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Modelling Households as Joint Producers and Consumers[1]

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Abstract

In national accounts HPHC should be correctly priced at basic prices when valuing national income; but in lesser developed economies the differences between basic and purchaser prices can be 40 or more percent, which means the presumption of strong separability between production and consumption decisions may produce misleading results. These differences are rarely included in CGE models. Large differences in marketing margins and commodity taxes mean that the benefits of trade and/or policy reforms are unlikely to be fully transmitted to semi subsistence farmers. In addition, non-SNA production activities – social reproduction and leisure – are usually excluded; but, as with HPHC, they are important for analyses of labour market options.

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2 The contents of this note have been influenced by work with various co-authors; notably Keren Thierfelder, Sandra Polaski, Emerta Aragie, Dorothee Flaig, Arndt Feuerbacher and Johanes Agbahey.

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1. Introduction

For many developing countries, principally those where semi subsistence agriculture remains an important source of livelihoods, home production is a very important form of economic activity. While some home production takes place within the SNA production boundary, e.g., home production for home consumption (HPHC), other dimensions of home production take place outside of the SNA production boundary but within a more widely defined *general* production boundary. If home production takes place within the SNA boundary then it becomes, at least in theory, part of measure economic activity, whereas if it takes place outside of the SNA boundary it is not part of measured economic activity, e.g., in the Mozambique social accounting matrix (SAM) for 1995 (Arndt *et al.*, 1998) HPHC represents over 40% of the value of domestic consumption. This note formalises some concepts relating to HPHC and non-SNA production with special reference to peasant households. The relationship of these activities to the definition of the production boundary is central to the discussion.

Household production is a fundamental feature of all economies that is lost from mainstream economic analyses through a assumption of strong separability, i.e., independent decisions about maximising profit (production) and utility (consumption). The key argument in this note is that household production, in all its forms, in developing and developed economies, requires a relaxation of the strong separability assumption. In its simplest form peasant households must decide about the mix of outputs (home production) for sale on the market or for consumption, i.e., HPHC, thereby linking the production can consumption decisions. At a more complex level households must decide how to allocate their time resources between the production of non-SNA services (so-called social reproduction), leisure and the labour market. This more complex setting opens a range of issues about the definition of the production boundary that should be applied in any whole economy model.

The System of National Accounts (SNA) defines a household "as a group of persons who share the same living accommodation, who pool some, or all, of their income and wealth and who consume certain types of goods and services collectively, mainly housing and food. In general, each member of a household should have some claim upon the collective resources of the household. At least some decisions affecting consumption or other economic activities must be taken for the household as a whole." (ISWGNA, 2009, paragraph 4.149 (see also Chapter 24)). Further it is noted that households "like corporations, … may also engage in production. Household unincorporated market enterprises are created for the purpose of producing goods or services for

sale or barter on the market. They can be engaged in virtually any kind of productive activity: agriculture, mining, manufacturing, construction, retail distribution or the production of other kinds of services. They can range from single persons working as street traders or shoe cleaners with virtually no capital or premises of their own through to large manufacturing, construction or service enterprises with many employees." (ISWGNA, 2009, paragraph 4.155 (see also Chapter 24)).

One major criticism of this approach to the analyses of household behaviour is that it makes the strong assumption, implicit if not explicit, that household decisions can be adequately modelled using a unitary household model. This assumption has been extensively questioned, e.g., Haddad et al., 1997.

Since the price formation processes for HPHC differ greatly from those for marketed commodities –in developing countries purchaser prices are often twice basic prices - a decision to ignore HPHC in the data and model formulation is a potentially large source of bias in price driven economic models. And yet most CGE models applied to developing countries do not identify or model HPHC (Lofgren *et al*., 2002 is an exception); this may be acceptable for developed and middle income economies where HPHC represents a sufficiently small part of economic activities that the loss of detail is not significant, but it is questionable elsewhere. Moreover, since HPHC is, or at least should be, included in the calculation of national account statistics a failure to recognise its existence could cause considerable bias in model results.

Semi subsistence agriculture accounts for the majority of HPHC, and in most developing economies, and especially in the least developed economies, semi subsistence agriculture accounts for most of the agricultural production. In the presence of HPHC two commodities that are notionally the same, e.g., rice, might simultaneously be consumed by a single household despite the fact that the prices 'paid' by the household differ;[3] failure to separately identify the two variants of the same commodity may therefore be distortionary. Moreover, the production and consumption of HPHC commodities is not separable. Consequently, both the consumption and production – resource allocation – decisions made by semi-subsistence agricultural households depend critically upon the interplay between 'basic' and 'purchaser' prices. This has substantive implications for how domestic policy changes are translated into the incentives faced by these households. This is explicitly recognised in the UN System of National Accounts (UN, 2008)[4], but generally ignored

3 This can viewed as a case of commodities differentiated by 'place of production'.

4 The appropriateness or not of the SNA guidelines and/or price systems is not considered in this paper (see Pyatt, 1984a and b for one critique). While the arguments advanced here are made in relation to a SNA style benchmark they carry over to any system of accounts that explicitly recognises differences in price formation process and provide a 'complete and consistent' set of national account statistics.

in economic models and in the strong assumptions made about the transmission of policy changes into changes in incentives. Furthermore, poverty is disproportionately concentrated in rural households; hence analyses that do not include relevant information are likely to produce compromised conclusions about the poverty implications of policy changes.

A argument advanced in this paper is that price driven economic models should acknowledge differences in price determination mechanisms; such differences are recognised in the SNA guidelines for compiling national accounts, i.e., in the data. Where these differences are substantial they should be explicitly incorporated into economic models: ultimately the decision depends on the empirical evidence about the differences/wedges between basic and purchaser prices; *a priori* it is reasonable to expect the wedges to be relatively small in developed economies and to be inversely related to the degree of development. Secondary arguments advanced in this paper are that semi subsistence agriculture requires households to make joint decisions over consumption and production and that the degree of labour market segmentation is an important determinant of the welfare implications of policy changes for such households.

Similarly, non-SNA production activities constitute a substantial part of economic activity that is excluded from national accounts and most whole-economy models (see Chadeau, 1992 and 1985). But both HPHC and non-SNA production activities requires modelling households as joint producers and consumers. HPHC involves the production of goods, for which the decision about selling or consuming may not be simultaneous, but non-SNA production requires simultaneous decisions about production and consumption: leisure cannot be produced now and then be stored for future consumptions

This leads to the key argument that HPHC and non-SNA production activities have major implications for the operation of labour markets, in both developed and developing economies. It is argued that not including these activities in whole economy models risks failing to do justice to the analyses of labour markets.

The rest of the note is organised as follows. The next section, two, briefly examines the characterisation of decision-making by peasant households. The definition of production boundaries in the System of National Accounts (SNA) is considered in section 3; this starts with a clarification of the SNA production boundary and then moves to consider the classification of a ‘general’ production boundary. Home production for home consumption within the SNA production boundary is considered in section 4. Then in sections 5 and 6 the twin issues of social reproduction and leisure are discussed. The discussions in sections 4,5 and 6 all consider how the requisite data may be recorded and how CGE models can be extended, but do not focus on the

implications for modelling the labour market; this topic is considered in section 7. There are no real conclusions. The note ends with four appendices that add to the discussions. The first consider the approach to modelling home consumption in the IFPRI standard model; this is important because this was the first known attempt at this subject and many of the arguments here a derive from the insights this model offered. The next 3 appendices consider aspects of the labour market: the first considers the arguments for factor market segmentation (and factor mobility functions), the second, consider labour-leisure trade-offs and the third, looks at labour migration.

2. Peasant Households

Peasant households have long been studied from the perspectives of social anthropology, sociology and economics, e.g., Chayanov (1986)[5]. Economic analyses of peasant (farm) households attracted substantial interest from development economists from the late 1950s until the 1990s, when the focus shifted towards analyses of institutional arrangements and responses to market failure. Some of the themes that emerge from models of peasant farm households that are relevant to the modelling of peasant households are that peasant societies are not static, uniform or isolated. The fact that peasant societies evolve is a long-term consideration while the fact that they are not isolated means that they engage with markets and exchange; the extent of engagement with markets is likely to depend, at least in part, on the 'stage' of evolution (see Wolf, 1966; Mintz, 1973). Within the broader perspective of peasant societies is the issue of peasant households who are simultaneously households and productive enterprises; it is this dimension of peasant farm households that is used for this study Ellis (1993).

Early considerations of the economics of peasant farms is often associated with Schultz's hypothesis that peasants were 'poor but efficient' (see Hopper, 1965; Schultz, 1964) where the analyses presumed that peasants were profit maximising farmers making separable production and consumption decisions. This 'neoclassical' approach 'ensured' that peasant farmers are producing on the production possibility frontier with a socially optimal use of inputs and output mix in the presence of perfect knowledge and markets. This approach has long been criticised for failing to recognise the constraints imposed on the decisions of peasant farmers due to, inter alia, imperfect markets (e.g., Hoff et al., 1996), agrarian institutions (e.g., Bardhan, 1989), surplus labour (e.g., Sen, 1966, 1967) and risk (e.g., Lipton, 1968). Moreover, since peasants simultaneously operate as households and productive activities their production and consumption decisions are non-separable: thus, peasant households should be included in economic models as agents that are simultaneously activities and households (see Aragie, 2014; McDonald, 2010).

Peasant Households in Whole Economy Models

If peasant households are included as both activities and households the underlying model should embody properties found in the models developed by Chayanov (1986), Sen (1966), Mellor (1963), Lipton (1968), Barnum & Squire (1980), Becker (1965) and Lopez (1986). Specifically, peasant

5 Chayanov's works first appeared in English on the 1980s, but these were translations of works from the first quarter of the 20th century.

households should operate simultaneously as households and productive activities so that decisions over consumption, including leisure and therefore the supplies of labour to productive activities, and production, including social reproduction, are simultaneous, i.e., a model with the optimisation of household utility (see Becker 1965; and Michael & Becker, 1973). This type of model has been labelled a 'drudgery-averse peasant' model (see Ellis, 1993, Chapter 6). Peasant households should seek to optimise one, or more, household objectives, i.e., peasants should act as rational economic agents (see Lipton, 1968); this is consistent with empirical evidence that peasants are responsive to market signals, changes in market arrangements, e.g., reductions in trade and transport costs, and changes in technology. Similarly, peasant households are not isolated from labour markets and any model should include the option that peasant households can interact with markets both to supply labour to other activities, as well as their own productive activities, and to demand labour in peak seasons. Finally, the seasonal fluctuations in labour demand dictated by the biological nature of agricultural production should be included. This reflects the fact that with "agriculture being a seasonal operation, it is somewhat misleading to speak in terms of a homogeneous unit of labor. A unit of labor at the time of harvesting is not replaceable by a unit of labor at a slack period" (Sen, 1966). This is important when simulating a pandemic since the seasons in which a pandemic occurs may have disproportionate impacts on peasant households.

3. Production Boundary

A production boundary is essential in all whole economy models since it defines the economic scope of the model, i.e., the transactions that are endogenous and exogenous to the model. It is widely acknowledged that even the most comprehensive of economic accounts and models do not encompass all transactions; the classic (undergraduate) discussion about the dimensions of economic transactions included in, or excluded from, measures of GDP/GNP are applications of the concept of a production boundary. The example of the production boundary applied to measured GDP/GNP, as recorded in national accounts, is directly relevant to all empirical whole economy models that are benchmarked against estimates of standard national accounts; if the GDP/GNP recorded in the database is to be consistent with the estimate of GDP/GNP in the national accounts then the measure of GDP/GNP in the whole economy model must be defined by reference to the same production boundary.

The decision about where to draw the production boundary is not only conceptually and theoretically tricky, it is also constrained by empirical concerns that seek to ensure consistency between the databases for whole economy models and national accounts.

In price driven whole economy models, e.g., CGE models, where the Law of One Price (LOOP) is typically presumed to hold[6] and each price is uniquely determined, it is reasonable to argue that production and consumption decisions relating to goods and services should only be deemed to take place within the production boundary if those goods and services can have uniquely determined prices. This is essentially the approached adopted by the SNA when it defines its production boundary.

Production and Consumption Boundaries

The definition of the production and consumption boundaries typically proceeds by defining those activities that are within the boundaries; activities outside the boundaries are thereby defined as those activities that are not within the boundaries.

The SNA recognises a definition of a *general* production boundary (SNA, 2008, 6.24 and 6.25) that has economic meaning. This defines all activities using inputs (primary and intermediate) that are controlled and organised by institutions, which means that all natural/unmanaged production takes place outside the boundary (6.24). This definition is relatively straightforward for goods but

6 The discussion here abstracts from those circumstances where the LOOP may be violated for pragmatic reasons.

rapidly becomes opaque for services. Services such as eating, exercising, sleeping etc., cannot be contracted out, and are not productive in the economic sense, but services such as childcare, cleaning etc., can be contracted out, and therefore fall within the *general* production boundary.

The SNA's definition of its production boundary is more restrictive. Activities that produce goods and services for sale on markets typically satisfy the SNA condition that the prices can be uniquely defined, whether they are sold or not sold. Consequently, home production for home consumption (HPHC) is within the production boundary (SNA, 2008, 1.41.and 1.42 and 6.27). But, the SNA boundary excludes "activities undertaken by households that produce services for their own use …… except for services provided by owner-occupied dwellings and services produced by employing paid domestic staff"[7] (SNA, 2008, 1.40, 6.26 and 6.27). Purchases of goods and services used by households to produce 'services for their own use' are within the production boundary; therefore, the inputs that are used to produce 'services for their own use' that are excluded from the accounts are (overwhelmingly) labour.[8]

The decision to exclude most services is driven by the fact that "household services are not produced for the market, there are typically no suitable market prices that can be used to value such services" (see SNA, 2008, 6.28 to 6.31). Thus, goods produced by households for own use (HPHC) and some services are within the production boundary; an oddity is "services produced by employing paid domestic staff", but the logic is that domestic staff are in paid employment and therefore their activities contribute directly to measured GDP.

SNA Production Boundary and Household Production

Household production is a feature of all economies, which is often lost from mainstream economic analyses through an assumption of strong separability. The SNA however recognises household production as an important component of economic activity.

In the System of National Accounts (SNA) (UN, 2008) the concept of the production boundary defines what should and should not be included in the generation of national accounts data; as such the concept is central to the compilation of national accounts and yet is poorly understood.[9] The application of the production boundary with respect to distribution of the products by activities

7 Contributions of time to NPISH are also excluded from the SNA production boundary (SNA, 2008, 1.40).

8 It is conceivable that other non-produced inputs, i.e., 'land', are used to produce such services.

9 Many critiques of national accounts data, e.g., GNP/GDP, are essentially critiques based on disagreements about where the production boundary should be drawn. It is indisputable that should a boundary needs to be drawn since without a boundary implementation is impractical.

through formal market networks is straightforward, whether the activities are formal or informal.[10] However the application of the production boundary concept with respect to the distribution of commodities generated by household production is much less straightforward. While all household production activities undertaken by households can add to welfare not all such activities are treated as within the production boundary. Specifically, the SNA states,

> "In the SNA, production is understood to be a physical process, carried out under the responsibility, control and management of an institutional unit, in which labour and assets are used to transform inputs of goods and services into outputs of other goods and services. All goods and services produced as outputs must be such that they can be sold on markets or at least be capable of being provided by one unit to another, with or without charge. The SNA includes within the production boundary all production actually destined for the market, whether for sale or barter. It also includes all goods or services provided free to individual households or collectively to the community by government units or NPISHs." (ISWGNA, 2009, paragraph 1.40, p 6).

The issue of production by enterprises/firms is simple to incorporate within this definition of a production boundary, but in addition to outputs from household activities that are sold on the market, household production includes

> "a. The production of agricultural goods by household enterprises for own final consumption;
> b. The production of other goods for own final use by households: the construction of dwellings, the production of foodstuffs and clothing, etc.;
> c. The production of housing services for own final consumption by owner occupiers;
> d. The production of domestic and personal services for consumption within the same household: the preparation of meals, care and training of children, cleaning, repairs, etc." (ISWGNA, 2009, paragraph 1.41, p 6).

Given the definition of the SNA boundary there is a need for national accounts to specify what is and is not included within the accounts in a manner that ensures the accounts are sufficiently comprehensive to ensure their use in economic models.

> "The SNA therefore includes all production of goods for own use within its production boundary, as the decision whether goods are to be sold or retained for own use can be

10 The distinction between formal and informal activities is contentious. To avoid confusion the distinction between formal and informal activities adopted in the text will be based on the tax incidence; the term informal will be used when referring to activities whose production or commodities in some manner escape taxes paid by formal activities.

> made even after they have been produced, but it excludes all production of services for own final consumption within households (except for the services produced by employing paid domestic staff and the own-account production of housing services by owner occupiers). The services are excluded because the decision to consume them within the household is made even before the service is provided." (ISWGNA, 2009, paragraph 1.42, pp 6-7)

Household production can be conveniently, if crudely, divided into two: household production within the SNA boundary and household production outside the SNA boundary but within a general production boundary. The latter has been called 'social reproduction'.

Production Boundary and Welfare

These definitions (general and SNA) of the production boundary ensure that absorption of goods and services produced within the production boundary and welfare differ; *total* economic welfare must be greater than, or, exceptionally, equal to, that derived from the absorption of goods and services generated within the SNA boundary. All uses of labour time by households to produce services, either by the households or NPISH, consumed by the households are excluded from absorption. The SNA's asserts that "[T]he exclusion of these services from the production boundary is not a denial of the welfare properties of the services but a recognition that their inclusion would detract from rather than add to the usefulness of the SNA for the primary purposes for which it is designed, that is economic analysis, decision-taking and policymaking" (SNA, 2008, 1.78); it may be argued that the exclusion of these services inhibits economic analyses.

The measurement of welfare is complicated by the implications of external events, e.g., weather effects (hurricanes etc.,) and epidemics, and by externalities, e.g., emissions and other forms of pollution. In both cases it is possible that welfare will decline despite apparent increases in GDP (SNA, 2008, 1.79 to 1.82).

An important consequence of the distinction between absorption and welfare is that welfare depends, at least in part, on the use of labour time within the *general* production boundary but outside the SNA production boundary. Consequently, if labour time is transferred from the production of services for own consumption to activities within the SNA production boundary, there will be positive and negative implications for welfare. Contributions to welfare from the own production of services will decline, if labour time outside the SNA production boundary has a

positive marginal product,[11] while the contributions to welfare from activities within the SNA production boundary will increase.[12] [13]

11 The possibility of negative marginal products of labour time is difficult to reconcile with economic theory, but the possibility that a lack of formal employment may have negative welfare implications cannot be lightly dismissed.

12 The definitions of welfare (equivalent variation – EV) thus need to be qualified as 'measured' welfare. If labour is transferred from own production of services to activities within the production boundary – called an endowment effect in the GTAP welfare decomposition – then the increase in 'measured' welfare will be an absolute upper bound BECAUSE the loss of welfare associated with own production of services has been ignored.

13 Matters relating to the modelling of labour markets are considered in McDonald (2018).

4 Household Production inside the SNA Production Boundary[14]

The SNA recognises several distinctive features about household production that is produced within the production boundary and consumed at home (HPHC). Specifically, the SNA explicitly distinguishes between household production of goods and services: "[F]or example, if a household engages in the production of agricultural goods, it does not follow that it intends to consume them all. Once the crop has been harvested, the producer has a choice about how much to consume, how much to store for future consumption or production and how much to offer for sale or barter on the market. Indeed, although it is customary to refer to the own-account production of goods, it is not possible to determine at the time the production takes place how much of it will eventually be consumed by the producer. For example, if an agricultural crop turns out to be better than expected, the household may dispose of some of it on the market even though it may have originally supposed it would consume it all. This kind of possibility is non-existent for services; it is not possible to produce a service and then decide whether to offer it for sale or not." (ISWGNA, 2009, paragraph 6.29a).

When HPHC outputs are recorded they must be recorded as inseparable incomes and expenditures; specifically, "the incomes generated are automatically tied to the consumption of the goods and services produced" (ISWGNA, 2009, paragraph 1.41, p 6). Furthermore while conventional (marketed) household consumption is valued at purchaser prices (ISWGNA, 2009, paragraph 9.74, p 188) HPHC is recorded at basic prices ("Goods produced on own account are valued at basic prices, consistently with their valuation as production", ISWGNA, 2009, paragraph 9.75, p 188).

Semi subsistence agriculture under the control of a household (institution) accounts for the majority of HPHC. In the simplest case households (farmers) engaged in semi subsistence agriculture may sell part of their output on the market, in which case it enters the market system, while the rest of their output is not marketed and then, by definition, can only be consumed by the specific household that produced the output. Consequently, it can be argued that each agricultural commodity should have TWO accounts since they have different price determination mechanisms; one for the HPHC variant and one for the commodity that is sold. Thus, HPHC activities/households receive incomes from two sources; the first, records commodities that are produced and consumed at home while the second, records incomes from sales to the market.

14 The first CGE model known to have addressed this issue was the IFPRI Standard model. How HPHC was modelling in the IFPRI Standard Model is analysed in Appendix 1.

Since HPHC commodities can only be consumed by the household that produced them, the only source of final demand is the household; therefore, each representative household group (RHG), which engages in HPHC, must be paired with a HPHC activity. The account for the RHG is the destination for final demand while the paired account is the purchaser of inputs and the source of supply. Importantly note how, by definition, the purchaser prices for HPHC must be equal to the basic prices since no taxes and/or margins are levied on HPHC. Moreover the 'correct' prices for valuing HPHC are the basic prices received for the same commodities sold by the HPHC activity to the market; hence the unique prices required for commodities within the production boundary are defined. The derivation of the basic prices derives directly from production costs.

Finally factor services provided by households, especially labour services, must be segmented between HPHC activities and conventional activities. But if factors are shifted from HPHC to conventional activities, and therefore HPHC decreases, then the extra returns to the factors moved to conventional activities must be sufficiently large to counter the opportunity costs of shifting to higher priced consumption commodities.

In default mode the SNA adopts a very simple definition for the production boundary; goods that can be priced are in, and services are out. But while this is the standard definition, which will for practical reasons be followed here, the SNA does not adhere rigidly to this definition and recognises that some analyses need more flexibility (see ISWGNA, 2009, paragraph 2.167, p 38) and that Social Accounting Matrices (SAMs) have often exploited this flexibility "The power of a SAM, as well as of the SNA, comes from choosing the appropriate type of disaggregation to study the topic of interest. In addition to a flexible application, SAMs may incorporate more extensive adjustments, which are of a satellite accounting nature, in order to serve specific analytical purposes." (ISWGNA, 2009, paragraph 2.164, p 37).

4.1 Valuing Household Production and Consumption

The distinctions between basic, producer and purchaser prices lie at the heart of this approach. In the SNA the definitions are transparent. Basic prices are defined as

> "the amount receivable by the producer from the purchaser for a unit of a good or service produced as output minus any tax payable, and plus any subsidy receivable, on that unit as a consequence of its production or sale. It excludes any transport charges invoiced separately by the producer" (UN, 1993, paragraph 205).

Producer prices are defined as

> "the amount receivable by the producer from the purchaser for a unit of a good or service produced as output minus any VAT, or similar deductible tax, invoiced to the purchaser. It excludes any transport charges invoiced separately by the producer". (UN, 1993, paragraph 205)

Purchaser prices are defined as

> "the amount paid by the purchaser, excluding any deductible VAT or similar deductible tax, in order to take delivery of a unit of a good or service at the time and place required by the purchaser. The purchaser's price of a good includes any transport charges paid separately by the purchaser to take delivery at the required time and place" (UN, 1993, paragraph 215).

For current purposes little more needs saying about producer prices. The key differences between basic and purchaser prices are trade and transport costs and commodity taxes paid by domestic purchasers, i.e., general sales taxes, excise taxes, non-rebated VAT, etc., and excluding import duties.

4.1.2 Trade and Transport Costs

Trade and transport costs relate to the costs incurred when moving commodities from the producers to the consumers. These are defined exclusive of the costs of wholesaler and retailer services[15], and therefore relate solely to the costs of relocating commodities. It reasonable to expect that these costs are proportionately higher the lower the density of population; the greater the distances between producer and consumer; and the less developed is the transport infrastructure. While some developing (Asian?) economies may be characterised high population densities and relatively limited distances, this is not the case for other, especially African, developing economies. And moreover, the transport infrastructures in developing countries are, almost by definition, less developed and hence it is reasonable to expect that trade and transport costs are inversely related to the level of development.

Since trade and transport costs represent an important determinant of the differences between basic and purchaser prices the database should, ideally, separately identify these cost components. This suggests the adoption of a Supply and Use Table (SUT) representation of the data since the

15 "The recording in the SNA of transactions for wholesalers and retailers does not mirror the way in which those involved view them. The purchases of goods for resale by wholesalers and retailers are not recorded by these units explicitly, and they are viewed as selling, not the goods, but the services of storing and displaying a selection of goods in convenient locations and making them easily available for customers. This partitioning measures output for traders by the value of the margins realized on goods they purchase for resale." (UN, 2008 paragraph 3.68, p 45).

use of commodities will then be valued in purchaser prices while the supply of commodities will distinguish between basic prices, employed to value sales by producers, and components that make up the differences between basic and purchaser prices. This contrasts with an Input-Output Table (IOT) representation wherein the use of commodities has been revalued in basic price terms, which *de facto* masks trade and transport costs.

4.1.3 Commodity Taxes

The second main difference between basic and purchaser prices is the inclusion of the commodity taxes paid by the consumer. These can be complicated. A general sales tax (GST) would typically be paid at the same rates by all domestic purchasing agents; similar arrangements are likely to exist for excise, fuel and other generalised commodity taxes. However increasingly commodity taxes are levied in the form of value added taxes (VAT)[16]; the key distinguishing feature of VAT being that VAT paid on intermediate inputs is rebated, at least partially, to the purchaser whereas VAT paid on final demands is not rebated.

In a stylised arrangement it could be assumed that all VAT levied on purchases for intermediate input use are rebated, which is simple to model. In reality the situation tends to be more complex since (a) activities do not necessarily reclaim all the VAT they pay, (b) there is often a turnover threshold for VAT below which VAT revenue is not paid to government and VAT expenditures are not reclaimed, and (c) some activities and commodities are defined as VAT exempt. These differences complicate the analyses in a real-world scenario but for present purposes a simple stylised representation will be adopted.

4.2 Integrating HPHC into a Social Accounting Matrix

The flexibility offered by a Social Accounting Matrix (SAM) makes it relatively simple to integrate HPHC, provided the underlying data are available,[17] while making transparent how HPHC is valued. Table 4.1 presents one way in which such a SAM[18] can be organised; sub matrices with

16 A common misconception is that VAT is a tax on value added by factors whereas in factor VAT is a tax on commodities.

17 The requisite data should be available since HPHC refers to transactions that lie within the production boundary. If SNA guidelines are followed in compiling SUT then values for HPHC should have been 'imputed' and therefore their separate identification requires unbundling these transactions. Inevitably there is a tendency for a degree of reticence among national account statisticians for disclosing imputed data; it is by definition less well founded than some other data and its inclusion in an aggregate masks its presence.

18 The SAM format adopted follows most closely the 1968 SNA. It would be easy to adapt the layout to conform to the 1993 or 2008 versions of the SNA; the chosen form is more typical of the format used in CGE models.

descriptions are those for which transactions are typically nonzero, while those with '0' entries are those for which transactions are required to be zero.

HPHC requires the introduction of 2 additional sets of columns and rows, which are in fact simply subdivisions of the existing commodity and activity accounts. The supply of HPHC commodities is recorded in the first column (sub matrix 3a:1a) while the demand for HPHC commodities in recorded in the first row either as intermediate demand by HPHC activities or final demand by households; all these entries are valued in basic prices, which is the correct basis. It is evident that the purchaser prices are the same as basic prices for HPHC commodities since there are no commodity taxes or trade and transport margins associated with these commodities. There are some additional accounting constraints that need to be considered for the commodity accounts and these are illustrated, for a stylised closed economy, in Table 4.2.

Table 4.1 Social Accounting Matrix including Accounts for HPHC

Expenditures / **Incomes**	**1a** HPHC Commod's	**1b** Market Commod's	**2** Margins	**3a** HPHC Activities	**3b** Activities	**4a** Labour	**4b** Capital	**5a** Households	**5b** Enterprises	**5c** Govt	**6** Capital Account	**7** Rest of World	**8** Total
1a. HPHC Commodities	0	0	0	HPHC intermediates	0	0	0	HPHC	0	0	0	0	HPHC demand
1b. Market Commodities	0	0	Trade & Transport	Intermediate inputs	Intermediate inputs			Marketed G&S		Govt demand	Investment	Exports (fob)	Market demand
2. Margins	0	Trade & Transport Costs	0	0	0	0	0	0	0	0	0	0	Total Margins
3a. HPHC Activities	HPHC G&S	Marketed G&S	0	0	0	0	0	0	0	0	0	0	HPHC
3b. Activities	0	Domestic Production	0	0									Production
4a. Labour	0		0	Imputed Wages	Wages							Incomes from RoW	GNP at factor cost
4b. Capital	0		0	Profits & Rent	Profits & Rent							Incomes from RoW	
5a. Households	0		0	0		Labour income	Profits	Intra-household		Transfers		Transfers from RoW	Household income
5b. Enterprises	0		0	0			Retained profits		Transfers	Transfers		Transfers from RoW	Enterprise income
5c. Government	0	Taxes on G&S	0	0	Production taxes	National insurance	Profits; Taxes on profits	Direct taxes	Direct taxes			Transfers from RoW	Govt income
6. Capital Account	0		0	0			Depreciation	Household saving	Enterprise saving	Government saving		Trade Balance	Total savings
7. Rest of World	0	Imports (cif)	0	0		Factor payments			Current transfers				Imports
8. Total	HPHC supply	Market Supply	Total Margins	HPHC Production	Production	Factor outlay		Households expenditure	Enterprise expenditure	Govt expenditure	Total investment	Foreign earnings	

cgemod

Table 4.2 Stylised Social Accounting Matrix with HPHC – Closed Economy

		Commodities			Margins	Activities				Factors			Household		Government		Totals
		H_food	M_food	M_nonF		A_HH1	A_HH2	A_food	A_nonF	Labour	Capital	Land	HH1	HH2	GST	Govt	
Commodities	H_food	0	0	0	0	10	5	0	0	0	0	0	20	10	0	0	45
	M_food	0	0	0	0	5	2	20	30	0	0	0	30	40	0	3	130
	M_nonF	0	0	0	45	5	1	12	26	0	0	0	30	60	0	22	201
Margins		0	20	25	0	0	0	0	0	0	0	0	0	0	0	0	45
Activities	A_HH1	30	15	0	0	0	0	0	0	0	0	0	0	0	0	0	45
	A_HH2	15	10	0	0	0	0	0	0	0	0	0	0	0	0	0	25
	A_food	0	55	20	0	0	0	0	0	0	0	0	0	0	0	0	75
	A_nonF	0	15	146	0	0	0	0	0	0	0	0	0	0	0	0	161
Factors	Labour	0	0	0	0	15	10	18	70	0	0	0	0	0	0	0	113
	Capital	0	0	0	0	2	2	15	35	0	0	0	0	0	0	0	54
	Land	0	0	0	0	8	5	10	0	0	0	0	0	0	0	0	23
Household	HH1	0	0	0	0	0	0	0	0	63	7	10	0	0	0	0	80
	HH2	0	0	0	0	0	0	0	0	50	47	13	0	0	0	0	110
Government	GST	0	15	10	0	0	0	0	0	0	0	0	0	0	0	0	25
	Govt	0	0	0	0	0	0	0	0	0	0	0	0	0	25	0	25
Totals		45	130	201	45	45	25	75	161	113	54	23	80	110	25	25	

Total expenditure on HPHC commodities by each household is identical to total income from HPHC commodities sales; note how there is an activity for each household and the expenditure encompasses both intermediate demand by the activity and final demand by the household. But the outputs by each of the HPHC activities are greater than the value of their output consumed by the matching households, i.e., the HPHC activities are semi subsistent activities in that they produced both for own consumption and for the market. Assuming that the basic prices for the HPHC commodity (H_food) and the market variant (M_food) are the same, which amounts to valuing commodities that are home consumed at their opportunity cost, then two thirds of the output by household 1's production activity (A_HH1) is home consumed and one third is marketed. Then the average purchaser price of marketed food is 36.8% greater than the HPHC variant[19]; thus, assuming that the marketing margins and general sales tax (GST) rates are identical for each commodity irrespective of source, HH1 is consuming 20 units of HPHC food and 21.9 units of marketed food.

Further note how the income to household 1 (HH1) is greater than the value added for the matching activity (A_HH1), which indicates that at proportion of the household's assets/factors are employed outside of the HPHC activity; the same applies to household 2.

Since most HPHC will be carried out by unincorporated business enterprises payments for factor services will usually be recorded as mixed incomes since allocation to specific factors is difficult. While mixed income is relatively easily recorded in a database, the distribution between factors may be difficult since almost inevitably it requires the decomposition of mixed income.

It may be reasonable to argue that labour, and other factors, used for home production activity are rewarded at the same rates, but it is less plausible to argue that the implicit wage rates for factors used elsewhere are the same since the purchaser prices of HPHC commodities are lower than marketed variants the wage rate needs to be greater to achieve the same real value. If factor quantity data exist this is likely to be manifest as substantial differences in the applied wage rates across activities, i.e., the implied value of marginal products differ. The extent which this is a consequence of activity specific differences, e.g., capital:labour ratios, activity specific productivity differences, etc., and/or factor specific differences, e.g., differences in the inherent productivity/quality of factors, can only be determined through case specific information. Where there is evidence of systematic differences in factors there is an *a priori* case for identifying different types of labour, although the degree of differentiation that is appropriate will always to some extent be a judgement call.

19 Value at basic prices is 95 and at purchaser prices is 130, therefore the 'mark-up' is 36.8%, i.e., 35/95.

However, it is reasonable to expect that labour used in HPHC is different in some ways to other labour and that some segmentation in factor markets is required. For instance, it may be appropriate to segment factors used by home production activities from the notionally same factors used by other activities. The precise options will depend upon the circumstances and the information available.

4.3. Modelling Prices and Household Production and Consumption

The IFPRI standard model (Lofgren *et al*., 2002) recognises the consumption choice issue and the important distinction of valuing HPHC at basic prices, but not the non-separability of the production and consumption decisions nor does it contain a treatment of the labour markets that partial integration across segmented factor types. In this section there is a discussion of model developments that allow a more complete treatment of HPHC. The discussion here will assume the starting point is the STAGE model (McDonald, 2007). The STAGE model is a member of the class of models that follow from the Dervis, *et al*., (1984) and is specifically a development of the USDA ERS model of the late 1980's (see Robinson, *et al*., 1990 and Kilkenny, 1991); as such the model shares the same origins as the IFPRI standard model and therefore contains many of the same features.

4.3.1 Price Definitions

Many single country CGE models do not identify the specific magnitudes of trade and transport costs/margins. This is a reflection of the fact such models are calibrated using SAMs (databases) that record inter industry transactions in a 'quasi' input-output format, which means purchases should be valued at basic prices, whereas in practical terms they are valued at basic prices plus any commodity tax paid by the purchaser under an implicit/explicit presumption that all agent pay the same *ad valorem* commodity tax rates. [20] In such a model the purchaser price (*PQD*) for commodity *c* would be defined as

$$PQD_c = PQS_c * (1 + ts_c) \qquad (1)$$

where *PQS* is a 'pseudo' basic price and *ts* the *ad valorem* commodity tax rate – in this case a general sales tax. As discussed above however the purchaser price should include an allowance for

[20] The approach followed in the Australian 'school' and by GTAP is arguably better since it retains the basic price value for transactions and then defines agent specific tax rates for each commodity.

trade and transport margins in addition to commodity taxes. Defining *PQS* as a 'true' basic price produces the following definition for purchaser prices

$$PQD_c = \left(PQS_c * \left(1 + mm_c\right)\right) * \left(1 + ts_c\right) \qquad (2)$$

where *mm* is the marketing margin rate.[21]

A distinct advantage of this formulation is that a term for the basic price for each commodity is maintained in the model, which in this case is an advantage since it will be useful when valuing HPHC.[22]

This approach requires that the entries in the row accounts for commodities are valued a purchaser prices while the supply of commodities – column accounts – are valued in basic prices.[23] This is the valuation system used in Supply and Use table (SUT) formulations of SAMs, which is the format used in Tables 2.1 and 2.2. From here on it will be assumed that the data are presented in SUT format rather than IOT format.

4.3.2 Nested Household Utility Functions

The basic STAGE model uses a one level utility function for households. This implies that the degree of substitutability between different commodities is identical, which is arguably inappropriate in the presence of HPHC since commodities that are differentiated by the 'place' of production are treated symmetrically with commodities that have inherently different characteristics. To a limited extent a linear expenditure system (LES) formulation mitigates problems by imposing marginal substitution possibilities and 'subsistence' consumption quantities, but it represents an unsatisfactory approach in the presence of HPHC.

A simple solution for including HPHC in the utility function is to adopt a two-stage nesting process whereby at the first level the HPHC commodities are treated as (constant elasticity) substitutes for their marketed counterparts, thereby generating composite consumption commodities that enter into a second stage function that can take any standard format. Figure 4.1 illustrates such a nested utility function for a 4 commodity case where one is an HPHC (food)

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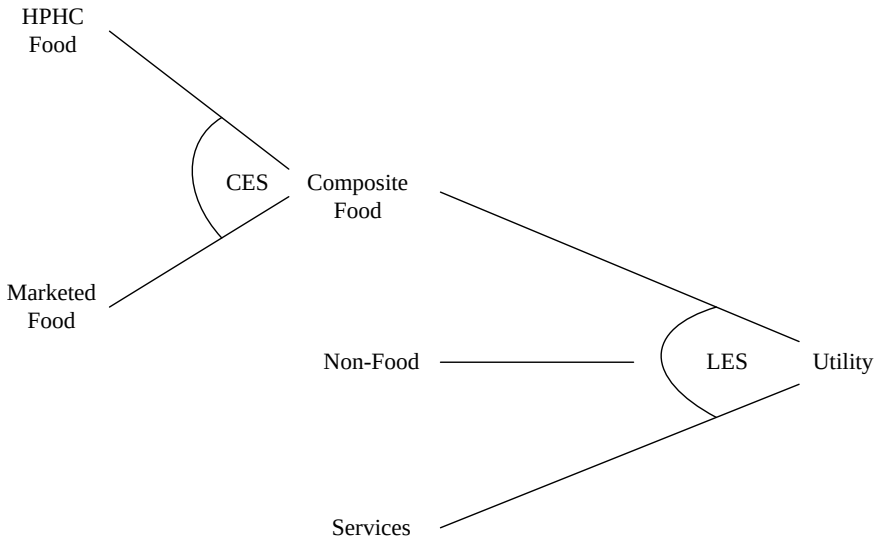
21 This can easily be adapted to the presence of multiple types of margin, e.g., where trade and transport costs are separately identified.

22 The IFPRI standard model includes marketing margins but introduces them in different price definition equations.

23 The approach followed in the Australian 'school' and by GTAP would allow the definition of agent specific marketing margins for each commodity. Note however that if so done the basic price definition for valuing transactions is confused.

commodity and its marketed (food) counterpart and two others - non-food commodities and services; the first level is a CES utility function and the second level is a LES utility function.[24]

Figure 4.1 Nested Utility Function for HPHC Commodities



This form of nested utility function retains the advantages of the LES compared, to Cobb-Douglas or CES, while achieving the flexibility of regular nested functions. It also retains the minimum levels of subsistence consumption, which is one of major advantages of the LES when used for households on very low incomes. In addition, it has the advantage of using functions whose properties are well known and understood while introducing a clean economic theoretic rational for the substitution between the HPHC and marketed variants of commodities by following the logic in the economics of consumer demand. Its major disadvantage compared to nested CES functions is that the effective substitution elasticities are not transparent.

The modelling of HPHC benefits from explicitly modelling the factor ownership by institution, which is considered briefly below.

24 This was used by Aragie (2014) and Aragie *et al*. (2016).

5. Household Production outside the SNA Production Boundary: Social Reproduction

While the SNA recognises the existence of a *general* production boundary it accords relatively little attention to how the services of productive activities outside the SNA boundary may be included in an *extended* definition of economic activity. The SNA notes that, with respect to "services produced for own use by households", that "[I]n most countries a considerable amount of labour is devoted to the production of these services, and their consumption makes an important contribution to economic welfare. …... The reasons for not imputing values for unpaid domestic or personal services produced and consumed within households may be summarized as follows:

a. The own-account production of services within households is a self-contained activity with limited repercussions on the rest of the economy. The decision to produce a household service entails a simultaneous decision to consume that service. This is not true for goods. ….. it is not possible to produce a service and then decide whether to offer it for sale or not.

b. As the vast majority of household services are not produced for the market, there are typically no suitable market prices that can be used to value such services. It is therefore extremely difficult to estimate values not only for the outputs of the services but also for the associated incomes and expenditures ……...

c. With the exception of the imputed rental of owner-occupied dwellings, the decision to produce services for own consumption is not influenced by and does not influence economic policy ….." (ISWGNA, 2009, paragraph 6.29).

There are reasons to question the assertion that "own-account production of services within households is a self-contained activity with limited repercussions on the rest of the economy", in both developing and more developed countries. For instance the labour force, in the SNA, is defined by reference to the SNA production boundary (see McDonald, 2018); but as economies have evolved so the proportions of the population engaged in the workforce have changed; in developed economies this most commonly mentioned in reference to the proportion of women working 'outside' the home. Consequently, changes in household decisions about social reproduction provide reasons why including social reproduction in whole economy models maybe valuable, especially where models are being implemented over extended time periods and/or where the migration of households, rural-urban and international, is of interest.[25]

25 A similarly argument will be made below for leisure.

Nevertheless, the argument made in the SNA that there are 'typically no suitable market prices' is clearly correct. But while it may be difficult, the inclusion of social reproduction in a whole economy model requires some method for determining the value of home production. There are two obvious alternatives: the opportunity cost of foregone employment and the market prices of comparable services, e.g., childcare, etc. The approach consider here is based on opportunity costs and requires time use survey data.

5.1 Valuing Social Reproduction

Each RHG must produce its own social reproduction services (SRS); this reflects the argument that the "decision to produce a household service entails a simultaneous decision to consume that service", i.e., as with HPHC the RHG simultaneously determines the production and consumption of social reproduction services. Moreover, each RHG can only use its own resources to produce its own SRS: if the services were produced by factors from other RHGs, i.e., employed factors, those services should have been included within the SNA boundary because the prices can be defined. Finally, the use of capital and land as factor inputs will be minimal if not zero: for instance, white goods used by households are recorded as consumption goods and imputed rents for housing are included within the SNA boundary.

Given this formulation, the inputs used to produce SRS can be reduced to the time (labour) devoted to SRS production by members of the RHG, and each RHG produces and consumes SRS that are unique to the RHG, i.e., each will have a unique price based on the quantities of each type of labour service used and the prices of each type of labour. The quantities of each type of labour service used can be determined from time use surveys, or as a residual from estimates of the total quantities of labour services available to each RHG. Therefore, the evaluation of the RHG specific prices for SRS will vary according to the prices attached to labour services used in its production.

Option 1: the opportunity cost of each labour type – this can be defined as the price of the same type of factor when used within the SNA boundary: this requires determining the total quantity of used type of labour available to each RHG and subtracting from this total the quantity used within the SNA boundary.

Option 2: the market price of the equivalent labour services available on the market, e.g., catering, cleaning, caring, etc., services: this requires determining the total quantity of used type of each equivalent labour service.

Option 1 is simpler in terms of data requirements and has the added advantage of allowing for movements of labour services from outside to inside the SNA boundary and vis a versa.

There has been an extensive literature on the problem of valuing labour used in producing SRS, although it is has largely disappeared from the current literature. In accounting terms this is clearly a major consideration, but as argued, below, how the movement of labour across the SNA boundary is modelled is critical.

5.2 Integrating Social Reproduction into a Social Accounting Matrix

Adding SRS to a SAM is relatively straightforward; the key consideration is the maintenance of the Law of One Price (LOOP). As illustrated in Table 5.1 the inclusion of SRS in a SAM follows the same principles used for HPHC.

Each RHG must have a paired SRS activity that produces a single set of unique SRS that are consumed only by the paired RHG. The prices of each RHG specific SRS has its own cost/production function that uses different mixes of labour. This ensures that LOOP is maintained.

5.3 Modelling Social Reproduction

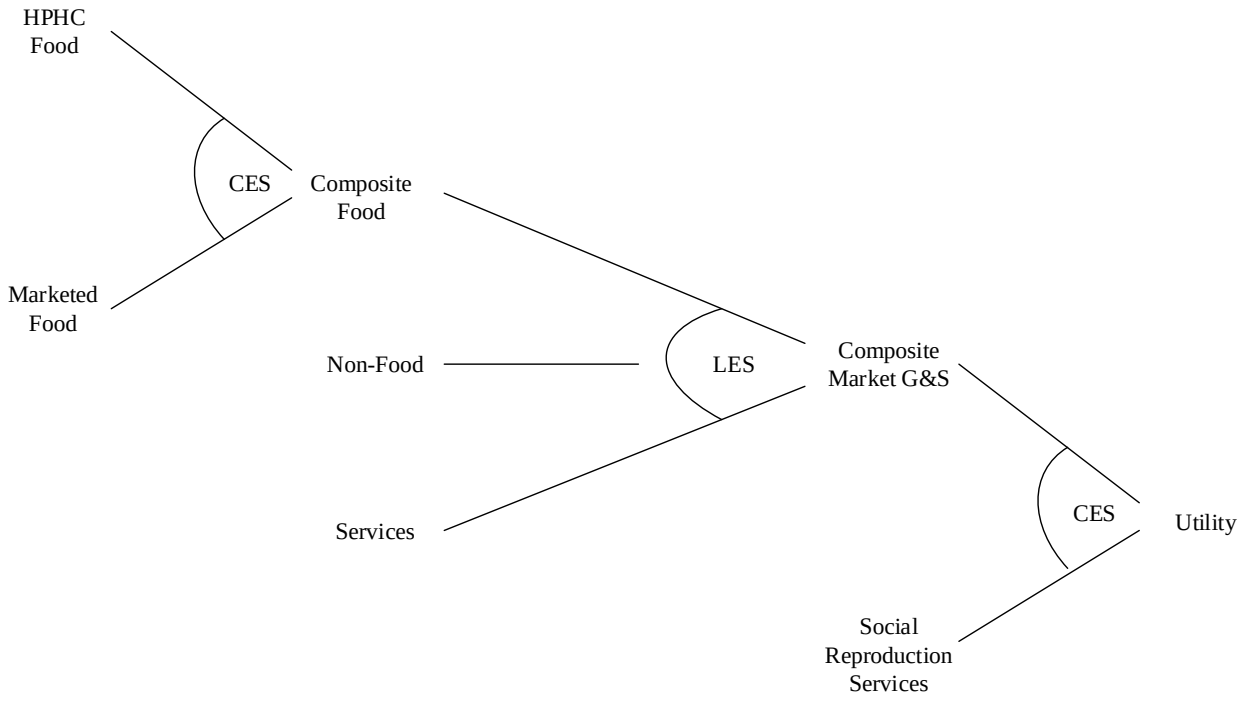
The modelling of the production of SRS can be the same as for other activities, except for the fact that labour services used for social reproduction 'trade' at shadow prices. Where the production of SRS becomes interesting is how labour services used within and without the SNA production boundary interact.

In the simplest implementation, following the practice in 'conventional' CGE models, labour of each type is mobile and can be allocated across all activities that use that type of labour in response to changes in wage rates. The constraint on labour mobility is then indirect. If the utility function is of the form illustrated in Figure 4.1 and social reproduction is an argument in the LES function, each RHG has a subsistence demand for SRS and substitution takes places according to the marginal budget shares. The lower the income elasticity of demand the lower the marginal budget shares and hence the lower the mobility response of the labour services of a RHG to changes in relative factor prices.

Another approach is to use a 3-level nested utility function. One option is a CES-LES-CES formulation, as illustrated in Figure 5.1. This form of nested utility function retains the advantages of the LES while achieving the flexibility of regular nested functions, for arguments over goods and services produced within the SNA production boundary, by retaining the minimum levels of

subsistence consumption. Adding the top-level CES does have the advantage of focusing attention on the arguments in the utility function that relate to the ease of substitution of labour services between activities within and without the SNA boundary. One approach is to calibrate the functions using estimates of the RHG specific elasticities of labour supply and elasticities of substitution for labour-leisure trade-off. (See Feuerbacher (2020) for an implementation).

Figure 5.1 Utility Functions



Alternatively, or in combination, the labour 'market' across the SNA boundary can be modelled directly by segmenting the labour 'market'. One approach to this involves the use of factor mobility functions (see McDonald and Thierfelder (2009), Flaig *et al*., (2013) and Aragie et al., (2016)). This approach involves explicitly modelling the factor ownership by institution, which is considered briefly below.

Table 5.1 Social Accounting Matrix including Accounts for Social Reproduction

Expenditures / **Incomes**	**1a** SRS Commod's	**1b** Market Commod's	**2** Margins	**3a** SRS Activities	**3b** Activities	**4a** Labour	**4b** Capital	**5a** Households	**5b** Enterprises	**5c** Govt	**6** Capital Account	**7** Rest of World	**8** Total
1a. SRS Commodities	0	0	0	0	0	0	0	SRS	0	0	0	0	SRS demand
1b. Market Commodities	0	0	Trade & Transport	0	Intermediate inputs			Marketed G&S		Govt demand	Investment	Exports (fob)	Market demand
2. Margins	0	Trade & Transport Costs	0	0	0	0	0	0	0	0	0	0	Total Margins
3a. SRS Activities	SR servicees	Marketed G&S	0	0	0	0	0	0	0	0	0	0	SRS
3b. Activities	0	Domestic Production	0	0									Production
4a. Labour	0		0	Imputed Wages	Wages							Incomes from RoW	GNP at factor cost
4b. Capital	0		0		Profits & Rent							Incomes from RoW	
5a. Households	0		0	0		Labour income	Profits	Intra-household		Transfers		Transfers from RoW	Household income
5b. Enterprises	0		0	0			Retained profits		Transfers	Transfers		Transfers from RoW	Enterprise income
5c. Government	0	Taxes on G&S	0	0	Production taxes	National insurance	Profits; Taxes on profits	Direct taxes	Direct taxes			Transfers from RoW	Govt income
6. Capital Account	0		0	0			Depreciation	Household saving	Enterprise saving	Government saving		Trade Balance	Total savings
7. Rest of World	0	Imports (cif)	0	0		Factor payments			Current transfers				Imports
8. Total	SRS supply	Market Supply	Total Margins	SRS Production	Production	Factor outlay		Households expenditure	Enterprise expenditure	Govt expenditure	Total investment	Foreign earnings	

6. Household Production outside the SNA Production Boundary: Leisure

One of the services that households may 'produce' is leisure, although the boundaries between leisure and social reproduction may be opaque, e.g., is do-it-yourself a leisure or social reproduction activity. Households cannot enjoy leisure without devoting time to leisure activities, in which case the household cannot be using that time for in the labour market or for social reproduction. It is therefore arguable that leisure can be treated as an activity within a *general* production boundary. This means that leisure can be treated as a service akin to social reproduction, i.e., a service produced outside the SNA boundary that requires households to devote some of their labour resources to its production can only be consumed by a household specific activity that produces the leisure services.

Again, there are reasons to question the assertion that "own-account production of services within households is a self-contained activity with limited repercussions on the rest of the economy", in both developing and more developed countries. Indeed 'standard' economic theory argues that leisure is a desired consumption good and that the consumption of leisure is foregone so as to purchase other goods and services by selling a household's time (labour). Changes in household decisions about the production of leisure services is a reason to include leisure in whole economy models because it is a determinant of the amount of labour services households may offer to activities within the SNA boundary, i.e., the size of the labour force.

The argument made in the SNA that there are 'typically no suitable market prices' is also relevant for leisure. The approach consider here is based on opportunity costs and requires time use survey data.

5.1 Valuing Leisure

Only the household can produce own leisure, which is essentially an argument that a 'decision to produce leisure requires a simultaneous decision to consume that service", i.e., the same as with HPHC and SRS. It is therefore reasonable to suggest that the same approach to valuation of labour time can be taken for both leisure and SRS.

As with SRS there are essentially two options: opportunity cost and market price. But since there is no market for an individual's leisure time, the opportunity cost option may be appropriate. It is also simpler in terms of data requirements and has the added advantage of allowing for movements of labour services from outside to inside the SNA boundary and vice versa. Again, a critical decision is how the movement of labour across the SNA boundary is modelled is critical.

5.2 Integrating Leisure into a Social Accounting Matrix

As with adding SRS to a SAM the key consideration is the maintenance of the Law of One Price (LOOP). This can be achieved by adopting the same approach as for SRS: add a household specific leisure producing activity for each RHG. Then the prices of each leisure service are determined by its own unique cost/production function; each of which uses different mixes of labour. This ensures that LOOP is maintained. The illustration for SRS in Table 5.1 indicates how leisure can be included when 'leisure' is substituted for SRS.

5.3 Modelling Leisure

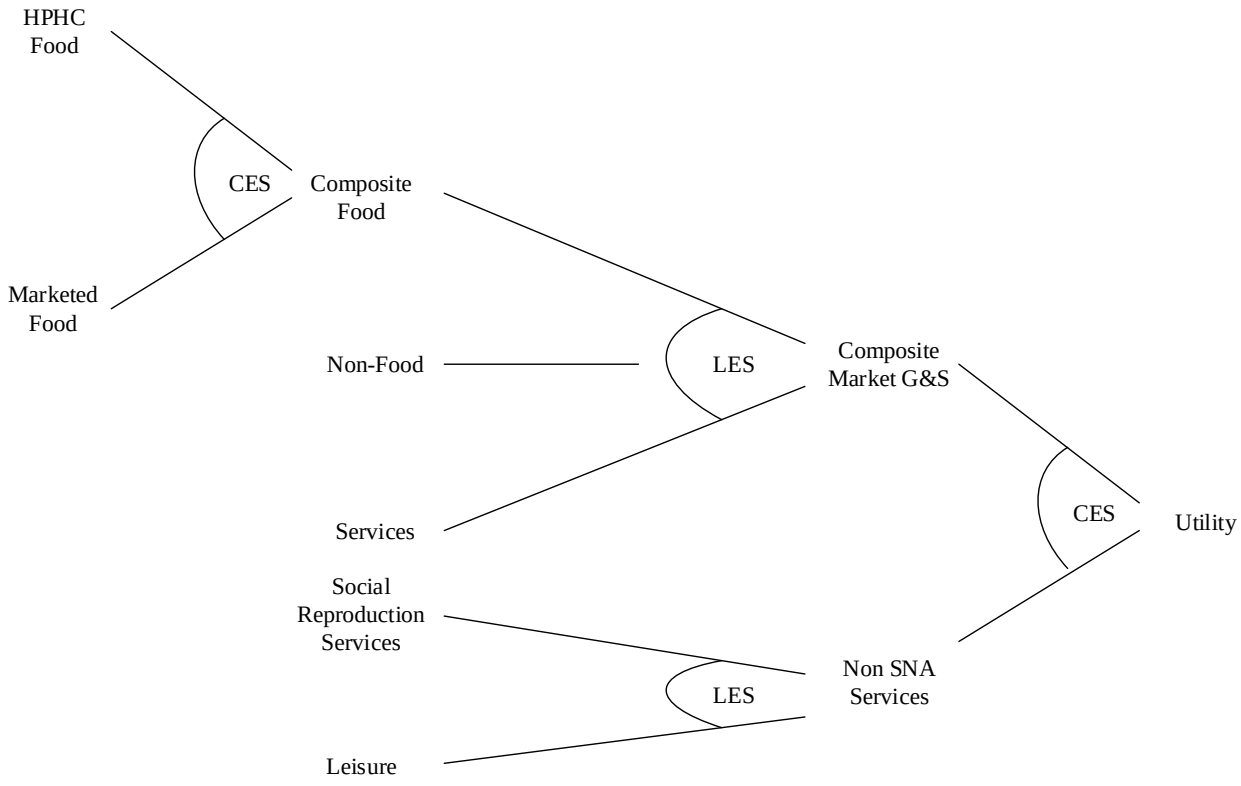
The modelling of the production of leisure can be the same as for other activities, except for the fact that labour services used for leisure 'trade' at shadow prices. As with SRS the interesting issue is how labour services used within and without the SNA production boundary interact.

Again, the simplest approach is to treat leisure as just another activity; but perfect mobility may be regarded as a strong presumption. This can be relaxed by segmenting the labour 'market' across the SNA boundary using factor mobility functions (see McDonald and Thierfelder (2009), Flaig *et al*., (2013) and Aragie et al., (2016)). This approach involves explicitly modelling the factor ownership by institution, which is considered briefly below.

It is also practical to extend the utility functions to include leisure. For a simple 2-level utility function (Figure 4.1) leisure could be another argument in the LES component of the function. For a 3-level utility function (Figure 5.1), a simple approach would be to include leisure with SRS and marketed G&S in the top-level CES function. A more elaborate approach would be to extend a 3-level function so that SRS and leisure were combined using an LES function, thereby ensuring minimum consumption levels, before entering the top-level CES function. Such a utility function is illustrated in Figure 6.1.[26]

[26] Feuerbacher (2020) presents one approach to calibrating the functions using estimates of the RHG specific elasticities of labour supply and elasticities of substitution for labour-leisure trade-off.

Figure 6.1 Utility Function



7. Household Production and Factor Allocations

While modelling of the consumption side and required price definition terms is simple the production side is more complex because of the need to address potentially important factor market considerations. HPHC and the production of leisure and SRS requires the use of factors. If a RHG's factors are used in production its HPHC, leisure and SRS activities they cannot be used elsewhere. Thus, it is necessary to define how the RHGs make decisions over the allocation of resources between HPHC, leisure and SRS activities and the factor markets. While HPHC involves the use of labour, land and capital, leisure and SRS production only uses labour, so labour is the focus of attention here with the discussion focusing on peasant households in developing economies, although many of the arguments could be extended to developed economies.

7.1 Labour Mobility Functions

Labour used in semi subsistence agriculture is usually dominated by family labour and it is difficult to define the skill classes for such labour. Moreover, such family labour does not fit tidily within the types of skills classification scheme used to define labour categories for other types of activities and there is a supply constraint on labour provided by each household. This can present problems for the modelling of labour markets; some examples illustrate the problems.

First, assume that there are two types of labour - skilled and unskilled – and that these two types of labour are employed, albeit in different ratios, by all activities and, for simplicity, that HPHC activities only use family labour. It is commonly assumed that the skill types are segmented rigidly but labour of each type is mobile across activities.[27] If such a classification is adopted then family labour needs to be segmented in the same way but it will typically be assumed that it is freely mobile across all activities, including HPHC, leisure and SRS; this has three difficulties

a) labour can freely relocate from and/or within the rural sectors, including between HPHC activities, in different geographic areas;
b) labour freely can relocate from rural to urban activities; and

[27] CGE models that follow in the tradition of Dervis *et al*, (1984) include activity specific parameters for factor productivity. These allow for productivity (marginal value product) differences that are revealed when there are data on the quantities of labour employed as well as data on transaction values; these productivity differences can be problematic if labour reallocations result in large changes in labour productivity. Some models use constant elasticity of transformation (CET) functions to adjust the quantity units of factors as the shift between activities; this is appealing since it implies that changes in factors productivity are not solely attributable to the activity that employs them but also depend partly on factor.

c) it does not address the real factor supply constraint at the household level by allowing an increase in HPHC labour use that exceeds the total supply from the household.[28]

Assume now that labour types are segmented between rural and urban skilled and unskilled, which gives four different skills classes. This configuration seemingly overcomes the difficulty presented by the apparently anomalous feature of seamless transfers of labour from rural to urban locations, but still leaves the other two difficulties while introducing an effective exclusion of rural-urban labour migration (Appendix D considers the issue of migration).

The available supply of household labour for SNA and non-SNA production can be relatively easily resolved by extending the market clearing conditions for factor markets. If factor supplies are defined at the household level, i.e., each household's factor endowments are recorded, then market clearing can also be defined at the household level by summing factor demands across SNA and non-SNA activities. Thus, the HPHC and non-SNA activities face an upper bound constraint on the use of own household factors; it cannot use other factors for HPHC or non-SNA production because it needs to sell output to pay factors. The inclusion of non-SNA activities effectively rules out unemployment (See McDonald, 2018).[29]

The other difficulties can be sub-divided into two; locational issues – rural vv urban, one region vv another region, etc., - and skill issues. At the heart of both these difficulties is a tendency to segment labour categories rigidly and thereby not allow labour for transitions between categories. But, for instance, if returns to employed labour increase sufficiently it would be reasonable to expect some family labour to transition from HPHC into the formal and/or informal labour market, essentially a change in skill classification, and for some labour to relocate, e.g., migrate from the rural to urban locations. One approach to this was developed by McDonald and Thierfelder (2009) and extended by Flaig *et al*. (2013) and by Aragie *et al*., (2016).

Each labour category has a bilateral labour supply function with every other labour category such that labour can transition between categories in response to changes in relative wage rates, where the elasticities of the supply functions control the degree of response to changes in relative

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28 There are of course reasons why HPHC activities might employ nonfamily labour, but these require that household activities sell products in order to pay wages. Also, from a practical perspective it is difficult to model such decisions if no non-family labour is employed in the base case.

29 There are issues with how to value the 'shadow price' of labour in non-SNA activities if an economy is characterised by UNDERemployment.

wage rates.[30] The supply elasticities provide control over the responses; it would be expected that the less closely related are the skill categories the lower would be the supply elasticities - if it is zero a transition is ruled out.

This approach does however generate a complication through the functional distribution of income aspects of the model. Typically, it is assumed that factor incomes are distributed to households in fixed proportions, which requires two important assumptions (a) all factors are fully employed and (b) that each household's endowments of each factor type are fixed. Clearly the former is breached in any model that includes unemployment and/or upward sloping labour supply curves, both of which this model allows, while the latter is breached in any model that allows labour to transition between types. These problems are circumvented in the same way; it is assumed that any changes in the supply of each type of labour is drawn from every RHG in the same proportions as the RHGs supplied the labour type in the base case, e.g., in the case of a surplus unskilled labour assumption the model will require that each RHG equiportionately contributes the extra unskilled labour – whether they are rich or poor RHGs!!![31]

A solution to both these problems is to replace the matrix of parameters that controls the functional distribution of income by a matrix of variables that tracks changes in the supply of each labour type made by each household.

7.2 Factor Supplies by Institutions

Including factor supplies owned by institution requires an additional satellite account that records the quantities of each factor type owned by domestic and non-domestic institutions, i.e., RHGs, (incorporated business) enterprises, the government (where the government is most easily accommodated by creating an enterprise account for the government) and the rest of the world.[32] Then the model code is adpated to replace the matrix of parameters that control the functional distribution of income by factor supply variables.

The shares of factor supplies owned by each institution are defined as

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30 The formulation in the model code uses a series of labour 'pools'. Each labour type is allocated to a 'pool' and the labour that wishes to leave a category, i.e., a category whose relative wage rate has fallen, transitions into the 'pool' from which categories seeking to expand attract labour. In the extreme cases there is a single 'pool' for all labour or each pool only has two members, i.e., there is a bilateral relationship.

31 This allows the presumption that the functional distribution of income is controlled by a matrix of parameters, i.e., the functional distribution of income is constant.

32 It is possible to derive an implicit matrix of factor supplies (FACTINS matrix) by institution from the transactions and factor use data; this option is included in the STAGE models and implemented if there is no FACTINS matrix in the database.

$$FSISH_{insw,f} = FSI_{insw,f} \Big/ \sum_{insw} FSI_{insw,f} \qquad (7.1)$$

where $FSI_{insw,f}$ is the supply of factor f by institution *insw* and $FSISH_{insw,f}$ is the share of each factor f supplied by each by institution *insw*.[33] Then the values of distributed factor incomes, *INSVA*, are

$$INSVA_{insw,f} = FSISH_{insw,f} * YFDISP_f \qquad (7.2)$$

where $YFDISP_f$ is the value of factor incomes available for distribution to owners.[34]

Then the labour market clearing, in quantities, equations needs to be defined as

$$\sum_{insw} FSI_{insw,f} = \sum_{alein} FD_{f,a} \qquad \forall a \text{ and } f\,(ff) \qquad (7.3)$$

$FD_{f,a}$ is the factor, f, demanded by activity, a. This endogenizes the distribution of income (Aragie *et al*., 2016).

With this formulation each RHG can supply its labour to its own agricultural and social reproduction/leisure activities and the labour market, and cannot use labour services from another RHG in the production of SRS and/or leisure provided the factor mobility functions are set to close off transitions of labour between RHGs for the production of SRS and/or leisure.

3.3.2 Other Factors

Other factors used by HPHC[35] can be more straightforward. The direct association of some activities with specific households means that it is reasonable to treat land as fixed, or at least quasi fixed, factor given a geographic specific relationship between place of residence and place of activity. This makes a strong case for using a Supply and Use structure for the database since it allows activities to be defined institutionally while commodities are defined in terms that are sensible from the perspective of utility functions.

Capital is clearly more mobile, but given the relatively small quantities and specific nature of capital items used in small scale and semi subsistence agriculture it is reasonable to suggest that capital should at least be segmented between agricultural and non-agricultural activities and that, arguably, little or no mobility is likely to be realised because such mobility contains an implicit presumption that household exit HPHC.

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33 The set *insw* is defined as domestic non-government institutions plus the rest of the world.

34 Equations 7.1 and 7.2 could be collapsed into one equation in the model, but it is useful to track the shares of *FSI*; this could be done in a results file, but modern computer programmes can easily handle the extra variables.

35 By presumption, SRS and leisure do not se other factors in their production.

8. Closing Comments

This is a fluid topic and one that interacts quite closely with the modelling of labour markets. At some point it may be possible to draw meaningful long terms conclusions.

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Appendices

Appendix A IFPRI approach of modelling home consumption

HPHC have not been properly accounted in most databases and models used for economic analysts. The only previous attempt to partially incorporate home consumption is one by IFPRI. However, the IFPRI standard model and SAMs have not provided an appropriate solution to the problem. The SAMs have not considered home consumed 'commodities' as commodities, do not explicitly incorporate households as producing units, and link the commodities produced at home with the households who involve in the production. Also, the model treats consumption decisions of semi-subsistence households following a single-stage consumption nesting while consumption under a case of HPHC is better represented following a multi-stage demand structure where the different rates of substitutability between different commodity groups are accounted for. These data generation and modelling approaches used by IFPRI are discussed in detail below, while the approaches followed by STAGE_DEV are elaborated subsequently.

A1 HPHC in the IFPRI standard SAM

In some of IFPRI SAMs which incorporate home consumption, home consumption is recorded by activity and households and not by commodities, activities and households. In these SAMs, home consumption is recorded at activity levels and treated in the SAMs as household payments directly to activities. The SAMs further assume that activities by non-household enterprises are identical with activities by farm households since there is no explicit treatment of households as producing units in the SAMs even if there is an implicit understanding of the role of households as activities. 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.

A2 HPHC in IFPRI standard model

The IFPRI standard model represents household consumption following a 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 follows

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

while household consumption spending on home consumption follows

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

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 household 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 consumption spending on marketed commodity c for household h, and

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

The consumption expenditures of households (EH_h) are exhausted on market consumption $(QH_{c,h})$ valued at market prices (PQ_c) and home consumption $(QHA_{a,c,h})$ valued at basic prices $(PXAC_{a,c})$. However, the model effectively imposes some subsistence levels of consumption for each of a market $(\gamma^m_{c,h})$ and HPHC $(\gamma^h_{a,c,h})$ variants of a commodity (e.g., Wheat), while it is more convincing to assume that households will rather be concerned with satisfying some minimum level of 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.

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 the household both supplies and uses factors, the factor market should reflect the decisions a peasant household is exposed to 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.

Specifically, household consumption spending on marketed commodities follows

$$PQ_c * QH_{c,h} = PQ_c * \gamma^m_{c,h} + \beta^m_{c,h}\left(EH_h - \sum_{c'} PQ_{c'} * \gamma^m_{c,h} - \sum_a PA_a * \gamma^h_{a,h}\right)$$

while household consumption spending on home consumption follows

$$PA_a * QHA_{a,h} = PA_a * \gamma^h_{a,h} + \beta^h_{a,h}\left(EH_h - \sum_{c'} PQ_{c'}\gamma^m_{c',h} - \sum_{a'} PA_{a'} * \gamma^h_{a',h}\right)$$

where

PQ_c = purchasers price for commodity c,
PA_a = activity price (gross revenue per activity unit),
$QHA_{a,h}$ = quantity of household home consumption 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,
$\gamma^h_{a,h}$ = subsistence consumption from activity a for household h,
$\beta^m_{c,h}$ = marginal share of consumption spending on marketed commodity c for household h, and
$\beta^h_{a,h}$ = marginal share of consumption spending on home consumption from activity a for household h.

The consumption expenditures of households (EH_h) are exhausted on market consumption ($QH_{c,h}$) valued at market prices (PQ_c) and home consumption ($QHA_{a,h}$) valued at activity prices (PA_a). However, the model effectively imposes some subsistence levels of consumption for each of a market ($\gamma^m_{c,h}$) and HPHC ($\gamma^h_{a,h}$) variants of a commodity (e.g., Wheat), while it is more

convincing to assume that households will rather be concerned with satisfying some minimum level of 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. In addition, the approach followed by the IFPRI model (i.e., valuing own consumption of a commodity by PA_a) blurs the actual differences in prices of different home consumed commodities produced by a multiproduct activity. It is normal that most activities in rural areas are multiproduct.

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 the household both supplies and uses factors, the factor market should reflect the decisions a peasant household is exposed to 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.

Appendix B Modelling Labour Supply and Factor Market Segmentation

Fully 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 changes are key to understand changes in income distribution. Evidences show that socio-economic impacts of shocks depend on the structure of factor markets and the speed of their reallocation across alternative uses, which to some extent depends on the degree of factor mobility, which is defined as the ease to which factors can move between uses in response to changes in returns. Some factors are more mobile than others: while labour is more mobile, land and natural resources are the most sluggish factors. Due to its sectoral specificity and scarcity in most cases, the rate of mobility of capital lies in between land and labour. For mobile factors, *citrus paribus*, there can be an equalisation of factor returns across sectors, while for sluggish factors, sectoral returns to seemingly identical factors may differ. The mobility of factors between sectors vary across economies depending on the level of rigidity and institutional interventions.

In many cases, the factor market is considered to be unified, operate smoothly, and factors are perfectly mobile across uses. This implies that factors are homogenous and that there are not restrictions and costs involved with the transition of factors between sectors/uses. However, the factor market, especially that of the labour market, differs from other markets such as commodity markets due to its structural complexity and specificity (Jakstiene, 2010), where, unlike commodity markets, the role of institutions (such as government policies), socio-economic-political factors (such as working conditions) are more crucial in characterising markets. Hence, the assumption of unified labour markets leaves the empirical observations associated with (i) persistent rural (agricultural) - urban (non-agricultural) wage differentials, (ii) farm vs off-farm wage disparity, and (iii) continuing urban-rural migration caused not due to skill differentials, but rather due to the nature of labour markets, unexplained. Traditionally, differences in skills and investments in skill developments are considered as the sole causes of differences in wage rates. That is, it has long been assumed that a labour is paid higher wages solely because it has a better skill level. Nevertheless, in reality, due to institutional and social influences, similar skills could earn different wage rates. This approach of looking at the labour market also leaves the empirical observation of the spatial differences in unemployment rates unexplained.

It is this failure of the classical approach to labour markets that lead to the emergence and use of 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 mainly in the case of developing countries where factor market segmentation is facilitated by several confounding factors. In most of these countries, there are deep-rooted non-economic barriers to 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-sectoral 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 high 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 are restricted to the extent that the wage differential between the segments are not fully illuminated. Segmentation also implies that the factor market clearing condition is defined for each segment; hence, there are *n* market clearing conditions for *n* segments with separate employment and wage setting mechanism. 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 unemployed factors in situations of unemployment.

While it has generally been recognised that labour markets are organised in segments, there is no a general consensus on how to define and organise the segments. The number of segments adapted is also a matter of empirical choice that is open to each respective context. Modellers can follow any of the three approaches for incorporating segmented factor markets in economic models: (i) by disaggregating each factor by its characteristics (gender, race, migration status) and by geography (rural vs urban); (ii) by the sector of employment (agriculture vs non-agriclture), and (iii) by some combination of the two. The sector of employment is related to 'industrial characteristics' used in most labour market literature; it involves the feature of the employing sector ('core' vs 'periphery' sectors) and the nature of the product market for the industry output. It also focuses on the nature of the demand for labour services since labour demand is a derived demand from the sectoral output.

There are two major approaches used to trace factor mobility in applied economic models: a CET and constant elasticity of factor mobility of factors functions with the assumption that factor mobility is imperfect. The rate of transformation or rate of mobility in response to changes in factor returns depends on the elasticity of transformation for models with CET and elasticity of mobility for models using constant elasticity of factor mobility function; higher elasticity values allow factors to move more smoothly in response to changes in relative wage rates while zero values imply complete rigidity.

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 transit from one skill type to the other or across employment types, the fixed share assumption becomes no more feasible and any transition will have important implications on the functional distribution of income. As suggested by McDonald (2010), 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.

Also, a CET function implies that the reallocation of labour in response to changes follows some efficiency units (Flaig *et al.*, 2012), which suggests that the equilibrium condition in the labour market should be defied 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. A useful approach in this regard is the one used by McDonald and Theirfielder (2009) where physical unit of labour can be allowed to transit across regions and skill types. The authors applied a constant elasticity labour supply function, a formulation that was later used by Polaski *et al.* (2009) and Flaig *et al.* (2012) to examine gains from trade in Brazil and labour market segmentation between Palestine and Israel, respectively.

In the constant elasticity of labour mobility function, mobility depends on relative wages, i.e., the relative magnitude of the wage the labour earns in his/her current employment and the average wage he/she could earn in another employment. It may be assumed that workers are indifferent between employment types and any shock in the economy that affects this relative wage can cause labour to migrate to where wage rate is higher. 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 regions or employment types.

Appendix C Incorporating labour/leisure trade-off

Many of the models currently employed for economic analysis and labour supply focuses on the portion of a household/individual time employed on work, treating the time available as fixed- which lead to the effective measurement of labour supply in head counts. On the other hand, in the economic theory, the supply of labour is understood to depend on the trade-off between utility from leisure and consumption which is a function of wage income from labour time. This requires considering the household/individual'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 empirical observation that labour supply depends on the trade-off between leisure and consumption/work, accounting 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.

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 than only on commodities, which is the custom in most economy-wide models. This is because, now, in the database, leisure is treated as a 'commodity' produced by the household at home using leisure time as input, and the total amount of leisure produced is entirely consumed within the household itself. The household's allocation of full consumption between leisure and demand for goods and services is an important factor that influences 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 significantly differ 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 this empirical observation.

Introduction of labour/leisure trade-off in an economy-wide data and model requires information contained in household time use surveys, which are growingly made available for many 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 total 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.

Incorporating the labour/leisure trade-off increases the policy relevance of the resultant data and model by (i) representing the actual labour supply and consumption decision rules of households, and (ii) allowing for a wide range of policy options to experiment. Labour and commodity tax policy, and environmental analyses are few 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 saying it otherwise, this policy can make consumption of commodities more expensive than 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 growing challenges.

Appendix D Incorporating labour migration function

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 until currently. 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 of different scales so far. 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 putting the prospects of migration a reality as long as the changes will put economies in a transitional level of disequilibrium and alter sectoral and spatial income distribution.

Modelling this old practice of mankind in response to policy and external shocks is a tricky 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, it is assumed that individuals/households decide to migrate from places of origin to destination if their relative incomes/wages change; existing differences in incomes are assumed to reflect non-accounted factors. Also, while most other attempts consider migration as an individual's decision, migration is more of a household decision where members of the household make collective decision with the objective of maximising/optimising the household's utility (objective function).

Hence, unlike the classical approach of relying on individuals 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, but 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 above), applied economic models tend to use CET and constant elasticity of labour mobility functions geographically, with the advantages and disadvantages of these two major approaches as

discussed above. A more appealing way of tracing the physical movement of people is using constant elasticity of labour mobility functions adapted in McDonald and Thierfelder (2009) and used by Polaski *et al.* (2009) and Flaig *et al.* (2012) for studying labour migration. Following the justification on treating migration as a household's decision vis-à-vis an individual's decision, the labour mobility function has to be modified to account for household migration, where the decision is based on average incomes here rather than wage rates as in Polaski *et al.* (2009) and Flaig *et al.* (2012).

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 household groups (RHG) level is needed to incorporate the alterations in factor distribution by each household involved in the migration either as origin, destination or both.