Structural adjustment and the peasantry in Morocco: A computable household model

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Summary

A computable nonseparable household (CNH) model approach is used as a tool to analyse, at the microlevel, the impacts of changes in macro and sectoral policies. Nonseparability originates in market failures for some products and factors and in a binding credit constraint. While the results are only suggestive until this type of model is consistently estimated, they indicate the tremendous heterogeneity of impacts across household types. For Morocco, they show that, while higher cereals prices displace resources from livestock to grains, rising prices of animal feeds induce a shift in how livestock is produced toward the use of factors with market failures, in this case child labour for herding and grazing in the commons.

Keywords: households, Morocco, adjustment, poverty.

1. Structural adjustment and Moroccan agriculture

Moroccan agriculture has been deeply affected in the last decade by implementation of a set of macroeconomic and sectoral policy reforms. These reforms were triggered by the foreign sector crises that followed the end of the phosphate export boom in the mid-1970s and a decline in the capacity to borrow on the international financial markets starting in the early 1980s. Initiated in 1983, they included a sharp depreciation of the real exchange

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rate, fiscal austerity, trade liberalization, and the privatization or abandonment of a number of activities in which the public sector had been directly involved in agriculture (Morrisson, 1991). Starting in 1989, and as part of the negotiations of an agricultural structural adjustment program (ASAP) loan with the World Bank, a new set of rules was introduced for the pricing of grains (soft and hard wheats, barley, and maize). The purpose of these rules is to move from a system where the government fixed domestic prices and controlled all imports to a situation where transactions are liberalized and the government only affects import prices through variable levies, thus insuring a closer relation between domestic and international prices (Aloui et al., 1989). Together with implementation of a minimum guaranteed price, these price reforms have the potential of creating significant benefits for cereals producers.

The objective of this paper is to analyse what these new rules for cereals price formation may imply for the weaker segments of Moroccan society, namely the small and medium farmers in rainfed areas, who account for the majority of the poor. Changes in cereals prices by a significant magnitude as proposed in ASAP will affect all other prices particularly through the real exchange rate. We trace out these price effects at the macroeconomic and aggregate sectoral levels by using a computable general equilibrium (CGE) model and, at a greater level of disaggregation within agriculture, a multimarket (MM) model. We zoom in at the household level on the effect of these price changes where they imply complex reallocations in production and consumption as well as in the distribution of the burden of work across household members. Because a certain number of markets for products (milk for some farms) and factors (child labour which is very important in animal production in a context of property rights without enclosures and of access to commons) are missing, and because of eventual credit constraints, decisions regarding production and consumption are not separable and the reallocations are traced out in a household model that solves simultaneously for these decisions.

We start, in Part 2, by explaining the new rules of price determination for cereals and we use the CGE and MM models to predict the expected changes in the price vector to which farm households will be confronted when the new rules apply. In Part 3, we use data from a farm household survey to characterize the structure of small and medium farms in the Haute Chaouia, a region of dryland agriculture and extensive poverty in spite of its proximity to Casablanca. We then proceed, in Part 4, to construct and quantify a computable nonseparable household model (CNH) with missing markets and credit constraint. This model is used in Part 5, to simulate the changes in resource allocation and welfare that the predicted price changes may have. The results allow us to derive, in Part 6, a set of policy implications with the potential of enhancing the positive effects of the price reforms on the welfare of Moroccan peasants.

The approach followed here thus shows the potential of using a CNH approach to trace out the differentiated household level effects of macro and sectoral policy changes. Two caveats apply. The first is that we zoom-in the CGE-MM price effects on households without zooming back into the CGE-MM model, thus leaving some inconsistency between macro and micro responses. The other is that, because the model is, at this stage, not consistently estimated (a feat that is yet to be achieved), the results are only suggestive of potential effects to which policy makers should pay attention.

2. New pricing rules for cereals

2.1. Predicted cereals prices

The new pricing rules for cereals have the objective of tying domestic prices to world market prices and also of raising the producer price of cereals, thus providing incentives to cereals production and improving the incomes of peasant households in the less favored areas (74% of cereals is produced on farms of less than 20 hectares, mainly in rainfed areas where rural poverty is concentrated). The new rules consist in the determination of an *import reference* price that is based on the calculation of two *base level* prices (Stryker et al., 1990):

1. An international '*threshold*' level equal to the average world price over the last five years, plus freight and insurance and a protective tariff of 25%.
2. A minimum *guaranteed* price. For soft wheat, barley, and corn, this minimum price is equal to the 1986 official producer price updated for inflation plus a 10% premium. For hard wheat, the minimum price is set by multiplying the soft wheat minimum price by the ratio of the two cereals threshold prices, considered to provide a fair margin determined by the international market.

The import reference price that actually applies is the maximum of these two base level prices. While the new price system should, in theory, create a link between world market prices and domestic prices, deterioration of international prices implies that the minimum guaranteed price has in fact prevailed over the international threshold price for the first year of implementation in 1989. To characterize the pre-reform prices that would have prevailed, we compute the 1986–1988 average real official price for the two controlled cereals (soft wheat and corn) and market price for coarse grains (hard wheat and barley) for which price controls were not effective. The resulting price levels and the increases due to the new pricing rules are:

Prices (1988) Dirham/ton)	*Pre reform*	*Post reform*	*% change*
Hard wheat	2363	2784	17.8
Soft wheat	2050	2313	14.4
Coarse grains	1513	1934	29.8

Using the shares of these different cereals in production, this corresponds to an overall price increase of 20.1% for cereals.

2.2. Transmission to other prices: CGE and MM predictions

These changes in the prices of cereals are sufficiently large that they can be expected to have significant macroeconomic effects and hence affect all the other prices in the economy. This is simulated using a modified version of Mateus' (1988) CGE model for Morocco.

The simulation experiment consists in an increase in the import tariff on cereals to raise the domestic price by the same amount which the new pricing rules predict (i.e., 20.1%). The main macroeconomic result, which is to be expected in an economy which produces the same cereals that it also imports (Sadoulet and de Janvry, 1990), is a sharp reduction in cereal imports coming from both an increase in domestic production by import substitution and a decrease in consumption. The relief on the balance of payments which this creates causes an appreciation of the real exchange rate of 5.7%. The price effects on the products which enter in the household model are as follows: livestock sector (meat, milk, and forage) 14.3%; fruits and vegetables 8.7%; handicrafts (textiles and leather) 6.1%; machinery and fertilizers 1.5%; other consumption goods 5%; and wages 6.7%.

The agricultural sector is more aggregated in the CGE than in the household model. We therefore use the Aloui et al. (1989) MM model to disaggregate the price effect predicted by the CGE for the livestock sector among the components of that sector. This gives us the following price effects: meat 12.8%, milk 8.3%, and forage 24%.

The new price rules for cereals and the CGE and MM predictions of the transmission of these prices give us the vector of price increases that will be used to simulate household responses. Before constructing a model of household behavior, we characterize the features of peasant households in the region analysed.

3. Farm household characteristics in the Haute Chaouia

The Haute Chaouia region, in the Settat Province, is an area of rainfed farming with highly uncertain precipitations. The data we use to characterize the structural characteristics of small (0 to 10 hectares) and medium (10 to 50 hectares) farms in Table 1 derive from a survey of 88 households conducted in 1986–1987 (Mohamed, 1987) and from a number of in-depth case studies of households conducted by students of the Institut Agronomique et Vétérinaire Hassan II in Rabat. These farms have sharply contrasted activities, schemes of labor use, sources of income, and degrees of reliance on the market for food consumption.

Land in the region is highly unequally distributed. Census data indicate that small farms account for 82% of the total number of farms and occupy only 34% of the land area, while medium-size farms represent 15% of farms and 34% of the land area. The small farms are severely land constrained. This is reflected by labour/land and animal/land ratios which are much higher on the small farms. Collective grazing lands are important and provide a complementary resource which is fundamental to small farmers. Because of this, the economy of small farms tends to be importantly vested in livestock activities, while that of medium farms is mainly oriented at the production of crops.

In crops production, cereals dominate, particularly on the medium farms. Hard wheat is produced on all farms, as it is important for home consumption, while soft wheat is a cash crop produced mainly on the medium farms. Coarse grains are produced for both home consumption and animal feed.

Animal production accounts for 56% of gross farm output on the small farms and 32% on the medium. While the production of milk and meat increases with farm size, it declines sharply on a per hectare basis from 1,819Dh to 656Dh due to access to collective grazing lands. The availability of child labour is crucial for livestock production both on private and collective lands since neither is enclosed and the low productivity of herding labour largely excludes adults. Most farms do not have easy access to a market for milk due to large price bands associated with perishability and poor transportation facilities. As a result, milk production is mainly for home consumption, and milk will be treated in the household model as a product for which the market fails.

Resident family size is larger on the medium (7.1 adult equivalent units) than on the small (4.9 units) farms, reflecting the facts that demography may still be bound by income among small farmers and outmigration higher on the smaller farms. In spite of this, the small farms have a surplus of labour and sell labour on the wage market. Thus male labour time is distributed as follows: 40% on-farm labour, 27% wage labour, and 33% home time. Female labour is distributed between 57% on-farm labour, 7% wage labour, and 36% home time. The medium farms, by contrast, have a labour deficit which they make up by hiring-in wage labour. Male labour time is distributed 39% on-farm work and 61% home time while female labour is 13% farm labour and 87% home time.

Labour allocation in the household is quite clearly defined by age and gender. Adult males principally concentrate in work on crops, services (particularly commerce), and off-farm wage labour, including migration to Casablanca. Married women are in principle classified as unemployed. They in fact participate actively in field labour at peak times of labour needs; help watch animals, particularly if these are kept on the farm; and generate side revenues in activities such as the production of butter, weaving, and the raising of minor animals, such as poultry. Children are fundamentally occupied in the herding of animals on fallows, stalks, and collective grazing

Table 1. *Structural characteristics of small and medium farms, Haute Chaouia (Data in 1000 Dirham unless otherwise indicated)*

Farm sizes	Small	Medium	Small	Medium	Small	Medium	Small	Medium
Structural characteristics	Total resources		Resources per hectare					
Average farm size (hectares)	5.10	22.80						
Labour (adult units)	4.90	7.10	0.96	0.31				
Animals (livestock units)	5.20	9.30	1.02	0.41				
Product and factor use	Production or availability		Factor use		Consumption and home time		Net sale	
Hard wheat	1.99	8.56			0.85	2.39	1.15	6.17
Soft wheat	0.42	6.73			1.42	1.72	−1.00	5.01
Coarse grains	2.95	12.07	2.78	5.40	1.61	1.55	−1.44	5.13
Fruits & vegetables	1.64	4.40			2.18	4.48	−0.54	−0.08
Forage (TC)	0.41	0.92	1.39	2.75			−0.99	−1.83
Milk (NT)	0.75	1.54			0.75	1.54		
Meat	8.56	14.13			1.71	4.08	6.85	10.05
Handicrafts & services	1.20	2.92					1.20	2.92
Machinery (TC)			0.04	3.42			−0.04	−3.42
Fertilizers (TC)			0.85	5.02			−0.85	−5.02
Male labour (TC)	8.86	12.84	3.55	6.60	2.95	7.90	2.36	−1.66
Female labour (TC)*	4.43	6.42	2.53	2.55	1.60	5.61	0.31	−1.74
Child labour (NT)*	3.73	5.24	1.76	1.91	1.78	3.22		
Interests and rents			1.94	3.53			−1.93	−3.52
Other consumption					3.74	7.72	−3.74	−7.72
Savings					1.34	4.29	−1.34	−4.29

Income	Gross income		Return to family labour and factors owned		Total consumption		Constraints	
Crops	7.40	32.68			Including home time		Cash constraint**	
Animals	5.14	7.52			19.92	44.49	0	0
Wage labour	2.67	0					Credit need***	
Other sources	1.20	2.92			Excluding home time		−3.21	−13.67
Total	16.41	43.12	13.58	27.75	12.25	23.47		

TC = Credit-constrained tradable; NT = nontradable.
*Female and child labour are valued at wages equal to 50% and 30% of male wage, respectively.
**Sum of net sales.
***Net between credit need for TC expenditures and availability of liquidity from half of wage earnings.

lands. Young girls are also involved in herding but usually only in the immediate proximity of the home.

Rural households in the Chaouia are in general reticent to let women work for a wage in other households' lands. However, only the richer households can afford this luxury. Small farms have a small surplus of female labour while the medium farms have a large deficit.

There is practically no market for child labour, even though a few transactions are reported for herding. This is due to three factors. First, there is a problem of moral hazard in the supervision of child labour since children can easily be abused and parents are little inclined to take this risk. Second, children are fundamentally used for herding, an activity with relatively little seasonality and hence thin seasonal labour markets. Finally, even though lack of proper care can be highly detrimental to the animals, it is virtually impossible to supervise herding labour. As a result, it is difficult to motivate children to take proper care of the animals, unless this is done within the family. This market failure for child labour explains the emergence of a variety of institutional arrangements which are used to secure child labour for herding, such as the practice of adoption by childless households and share contracts with herders who have children of their own. But by far most herding is done by child labour from the family itself and we will assume that there is market failure for child labour.

Both the small and the medium farms have marketed surpluses of hard wheat and meat. For soft wheat and coarse grains, the small farms are net buyers while the medium farms have marketed surpluses. All three types of cereals are thus important cash crops for the medium farms. The small farms have a large deficit in coarse grains due to their use as animal feed and the great importance of animals in their economies. Both types of farms also produce animal forage and are deficitary, buying forage that is shipped from irrigated areas. Grazing on the commons offers a substitute to purchased forage for as long as sufficient child labour can be mustered for this purpose.

We now proceed to construct a household model that captures the structural features identified above, including the existence of market failures for milk (which is of marginal importance as this production is fairly secondary) and child labour (which is quite important as livestock is a fundamental source of income, especially for the poorer households) and eventual credit constraints in responding to price signals.

4. A household model with market failures and credit constraint

4.1. The model

The household model developed here aims at capturing the decisions of two types of households representative of small and medium farms in the Haute Chaouia. The household produces ($q \geqslant 0$) hard wheat, soft wheat, coarse

grains, other crops (fruits and vegetables), forage, milk, and meat. Nonagricultural sources of income include handicrafts and services and the sale of labour. The factors ($q \leqslant 0$) it uses in production are machinery and fertilizers; coarse grains and forage; male, female, and child labour; and the depreciation of fixed factors. Products and factors are related through the production technology $G(q, z^q)$, where z^q is a vector of structural characteristics of the farm household and fixed factors (land, livestock, and capital). The household consumes ($c \geqslant 0$) hard wheat, soft wheat, coarse grains, other crops, milk, meat, nonagricultural goods and services, home time (male, female, and child) and they also save for future consumption and investment.

The household has initial endowments ($E \geqslant 0$) in total time (male, female, and child) and receives net transfers S. Expenditures on machinery, fertilizers, forage, and hired labour have to be incurred ahead of harvest and this requires financial liquidity at that time of the year. For this, the household has access to liquidity from a fraction of its annual wage earnings, if it is a net seller of labour, and from credit for working capital expenditures in an exogenous amount K (which includes past savings and transfers received ahead of harvest). Since all farms have a surplus of coarse grains, they carry over stocks of these grains, with the result that they do not enter in the liquidity constraint. According to the net of these entries and outlays that occur before harvest, the credit constraint may or may not be binding. Annual savings are for future consumption and investment and consequently do not create liquidity for current expenses.[1]

The household may be a net seller or a net buyer of any product and factor. It is a price taker ($\bar{p}$) for all products and factors for which markets exist (or more exactly for which the subjective equilibrium price falls outside a price band between risk equivalent sale and purchase prices). For milk and child labour, market failure (or a subjective equilibrium within the effective price band) implies that an internal equilibrium must obtain between the supply ($q + E$) and demand (c) of these nontradable commodities.

The household maximizes a utility function $U(c, z^c)$, where z^c denotes exogenous household characteristics, with respect to production and consumption decisions subject to a cash constraint, a credit constraint, a technology constraint, and equilibrium conditions for tradables and nontradables. Goods are decomposed into three categories:

Tradables, T, which are decomposed into two subsets:
  Tradables which are not subject to a credit constraint, TNC;
  Tradables subject to a credit constraint, TC;
Nontradables, NT.
The household's problem is thus to:

$$\underset{c,q}{\text{Max}}\ U(c, z^c) \qquad \text{subject to:} \tag{1a}$$

$$\sum_{i \in T} p_i(q_i + E_i - c_i) + S \geq 0, \qquad \text{cash constraint,} \tag{1b}$$

$$\sum_{i \in TC} p_i \alpha_i (q_i + E_i - c_i) + K \geq 0, \quad \text{credit constraint,} \tag{1c}$$

$$G(q, z^q) = 0, \quad \text{production technology,} \tag{1d}$$

$$p_i = \bar{p}_i, \; i \in T, \quad \text{exogenous market prices for tradables,} \tag{1e}$$

$$q_i + E_i = c_i, \; i \in NT, \quad \text{equilibrium for nontradables,}$$

where α_i is the fraction of the i^{th} product, factor, endowment, or consumption good that requires or generates liquidity.

The Lagrangean associated with the constrained maximization problem is written as:

$$L = U(c, z^c) + \lambda \left[\sum_{i \in T} \bar{p}_i (q_i + E_i - c_i) + S \right] + \eta \left[\sum_{i \in TC} \bar{p}_i \alpha_i (q_i + E_i - c_i) + K \right] + \phi G(q, z^q) + \sum_{i \in NT} \mu_i (q_i + E_i - c_i),$$

where equilibrium condition (1e) has been imposed by substitution.

The three types of goods can be treated symmetrically in the first order conditions by defining endogenous decision prices as follows:

$$p_i^* = \bar{p}_i, \; i \in TNC, \tag{2a}$$

$$p_i^* = \bar{p}_i (1 + \alpha_i \lambda_c), \; \lambda_c = \eta / \lambda, \; i \in TC, \tag{2b}$$

$$p_i^* = p_i = \mu_i / \lambda, \; i \in NT. \tag{2c}$$

Since the credit constraint may not be effective, we use the Kuhn-Tucker conditions for this constraint, and the first-order conditions can be written as:

$$U_i = \lambda p_i^*, \quad i \in \text{all consumer goods,} \tag{3a}$$

$$\sum p_i c_i = \sum (q_i + \mathrm{E}_i) p + S, \quad \text{all } i\text{, full income constraint,} \tag{3b}$$

$$\begin{cases} \eta \left[\sum_{i \in TC} p_i \alpha_i (q_i + E_i - c_i) + K \right] = 0 \\ \eta \geq 0 \\ \sum_{i \in TC} p_i \alpha_i (q_i + E_i - c_i) + K \geq 0 \end{cases} \quad \text{credit constraint,} \tag{3c}$$

$$\phi G_i = -\lambda p_i^*, \quad i \in \text{all producer goods,} \tag{3d}$$

$$G(q, z^q) = 0, \quad \text{technology constraint,} \tag{3e}$$

$$q_i + E_i = c_i, \quad i \in NT\text{, equilibrium nontradables,} \tag{3f}$$

$$p_i = \bar{p}_i, \quad i \in T\text{, equilibrium tradables,}$$

where U_i and G_i are the partial derivatives of U and G with respect to c_i and q_i, respectively.

The first-order conditions fall into four blocks of equations:

(1) Consumption decisions are taken in equations (3a) and (3b),
(2) The credit constraint is imposed by equations (3c),
(3) Production decisions are taken in equations (3d) and (3e),
(4) Equilibrium conditions for price formation are given by equations (3f) and (3g).

At the level of the reduced form, these four blocks of equations can be written as follows. Production decisions that satisfy equations (3d) and (3e) are represented by a system of supply and factor demand functions in the endogenous decision prices p^* that derive from maximizing a generalized profit function π^* for all tradables and nontradables:

$$\pi^* = \sum p_i^* q_i, \tag{4a}$$

$$q = q(p_i^*, z^q). \tag{4b}$$

On the demand side, decisions are also made in terms of the p^* prices in equation (3a). The income constraint in p^* prices is derived as follows from the full income and the credit constraints (3b) and (3c):

$$\begin{aligned} y^* = \sum p_i^* c_i &= \sum p_i c_i + \lambda_c \sum_{i \in TC} \alpha_i p_i c_i, \\ &= \sum p_i (q_i + E_i) + S + \lambda_c \left[\sum_{i \in TC} p_i \alpha_i (q_i + E_i) + K \right], \\ &= \sum p_i^* (q_i + E_i) + S + \lambda_c K, \\ &= \pi^* + \sum p_i^* E_i + S + \lambda_c K, \end{aligned} \tag{4c}$$

which is equivalent to an extended full income constraint.

Equations (3a) and (4c) define a demand system

$$c = c(p^*, y^*, z^c) \tag{4d}$$

that maximizes the utility function (1a) under the extended full income constraint (4c).

The Kuhn-Tucker condition (3c) on the credit constraint can also be written using a slack variable K_{net} in the credit constraint as:

$$K_{net} \lambda_c = 0, \tag{4e}$$

$$K_{net} = K + \sum_{i \in TC} \bar{p}_i \alpha_i (q_i + E_i - c_i) \geqslant 0, \tag{4f}$$

$$\lambda_c \geqslant 0. \tag{4g}$$

In these equations,

- either the credit constraint is effective in which case $K_{net} = 0$ and $\lambda_c > 0$;
- or it is ineffective in which case $K_{net} \geqslant 0$ and $\lambda_c = 0$.

The household model with nontradables and credit-constrained tradables thus contains three sets of prices: Decision prices, prices of tradables, and prices of nontradables. Decision prices p^* affect how production and consumption decisions are taken to accommodate the credit constraint. The endogenous markup λ_c on the price of the credit constrained tradables serves to raise the decision price of the credit constrained tradable products and factors with a positive marketed surplus (in particular labour on the small farms). Even though these goods are transacted at the market price $\bar{p}$, their supply increases and their home use falls, since $p^* > \bar{p}$, reflecting the fact that higher exports of these goods and factors help ease the credit constraint. Similarly, the endogenous markup λ_c raises the decision price of the credit-constrained tradables of which the household is a net buyer, such as forage on all farms and labour on the medium farms, inducing it to produce more of them for import substitution and to use less of them in production. Even though the transaction occurs at the market price $\bar{p} < p^*$, imports of these goods and factors are reduced to accommodate the credit constraint.

The model to be solved is thus composed of the four blocks of equations:

- production decisions (4a and 4b),
- consumption decisions (4c and 4d),
- credit constraint (4e, 4f, and 4g), and
- equilibrium conditions for price formation (3f and 3g).

Because of the existence of both a credit constraint that transforms the prices of credit-constrained tradables into endogenous prices and of endogenous nontradables prices, production and consumption decisions are not separable. This system of equations consequently needs to be solved simultaneously. Since this is analytically intractable, as is usually the case in models with policy relevance, we proceed by setting up a computable version of this model as follows.

4.2. A computable version of the household model

Functional forms need to be specified for the profit function and the indirect utility function that are both as unrestrictive as possible and analytically convenient. Because we are at this stage unable to estimate consistently the whole model, with in particular its endogenous decision prices for the credit-constrained tradables and the nontradables, we proceed to quantify the model as though there were no market failures and no credit constraint. We consequently start from an equilibrium point where the credit constraint is postulated to be exactly satisfied ($K_{\text{net}} = 0$) and the two systems are written in terms of market prices for all tradables and nontradables.

$$\pi = \sum_{i,j} b_{ij} \sqrt{p_i p_j} + \sum_{i,m} b_{im} p_i z_m^q$$

with a derived system of output supply and factor demand,

$$q_i = \sum_j b_{ij} \sqrt{p_j / p_i} + \sum_m b_{im} z_m^q, \quad \text{with} \quad b_{ij} = b_{ji}, \tag{5}$$

To determine the values of the b_{ij} and b_{im} parameters of this system, we start from a set of 'best guess' price and fixed factor elasticities derived from the literature. For the medium farm, these elasticities are taken principally from the MM model for Moroccan agriculture by Aloui et al. (1989), complemented with values derived from the compilation of elasticities for the Middle East and North Africa by Sullivan et al. (1989). These elasticities are then calibrated to satisfy the homogeneity and symmetry constraints that a consistent system derived from profit maximization implies. We do this by using an algorithm that minimizes, with respect to b_{ij} and b_{im}, the sum of the squares of the discrepancies between this initial set of elasticities and a set of new elasticities that derive from the Generalized Leontief, keeping untouched the diagonal values on which we have the greatest confidence.

Neither the parameters nor the elasticities of the medium farms can be directly applied to the small farms. This can be understood by noticing that the unit of measurement of the parameters b_{ij} in equation (5) is in the dimension of $b_{im}z_m^q$, which indicates that the small farms b_{ij} need to be scaled down to the level of their fixed factors. As for the elasticities, the need for calibration comes from the symmetry constraint, $w_iE_{ij}=w_jE_{ji}$, which states that cross-price elasticities are inversely proportional to the shares in profit $w_i=p_iq_i/\pi$.[2] Based on this, we derived the elasticities for the small farms by scaling the elasticities of the medium farms using the relative profit shares as follows:

$$E_{ij}^s = \frac{w_i^m}{w_i^s} E_{ij}^m,$$

where w_i^m and w_i^s are the shares of commodity or input i in the profits of medium and small farms, respectively. These elasticities satisfy the additivity and symmetry constraints. Note that this scaling method, which is not the only possible method, also satisfies the property of constant return to scale in production. The two sets of elasticities are given in Appendix Table 1.[3] Among them, the direct and cross-price elasticities for the different labour categories are the least well established and will need serious further study before robust policy implications can be derived.

The price and income elasticities in consumption are partially derived from AIDS systems estimated for rural areas by Laraki (1989) and by Stryker et al. (1990) and partially from point estimates of elasticities for the Chaouia calculated from the household survey. These first guess elasticities are calibrated using the same algorithm as above to satisfy all the additivity and symmetry constraints, with the elasticities deriving from a Translog indirect utility function,

$$V=\sum_k \alpha_k \ln(p_k/y) + \frac{1}{2}\sum_{k,l} \beta_{kl} \ln(p_k/y) \ln(p_l/y)$$

where $y = \pi + \sum_i p_i E_i + S$, full income. It corresponds to the expenditure system,

$$\frac{p_i c_i}{y} = \frac{\left[\alpha_i + \sum_j \beta_{ij} \ln p_j/y\right]}{\left[\alpha_y + \sum_j \beta_{yj} \ln p_j/y\right]},$$

where

$$\alpha_y = \sum_i \alpha_i = -1, \beta_{yj} = \sum_i \beta_{ij}, \text{ and } \beta_{ij} = \beta_{ji}.$$

These calibrated elasticities are reported in Appendix Table 2. Among them, the price and income elasticities for leisure of the different household members are the least well known and will need further empirical research.

5. Simulation results

5.1. Simulations of single price changes

We have seen that the new pricing rules for cereals imply a sharp increase not only in the prices of hard wheat (17.8%), soft wheat (14.4%), and coarse grains (29.8%), but also, indirectly through general equilibrium effects, in the prices of forage (24%) and meat (12.8%) and in the agricultural wage (6.7%). Before analysing the joint effect of these direct and indirect price effects, we simulate the separate effects of a 10% increase in these prices to understand how they each affect the two types of rural households. Partial results are given in Table 2. The overall welfare effects on the households are measured in equivalent variation in full income, i.e., by the income transfer that would, at base prices, create the same indirect utility effect as the policy does.

Both farm types are net sellers of hard wheat and consequently benefit from a higher price. The marketed surplus of hard wheat increases in both farms. Since cereals production is demanding principally in men labour time, male labour required for production increases. The income effects induce the consumption of more home time. Higher on-farm labour needs and more home time thus lead to a fall in the sale of male wage labour by the small farmers (−1.1%) and to a sharp increase in the hiring by the medium farmers (7.7%). Because there is a high marginal utility of income for home time among women, the impact is much greater on female labour: The sale of wage labour by women on small farms falls by 10.2% while the hiring of female labour on the medium farms increases by 12.2%, allowing an increase in their consumption of home time, particularly on the medium farms. The impact on animal production and consequently on

child labour is small, indicating that cereals and animal production do not compete importantly.

When it is the price of soft wheat that increases, the contrasted effect on small versus medium farms comes from the fact that the medium are net sellers of soft wheat, and thus receive an income gain from the price change, while the small are net buyers, and consequently face a rising consumption cost. The sale of a marketed surplus of soft wheat thus increases by 11.3% on medium farms while the purchase of soft wheat falls by 23.4% on the small. The negative income effect on the small farms is reflected by more on-farm work for men, more sale of wage labour, and a fall in their home time. Women and children are able to increase home time first because of the high elasticity of home time with respect to nominal income and second because livestock production declines. On medium farms, by contrast, all family members enjoy more home time and the farm makes up for the labour deficit by greater hiring-in of outside wage labour (5.5% male and 7.9% female). Improving the welfare of the small farmers would consequently require a lowering of the price of soft wheat or using technological change in soft wheat to compensate for rising prices. A rising price of coarse grains would have the same unequal welfare effects as a rising price of soft wheat since small farmers are net buyers while medium farmers are net sellers.

A rising price of forage creates a sharply negative income effect on both types of farms as they are net buyers, particularly the small ones whose economy is heavily vested in animals. More interestingly, it also creates an increase in the demand for child labour, in spite of the fact that children are not particularly involved in the production of forage and that the production of livestock declines due to higher production costs. This is due to the fact that rising forage prices lead to a substitution in the use of animal feed toward coarse grains and grazing in the commons. Since the latter requires child labour, we see that the substitution effect is greater than the effect of declining meat production on the demand for child labour. Their workload increases and their home time declines correspondingly, particularly on the small farms. Children and the commons thus bear the burden of adjusting to higher forage prices.

We have seen that all farms are important producers of meat, but particularly the small for whom it accounts for a very large share of total income. A rising price of meat thus allows a sharp increase in the home time of men (4.8%) and especially of women (10.7%) on the small farms, and to a lesser extent also on the medium farms (3.0 and 7.6%, respectively). Greater adult home time leads to less sale of wage labour by the small farmers, particularly female labour (−60%), and more purchase by the medium, particularly of female labour (29.5%). In production, male labour is replaced by female labour as women are more important than men in animal husbandry. Because the consumption of meat, in spite of a high income elasticity, does not increase due to the price effect, it is the consumption of the other goods,

Table 2. *Simulation of household behaviour: Price responses (Results in percentage changes over base run unless otherwise indicated)*

Experiment	Base run in 1000 Dirham		10% increase in price of hard wheat		10% increase in price of soft wheat	
Farm size	Small	Medium	Small	Medium	Small	Medium
Full income	19.92	44.43	0.6*	1.4	−0.4	1.2
Consumption						
Home time men	2.95	7.90	0.6	1.5	−0.7	1.0
Home time women	1.60	5.61	2.0	3.8	0.7	2.6
Home time children	1.78	3.22	0.4	1.0	0.4	1.0
Total consumption	12.25	23.47	0.4	0.8	−0.6	0.9
*Net output***						
Hard wheat	1.99	8.56	4.5	4.9	−1.1	−1.2
Soft wheat	0.42	6.73	−5.2	−1.5	19.0	5.6
Coarse grains	0.17	6.67	−9.3*	−1.1	−4.9	−0.6
Forage	−0.98	−1.83	−0.4	−0.9	−0.3	−0.7
Total crops	3.24	24.54	1.2	0.8	1.3	0.8
Total livestock	9.31	15.67	−0.4	−1.4	−0.2	−0.7
Factor use						
Mach. & fertilizer	−0.90	−8.44	1.0	1.8	4.0	0.5
Labour men	−3.55	−6.60	0.2	0.2	0.2	0.2
Labour women	−2.53	−2.55	0.0	−0.1	−0.1	−0.4
Labour children	−1.76	−1.91	0.4	−1.6	−0.4	−1.7
Shadow prices						
Labour children	1.06	1.02	0.5	1.0	−0.4	0.5
New supply of wage labour						
Men	2.36	−1.66	−1.1	7.7	0.6	5.5
Women	0.31	−1.74	−10.2	12.2	−2.4	7.9
Marketed surplus						
Hard wheat	1.14	6.17	12.4	8.8	−5.8	−3.2
Soft wheat	−1.00	5.01	7.3	−3.1	−23.4	11.3
Meat	6.85	10.05	−0.6	−2.9	0.0	−1.5

*Equivalent variation in full income to the change in indirect utility at base prices.
**Net of intermediate uses for coarse grains and forage.

mainly purchased manufactured goods, that increases sharply (4.7% on small and 3% on medium farms [not reported in Table 2]), indicating the importance of an elastic supply of manufactured consumption goods in inducing peasant households to respond to higher prices.

The more interesting part of the story of rising meat prices concerns, however, children, who are very important for animal production and for whom there is no labour market. The use of child labour in production increases (0.6% on small and 4.5% on medium farms) and their home time decreases correspondingly. The shadow price of child labour, which indicates

10% increase in price of forage		10% increase in price of meat		10% increase in wage of men		10% increase in wage of women	
Small	Medium	Small	Medium	Small	Medium	Small	Medium
−0.5	−0.4	3.4	2.4	1.2	−0.3	0.2	−0.3
−0.6	−0.4	4.8	3.0	0.3	−1.6	0.0	0.1
−1.0	−0.7	10.7	7.6	2.1	−0.1	−16.2	−15.8
−0.2	−0.6	−0.6	−2.7	0.1	0.2	−0.3	−0.5
−0.4	−0.3	2.3	1.2	1.2	0.1	2.3	2.7
0.2	0.2	−1.6	−2.3	−0.3	−0.1	0.1	0.1
0.7	0.2	−2.5	−1.3	−1.1	−0.1	0.7	0.3
2.8	0.3	−13.1	−2.0	−14.1	−1.3	−1.4	−0.2
−1.1	−2.8	2.8	6.9	−0.4	−1.1	0.5	1.6
0.8	0.5	−3.2	−2.6	−1.5	−0.6	−0.1	−0.1
−0.3	−0.8	0.9	4.9	0.2	0.3	−0.1	−0.6
−0.3	−0.1	−2.6	0.1	−0.3	−1.2	−0.8	−0.9
−0.1	−0.4	−0.7	−0.9	−1.5	−2.8	0.0	0.0
0.2	0.9	0.5	3.4	0.1	0.2	−0.7	−2.1
0.2	1.0	0.6	4.5	−0.1	−0.4	0.3	0.9
−0.2	0.0	3.4	3.5	2.3	1.4	0.2	0.9
0.9	−3.1	−5.0	10.7	1.9	−18.6	0.1	0.1
3.9	−0.8	−60.0	29.5	−11.8	−0.1	90.1	−53.9
0.9	0.5	−6.1	−4.5	−1.8	−0.1	−1.1	−0.8
−0.3	0.3	1.0	−1.4	0.2	−0.2	2.4	−0.1
−0.2	−1.0	1.7	9.3	−0.4	0.2	−1.0	−2.4

its scarcity value, increases sharply (by 3.4 and 3.5%, respectively), revealing the pressure that exists for the provision of child work. The rising price of a tradable factor (forage) thus puts strong upward pressure on the shadow price of a substitutable nontradable factor (child labour and grazing in the commons). Were this nontradable a tradable, the supply elasticity of the product (meat) would be even higher as there would be no factor price effect. Market failures on the factor side thus reduce the elasticity of supply response of tradables. The cost of this demand on child time has to be less school attendance and more pressure on the commons which are used proportion-

ately to child labour. Higher illiteracy and more ecological destruction are thus the long run costs of higher meat prices. This is not the case when price increases occur in cereals, which are intensive in adult labour, principally that of men. We thus conclude that higher meat prices create strong welfare gains for the adult population, particularly on the small farms and for women, and much stronger than an equal percentage increase in the price of cereals, but that this happens at a high cost in terms of child labour and overgrazing in the commons.

The fifth experiment in Table 2 consists in raising the wage of male labour by 10%. Since the small farms are net sellers of labour while the medium are net buyers, this has opposite effects on their welfare, with the small gaining and the medium losing. The small farms respond by selling more male wage labour (1.9%), using less male labour in farm production (−1.5%), and increasing the home time of all labour categories as a result of a positive income effect. Crops production falls as the opportunity cost of adult labour has increased. Medium farms, by contrast, hire less male labour (−18.6%), use less labour in production (−2.8%), and substitute family male and female labour for previously hired labour, with the result that male and female home time decline due to both income and substitution effects. As on small farms, crops production also falls, but not for the same reason and not to the same extent: It falls because labour costs have risen, but the impact on production is mitigated by reduced family home time. On both farms, male labour is principally used in cereals production, and the production of these crops decline.

Finally, when it is the wage of women that increases by 10%, the resulting readjustments, which occur for very different reasons on the small and medium farms, are devastating on their home time. Small farmers are net sellers of female labour and consequently gain from a higher wage. With rising wages, female labour in farm production decreases (−0.7%), their off-farm wage labour increases sharply (90.1%), and their home time declines (−16.2%). Farm production declines correspondingly to their lower participation in farm work, but the net effect of higher family income and greater demands for farm work leave male home time unchanged. The medium farmers are net buyers of female labour. Higher wages lead them to reduce the hiring of female workers (−53.9%) and to substitute family female labour for previously hired workers. The net is to leave production and the welfare of the other members virtually unchanged, while the work load of women increases sharply and their home time falls by 15.8%.

These experiments thus show that the output and welfare effects of changes in different product and factor prices are sharply contrasted across farm types and across household members. Global statements about the effects of rising product prices or rising wages are consequently much more meaningless than could have been recognized at first sight, calling upon a great

degree of caution in assessing the effects of structural adjustment on the welfare of different members of the peasantry.

5.2. Impact of the agricultural structural adjustment program

The new pricing rules for cereals introduced by the ASAP, together with the secondary effects they induce in other prices and wages, result in a complex set of readjustments that are given in Table 3. Since the changes are very large, the possibility of a credit constraint on the ability to respond to price incentives arises, and we consequently simulate the effects of ASAP when this constraint is alternatively present and relaxed.

While it is no longer possible to see what exactly comes from which price change, the net effect is clearly contrasted between small and medium farms, with the medium farmers deriving significant welfare gains from ASAP while the gains are much more modest for the small farmers as they are caught, on the consumption side, by rising prices for food, of which they are important buyers. Rising cereals prices redesign the farm economy towards crops and away from livestock. In this response, it is the medium farms that are most constrained by credit needs as the markup on the prices of credit constrained tradables (λ_c in the model) is 16.6% on these farms as opposed to 8.4% on the small. This is due to the fact that the small farms are importantly engaged on the labour market as net sellers and consequently find in wage incomes an important source of credit. While only a fraction (taken here as 50%) of annual labour income is available at the time when credit is needed, it nevertheless provides important liquidity. The effect of the credit constraint on the medium farmers is to sharply reduce their ability to hire labour and to expend on machinery and fertilizers. As a result, even though cereals prices rise, the hiring of female labour and the use of machinery and fertilizers fall to accommodate the hiring of more male labour. Their overall supply response is negative as the fall in livestock production more than overwhelms the small increase in crops production. Relaxing this constraint, by contrast, enables them to hire more labour and to use purchased inputs, allowing them to have a positive aggregate elasticity of supply response.

On the small farms, the credit constraint prevents these households from reducing the sale of labour in spite of rising farm prices and the incentive to import substitute. This is because the labour market is their source of access to credit. When this constraint is relaxed, the sale of labour falls sharply (−4.7% for men and −59.1% for women) and the elasticity of supply response increases. Eliminating the credit market failure thus increases the elasticity of supply response of the traded goods that make use of credit in production.

The paradoxical result of ASAP is that, in spite of displacing the farm economy from livestock to crops, resulting in a falling production of milk

Table 3. *Simulation of household behaviour: ASAP responses (Results in percentage changes over base run unless otherwise indicated)*

Experiment	Base run in 1000 Dirham		ASAP Credit constraint		ASAP No credit constraint	
Farm size	Small	Medium	Small	Medium	Small	Medium
Full income	19.92	44.43	1.6*	7.2	1.6	7.7
Credit						
Credit deficit (1000 Dh)			0	0	0.4	2.9
Price markup on TC (%)			8.4	16.6	0	0
Consumption						
Home time men	2.95	7.90	1.4	6.1	2.6	8.4
Home time women	1.60	5.61	−5.4	−9.7	10.3	14.4
Home time children	1.78	3.22	−0.9	−1.9	−0.9	−2.8
Total consumption	12.25	23.47	1.8	9.8	−0.1	5.4
*Net output***						
Hard wheat	1.99	8.56	1.6	1.8	2.0	1.8
Soft wheat	0.42	6.73	2.1	−0.7	8.5	2.3
Coarse grains	0.17	6.67	82.5	8.1	98.6	11.5
Forage	−0.98	−1.83	−2.6	−8.3	−1.5	−3.3
Total crops	3.24	24.54	4.4	1.8	6.5	3.8
Total livestock	9.31	15.67	−1.0	−4.1	−1.0	−1.8
Factor use						
Mach. & fertilizer	−0.90	−8.44	3.1	−2.0	7.1	4.0
Labour men	−3.55	−6.60	−0.5	−5.0	1.0	2.2
Labour women	−2.53	−2.55	0.1	−0.4	0.7	5.5
Labour children	−1.76	−1.91	0.9	3.1	0.9	4.7
Shadow prices						
Labour children	1.06	1.02	12.7	17.1	11.2	13.2
Net supply of wage labour						
Men	2.36	−1.66	−1.0	9.1	−4.7	48.7
Women	0.31	−1.74	27.5	−31.8	−59.1	54.4
Marketed surplus						
Hard wheat	1.14	6.17	3.6	−0.5	4.9	1.4
Soft wheat	−1.00	5.01	2.7	−1.2	−2.1	0.5
Meat	6.85	10.05	−1.4	−11.2	−0.6	−4.4

*Equivalent variation in full income to the change in indirect utility at base prices.
**Net of intermediate uses for coarse grains and forage.

and meat, rising forage prices induce a substitution in meat production from the use of forage to the use of grazing in the commons and hence intensified need for child labour. As a result, the use of children in production increases, their shadow price rises sharply, and their home time falls. Market failure for child labour and access to commons increase the negative effect of ASAP on the livestock economy. But, as mentioned above, the long-run conse-

quence is increased school absenteeism and more overgrazing in the commons, two of the curses of Moroccan underdevelopment.

We thus conclude by observing that the effects of price adjustments brought about by ASAP, given the set of elasticities used here, appear to be highly positive on the welfare of medium farmers who have important marketed surpluses, particularly if the ASAP is accompanied by credit availability that allows them to incur the higher cash expenditures necessary for the hiring of labour and the use of modern inputs. For small farmers, rising prices may be a mixed blessing, as they are important buyers of cereals for consumption and feed. And relaxation of the credit constraint brings only small relief as they, in any case, can use the labour market as a source of cash at a small efficiency cost. As such, the effects of ASAP would be regressive on the distribution of income in agriculture. As we will argue in conclusion, this suggests that ASAP would need to be complemented by vigorous programmes of rural development targeted at small farmers if this unequalizing effect is to be avoided. In all types of farms, however, the effects may be negative on the welfare of children, and thus indirectly on literacy and the environment, unless the productivity of forage production is enhanced, suggesting also complementary types of interventions to the price effects of ASAP if these negative consequences are to be avoided.

6. Conclusion

This paper has, we believe, opened the field of computable nonseparable household (CNH) modelling as a microlevel instrument of policy analysis. This can be thought of by analogy with the CGE (Johansen, 1964; Adelman and Robinson, 1978; Taylor, 1982), the MM (Quizon and Binswanger, 1986; Braverman and Hammer, 1986), and the integrated MM-CGE (Sadoulet and de Janvry, 1990) approaches, which offer macro and sectoral instruments of policy analysis that are now widely used. The household and macro-sectoral modelling approaches indeed have much in common, from use of the concepts of tradables and nontradables to that of identical computational algorithms. A clear advantage of the CNH approach is that survey data are available for the whole model as opposed to the CGE and MM situations, making estimation of the model possible, clearly the next step in pursuing this approach.

CGE, MM, and CNH models all find their policy usefulness in the systematic lack of comparable data over time that would allow to separate ex-post the impact of policy instruments. For this reason, recourse is made to simulation of policy impacts in such models, either to retrace historical effects in duly calibrated models or to explore alternative policy scenarios. As exemplified here, CNH models allow an exploration at the household level and in considerable detail of the effects of stabilization and adjustment

policies predicted by CGE-MM analyses. This zooming in on CGE-MM solutions through CNH is, however, a one way street that fails to create consistency between the two levels of analysis.

The results we have obtained in this paper fall in two categories: those that are based on the structural features of the model and those which derive from the interplay of the particular values of the elasticities used in the model. Among the first, the main results are:

(1) The elasticity of supply response of tradables is reduced by the presence of nontradables among either products which are home consumed or factors of production (see also de Janvry et al., 1991). The lower the substitutions between these goods and tradable alternatives, and the larger the shares of these goods in production or consumption, the lower the elasticity of supply response of tradables. To increase the elasticity of supply response of tradables, technological change needs to be directed at the nontradable products and factors, to ease the constraint which their production or availability imposes on the production of tradables.

(2) Accommodating a credit constraint imposes an endogenous markup on credit dependent tradables. This distorts the household's allocation of resources toward import substitution and greater exports of the credit-constrained products and factors. Small farmers were thus seen to remain heavily on the labour market, in spite of rising cereals prices, because wages give them an escape to the credit constraint at a relatively low efficiency cost. Such low-cost escape is not available to the medium farmers. Their elasticity of supply response and their ability to benefit from the higher prices offered by ASAP depend on relaxation of this credit constraint, confirming the fundamental importance of credit components in ASAP loans.

(3) For the small farmers, vigorous programmes of rural development must be put into place to allow them to become net sellers of the commodities whose prices have increased. The productivity of their land must consequently be raised and the new ASAP pricing rules should be seen as a historical opportunity to mount a massive complementary programme of rural development.

The conclusions which are dependent on the particular set of elasticity values used, and which are consequently to this point not as robust as the above, are the following. While ASAP displaces the farm economy from livestock to crops, pressures on the use of children for herding and overgrazing in the commons will not be relaxed if the price of forage increases with that of cereals due to competition in production. Avoiding this secondary effect thus requires focusing on the technology of forage production to lower its production costs. While the price adjustment occurs in cereals, technological change is needed in the forage-livestock economy. It also stresses the need to seek infrastructure investments and institutional arrangements that can reduce and ultimately eliminate the need for child labour in animal

production. They include the enclosure of fields and innovations in contracts for herding that achieve economies of scale (and thus raise the productivity of labour in herding, making it a remunerative activity for adults) while avoiding the problems of moral hazards which, to this day, have kept economically rational this ancestral practice of child use.

While the results obtained here should be suggestive, if only of the tremendous complexity and heterogeneity of the impact of macro and sectoral policies on different classes of households and on different members within these households, further research is needed before the CNH approach achieves reliable usefulness in policy analysis. Future areas of research include incorporation of behavior toward risk, specification of household-specific transactions costs on tradables, inter-temporal decision making on stocks and investment, institutional responses to market failures, and full estimation of the model.

Appendix Table 1. *Production elasticities*

	Hard wheat	Soft wheat	Coarse grains	Fruit & veg.	Forage	Milk	Meat	Handicft.	Machinery	Fertilizer	Male labour	Fem. labour	Child labour
Medium Farm Household													
Hard wheat	0.52	−0.13	−0.09	−0.09	0.02	−0.01	−0.18		−0.03	−0.02	−0.04	0.01	0.03
Soft wheat	−0.16	0.60	−0.06	−0.08	0.02	0.00	−0.09		−0.04	−0.21	−0.04	0.02	0.05
Coarse grains	−0.11	−0.06	0.78	−0.16	0.03	−0.03	−0.12		−0.04	−0.08	−1.16	−0.01	−0.06
Fruits & vegetables	−0.18	−0.13	−0.24	0.90	0.04	−0.01	−0.16		−0.04	−0.03	−0.20	0.00	0.05
Forage	−0.11	−0.08	−0.12	−0.10	−0.30	0.09	0.62		−0.01	−0.07	−0.13	0.11	0.11
Milk	−0.03	0.01	−0.12	−0.02	−0.10	0.85	−0.27		0.22	0.02	0.08	−0.36	−0.27
Meat	−0.11	−0.04	−0.06	−0.05	−0.08	−0.03	0.30		0.04	0.01	0.08	−0.01	−0.05
Handicrafts & services								0.70			−0.50	−0.10	−0.10
Machinery	0.07	0.07	0.07	0.06	0.00	−0.10	−0.17		−0.20	−0.02	0.17	0.04	0.02
Fertilizers	0.04	0.29	0.10	0.03	−0.03	−0.01	−0.03		−0.02	−0.10	−0.13	−0.08	−0.07
Male labour	0.05	0.04	0.16	0.14	−0.04	−0.02	−0.16	0.22	0.09	−0.10	−0.40	0.00	0.01
Female labour	−0.02	−0.05	0.02	0.00	0.08	0.22	0.07	0.11	0.06	−0.16	0.01	−0.40	0.06
Child labour	−0.12	−0.15	0.19	−0.11	0.09	0.20	0.30	0.13	0.03	−0.16	0.03	0.07	−0.50
Small Farm Household													
Hard wheat	0.48	−0.12	−0.08	−0.08	0.02	0.00	−0.17		−0.02	−0.02	−0.04	0.01	0.03
Soft wheat	−0.55	2.05	−0.20	−0.29	0.07	0.01	0.32		−0.12	−0.74	−0.15	0.06	0.16
Coarse grains	−0.89	−0.49	6.32	−1.28	0.26	−0.23	−0.97		−0.30	−0.61	−1.26	−0.07	−0.48
Fruits & vegetables	−0.10	−0.07	−0.14	0.52	0.02	0.00	−0.09		−0.03	−0.02	−0.12	0.00	0.03
Forage	−0.04	−0.03	−0.05	−0.04	−0.12	0.03	0.25		0.00	−0.03	−0.05	0.05	0.04
Milk	−0.01	0.00	−0.05	−0.01	−0.04	0.38	−0.12		0.10	0.01	0.03	−0.16	−0.12
Meat	−0.04	−0.02	−0.02	−0.02	−0.03	−0.01	0.11		0.01	0.00	0.03	0.00	−0.02
Handicrafts & services								0.36			−0.26	−0.05	−0.05
Machinery	1.32	1.37	1.42	1.13	−0.10	−1.97	−3.38		−3.97	−0.45	3.42	0.87	0.34
Fertilizers	0.05	0.36	0.13	0.03	−0.03	−0.01	−0.03		−0.02	−0.13	−0.16	−0.10	−0.09
Male labour	0.02	0.02	0.06	0.05	−0.01	−0.01	−0.07	0.09	0.04	−0.04	−0.16	0.00	0.00
Female labour	0.00	−0.01	0.01	0.00	0.02	0.05	0.01	0.02	0.01	−0.03	0.00	−0.09	0.01
Child labour	−0.03	−0.04	0.05	−0.03	0.02	0.05	0.08	0.03	0.01	−0.04	0.01	0.02	−0.13

Appendix Table 2. *Consumption elasticities*

	Price elasticities											Income
	Hard wheat	Soft wheat	Coarse grains	Fruit & veg.	Milk	Meat	Others	Home men	Home women	Home children	Savings	elasticities
Medium Farm Household												
Hard wheat	−0.84	0.20	−0.10	−0.10	−0.08	−0.15	−0.14	−0.23	0.12	0.16	−0.11	1.26
Soft wheat	0.33	−1.21	0.30	0.04	−0.08	−0.08	0.55	−0.04	0.20	0.18	−0.03	−0.08
Coarse grains	−0.05	0.34	−0.71	0.28	−0.05	0.01	0.05	0.07	0.26	0.22	0.03	−0.44
Fruits & vegetables	−0.03	−0.05	0.06	−1.50	−0.02	−0.02	0.18	−0.06	0.33	0.28	0.02	0.79
Milk	−0.10	−0.12	−0.10	−0.05	−1.23	0.42	0.09	−0.09	0.17	0.18	−0.03	0.87
Meat	−0.07	−0.08	−0.06	−0.04	0.17	−1.03	−0.16	−0.16	0.24	0.24	0.04	1.00
Others	−0.02	0.09	−0.04	0.10	0.02	−0.07	−0.90	−0.28	0.19	0.16	−0.06	0.80
Home time men	−0.05	−0.05	−0.04	−0.04	−0.02	−0.07	−0.29	−0.30	−0.10	0.14	−0.08	0.89
Home time women	0.02	−0.01	0.00	0.18	0.02	0.11	0.10	−0.30	−2.00	0.00	0.12	1.78
Home time children	0.11	0.04	0.04	0.32	0.07	0.25	0.27	0.25	0.05	−3.00	0.26	1.33
Savings	−0.07	−0.08	−0.06	−0.04	−0.03	−0.08	−0.23	−0.25	0.19	0.20	−1.00	1.47
Small Farm Household												
Hard wheat	−0.84	0.49	−0.17	−0.16	−0.12	−0.20	−0.15	−0.27	0.03	0.09	−0.15	1.44
Soft wheat	0.37	−1.21	0.33	−0.02	−0.03	−0.06	0.25	−0.07	0.20	0.34	−0.02	−0.09
Coarse grains	−0.01	0.33	−0.71	0.18	0.00	0.01	−0.03	0.02	0.27	0.43	0.03	−0.51
Fruits & vegetables	−0.04	−0.08	0.02	−1.50	−0.02	−0.02	0.14	−0.06	0.24	0.41	0.02	0.90
Milk	−0.12	−0.13	−0.12	−0.06	−1.23	0.38	0.08	−0.10	0.14	0.21	−0.04	0.99
Meat	−0.09	−0.13	−0.12	−0.05	0.16	−1.03	−0.19	0.16	0.18	0.32	−0.04	1.15
Others	−0.01	0.03	−0.12	0.08	0.02	−0.07	−0.90	−0.26	0.12	0.24	−0.03	0.91
Home time men	−0.06	−0.11	−0.11	−0.06	−0.03	−0.08	−0.34	−0.30	−0.12	0.25	−0.06	1.01
Home time women	−0.01	0.02	0.05	0.19	0.03	0.11	0.06	−0.35	−2.00	−0.20	0.08	2.03
Home time children	0.03	0.11	0.15	0.34	0.05	0.22	0.29	0.26	−0.11	−3.00	0.15	1.52
Savings	−0.10	−0.14	−0.13	−0.06	−0.05	−0.09	−0.23	−0.23	0.12	0.23	−1.00	1.67

Notes

1. Since this model is static, it cannot explain savings behaviour in relation to consumption smoothing and investment decisions. Savings are thus treated as an additional consumption expenditure from which utility is derived. Past accumulated savings enter in K and are undistinguishable from current credit. At the base point, K is assumed to be such that the credit constraint is non-binding.
2. The intuition behind the symmetry constraint is that marginal reallocation of resources among crops or inputs should produce the same profit and thus, at unit price, the same absolute increase in quantities or, equivalently, relative changes that are inversely proportional to the initial levels.
3. The fixed factor elasticities need not be reported: since we do not vary the level of fixed factors, their effect is included in the constant term as $b_{ii} + \sum_m b_{im} z_m^q$, and this value can be recuperated at the base run from $p_i\left(b_{ii} + \sum_m b_{im} z_m^q\right) = q_i - \sum_j b_{ij}\sqrt{p_i p_j}$.

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