be matched by demands (expenditures equal incomes) for marketing services, which are recorded as negative expenditures in the columns for the commodities that make up marketing services. While the convention of entering marketing services in this sub matrix is parsimonious, in the use of space, it can be a bit confusing. An alternative representation includes accounts for marketing services with the expenditures as entries in the commodity columns and the demands as incomes in the commodity rows.[32]

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[30] Note that a SAM does not contain information that allows the user to track the evolution of stocks. If an entry for stock changes is negative it indicates that a stock has been drawn down, and if it is positive that a stock has been added to. But, the transactions provide no information on the size of the stocks. A zero entry does not imply that there are no stocks.
[31] VAT is a tax on (final demand) commodities and NOT a tax on value added.
[32] This exploits the fact that if an entry is transposed and the sign is changed the SAM remains balanced and the information content is preserved – a negative income is an expenditure, etc.

Note that exports, and export taxes, are treated as commodity accounts. The treatment of export taxes as an expenditure by the commodity account is sensible since *de facto* the taxes are paid by domestic agents with the RoW paying free on board (*fob*) prices, which are inclusive of export taxes, for exports. Note how the inclusion of export taxes, and export subsidies, is necessary since they are expenditures (taxes) or incomes (subsidies) to the commodity accounts that ultimately pass down to the activities responsible for their production. In an alternative SAM representation exports, and export subsidies, are recorded within the activity accounts, e.g., Dervis *et al*., (1985). The commodity accounts then emphasise domestic production for the domestic market, and require the SUPPLY sub matrix only has entries on the principal diagonal. This alternative is a reduced form of the SAM represented in Table 1. It has historical and current relevance in the CGE literature since it was the formulation used by the early CGE models and is a layout that could be adopted for many current CGE models, e.g., the GTAP model and any model calibrated using standard GTAP data.

4.2.2 Activity (or production) accounts

Activity accounts record the input (production) and output structures of activities. The column entries record purchases that include intermediate inputs, both domestic and imported, and value added, where value added is broken down into payments to different factors, broadly or narrowly defined, and taxes/subsidies paid by activities on production, e.g., output taxes, and/or the use of factors, e.g., employer contribution to factor 'insurance' taxes, taxes on value added (NOT VAT). Hence the column entries detail the costs incurred during production by activities and the column sums record the inputs to productive activities. Entries across the activity rows identify the commodities 'made' by each activity - part of the SUPPLY matrix.

The major concern with the activity accounts is the detailing of the cost structures in production and payments to factors. This is reflected in the relatively common practice of only recording incomes to the activity accounts from the sale of commodities.

Note how government subsidies paid directly to activities are recorded as negative input costs despite the arguable case that they represent incomes to activities. It would be equally defensible to enter such subsidies in Activity:Government sub-matrix, i.e., as income to activities, although it is common practice to treat them as <u>negative</u> taxes. This reflects a useful feature of a SAM. Entries can be transposed and the sign reversed without affecting the information content of the SAM. It does change the row (income) and column (expenditure) totals but the requisite accounting identities are preserved. The choice of method largely depends upon the preferences of the agency constructing the SAM. If users have different preferences, then reorganising a SAM does not change the information content and is therefore legitimate.

The activity accounts record all the productive activities of an economic system, i.e., the generation of value added: the Factor:Activity submatrix should record the domestic employment of all factors within the system. The definition of a productive activity is important. Productive activities are defined as all those processes within an economy that can and/or do use factors to produce commodities, i.e., goods and services. This is relatively straightforward, and intuitive, when referring to industries, e.g., farming, manufacturing and services, but in some instances the definition is less transparent where a non-activity agent apparently employs factors. For instance, the government final demand account should not include direct payments to factors, but rather there should be one or more activity accounts, e.g., education, defence, etc., that employ factors and sell their output to the government. Thus, the government can be classified as both an agent and one or more activities through which it employs factors and produces outputs – services, defence, etc. But, for instance, defence could be classified as an activity whose output is purchased by the government's final demand account; such a choice of classification would be particularly useful if the defence system is part of the analyses or a large part of the economy.

Even less transparent may be what to do about home production for home consumption (HPHC); in such cases the household is simultaneously an activity and an institution and therefore each household would have a related activity account since only that household can produce output for home consumption. In a similar manner, the leisure consumed by each household can only be produced by that household; one method for recording leisure in the system is through having a leisure activity for each household whose output is only consumed by the paired household.[33]

4.2.3 Factor accounts

The row entries for factor accounts are incomes paid to factor accounts for productive services. The sum of these payments, plus incomes from factor sales abroad are Gross National Product (GNP) at factor cost. Detailed information about factor income is important if SAM data are used to analyse policy issues relating to the operation of factor markets and/or income distribution. Thus, some SAMs report detailed information about the demand for labour of different types, e.g., skilled, unskilled, clerical, manual, professional, etc., and other factors, e.g., building and machine capital, arable and pasture land, etc., by different activities. The determination of those characteristics that should be used to segment each broad factor type depends upon both the economy and the policy issues being addressed: this is particularly the case for labour accounts where distinguishing characteristics that are relevant to income distribution issues are often country specific, e.g., in South Africa it may be appropriate to distinguish between labour types on the basis of ethnicity, while in some economies gender may be a particularly important characteristic. But it is important to note that disaggregating factor types will only provide useful information on the transmission of employment changes, e.g., on income distribution, if there is a 'matching' disaggregation of the institutional accounts, especially by household types (see below).

The expenditures by the factor accounts are recorded in the columns. Factor incomes are distributed between different types of households as labour income and distributed profits, to (incorporated business) enterprises as non-distributed profits, to government as the payment of taxes etc., and profits from government owned enterprises. Note also payments to overseas factors.

It is the functional distribution of factor incomes implicit in the expenditures by the factor accounts that makes it so important to ensure that the degrees of detail with respect to factor types and domestic institutions are compatible (Pyatt, 1991). For instance if there are multiple factor types but only one household type then changes in the incomes of different factors are not reflected in changes in the incomes of different households and hence changes in factor incomes do not feed down into changes in demand associated with differences in preferences across households.[34]

The SAM in Table 1 records depreciation as being expenditures by the factor accounts. Given this representation the payment to factors that depreciate (capital factors) by activities are defined as gross of depreciation, e.g., gross operating surplus, and therefore contains the implicit presumption that depreciation is an expenditure by a factor account and not by activity accounts. Alternatively, depreciation could be recorded by each activity, which recognises that deprecation rates may differ across activities, and then payments to relevant factors in the activity account columns are net of

[33] Note, in passing, that the examples here all relate to activities within the SNA's production boundary. The complications, and hence limits, imposed by the production boundary are discussed below.

[34] The importance of differences in preferences and the functional distribution of income has been well illustrated by Defourney and Thorbecke (1984).

depreciation, e.g., net operating surplus.[35] Clearly the information contents of the different representations differ as do the data requirements to compile the SAM.

4.2.4 Institutional accounts

These accounts include different household types (Representative Household Groups – RHG), incorporated business enterprises, other domestic institutions, e.g., non-profit organisations, and government. Incomes to institutions are recorded as row entries and expenditures as column entries. Note how the government realises different forms of tax revenue: VAT on commodities, tariffs on imports, direct and profit taxes on institutions, etc.

The distinction between incorporated and unincorporated business enterprises is important. The firms that make up activities can be owned directly by households, unincorporated business enterprises, or by incorporated business enterprises; in which case households are the owners of incorporated business enterprises, and hence indirectly own firms. This distinction is relevant for the capital and, sometimes, the land factors, since ownership of firms is defined by reference to the ownership of capital.

4.2.5 Household Accounts

Households primarily receive incomes from factor sales on domestic or foreign markets. Income received directly from the factor accounts are dominated by payments for labour services, with payments for capital and land services being those associated with the incomes to those factors earned by unincorporated business enterprises, e.g., self-employed business and farmers[36]. Since self-employed incomes are relatively more important in less developed economies the proportions of household incomes that come directly from the factor accounts are likely to be proportionally larger.

Household incomes from enterprise accounts are dominated by the distributed profits of enterprises, although they would also include any transfers directly from enterprises to households. Similarly, payments to households from government will be dominated by transfers – social security transfers made directly to households. Finally, there are factor incomes from abroad. Again, these will be dominated by payments for labour services since payments for capital services will most often be received by the enterprise accounts.

Household expenditures are dominated by consumption expenditures – demand for final commodities: these are valued inclusive of any commodity taxes due on consumption by domestic households[37] and trade and transport (margin) costs, i.e., at purchaser prices. Households engage in transfers with other domestic institutions, principally other households, and with non-domestic institutions – mostly as some form of remittance. Households must also pay income taxes; in many countries, direct taxes on households and transfers from government to households are both substantial and data limitations can make it difficult to separate out these transactions. Hence they are often treated jointly as net direct tax payments by the households; thus, negative NET income tax rates may be implied, which despite being an appropriate representation of net transactions can cause difficulties for policy experiments. Finally, the *ex post* accounting identity is ensured by the savings of households being a residual category; what is not spent or accounted for elsewhere is recorded as saving/dissaving. This reflects the fact

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[35] Note how gross operating surplus is defined as net operating surplus plus (activity specific) depreciation, which ensures that the costs for activities are unchanged. If depreciation is paid by factor accounts, it will result in an implicit assumption that the depreciation rates on the factor are the same for all activities when used in a (behavioural) model.

[36] The difficulties of allocating factor incomes between labour, capital and land services means that incomes from self-employment activities is often treated as 'mixed' income; this must be resolved if the SAM is to be used to calibrate a CGE model.

[37] VAT is levied on all domestic demand and then rebated, at least partially, to all domestic purchasers except for households.

that data on savings by households are often partial and/or difficult to verify, which can result in estimates of savings being derived as a residual.

4.2.6 Incorporated Enterprise Accounts

Incorporated enterprises are in many economies the principal recipients of the profits – returns on capital – from activities. Thus, while incorporated enterprises are ultimately owned by other (domestic) institutions – primarily households but also by government (parastatals and nationalised companies) – they should be included in a SAM, since they are important institutions in terms of their responsibility for a large proportion of domestic savings and in the pathways by which factor incomes are translated into disposable incomes that fund domestic demand.

Incomes to enterprises are dominated by the returns to capital, and to a much lesser extent land, both within the domestic economy and the rest of the world – remitted profits. Expenditures are dominated by savings out of retained profits – often among the largest sources of investment funds in developed economies – transfers to households and government, who are the domestic owners of enterprises, or to foreign owners of the enterprises. Finally, enterprises pay direct taxes, e.g., corporation taxes, to the government, which, as with households, may be recorded net of transfers from government to enterprises.

4.2.7 Government Accounts

Tax revenues are the principal source of government incomes in most countries. Although taxes are required to fund legitimate government activities they represent potential policy instruments that can affect/influence economic incentives while being, arguably, the most important single group of policy instruments available to governments. Thus, tax revenues – note that SAMs record transactions (revenues) not rates – are critically important when constructing a SAM.

Ideally tax transactions will be recorded in sufficient detail to identify the major different types of tax instruments applied by a government; although it is very unlikely all separate instruments will be recorded as separate accounts, all tax revenues must be accounted. Taxes on commodities might separately identify import duties, export taxes, VAT, general sales taxes (GST), excise taxes, etc., taxes on activities might include taxes on output and factor use – individually or in aggregate, taxes on factors may include national insurance contributions paid directly by the factor[38] and taxes on institutions will be made up primarily by direct (income) taxes. Clearly the balance will vary by country; it may be expected that indirect taxes, especially trade taxes, are relatively more important the less wealthy is a country while direct taxes will be relatively more important the richer is a country and/or household group. Negative taxes, i.e., subsidies, are also possible and although it might be expected that they are positively correlated with a country's wealth, e.g., domestic agricultural support schemes in the EU and USA, there is ample evidence that subsidies are non-trivial in many less wealthy countries.

Ultimately it is the responsibility of the compiler to ensure that the detail on tax accounts included in the SAM provides a reasonable representation of the tax system operating in the country. This can be difficult since often the information on tax revenues is limited, e.g., revenues by each instrument may be recorded but it is rare to find details about tax payments by different agents. The common 'habit' of aggregating multiple tax instruments into a catchall category, e.g., only recording import duties and a residual commodity tax, seriously compromises the usefulness of a SAM for policy analyses. Although it may be tempting to accept the limitations imposed by readily available data there are strong arguments for separating out different tax instruments even if the

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[38] Some contributions to such insurance schemes will be paid by the employer, i.e., activity, and are therefore part of the costs of employment incurred by activities.

process may involve a substantial degree of '*guesstimation*'; in particular it is 'better' to analyse policy questions using correctly formulated tax instruments even if the recorded initial applied rates are of low reliability.[39] Consider for instance the case of an economy with both GST and VAT systems for which the SAM only records import duties and other commodity taxes. If the VAT component is ignored and the other commodity taxes are modelled as a GST then – for positive VAT rates – the assumed tax rates on households will be underestimated while those on other agents will be overestimated and the impacts of changes in the commodity tax rates will be biased, e.g., if the GST rates are increased rather than the VAT rates to achieve a given revenue target, then production costs (for activities) will be increased while consumption costs (for households) will not increase as much as they would have done with a VAT system.

Other sources of government income include distributed profits from state owned enterprises and payments from abroad; the components of these depend upon the institutional arrangements but in most cases, they will be dominated by inter government transfers.[40] A major component of inter government transfers for some countries will be official development assistance (aid) in all its guises; since in some of the least developed countries aid may constitute a substantial part of government income. These transfers are not under a government's (direct) control but it is important to record these transfers accurately, since they will be important components of the Rest of the World account. Similarly, expenditures on aid will need accurate recording; given 'target' rates of aid remittances for OECD countries of between 0.25 and 1 % of GDP such expenditures are potentially important.

Other government expenditures can be complicated. In a SAM based on Supply and Use tables government consumption expenditures will cover a very limited range of commodities – this reflects the fact that in such a representation government will be included as an activity, whereas in an input-output framework government will purchase multiple commodities because it will not be treated as an activity. Whichever option is chosen it is likely consumption expenditure will account for most of government expenditure. Other categories of government expenditure include transfers to domestic and foreign institutions and government savings.

Government savings are recorded as expenditure and therefore a negative entry represents the government's borrowings. Since the internal balance is an important government policy target that will often require the government to vary tax rates to ensure its achievement it represents an important entry in any SAM.

4.2.8 Capital accounts

This account refers to investment and its funding. Commodities in the capital account column record investments whereas the funding of investment is recorded as savings by institutions and the balance on the capital account. The representation in Table 1 ensures that a surplus on the capital account (deficit on the current account) is recorded as positive and a deficit (surplus on the current account) is recorded as negative.

In many SAMs it is common to include an account that records stock changes – the column account will record the values of stock changes that will be funded by incomes provided by the main capital account. However, since stock changes can be legitimately negative, while (gross) investments must be positive, the merging of the investment and stock change accounts can generate the seemingly odd situation of apparently negative investments.[41]

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[39] Part of this argument is that it is the information about changes in the tax rates that more important than the initial rates.
[40] Returns on investments abroad by state owned enterprises will most commonly be recorded as income to the enterprise accounts.
[41] If the two accounts are combined it may be necessary to address this situation in the formulation of the model.

4.2.9 Rest of the World accounts

The rest of the world accounts record trade and other foreign transactions. These include the current and capital accounts, and visible and invisible trade. Imports are implicitly valued carriage insurance and freight (*cif*) paid in Table 1, which is a typical approach when constructing a SAM for a single region, while exports are recorded free on board (*fob*). When a SAM is constructed to analyse trade issues that may involve changes in trade costs for imports then it may be appropriate to include multiple trade accounts with imports valued *fob* from the source regions and to include accounts that record trade costs by trade partner.

Visible trade - trade in goods and services – is relatively straightforward but only constitutes part of the current account. Other components of the current account, which have been detailed above, are important. Any transactions missing from the current account are likely to end up either being included in the balance on the capital account, which will then not be reconciled with the national accounts, or as distortions in the estimates of other transactions on the current account. Where other transactions on the current account are relatively small this may not be an issue, but, as noted above, in some countries aid transfers may make up a substantial proportion of government income and household may receive a substantial proportion of their incomes from remittances.

4.3 Prices in a SAM

The prices for every entry in a row of a SAM must be identical.

Formally, a SAM is a system of single entry book keeping presented in the form of a square matrix wherein each account is represented by a row and a column. The entries in the SAM are transaction values, i.e., prices multiplied by quantities: the row entries represent incomes to the accounts and the column entries represent expenditures by the respective accounts. Hence, the entry in the i^{th} row and j^{th} column is simultaneously the expenditure by the j^{th} account on the 'product' of the i^{th} account AND the income to the i^{th} account from sales of its 'product' to the j^{th} account. A SAM must be complete and consistent: complete in the sense that it covers all transactions in an economy and 'consistent' in the sense that every expenditure by an agent has a matching and corresponding income for another agent. Hence, a consequence of being complete and consistent is that the income and the expenditures for every account must equate, i.e.,

$$\sum_i p_{ij}.q_{ij} = \sum_i T_{ij} = \sum_j T_{ij} = \sum_j p_{ij}.q_{ij} \quad \forall i = j$$

where p_{ij} and q_{ij} are the price and quantity of account j used by account i and T_{ij} the transaction (value) between account j and i.

By **definition**, the price for any transaction in a row is the same irrespective of the agent/account that makes the purchase. This means that the quantities in any row are homogenous (undifferentiated) and can be measured in commensurate units; hence they can be meaningfully summed so that the row totals are defined as the product of the respective price and the sum of the quantities that are recorded in each transaction in the row

$$T_{ij} = \sum_j p_i q_{ij} = p_i Q_i \qquad \textit{and} \qquad \sum_j q_{ij} = Q_i .$$

Since the transactions in each row refer to items that are homogenous, the prices do not differ by reference to the purchasing agent. This characteristic is a consequence of the 'law of one price' (LOOP) that applies to any SAM and is important for an understanding of a SAM and its use to calibrate any model and its underlying system of prices.

The LOOP is critical to the understanding of the price system in a SAM and the strictures placed upon the price system in any model calibrated with a SAM. Indeed, the price system embedded within a SAM defines the price system that must be applied in any model calibrated with that SAM; if not there will be a fundamental tension between the data and the model's behavioural relationships.[42] Moreover, an understanding of LOOP and the price system in a SAM is critical to an understanding of the behavioural relationships in ALL whole economy models, since the databases for all whole economy models can be presented in the form of SAMs.

4.4 Distinctive Features of a SAM for STAGE_DEV Model

The SAMs used for the STAGE_DEV model are fully consistent with the structure of the SAM illustrated by Table 1. The distinctive features relate solely to the account structure and are determined by the necessity of ensuring that the SAMs are fully consistent with the LOOP, while recognising the constraints imposed by the SNA's production boundary.

4.4.1 SNA Production Boundary

The production boundary of the SNA is both a simple and controversial concept. Transactions that take place within the production boundary are defined as those for which an unambiguous price can be identified; those prices might be basic and/or purchaser prices. Thus a farmer may produce maize that is sold at basic prices – the valuation relevant to the supply matrix (activity:commodity sub matrix) – and purchased by activities and institutions at purchaser prices – the valuation for the rows of the commodity accounts. This definition implies that only those commodities that are sold can be defined as within the production boundary because they are the commodities for which unambiguous prices can be identified.

This is problematic with respect to domestic activities that are not sold, such as child care by parents, domestic duties (cleaning, cooking, etc.) undertaken by individuals for their own benefit and other such commodities. This means a large proportion, often estimated at 30% or more of GDP, of economic activities are not recorded or included in GDP. However, if a household employs cleaners, cooks, nannies, etc., on the market, these commodities enter within the production boundary and thus become part of GDP.

The valuation issue can be reduced to a question of whether activities outwith the current production boundary should be valued at market price or opportunity cost. Consider the case of two equally high earning households: the first household does all household and caring services themselves while the second relies on employed staff. In the first case, the services should be valued at opportunity costs – the incomes foregone, while the second household values the services at purchaser prices. Given that staff providing household and caring services are relatively poorly paid, the same services will have different valuations. Moreover, when comparing the valuation of the same household services by households with different earning potentials, it is evident that the opportunity costs of the same services will be greater for the relatively richer – higher earning households.

4.4.2 Home Production for Home Consumption (HPHC)

The prices of commodities that are purchased on the market are inclusive of any trade and transport margins and domestic commodity taxes, e.g., GST and VAT, which means that they should be valued at purchaser prices. But HPHC commodities do not enter the market system and therefore should be valued at basic prices.[43] This distinction is explicitly recognised in the SNA, wherein national accountants are required to derive estimates of the imputed expenditures on HPHC valued at basic prices. The reporting of the expenditures on selected commodities by RHG that aggregates expenditures valued

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[42] For instance, all CGE models that use CET functions violate the LOOP.

[43] From the producer perspective, the price/valuation is the same whether sold on the market or retained for home consumption. If the retained for home consumption, then the basic and purchaser prices are identical since no taxes or trade and transport margins are incurred.

at both purchaser and basic prices may be an acceptable approximation where HPHC accounts for a relatively small share of expenditures. But in many lesser developed economies HPHC accounts for a large proportion of the volume of some commodities consumed by RHGs.

Extending a SAM to better report HPHC requires introducing sets of columns and rows as sub-columns and sub-rows of the commodity and activity accounts. The additional rows and columns in the commodity accounts distinguish between commodities that are marketed and those that are HPHC, e.g., farmers may grow maize some of which they retain for home consumption and some of which they sell, and they may also, later in the year, also purchase maize for consumption. Thus, the additional commodity accounts identify the differences in the costs structures of marketed and HPHC commodities.

The activity accounts are somewhat different. HPHC commodities can only be produced by the RHGs that consume those commodities, and thus, each RHG must simultaneously be a household and an activity; this requires that RHGs that can engage in HPHC are paired with an activity. These paired activities only engage in the production of commodities (goods and services) that are within the SNA production activities; these activities can use intermediate inputs, the paired RHGs own factors and purchase factors from other RHG. Practically most of these RHG and activity pairs will be rural households, since HPHC within the production boundary will primarily relate to agricultural commodities and commodities where access to markets limits the scope of households to purchase marketed commodities

4.4.3 'Leisure' and Commodities outwith the SNA Production Boundary

A further issue arises with respect to the 'choices' made by households over whether to retain their labour services to produce commodities outwith the production boundary and/or for leisure or to sell labour services on factor markets. These 'choices' may be voluntary or involuntary, but for current purposes this may be sidestepped.

If a household chooses the sell some more of its labour services it foregoes the use of those labour services for production outwith the SNA production boundary and/or their use for leisure. One way to accommodate this feature is to create a further set of paired RHG and activity accounts. These paired activities may purchase some intermediate inputs but can only use labour supplied by the paired RHG. From the perspective of the model it is the labour services that are important since the paired activities absorb all labour that is not offered on the market and is used for purposes of producing household services and leisure. This defines the demand for labour supplied by each household as equal to the demand; hence there is full employment. Thus, if more labour is supplied to the market the RHG faces opportunity costs due to reductions in the amount of labour dedicated to the production of household services and leisure.

4.5 STAGE_DEV data requirements

The data requirements of a SAM for STAGE_DEV are slightly greater compared to a typical SAM. Estimates are required for the additional commodity and activity accounts, data are required to populate an additional satellite account for the ownership of factors by households (*factinsw*) and additional elasticity estimates are required to calibrate some of the extra behavioural equations. The elasticities for household migration and factor mobility are difficult to estimate empirically and hence will require subjective judgements and sensitivity analyses. The additional utility function elasticities may be estimable but there are serious data limitations; hence subjective judgements and sensitivity analyses will be necessary. The model's code tests for 'consistency' between the various data components, although it is likely that some databases will pass these tests but still generate issues for the operation of the model.

The following sub sections review the data sources and identify possible data sources by reference to data collected for some African economies. More detail about data sources and estimation methods are reported in an associated publication (see Mainar et al., 2017), so the commentary here is brief. Suffice to say that some form of estimation techniques are necessary so that data from different sources (surveys and censuses) collected for different purposes can be reconciled; a task made more difficult by the fact that statistically agencies usually conduct a limit number of surveys each year so the reconciliation process requires ‘bridging’ time periods. However, it is argued that the additional data work is justifiable if policy decisions are to be evidence based, since the credibility of policy advice will relies on the quality of the databases.

4.5.1 Main data sources for HPHC

Data for HPHC requires segmenting consumption demand between marketed and HPHC commodities and identifying the costs structures used in production. This will require reconciling data from different sources, especially household income and expenditure, labour force and agricultural (production) surveys. The household surveys may provide data on consumption patterns and income sources, the labour force survey on the patterns of employment and agricultural surveys on production costs. If the RHGs, and paired activities, are defined by location – province, agronomic zone, etc., - then it may be easier to classify RHGs in ways that reduce the difficulties in reconciling data. But ultimately the compiler of the SAM will be required to make judgements about the trade-offs between detail and data reliability. Agricultural surveys are often rich in information on the production and use of outputs of households since households involved in own account consumption tend to engage strongly in agricultural activities.

Taxes and trade and transport costs incurred should be allocated solely to the marketed component of the commodity. Unfortunately, it is often unclear how transactions have been valued, especially in SAMs constructed by agencies other than national statistical agencies.

Examples of specific data and data sources used for Ethiopia are:

- National accounts data: Ministry of Finance and Economic Development (MoFED)
- Tax and fiscal data: Ministry of Finance and Economic Development (MoFED)
- BoP and external sector data: National Bank of Ethiopia (NBE)
- Household Consumption Expenditure survey: Ethiopian Central Statistical Agency (CSA)
- Agriculture sample survey: Ethiopian Central Statistical Agency (CSA)
- Population and housing census: Ethiopian Central Statistical Agency (CSA)
- Labour force and other socioeconomic surveys: Ethiopian Central Statistical Agency (CSA)

4.5.2 Data Requirements for labour-leisure trade-off

The data required to implement this component of STAGE_DEV are:

- Quantities of each factor type used by each activity including leisure (*factuse*);
- Quantities of each factor type supplied to the market by each institution (*factinsw*).

Data on factor use by activity are often available in both labour force and household income surveys. Since these surveys are conducted for different purposes they require reconciliation; however this is not unique to the STAGE_DEV model since factor use data should (ideally) be used in a CGE models.

Estimates of the labour types used by each RHG to produce leisure, and other commodities outwith the SNA production boundary, are problematic on at least two counts. First, the boundaries on use of labour need to be defined to exclude time spent on domestic duties, e.g., child care, cleaning, cooking, etc.; rest and other maintenance actions, e.g., sleeping, eating, washing, etc.; and other activities outwith the SNA's production boundary but needed by households, e.g., HPHC, water and firewood collection. Second, labour that may never have been allocated to the market needs to be categorised within the range of labour types sold on the market so that it can be given an opportunity costs. Clearly these additional data requirements involve additional data collection efforts and estimation, which increase the time requirements, and judgement.

Some of the data are available in household surveys. Additional data may be found in household time use surveys, which are becoming available for some developing countries. Time use surveys measure the amount of time people spend doing various activities, such as paid work, childcare, volunteering, etc. Also, these surveys allow measuring households' labour endowment in hours where labour endowment can be broken down to leisure time and time spent on work, the latter of which can further be split to time working at home on productive activities and outside the household.

It is likely that leisure time and time spent on activities outwith the SNA production boundary will be conflated for pragmatic purposes. If this is the case then the responsiveness of RHGs in supplying more labour to the labour market will need to be muted to reflect the fact that a substantial proportion of the time will be needed for necessary domestic activities.

There are no known sources of data for the income elasticities of demand for leisure. Hence their use requires some degree of sensitivity analyses to assess the reliability and/or sensitivity of the results to the chosen elasticities.

4.5.3 Data Requirements for household migration

The additional data required to implement this variant are:

- Quantities of each factor type used by each activity (*factuse*);
- Quantities of each factor type supplied by each institution (*factinsw*);
- Estimates of household migration elasticities (*etamig*).

The factor data are the same as required for the factor mobility functions and hence do not require additional collection efforts and estimation.

There are no known sources of data for the household migration elasticities. Hence their use requires some degree of sensitivity analyses to assess the reliability and/or sensitivity of the results to the chosen elasticities.

4.5.4 Data Requirements for factor mobility functions

The additional data required to implement this variant are:

- Quantities of each factor type used by each activity (*factuse*);
- Quantities of each factor type supplied by each institution (factinsw); and
- Estimates of factor mobility elasticities (etamob).

Most of the factor data are reported in labour and household surveys although the classification schemes may differ and/or be inconsistent and thus require the use of estimation methods.

There are no known sources of data for the factor mobility elasticities. Hence their use requires some degree of sensitivity analyses to assess the reliability and/or sensitivity of the results to the chosen elasticities.

Clearly these data requirements are likely to involve additional data collection efforts and estimation, which increase the time requirements. But the analyses to date (Flaig et al., 2013a and b; McDonald et al., 2015) demonstrate that the policy implications of the results are sensitive to the specification and calibration of labour markets and hence indicate the potential returns to additional data collection and estimation.

5. Conclusions and future developments

The STAGE_DEV model embodies a series of behavioural relationships that are particularly relevant to the analyses of policy issues pertinent to developing countries where HPHC and household migration are important real world phenomena that influence the response of households, especially rural/agricultural households.

The consolidation of the additional behavioural components into the STAGE_DEV model are complex, although once the behavioural dimensions of the model's developments are resolved many of the difficulties are associated with getting the raft of new behavioural relationships to interact correctly. The report demonstrates that evidence based policy analyses require the compilation of a range of satellite accounts which are not minor exercises. More important however has been the evidence that the workload is justified because of the increases in insights far outweighs the increase in costs associated with developing the extended databases. The code has been developed so that if data are unavailable to populate some of the behavioural relationship the model is still operational. The flexibility these attributes provide is useful for policy analysts and facilitates timely generation of policy analysis results.

The comparative static variant of the STAGE_DEV model extends the standard version of STAGE2 by adding the following components:

1. a nested consumption/utility functions module;
2. an endogenous functional distribution of income module;
3. an HPHC module;
4. a labour/leisure trade-off module;
5. an household migration module; and
6. a factor market segmentation module.

As such the STAGE_DEV model embodies a series of behavioural relationships that are particularly relevant to the analyses of policy issues pertinent to developing countries where HPHC and household migration are important real world phenomena that influence the response of households, especially rural/agricultural households.

New model developments result in the identification of other aspects of the model that would benefit from further development. In the short to medium terms the most beneficial work programme is likely to revolve around the extension and enhancement of demographic accounts.

Three developments of the STAGE_DEV model are attractive in the short-run:

1. The addition of an extra level to the nested utility function for use in the context of HPHC. This would allow the definition of subsistence consumption requirements at an aggregate level, e.g., food, while retaining the distinction between home-produced and marketed commodities.
2. A generalisation of the nested production system to provide richer specifications of the production technologies available to activities.
3. A generalisation of the trade accounts to allow for multiple trade partners; the code for this development already exists in another variant of STAGE. This would allow for richer specifications of trade policy scenarios and reduce the degree of approximation necessitated by the current (standard) specification.
4. A module on nutrition to evaluate in terms of calories (and other macro nutritional indicators) intakes associated with food consumption patterns changes due to policy shocks.
5. Extend the system of taxes to provide a richer categorisation of tax instruments and policies in response to the systems in place in different countries.

Moreover, it should be underlined that moving from a static to a recursive dynamic version will open the door to additional analysis including: improving the modelling of the ownership of capital goods by institutions; endogenising the productivity of new physical capital through some functional relationship with R&D expenditures; improving the modelling of skill acquisition by labour while the inclusion of demographic account and the modelling of educational attainment by level of and/or health status will help to better define how educational (and health) attainment translates into labour productivity.

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Appendix 1 Treatment of HPHC in Other CGE Models

The only other model for which it has been possible to verify how HPHC is included in the model is the International Food Policy Research Institute (IFPRI) Standard Model (Lofgren et al., 2002), while the only other single country models for which the computer codes are open source, i.e., PEP-1-1[44] (Decaluwe et. al., 2009) and Orani[45] (Horridge, 2014), do not include HPHC. All three models adopt the Linear Expenditure System (LES) for which the utility functions are Stone-Geary. However the only model that includes HPHC and for which the code can be verified is the IFPRI Standard Model.

In the SAMs developed by IFPRI, HPHC is recorded in the activity by households sub matrix of the SAM. This is consistent with the model's code where the household utility functions are defined over arguments that encompass the commodity by household and activity by household sub matrices, i.e., households are defined as consuming commodities purchased on the market and the 'outputs' of activities 'provided' by 'home production'. Thus it is the 'outputs' of activities that are deemed to constitute HPHC. Examination of the code demonstrates that the prices paid for commodities consumed by households are valued at purchaser prices, i.e., inclusive of trade and transport margins and non-rebated commodity taxes, while the prices paid for the 'outputs' of activities consumed by households are valued at basic prices, i.e., exclusive of trade and transport margins and non- rebated commodity taxes. As such the principles underpinning the price definitions are consistent with the SNA definitions are consumption deemed to be HPHC is correctly valued at basic prices.

There are four key issues with the accounting relationship that underpin the treatment of HPHC in the IFPRI Standard Model (Lofgren et al., 2002). First, the 'outputs' of activities can only be defined as commodities if and only if each activity produces a single commodity and each commodity is produced by a single activity. Second, in the model activities are defined generically as multi product activities, which means that the 'outputs' of activities are defined as composites made up from fixed quantity shares of commodities. Third, each activity can supply HPHC to multiple households, as a result, the consumption of activity 'outputs' at home cannot be traced and linked to the agent (household) involved in its production. And fourth, there is no explicit treatment of households as producing units in the SAMs, even if there is some implicit presumption of the role of households as activities.

The IFPRI Standard Model (Lofgren et al., 2002) uses Stone-Geary utility functions. An examination of the properties of these utility functions demonstrates that commodities and the 'outputs' of activities are defined as independent arguments in the utility functions: thus subsistence and marginal demands are specified for both market commodities and the 'outputs' of activities. This raises a number of logical issues even leaving aside the third and fourth accounting issues identified above. If each activity produces a single commodity and each commodity is produced by a single activity, then two subsistence quantities of notionally the same commodity, e.g., wheat, are defined and substitution possibilities between market and home produced commodities are defined as being the same as between other commodities. If activities produce multiple products, then multiple subsistence quantities of notionally the same commodity, e.g., wheat, are defined, i.e., one for each activity that produces any of the commodity and one for the commodity account, and substitution possibilities between market and composite home produced commodities are defined as being the same as between other commodities. This may be regarded as an acceptable approximation but there is a degree of 'tension' between the behavioural relationships and economic logic.

[44] Available from https://www.pep-net.org/pep-1-1-single-country-static-version.
[45] Available from http://www.copsmodels.com/oranig.htm.

A1.1 Utility Functions in the IFPRI Standard Model

The IFPRI Standard Model (Lofgren et al., 2002) represents household consumption as single-stage LES demand systems separately for market consumption and home consumption, i.e., separate set of LES demand systems are specified for a group of home consumed commodities and marketed commodities. Specifically, household consumption spending on marketed commodities is defined as

$$PQ_c * QH_{c,h} = PQ_c * \gamma^m_{c,h} + \beta^m_{c,h}\left(EH_h - \sum_c PQ_c * \gamma^m_{c,h} - \sum_a \sum_c PXAC_{a,c} * \gamma^m_{c,h}\right)$$

while household consumption spending on home consumption follows

$$PXAC_{a,c} * QHA_{a,c,h} = PXAC_{a,c} * \gamma^h_{a,c,h} + \beta^h_{a,c,h}\left(EH_h - \sum_c PQ_c * \gamma^m_{c,h} - \sum_a \sum_c PXAC_{a,c} * \gamma^h_{a,c,h}\right)$$

[46]Where

PQ_c = purchasers price for commodity c,

$PXAC_{a,c}$ = producer price of commodity c for activity a,

$QHA_{a,c,h}$ = quantity of home consumption of commodity c from activity a for household h

$QH_{c,h}$ = quantity of consumption of marketed commodity c for household h,

EH_h =household consumption expenditures

$\gamma^m_{c,h}$ =subsistence consumption of marketed commodity c for household h,

$\gamma^h_{a,c,h}$ =subsistence consumption of home commodity c from activity a for household h

$\beta^m_{c,h}$ =marginal share of spending on marketed commodity c for household h, and

$\beta^h_{a,c,h}$ =marginal share of spending on home commodity c from activity a for household h

The consumption expenditures of households are exhausted on market consumption valued at market prices and home consumption valued at basic prices . However, the model effectively imposes some subsistence levels of consumption for each of a market and HPHC variants of a commodity, e.g., wheat.).

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[46] In some versions of the IFPRI Standard Model this equation is specified as $PA_a * QHA_{a,h} = PA_a * \gamma^h_{a,h} + \beta^h_{a,h}\left(EH_h - \sum_c PQ_c * \gamma^m_{c,h} - \sum_a PA_a * \gamma^h_{a,h}\right)$ where *PAa* is the activity price. The interpretation of this formulation is marginally different but does not impact on the basic argument.

It is more convincing to assume that households will rather be concerned with satisfying some minimum consumption of the composite commodity irrespective of the sources of the components (different variants of a commodity type) as long as the composite are determined in a cost effective or optimal way.

A1.2 HPHC and Factor Markets

On top of the unsatisfactory treatment of consumption relationship under HPHC, the model does not capture a treatment of the factor market that is implied by the recognition of the involvements of households both as producers employing factors and suppliers of factors to the labour market within and outside the household. In a context where a household both supplies and uses factors, the factor market should reflect the decisions a household must make in terms of where to allocate factors, i.e., to the household activities or to the labour market outside the household. This also requires constraining factor use by the household on own activities by the level of its factor endowment.

As a result, the consumption of a commodity at home cannot be traced and linked to the agent (household) involved in its production. IFPRI SAMs do not also record the use of own inputs as intermediates in the production process, a limitation caused by the fact that the SAMs do not consider home consumed commodities as part of the commodities account; this is despite a wealth of information embodied in countries agricultural surveys on output utilisation that farm households use a noticeable share of their own outputs as inputs.

Since IFPRI standard SAMs do not explicitly record the production roles of households, the endogenous relationship between factor supplies and factor use by households are not recorded in the databases complementing the SAMs, i.e., supplies of factors (mainly labour) by representative households are not presented as satellite accounts of any form. Thus the model cannot as formulated address the deep seated issue of the lack of any behavioural link between the consuming and producing agent, which contains the implicit presumption of separability in decision-making that may be appropriate in developed market economies but is questionable in developing countries.

List of abbreviations

BoP: Balance of Payments

CGE: Computable General Equilibrium

CES: Constant Elasticity of Substitution

CSA: Ethiopian Central Statistical Agency

DG DEVCO: Directorate-General for International Cooperation and Development

EC: European Commission

ESA: European System of National and Regional Accounts

EU: European Union

GAMS: General Algebraic Modeling System

GDP: Gross Domestic Product

GLOBE: A SAM Based Global CGE Model using GTAP Data

GMig: Global Migration model

GNP: Gross National Product

GST: General Sales Taxes

GTAP: Global Trade Analysis Project

HPHC: Home Production for Home Consumption

IFPRI: International Food Policy Research Institute

iMAP: integrated Modelling Platform for Agro-economic Commodity and Policy Analysis

IOT: Input Output Table

IPTS: Institute for Prospective Technological Studies

JRC: Joint Research Centre

LES: Linear Expenditure Systems

LOOP: Law of One Price

MCP: Mixed-Complementarity Problem

MoFED: Ethiopian Ministry of Finance and Economic Development

NBE: National Bank of Ethiopia

PE: Partial Equilibrium

PEP: Partnership for Economic Policy

RHG: representative household groups

SAM: Social Accounting Matrix

SNA: System of National Accounts

STAGE: STatic Applied General Equilibrium model

SSA: Sub-Saharan African countries

SUT: Supply-Use Table

VAT: Value Added Tax

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doi:10.2760/90737

ISBN 978-92-79-69103-4