Modelling Households as Joint Producers and Consumers

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Abstract

National accounts are designed so that home production for home consumption is correctly priced at basic prices when valuing national income. In least developed economies the differences between basic and purchaser prices can represent an uplift of 40 or more percent, which means that there are very large differences in the incentives faced by consumers and producers and between the prices producers are paid for outputs and the prices they must pay for consumption goods. Unfortunately these differences are rarely recorded or modelled in many CGE models, which means that the policy conclusions may be distorted. In particular these large marketing margins and commodity tax differences often mean that the benefits of trade and/or policy reforms are unlikely to be fully transmitted to semi subsistence farmers. The potential implications of modelling home production for home consumption are illustrated using (semi stylised) data for Mozambique.

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1. Introduction

For many developing countries, principally those where semi subsistence agriculture remains an important source of livelihoods, home production for home consumption (HPHC) is a very important form of 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. 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 the vast majority of 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; 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)\(^1\), but generally ignored in economic models and in the strong assumptions made about the transmission of policy changes into changes in incentives. Moreover 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.

\(^1\) This can viewed as a case of commodities differentiated by ‘place of production’.

\(^2\) 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.
The key 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; \textit{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.

The rest of the paper is organised as follows. The next section, two, explores how HPHC is and should be recorded in national accounts, while section 3 considers the extension to standard CGE models required to comprehensively include home production for home consumption. The data and model are described in section 4, which are then used in the simulations reported in section 5. The paper finishes with a series of concluding comments.

2. Household Production and Consumption in National Accounts

In essence the principles underpinning the concept of HPHC are simple. Households that engage in productive activities employ their own resources (factors of production) to produce commodities that they either sell into the market system or retain for consumption within their own household. It is reasonable to hypothesise that the amounts they choose to sell depend, \textit{inter alia}, upon commodity prices and market opportunities. Similarly the decisions made by households about the deployment of their resources depend upon factor prices and the employment opportunities; if factors are used for HPHC they cannot be sold elsewhere. Thus models that include HPHC should recognise that such households must make simultaneous and interdependent choices over consumption and production, and that household production is conducted by household specific activities that are typically unincorporated business enterprises. In fact the SNA recognises these relationships in the guidelines for compiling national accounts.

2.1 Household Production and the SNA Production Boundary

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. The application of the production boundary with respect to distribution of the products by activities through formal market networks is straightforward, whether the activities are formal or informal. 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.” (UN, 2008, 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

- The production of agricultural goods by household enterprises for own final consumption;
- The production of other goods for own final use by households: the construction of dwellings, the production of foodstuffs and clothing, etc.;
- The production of housing services for own final consumption by owner occupiers;
- 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.” (UN, 2008, paragraph 1.41, p 6).

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3 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.

4 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.
Consequently there is a need for national accounts to specify boundaries that define 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 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.” (UN, 2008, paragraph 1.42, pp 6-7)

The SNA recognises several distinctive features about household production that is produced within the production boundary and consumed at home (HPHC). In particular 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” (UN, 2008, paragraph 1.41, p 6). Furthermore while conventional (marketed) household consumption is valued at purchaser prices (UN, 2008, 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”, UN, 2008, 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.

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 HPHC decreases as a consequence, 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 UN, 2008, 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.” (Un, 2008, paragraph 2.164, p 37).

2.2 Valuing Household Production and Consumption

The distinction between basic, producer and purchaser prices lies 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.

2.2.1 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\(^5\), 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 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 \textit{de facto} masks trade and transport costs.

2.2.2 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

\(^{5}\) “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).
exist for excise, fuel and other generalised commodity taxes. However increasingly commodity taxes are levied in the form of value added taxes (VAT); 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.

2.3 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, while making transparent how HPHC is valued. Table 2.1 presents one way in which such a SAM can be organised; sub matrices with descriptions are those for which transactions are typically non zero, 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 sub divisions 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 is 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 2.2.

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6 A common misconception is that VAT is a tax on value added by factors whereas in factor VAT is a tax on commodities.
7 By definition 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 that some other data and its inclusion in an aggregate masks its presence.
8 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.
Table 2.1  
Social Accounting Matrix including Accounts for HPHC

<table>
<thead>
<tr>
<th>Expenditures</th>
<th>Incomes</th>
<th>1a</th>
<th>1b</th>
<th>2</th>
<th>3a</th>
<th>3b</th>
<th>4a</th>
<th>4b</th>
<th>5a</th>
<th>5b</th>
<th>5c</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>HPHC</td>
<td>Market</td>
<td>Commodities</td>
<td>Commodities</td>
<td>Margins</td>
<td>HPHC</td>
<td>Activities</td>
<td>Activities</td>
<td>Labour</td>
<td>Capital</td>
<td>HPHC</td>
<td>consumption</td>
<td>0</td>
<td>0</td>
<td>Total</td>
</tr>
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<td>Commodities</td>
<td></td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>HPHC</td>
<td>intermediate</td>
<td>inputs</td>
<td>Intermediate</td>
<td>inputs</td>
<td>0</td>
<td>0</td>
<td>HPHC</td>
<td>consumption</td>
<td>0</td>
</tr>
<tr>
<td>Market</td>
<td>Commodities</td>
<td>0</td>
<td>0</td>
<td>Trade &amp; Transport Costs</td>
<td>HPHC</td>
<td>intermediate</td>
<td>inputs</td>
<td>Intermediate</td>
<td>inputs</td>
<td>0</td>
<td>0</td>
<td>HPHC</td>
<td>consumption</td>
<td>0</td>
</tr>
<tr>
<td>2. Margins</td>
<td></td>
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<td>0</td>
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<td>0</td>
<td>0</td>
<td>Total</td>
</tr>
<tr>
<td>3a. HPHC</td>
<td>Activities</td>
<td>Non marketed</td>
<td>Commodities</td>
<td>Marketed</td>
<td>Commodities</td>
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<td>0</td>
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<td>0</td>
<td>0</td>
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<td>0</td>
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<td>3b. Activities</td>
<td>Domestic</td>
<td>Production</td>
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<td>0</td>
<td>0</td>
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<td>0</td>
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<td>HPHC Production</td>
</tr>
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<td>4a. Labour</td>
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<td>Imputed Wages</td>
<td>Wages</td>
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<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
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</tr>
<tr>
<td>4b. Capital</td>
<td></td>
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<td>0</td>
<td>0</td>
<td>Imputed Profits</td>
<td>Profits &amp; Rent</td>
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<td>0</td>
<td>0</td>
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<td>5a.</td>
<td>Households</td>
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<td>Labour income</td>
<td>Distributed</td>
<td>profits</td>
<td>Transfers</td>
<td>Transfers</td>
<td>Transfers</td>
<td>Transfers</td>
<td>Transfers</td>
<td>Transfers</td>
<td>Transfers</td>
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<tr>
<td>Enterprises</td>
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<td>0</td>
<td>Labour income</td>
<td>Distributed</td>
<td>profits</td>
<td>Transfers</td>
<td>Transfers</td>
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<td>Transfers</td>
<td>Transfers</td>
<td>Transfers</td>
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<td></td>
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<td>0</td>
<td>0</td>
<td>National insurance</td>
<td>Distributed</td>
<td>profits</td>
<td>Taxes on profits</td>
<td>Transfers</td>
<td>Transfers</td>
<td>Transfers</td>
<td>Transfers</td>
<td>Transfers</td>
<td>Transfers</td>
</tr>
<tr>
<td>6. Capital Account</td>
<td></td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>Household saving</td>
<td>Enterprise saving</td>
<td>Government saving</td>
<td>Trade Balance</td>
<td>Total savings</td>
<td>Trade Balance</td>
<td>Total savings</td>
<td></td>
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<td>7. Rest of World</td>
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<td>Imports</td>
<td>(cif)</td>
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<td>0</td>
<td>Factor payments</td>
<td>Current transfers</td>
<td>RoW</td>
<td>Imports</td>
<td>Imports</td>
<td>Imports</td>
<td>Imports</td>
<td>Imports</td>
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<td>8. Total</td>
<td>Total HPHC supply</td>
<td>Total Market Supply</td>
<td>Total Margins</td>
<td>HPHC Production</td>
<td>Production</td>
<td>Factor outlay</td>
<td>Households expenditures</td>
<td>Enterprise expenditure expenditures</td>
<td>Government investment</td>
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## Table 2.2 Stylised Social Accounting Matrix with HPHC – Closed Economy

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<th>Commodities</th>
<th>H_food</th>
<th>M_food</th>
<th>M_nonF</th>
<th>Margins</th>
<th>A_HH1</th>
<th>A_HH2</th>
<th>A_food</th>
<th>A_nonF</th>
<th>Labour</th>
<th>Capital</th>
<th>Land</th>
<th>HH1</th>
<th>HH2</th>
<th>GST</th>
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<th>Totals</th>
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Modelling Households as Joint Producers and Consumers

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\(^9\); 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 a 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 they is evidence of systematic differences in factors there is an \textit{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.

\(^9\) Value at basic prices is 95 and at purchaser prices is 130, therefore the ‘markup’ 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.

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.

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 \textit{ad valorem} commodity tax rates. In such a model the purchaser price ($PQD$) for commodity $c$ would be defined as

\[ PQD_c = PQS_c * (1 + ts_c) \tag{1} \]

where $PQS$ is a ‘pseudo’ basic price and $ts$ the \textit{ad valorem} commodity tax rate – in this case a general sales tax. As discussed above however the purchaser price should include an allowance for trade and transport margins in addition to commodity taxes. Defining $PQS$ as a ‘true’ basic price produces the following definition for purchaser prices.

\[ \text{The approach followed in the Australian ‘school’ and by GTAP is arguably better since it retains the basic price value for transactions and then defines agent specific tax rates for each commodity.} \]
Modelling Households as Joint Producers and Consumers

\[ PQD_c = \left( PQS_c \times (1 + mm_c) \right) \times (1 + ts_c) \]  \hspace{1cm} (2)

where \( mm \) is the marketing margin rate.\(^{11}\)

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.\(^{12}\)

This approach requires that the entries in the row accounts for commodities are valued at purchaser prices while the supply of commodities – column accounts – are valued in basic prices.\(^{13}\) 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.

3.2 Nested Household Utility Functions

The 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 composites consumption commodities that enter into a second stage function that can take any standard format. Figure 3.1 illustrates such a nested utility function for a 4 commodity case where one is an HPHC (food) 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.

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11 This can easily be adapted to the presence of multiple types of margin, e.g., where trade and transport costs are separately identified.
12 The IFPRI standard model includes marketing margins but introduces them in different price definition equations.
13 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.
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 same logic as the Armington insight. Its major disadvantage compared to nested CES functions is that the effective substitution elasticities are not transparent.

3.3 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 requires the use of factors. If a RHG’s factors are used in production by its HPHC activity then clearly they cannot be used elsewhere. Thus it is necessary to define how the RHGs make decisions over the allocation of resources between HPHC activities and the factor markets.

3.3.1 Labour

Labour used for HPHC 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.\textsuperscript{14} 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; 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 (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.\textsuperscript{15}

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.

The available supply of household labour for HPHC 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 HPHC and other activities. Thus the HPHC activity faces an upper bound constraint on the use of own household factors; it cannot use other factors for HPHC production because it needs to sell output to pay factors. Unemployment and/or underemployment can be addressed by assuming an infinitely elastic supply of the household’s labour, with or without some upper bound on the supply of labour and with or without some element of an upward sloping labour supply curve.

The other difficulties can be subdivided into two; locational issues – rural vv urban, one region vv another regions, etc., - and skill issues. At the heart of both these difficulties is a tendency to segment labour categories rigidly and thereby not allow labour to transitions between categories. But, for instance, if returns to employed labour increase sufficiently it would be

\textsuperscript{14} 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.

\textsuperscript{15} There are of course reasons why HPHC activities might employ non family 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.
Modelling Households as Joint Producers and Consumers

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 is developed by McDonald and Thierfelder (2009). 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 wage rates. 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 they are zero the 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. The 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.

3.3.2 Other Factors

Other factors used by HPHC 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 the 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 and implicit presumption that household exit HPHC.

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16 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.
4. Data and Model

4.1 Data: Mozambique Social Accounting Matrix

Adapting the databases – SAMs - to include HPHC is relatively straightforward: it requires the addition of production activities that are paired with each representative household group (RHG), adding commodity accounts for HPHC commodities and appropriately segmenting the factor accounts. For purposes of this study an existing SAM has been adapted, specifically a SAM for Mozambique that was developed in the 1990s (Arndt et al., 1998). The advantage of this SAM, as with several other produced by IFPRI as part of the MERRISA project, is that home consumption is separately identified in the database and is correctly valued, i.e., at basic prices, while consumption of marketed commodities is valued at purchaser prices. Thus the consumption data are appropriately recorded for current purposes. However the production accounts are not appropriate for current purposes since agricultural production activities are based on a commodity classification scheme while this model requires them to be classified according to an institutionally defined activity, namely a household production activity.

There are only two households in the original SAM – rural and urban. For the urban household HPHC only accounts for about 3% of the value of final consumption, while for the rural household HPHC accounts for a third of the value of final demand and some 40% of the value of final demand for food represents some 90% of total HPHC. For both household types the final demand for HPHC is reported and hence the supply is known by definition, and therefore the key concern is the identification of production technologies. This simplified because for the analyses of the implications of HPHC it is the rural household that is critical, while the urban household is secondary.

In the original SAM home consumption is recorded as demands for the outputs of activities by households, where the activities are defined on the basis of a commodity classification scheme. The demands by each RHG are recorded as columns in the activity:household sub matrix. For each HPHC commodity a row and column is added to the set of commodities and the final demands are relocated into the commodity:household sub matrix; these entries are also the values of each HPHC commodity supplied by the household specific activity in the sub matrix activity:commodity. This achieves accounting balances for the commodity accounts and preserves the household income and expenditure balance.

17 This project was led by Sherman Robinson and Hans Lofgren.
18 A commodity classification scheme could be used in combination with an institutional or geographic scheme. This would require detailed data on the production technologies and costs associated with each commodity for each institution or region.
Assuming for the moment that there is no HPHC by the urban household the agricultural activity accounts can be collapsed by row and/or column summation. This produces a single agricultural activity which is assumed to be the HPHC activity that is paired with the rural household. This agricultural activity is treated as multiproduct activity with a single production technology; this does have limitations with respect to price determination mechanisms when the output mix of a production activity can change in response to changes in relative output (basic) prices (see McDonald, 2008), but does have the benefit of recognising agricultural enterprises as genuinely multi product activities. It also has benefits when compiling the data; it is notoriously difficult to allocate inputs to specific outputs in agriculture, both because fixed costs are shared and because output decisions depend upon multiple considerations, e.g., risk spreading, crop rotation schemes, sequencing of operations, etc. Many of the limitations imposed by this assumption are greatly reduced when there are multiple HPHC activities that are defined by the agronomic characteristics of the regions within which they are located; input and output mixes typically vary according to the agronomic features of different regions and the amount of land available in each region is by definition, effectively, fixed.

For the urban household it was assumed that the HPHC activity only produced for home consumption and the input mix was derived in line with the input mix of agricultural in general. Both HPHC activities are limited by the lack of data on the use of HPHC commodities as intermediate inputs; effectively this amounts to an assumption that the supply of HPHC commodities is net of intermediate input use.

In this instance it was assumed that (nearly) all agricultural production was carryout by a single activity; thus the HPHC activity also produces all the output going to the market. In situations where ‘commercial’ agriculture exists alongside semi subsistence agriculture, e.g., (historically) Zimbabwe and where plantations agriculture is common, it would be more appropriate to separate out commercial agricultural activities.

The original database only identifies labour and capital as factors. For this study it is assumed that labour and capital are segmented between agricultural and non agricultural activities and the functional distribution of income matrix is adjusted in line with this simple distinction; just over half of the labour income to rural households comes from labour used in agriculture and about 15% of capital income comes from agriculture.\[19\]

\[19\] The original SAM records all capital income as going through the incorporated enterprise accounts. This is clearly wrong since agricultural activities are predominately unincorporated enterprises; thus a simple, and crude, adjustment was made to the accounts to adjust for this error. Since the data are indicative more that anything else this seems acceptable.
4.2 STAGE H Model

For this study the STAGE model is adapted to include HPHC and the labour markets are segmented so that households make choices over the allocation of labour between HPHC and conventional activities. The following substantive changes were made to the basic STAGE model

1. nested utility functions were introduced by combining CES and LES preferences (see Figure 3.1 above);
2. marketing margins were introduced to the model (this was taken from a variant of PROVIDE model, see McDonald, 2005);
3. CET functions were introduced so that agricultural output mixes were sensitive to changes in the basic prices of commodities (this was taken from a variant of PROVIDE model, see McDonald, 2005);
4. labour migration functions were introduced to allow labour to transition between HPHC activities and market activities and unemployment was rendered endogenous by using an MCP formulation (these were taken from McDonald and Thierfelder, 2009);
5. the functional distribution of income was made variable depending upon changes in total factor supply and changes in labour category (this was adapted from a variant of PROVIDE model, see McDonald, 2005); and
6. the factor market clearing conditions were extended to include household specific factor supply constraints.

A detailed technical document is in preparation.

5. Analysis

The simulations conducted for this study are a series of stylised experiments designed to highlight how the changes in behavioural functions are likely to impact of policy advice in an economy that has the properties represented by the stylised SAM. These results, and the associated analyses, should not be interpreted as representing policy advice that is relevant to Mozambique; not only are the data dated they have also been subjected to a number of (largely) ad hoc adjustments.

5.1 Simulations, Market Clearing and Macroeconomic Closure

The simulations used were simple:
a) elimination of all import duties on agricultural products;
b) reductions in marketing margin rates by 25% (other rates were explored);
c) elimination of all import duties on agricultural products and 25% reductions in marketing margin rates;
d) elimination of import duties on processed food products;
e) elimination of import duties on agricultural and processed food products; and
f) elimination of import duties on agricultural and processed food products and 25% reductions in marketing margin rates.

The discussion focuses on the first three simulations.

The macroeconomic closures were standard for this class of model and a country with these characteristics:

a) external balance was fixed and the exchange was made flexible to clear the trade account;
b) investment was assumed to fixed with savings rates by household flexible to clear the capital account;
c) government savings and savings/borrowings were fixed and the account was cleared by changes in the household and enterprise income tax rates;
d) technologies were fixed; and
e) the numéraire was the CPI.

The market clearing conditions assumed full employment of all types of labour. This ensured that relative wage rates changed and therefore that the migration/transition functions were implemented.\textsuperscript{20}

\textsuperscript{20} Further developments are being undertaken to introduce upward sloping labour supply functions so as to improve the representation of the operation of the labour markets.
5.2 Results

6. Closing Comments

Specifically it is demonstrated that the responses to liberalisation of trade in agricultural commodities are substantially less than in models which do not incorporate HPHC and the associated labour market segmentation; these (preliminary) results provide an economically rational explanation for the muted responses that are often reported.

References


