Block-diagonal representation of a dualistic agricultural economy and its application in formal modelling: the case of Bulgaria

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Abstract

The paper discusses some of the problems of subsistence agriculture in countries in transition and proposes a methodology for analysis. It demonstrates that approaches which ignore the dualistic agriculture structure cannot provide consistent estimates of the behavioural parameters of the total agricultural sector. The bias is analysed using stochastic simulation and it is concluded that the subsistence agricultural sector has to be explicitly modelled alongside commercial agriculture. This is achieved using the principle of a block diagonal representation of dualistic agriculture, which is then applied to Bulgaria. This allows efficient decomposition of the different effects and provides a reliable representation of the process of agricultural commercialisation. The effects of subsistence farming on overall agricultural performance are presented and interpreted within a Structural Change Agricultural Policy Analysis Model (SCAPAM). The place of subsistence agriculture in transition economies is found to be compatible with optimisation principles and it is concluded that subsistence agriculture plays the role of market clearing. Some extensions of the methodology are discussed.

JEL classification: C13, C15.

Non-technical summary

None available

1. Introduction

Transition to the market economy in Central and Eastern Europe has resulted in a number of outcomes one of which is the widespread practice of small-scale subsistence or "peasant" farming. Consequently agriculture in the CEECs is now characterised by a dualistic structure comprising a market-oriented sector of commercial farms and much small scale subsistence farming. An important part of the production and consumption of many food products is not marketed. This large share of the subsistence sector makes overall agricultural performance unpredictable. Hence the prevalence of subsistence farming is a major problem in achieving a stable agricultural situation and in predicting aggregate policy effects. Uncertainty about future developments of subsistence farming creates problems for agricultural and rural development. Thus its analysis is important for policy making strategies which will lead to adjustments in the agricultural and rural economy.

In this paper we show that ignoring the underlying dualistic agriculture structure leads to models with unreliable forecasting abilities. The reasons for this failure are discussed and the conditions under which one can obtain reliable approximations by not explicitly modelling dualistic agriculture are defined. These are found to be restrictive and inapplicable to transition economies. It is then demonstrated how to model subsistence agriculture and its impacts on total agriculture are estimated.

The paper is organised as follows. First we present a description of the existing subsistence patterns in one country in transition, Bulgaria. The existence of similar patterns of subsistence agriculture in other CEECs is also shown, but our analysis is for Bulgaria. A brief review of recent analysis is presented followed by formal representation of a dualistic agricultural economy which investigates the ability of conventional modelling to produce unbiased results. It is shown that bias exists but has no specific analytical representation. The bias is further analysed via a stochastic simulation experiment, which leads to the conclusion that ignoring the dualistic structure of agriculture in countries in transition can have major effects on the results. Using the principle of a block diagonal representation, a dualistic agriculture sector model is then developed. Impacts of the subsistence patterns in Bulgaria are analysed using this approach and implications of the results and future research discussed.

2. The role and place of subsistence patterns in Bulgarian agriculture and other CEECs

Bulgarian agricultural production is characterised by a bimodal farm structure comprising a small number of very large productive units – co-operatives, private farming companies, informal associations and partnerships and a very large number of small scale farms. In 1996, 72% of farms cultivated only 7.2% of the total land, while, at the other extreme, only 0.4% of farms cultivated 85% of the land. The first group of farms is often ignored in economic analysis. It is regarded as an "exception to the rule" and defined as "neither efficient nor equitable" (Sarris et al. 1999). The conclusion of this approach is that small scale farms are not viable and will disappear in the near future. Such a view is incomplete. The farms exist all over Eastern Europe and can not be dismissed. They have now survived for more than ten years during transition and are the rule rather than the exception. In Bulgaria, small scale household farms currently account for more than 30% of total agricultural production.

The main feature of small scale agricultural production is its loose and incomplete links with the market. A substantial part of total consumption is not provided through the market but by household self-sufficient production. Table 1 shows the share of marketed quantities in total consumption which demonstrates the tendency towards household self-sufficiency, since the share of marketed quantities in total consumption has decreased during transition. The market provides less than half the supply of major food products and indicates the importance of household production in Bulgarian agriculture. This production is mainly self-sufficient and we define it as subsistence farming.

Table 2.1

Percentage of Bought Quantities in Total Consumption of Some Food Products in Bulgaria, 1989-1998.

Products	**1989**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**
Vegetables	75.9	71.4	60.0	59.9	63.6	68.1	59.8	63.9	62.9
Meat products	74.1	64.2	57.8	59.3	61.1	66.1	59.8	54.1	52.3
Milk	80.2	82.4	68.5	60.6	59.4	52.4	52.4	48.3	47.5
Potatoes	55.2	46.0	39.5	39.9	44.4	39.6	44.3	48.2	43.3
Meat	70.4	65.6	54.9	52.0	55.0	54.5	48.8	44.1	47.9
Fresh fruits	55.6	60.0	62.3	51.5	45.0	46.1	49.2	39.7	50.9
Eggs	39.4	39.6	41.2	43.5	38.8	40.9	38.4	34.4	36.7

Source: National Statistical Institute, Household Budgets Data.

Although consumption provides a general picture of the overall importance of subsistence behaviour, we are mainly interested in production. Table 2.2 presents information on the degree of commercialisation of various farming structures. A significant number of individual farms (77.2% on average) do not sell any production. This indicates the dominance of subsistence behaviour. Even large (over 10 ha) individual farms exhibit a low degree of commercialisation. Only 21% of large individual farms sell more than half their production. Part of the non-marketed production however is used as inputs for further production (e.g.. fodder for livestock), and the statistics do not accurately represent subsistence. Large private companies and co-operatives appear to be market oriented. Non-marketed production in the companies can be attributed to the use of some products as inputs, whilst the smaller degree of commercialisation in co-operatives could indicate some subsistence behaviour. The figures on small co-operatives reveal a strong self-sufficiency tendency. There is a polarisation among small private companies. About half are predominantly self-sufficient, while the other half are mainly commercial.

Table 2.2

Distribution of Farms, According to Degree of Commercialisation (Share of Marketed Production) and Size, Bulgaria, Cropping Season 1997/1998.

	0	up to 25%	up to 50%	up to 75%	up to 100%
Individual farms					
less than 0.5 ha	84.0	6.0	3.4	3.3	3.4
0.5 - 1 ha	64.0	9.3	11.4	10.5	4.8
1 - 5 ha	63.5	6.0	12.4	13.6	4.4
5 - 10 ha	31.2	32.4	11.5	9.7	15.2
more than 10 ha	10.8	14.4	54.0	11.9	8.9
Companies and co-operatives					
Small company	40.0	15.0	0.0	5.0	40.0
Large company	0.0	8.3	8.3	16.7	66.7
Small co-op	68.0	0.0	4.0	8.0	20.0
Medium co-op	11.5	9.0	24.4	26.9	28.2
Large co-op	0.0	6.7	20.0	35.6	37.8

Source: FAO, 1999.

This bimodal farm structure is not peculiar to Bulgaria, but exists in all countries in transition. It is however difficult to present a comprehensive comparative picture of farming structures in Eastern Europe because of the different formats of information.

Sarris et al. (1999) present detailed data. In Romania in 1995, 0.6% of farms cultivated over 40% of the land. A similar pattern occurs in Hungary, where, in 1994, the largest farms, comprising 0.2% of the total number of farms, cultivated 84% of the land, and at the other extreme, 77% of farms cultivated only 4% of the land. Data on the Czech Republic and Slovakia reveal similar bimodal farm structures.

The loose link of small scale household based production with the market is another common feature of agricultural economies in the CEECs. In Romania in 1996 (Sarris et al., 1999) 51% of farm households did not sell any production. It was officially recognised that in Poland "... over half of all farms have practically no involvement with the market." (Kwasniewski, 1999). Some 40% of the overall agricultural output in Russia in 1995 can be attributed to household self-sufficient production (Serrova et al., 1999). In Slovenia, in 1996, households consumed 54% of their own production (Sarris et al., 1999). The real problem is the lack of the market and the primary aim of this type of production is self-sufficiency rather than for sale. Subsistence farmers in Eastern Europe are surviving rather than pursuing profit objectives and conventional market analysis is not easily able to accommodate their situation.

Subsistence farming is not new in economics. This phenomenon characterises agricultural and rural economies in many LDCs. The term "subsistent" or "peasant" does not have an established definition. Often it is referred to as self-sufficient and non-marketed production. For an extensive description of subsistence agriculture see Wharton (1970). The widespread existence of subsistence patterns is not temporary and the problem lies not just in the nature of subsistence, but in its significant size and place in the overall agricultural economy. How can market derived analysis be applied to situations where the market does not exist? One could assume that, subsistence farmers act rationally and in the same way as commercial farmers. Subsistence farmers maximise utility functions that reflect both economic and non-economic factors and are subject to economic and non-economic constraints. Subsistence farming uses resources which could be used elsewhere in market-oriented farming and other sectors and its existence may cause a loss of overall production efficiency. Notwithstanding this loss of efficiency at the aggregate level, subsistence farmers may be efficient with regard to their own utility functions. Consequently from a conventional economics point of view, small-scale farmers are unlikely to react to government policies in a normal, "rational" way. However when they dominate the production of some products, predictions based on “normal” economic models may be unreliable. The reactions of the small farm sector to market signals are probably weak and a market-oriented agricultural policy may not have much influence.

The lack of markets and inclusion of non-economic considerations in decision-making processes are important aspects of subsistence agriculture. Subsistence behaviour could cause a perverse supply response (Ozanne, 1999) or an unusual consumption response which could invalidate the conclusions of market-grounded analysis. Even if subsistence farmers exhibit similar behavioural patterns to commercial ones, they will be different.

These differences destroy the image of representative economic agents and produce a world of heterogeneous economic behaviour. By not fully accounting for this, we may thus introduce bias into aggregate analysis which may lead to inconsistent results.

The first recognition of the existence of the problem is probably Mishev (1997) who stressed the different economic behaviour of subsistence farmers, compared to commercial ones. The framework of analysis is similar to that of Aghion and Howitt (1998) on market structure and firm behaviour. Subsistence farming is only loosely connected to markets and this approach was adopted by Sarris et al. (1999) and Serova et al.(1999). Its political dimensions were recognized by Kwasnewski (1999) and OECD (1999) now acknowledges the widespread subsistence practices in economies of transition.

The significance of subsistence is revealed by estimates of its share in production and consumption of major agricultural products. The AECD (Agency for Economic Co-ordination and Development) 1997 annual report, Bulgaria, determines shares from household budget data and presents an explanation for the growth of subsistence due to the fall in real incomes. A similar outcome is shown by Todorov (1998) who assesses the non-marketed sector using social accounting matrices. Caskie (2000) explains subsistence patterns as the outcome of the overall economic situation, which replicates work of Tho Seeth et al. (1998).

A quantitative evaluation of the likely effects of the subsistence sector on the overall agricultural economy in a partial equilibrium framework is developed in Mishev et al. (2002). They concentrated on the relationships of subsistence with the rest of the agricultural system and an intuitive informal justification of their approach is presented in Kostov (1999). Beckmann and Pavel (2000) apply a combination of computable general equilibrium and household models, but do not explicitly consider the relationships between subsistence and commercial agriculture.

3. Consequences of conventional modelling of a dualistic agriculture

It is common practice to ignore subsistence farming in quantitative analysis of agriculture. The weak price response of the subsistence sector combined with the stronger effects of commercial agriculture leads to a situation where the total production response is lower than when only commercial farming exists. The process of construction and estimation of a conventional non-dualistic agricultural model is based on pooled data from both subsistence and commercial agriculture and the parameters of the latter will be a mixture of those of the underlying sub-sectors. We ask whether a modelling exercise of a dualistic agricultural economy which ignores subsistence can be constructed to properly represent overall agriculture? Comparisons to a such model can provide a view about how conventional modelling can cope with the challenge of subsistence farming. We investigate whether it is possible to assess this response without explicitly including information about the subsistence sector in modelling the total sector. It seems intuitively clear that by ignoring the underlying dualistic structure will introduce bias in the results. We are interested in the nature and reasons for such bias and likely ways to overcome it. A dualistic agriculture which comprises both subsistence and commercial sectors with their own production and consumption functions could in a static framework be represented by some combination of them. It is clear that having only aggregate data one can estimate production and consumption functions for the total agriculture. Moreover if the period of interest is one year, this representation would be an exact one. The potential for bias in such a representation arises only in a dynamic framework. In general we do not know the exact form of the underlying production and consumption functions. Owing to this employing in the estimation of the parameters of total agriculture functional form which is different from the "true" production and consumption functions of subsistence and commercial agriculture, could in principle lead to reasonable approximation of the dynamics of total agriculture. If this is the case, then we would be able to predict the total agricultural response to given policies and thus subsistence would not represent a challenge for agricultural models. The important question that we investigate is when and how we can derive a reasonable representation of a dualistic agricultural economy?

3.1. Dualistic agriculture and its block diagonal representation

Let us consider an agricultural economy consisting of k commodities. Then the production vector can be expressed as:

$$p = (P_1, P_2, \ldots P_k, P_{k+1}, \ldots P_{2k})',$$

where production of the individual commodities has been split into commercial and subsistence components and ordered such that P_i and P_{k+i} for all $i \leq k$ are the commercial and subsistence components of the same commodity. If we denote p_c and p_s as the vectors of commercial and subsistence production we can express the "true" model of a dualistic agriculture as:

$$p(t+1) = \begin{pmatrix} p_c(t+1) \\ p_s(t+1) \end{pmatrix} = X(t) * p(t) = \begin{bmatrix} X_A(t) & X_B(t) \\ X_C(t) & X_D(t) \end{bmatrix} * \begin{pmatrix} p_c(t) \\ p_s(t) \end{pmatrix}, \quad (1)$$

where

X(t) is a matrix in which elements are general functions and which is partititioned above into four (k x k) matrices. We refer to the matrix X as a transition matrix. We use t to denote the information set at a given moment in time and the notation can accomodate any time dependency in the model. We consciously apply such a level of generality in order to be able to assess all potential implications. The above model is general and thus can represent any dualistic agriculture. Specifying the functional relationships in this case is unacceptable, because it would destroy the universal application of our analysis.

The above can be expanded into:

$$p_c(t+1) = X_A(t)p_c(t) + X_B(t)p_s(t) \quad (2)$$

$$p_s(t+1) = X_C(t)p_c(t) + X_D(t)p_s(t) \quad (3)$$

$(X_A - I)$ and $(X_D - I)$ give the own impacts of commercial and subsistence production on themselves one period ahead, while X_C represents the impact of commercial farming in the current period on subsistence farming in the next period. Similarly X_B gives the influence of subsistence production on the commercial sector one period ahead. These matrices are functionals not parameters, so without loss of generality we can cut off longer lags by simply accomodating them in a modified functional form. From a statistical point of view, the representation can be viewed as a projection of the "true" model expressed in a state space form

The most appropriate way to determine whether some alternative representation provides an acceptable way to deal with the problem is to compare the total aggregate effect. That is to compare, for example, total production obtained according to the alternative representations. Total production can be represented by:

$$y(t+1) = p_c(t+1) + p_s(t+1) = X_A(t)p_c(t) + X_B(t)p_s(t) + X_C(t)p_c(t) + X_D(t)p_s(t) \quad (4)$$

Let $p_s(t) = Q(t)y(t)$, where Q(t) is a diagonal matrix with elements defining the share of subsistence in total production that is $Q_{ii}=P_i/(P_i + P_{k+i})$ for all $1 \leq i \leq k$.

Then

$$y(t+1) = X_A(t)(I - Q(t))y(t) + X_B(t)Q(t)y(t) + X_C(t)(I - Q(t))y(t) + X_D(t)Q(t)y(t) =$$

$$[X_A(t) + X_C(t)](I - Q(t))y(t) + [X_D(t) + X_B(t)]Q(t)y(t)$$

Denoting $A(t) = X_A(t) + X_C(t)$ and $D(t) = X_D(t) + X_B(t)$ we can write this as

$$y(t+1) = A(t)p_c(t) + D(t)p_s(t) \tag{5}$$

which means that a block diagonal transition matrix can provide an exact representation of the total production effects. In order for the estimates obtained from this representation, to hold for more than one period ahead, the relative shares of subsistence and commercial production obtained must be true. If this occurs then these estimates will be true in general. That is we need:

$$p_c(t+1) = A(t)p_c(t) = X_A(t)p_c(t) + X_B(t)p_s(t)$$

and $$p_s(t+1) = D(t)p_s(t) = X_C(t)p_c(t) + X_D(t)p_s(t)$$

Both the above occur if and only if, $X_C(t)p_c(t) = X_B(t)p_s(t)$ (6)

Simply stated, the latter requires that the effects of subsistence on commercial agriculture be equal to those of commercial on subsistence agriculture. In order for this to occur, it is sufficient to base the model on a characteristic of production for which these effects are invariant with regard to the subsistence/commercial division of agriculture. One such characteristic for production is the resource base, that is area for crop products and number of animals for livestock products. A unit of land can be employed either in subsistence or in commercial agriculture. Consequently the effect of subsistence on commercial and commercial on subsistence will be the transfer of resources between the two sectors. Assuming indivisible units for these resources leads to equal effects between the sectors. This approach allows us to divide total agriculture into two autonomous sub-sectors, which can be modelled separately, but in a similar way on the resource basis. Therefore a block diagonal transition matrix can be applied to resources, which can have a dynamic behaviour (i.e. animals, machinery) specified but at any given time they can be employed in only one of the two subsectors. By later applying appropriate yield and production functions we can assess the total production effects. We denote the representation defined by (5) and (6) as a block diagonal representation.

Let us examine whether this choice of $A(t)$ and $D(t)$ is the only one possible. We assume there exist $A^*(t)= A(t)+U(t)$ and $D^*(t)=D(t)+V(t)$ which provide the true representation of dualistic agriculture. Then:

$y(t+1) = [X_A(t) + X_C(t)](I - Q(t))y(t) + [X_D(t) + X_B(t)]Q(t)y(t) =$

$A^*(t)(I - Q(t)) + D^*(t)Q(t) =$

$[X_A(t) + X_C(t) + U(t)](I - Q(t))y(t) + [X_D(t) + X_B(t) + V(t)]Q(t)y(t) =$

$y(t+1) + U(t)(I - Q(t))y(t) + V(t)Q(t)y(t) = y(t+1) + U(t)p_c(t) + V(t)p_s(t)$

Therefore $U(t)p_c(t) + V(t)p_s(t) = 0$ (7)

On the other hand from (2) and (3)

$p_c(t+1) = A^*(t)p_c(t) = X_A(t)p_c(t) + X_B(t)p_s(t)$

$p_s(t+1) = D^*(t)p_s(t) = X_C(t)p_c(t) + X_D(t)p_s(t)$

$X_A(t)p_c(t) + X_C(t)p_c(t) + U(t)p_c(t) = X_A(t)p_c(t) + X_B(t)p_s(t)$

$X_D(t)p_s(t) + X_B(t)p_s(t) + V(t)p_s(t) = X_C(t)p_c(t) + X_D(t)p_s(t)$

$X_C(t)p_c(t) + U(t)p_c(t) = X_B(t)p_s(t)$

$X_B(t)p_s(t) + V(t)p_s(t) = X_C(t)p_c(t)$

The above two equations are combinations of (6) and (7). This means that there is no gain in imposing requirements for uniqueness on the block diagonal transition matrix.

In the case of consumption, the invariant role with regard to the subsistence/commercial division can be represented by consumption units, that is population units. Although it is possible for a given person to consume both subsistence and commercial components of the same products, we can assume that consumption of the subsistence and commercial components of a product are backed up by "product populations" and every population unit only belongs to one of the two subgroups. Since every product will have its own "population" division, the population variable in such a model will be multiplied by the number of products. We do not need to explicitly model these "population" variables, but only their changes, which can be assessed as appropriate functional transformations of existing variables in the model.

3.2. Modelling dualistic agriculture by ignoring its structure

Now let us examine the consequences of discarding or ignoring subsistence farming. The traditional approach will not distinguish between p_c and p_s but will treat them as similar. We note explicitly that although this means we treat all agriculture as commercial, it does not imply that the parameters in the behavioural functions defining this total agriculture will be similar to these of the real commercial agriculture. The existence of subsistence means that this approach imposes some restrictions on the transition matrix. This can be regarded as a sub-case of the discussed alternatives of block diagonal transition matrix representation with

$$A^*(t) = X_A(t) + X_C(t) + U(t) = D^*(t) = X_D(t) + X_B(t) + V(t) = Z(t) \quad (8)$$

From (4), (7) and (8)

$$y(t+1) = Z(t)\, y(t) = [X_A(t) + X_C(t)]y(t) + [U(t) - V(t)]Q(t)y(t) \quad (9)$$

On the other hand using (7)

$$U(t)p_c(t) = -V(t)p_s(t)$$

$$U(t)(I - Q(t))y(t) = -V(t)Q(t)y(t)$$

$$U(t)y(t) - U(t)Q(t)y(t) = -V(t)Q(t)y(t)$$

$$U(t)y(t) = [U(t) - V(t)]Q(t)y(t)$$

The right hand side of the above is the last term in (9) which can be substituted to obtain

$$y(t+1) = =X_A(t)y(t) + X_C(t)y(t) + U(t)y(t) \quad (10)$$

It is clear from the discussion on the nature of the block diagonal representation that (10) should hold for any choice of U(t), which is not possible. While the choice of U(t) in an explicit representation of a dualistic agricultural economy will lead to an alternative representation of the latter, ignoring this dualistic structure can create substantial bias, which is expressed by the choice of U(t). It is not possible at this level of generality to say anything about the dimensions of this bias, but it it depends on the specific functional forms for the model. It is also not possible to present any analytical results for this bias. It will depend on the estimated parameters of the specific functional forms. Within the block diagonal representation framework, it is possible to get a representation in which U(t) is zero. As defined U(t) gives the "error" made in estimating the cross-effects between the subsistence and commercial sectors and as demonstrated this "error" does not have serious consequences on the future performance of the estimated model. This suggests that it is impossible to make U(t) zero in the case when we ignore the dualistic structure, because, in this case, this definition of U(t) does not make sense. Viewing U(t) as a term in the process of interaction between the subsistence and commercial agriculture sectors leads to the conclusion that the indirect "estimate" obtained when ignoring the dualistic structure will depend on both the size of the subsistence sector and the relative difference between its behaviour and to the commercial sector.

4. A simulation experiment

A simulation experiment was designed to analyse and assess the size of this bias and clarify when a conventional approach towards dualistic agriculture will not have serious consequences.

4.1. Design of the study

A hypothetical dualistic agricultural economy was constructed and a simple data generating process (DGP) assumed. Estimation of the behavioural parameters of this economy was carried out, ignoring the dualistic structure. Finally projected figures for total agricultural production are compared to those generated by the assumed real DGP.

We have prviously considered a general case without assuming any precise functional forms. We now assume specific forms to produce results. It is assumed that the agricultural production system operates under constant production elasticities and that the processes of estimation and forecasting also employ constant elasticities. Therefore it is necessary to construct an elasticities matrix and initial vector with production values for the base period. The latter was generated randomly. The elasticities matrix was constructed from a lower triangular matrix with randomly generated values which subsequently was corrected in accordance with the theoretical requirements of homogeneity and symmetry and the restriction for strictly positive values of the own price elasticities. The size of the simulated agricultural system was restricted to ten commodities and the minimum period for estimation of the corresponding elasticities matrix is ten years, the average length of transition. All major agricultural products can be covered in this model. For simplicity a deterministic DGP was considered. It was assumed that in the base year, half the total production for each commodity is subsistence based, the remainder commercial production, and the elasticities matrix constructed applies to the commercial part of agricultural production. Subsistence production was assumed to exhibit similar behaviour to the commercial sector but with a weaker price response. Its elasticities matrix was constructed by scaling the elasticities matrix for commercial production by 0.6. We rule out the possibility for perverse supply response (Ozanne, 1999), which can lead to greater differences than the design assumed here. The shares of subsistence correspond to the current values for commodities in countries in transition. A process of transformation of subsistence into commercial agriculture is assumed which further decreases the size and share of subsistence. The other difficult assumption is the equal share of subsistence for all products. This is employed to avoid the possibility of mixing up the effects of the different shares of subsistence with the price changes and the speed of transformation of subsistence into commercial agriculture.

One could ask why we have employed a hypothetical economy. Would it not be better to base our experiment on a real agriculture? First, we want to produce general, not specific results. Moreover, the characterisation of the existing dualistic agricultural economies in Central and Eastern Europe is in its infancy. Even basic measures of the share of subsistence agriculture are missing, let alone the functional parameters. Where the latter are available, as is the case of Bulgaria Mishev et al. (2002) employ quasi-constant production and consumption elasticities) the quality of the estimates is dubious due to the shortage and unreliability of the estimation data. The simulation can be valid only if one knows the true data generating process. The latter is impossible even if we had extremely long time series of reliable data simply because we would have to use the same data used in estimating the data generating process which would have been technically flawed.

Data for a period of 30 years has been generated thus: randomly generated price changes vectors for each of the 30 years have been applied consecutively to the base and following years separately to both subsistence and commercial production and total production has been estimated. 30 years length is sufficient to allow for generalisation of the experimental results. In addition, a constant rate of transformation of subsistence into commercial agriculture has been assumed and incorporated into the DGP. Schematically this can be represented by:

$$y_{st} = y_{s,t-1} + D_{s,t-1}*E_s*p_t - r*y_{s,t-1} \quad (11)$$

$$y_{ct} = y_{c,t-1} + D_{c,t-1}*E_c*p_t + r*y_{s,t-1} \quad (12)$$

where y is the production vector; E is the elasticities matrix, p - a vector of price changes, and r is the rate of transformation of subsistence into commercial. D is a symmetric diagonal matrix with production on the main diagonal and zeros elsewhere.

The subscript t refers to the time period (1 to 30) and the subscripts s and c denote subsistence and commercial production. The assumption of a constant transformation process of subsistence into commercial has been included to enable easier estimation of the behavioural parameters when subsistence is ignored and to restrict the possibility of additional bias. The simplistic assumption of a constant rate of transformation allows us to isolate the effects we wish to analyse without explicitly concentrating on the interaction process.

Based on the generated data, a model that ignores subsistence was constructed. Elasticities matrices, estimated by recursive least squares[1] on the basis of the first 10, 11 and so on years were constructed and the remainder of the 30 years period forecasted using the elasticities matrices. Projected values were then compared to the DGP. This process was replicated 500 times and the results averaged. This has been repeated for 12 different combinations of the rate of transformation and the variance of the randomly generated (from a normal distribution) price vectors. The values of the rate of transformation were set at 0, 0.01, 0.02 and 0.03. Price variation values were set at 0.02, 0.05 and 0.1. The case of no transformation was included to distinguish between pure price effects and the combined impacts of price and transformation changes. The last value of the rate of transformation is the limit that will complete the transformation of subsistence into commercial over the period. Therefore it is natural to divide the range of the values of interest for the rate of transformation (from 0 to 0.03) into several segments. The price variation values analysed correspond to average price changes of between 14% and 30. Actual price changes in the first years of transition were often much more dramatic. Using different price variations for the beginning and remainder of the period would allow us to represent the changes that avctually took place during transtition. This however introduces a structural break into our experiment, which will influence the results. Thus the simplifying assumptions rule out some factors that could possibly increase the effects we analyse. We seek generality of the results and owing to this we intentionally bias our experiment in a direction towards smaller differences. If in such a simplified and intentionally biased experiment the differences are substantial, this means that it is not possible to obtain reliable results by ignoring subsistence agriculture.

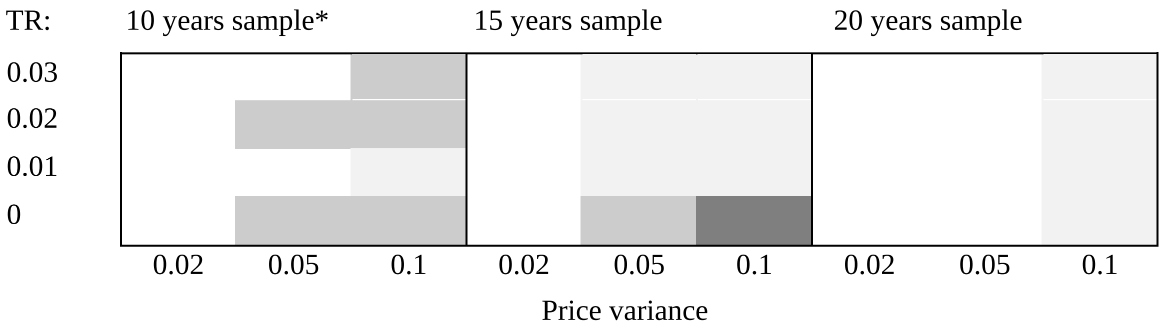
4.2. Simulation Results

[1] In this case the results will be inconsistent, because we have "mixing distributions". It is however impossible to obtain consistent estimates without employing information about the underlying distributions, that is the dualistic nature of the production process.

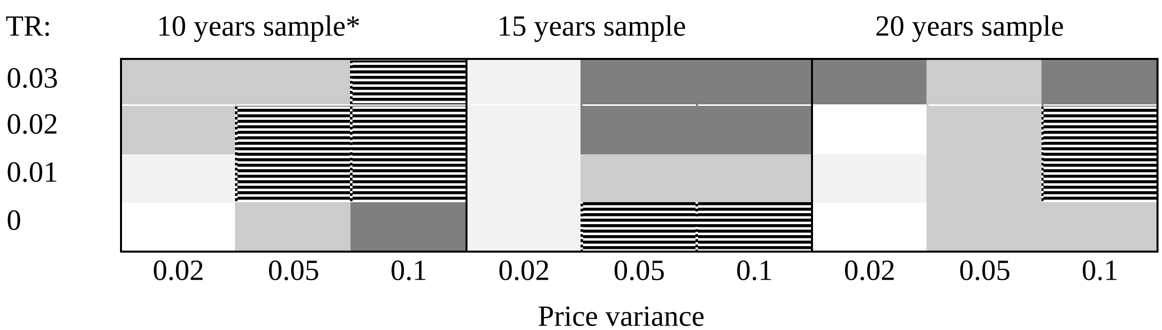
It was expected that both the transformation rate and prices variance would have negative impacts on the forecasting capabilities of the models. The greater price variance

Figure 1 Simulation Results

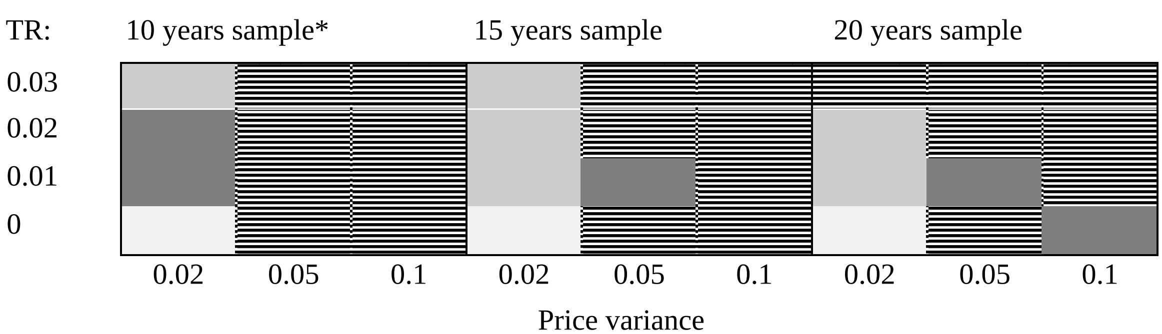
One year ahead forecast average error



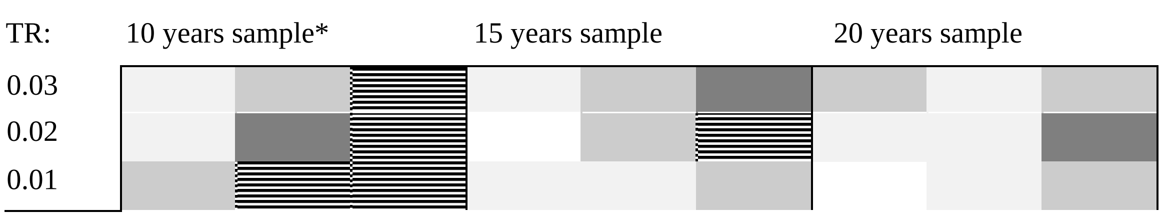
Five years ahead forecast average error

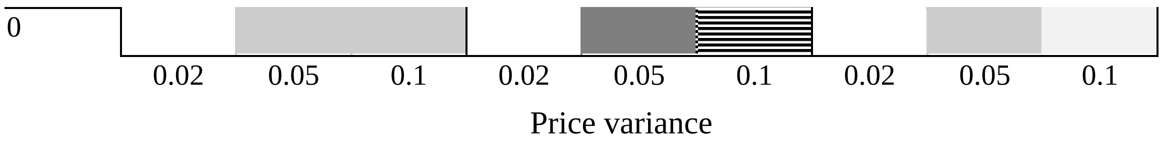


Ten years ahead forecast average error

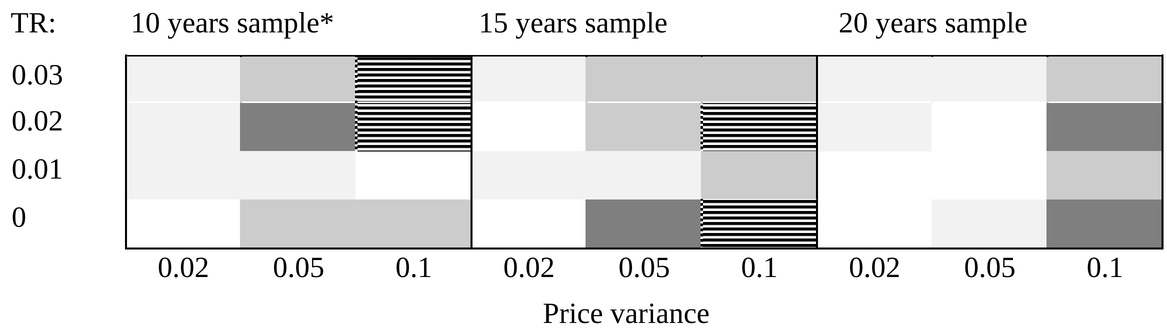


One year ahead forecast maximum error

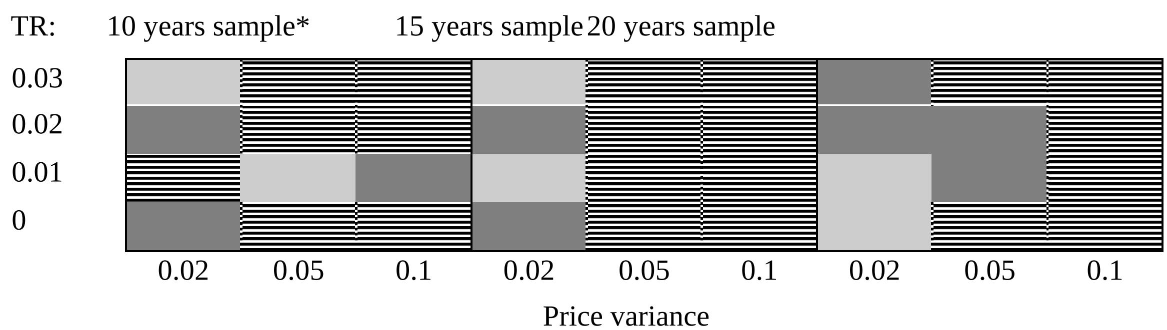



0
0.02
0.05
0.1
0.02
0.05
0.1
0.02
0.05
0.1
Price variance

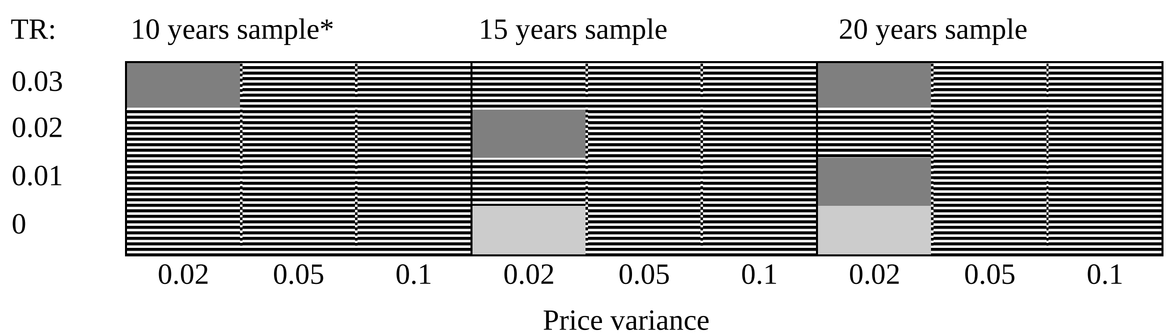
One year ahead forecast error bandwidth



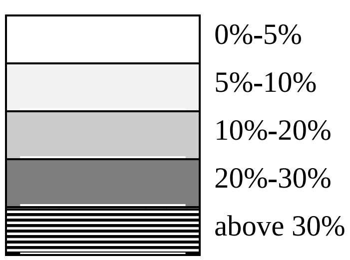
Five years ahead forecast error bandwidth



Ten years ahead forecast error bandwidth



Legend



TR - Transformation rate

has an impact. The greater price change increases the production outcome from the different types of economic behaviour and therefore the error following estimation will be larger. The impact of the transformation rate is not straightforward. When forecasts are based on the minimum sample size[2], as well as a low price variance, the greater transformation rate is associated with larger errors. However when the estimation is carried out over 15 or more observations and price variance is increased, the relationship is blurred. The lack of transformation between subsistence and commercial does not substantially improve results. The forecasts are still unreliable. In the case of five years ahead forecasts, augmentation of the estimation sample reduces the forecasting error; for 10 years ahead forecasts, this improvement is insignificant which is probably an indication of model misspecification.

It appears that the short term forecasts are reliable, because the average deviation from real values is small. Looking at the maximum deviation (the difference between projected and real values for the product with greatest error) this desirable picture vanishes. Nevertheless, the projections behave well when the estimation sample increases and this improvement is significant for smaller price changes. This shows that the short term forecasting abilities of a model that ignores subsistence, can be good under stable prices and for a long data set with which to estimate the behavioural parameters. Unfortunately this is not the case for countries in transition. Although the requirement for stable prices can be met for some countries, by cutting off the first dramatic transition years, there is often not sufficient data length. In the case of middle term forecasts, the estimated models are unreliable. Therefore subsistence has to be explicitly modelled to obtain reliable projections.

The bandwidth containing the error of the estimated models is defined by the difference between the smallest and largest error. Increasing the estimation sample decreases this bandwidth. In the case of transformation of subsistence into commercial, the bandwidth shrinks rather fast and although the average error does not converge, the bandwidth does. This means that the estimated models are biased, but introducing a shift parameter may increase their forecasting reliability. Thus we see that the existence of subsistence in this deterministic case of a DGP leads to the conclusion of a structural break. The problem with such a shifter is that for it to have a durable effect, it has to be constructed continuously as a sequence of structural breaks or as shift function rather than a parameter. It has been argued (Kostov, 1999) that these types of shifters are non-linear, due to the non-linear nature of the interaction process between subsistence and commercial. An attempt to find a linear approximation to the shifting function, when subsistence and commercial are modelled separately was carried out (Mishev et al.

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[2] In some cases the matrices formed by the data were near singular, and therefore estimation of the elasticities inefficient, the minimum sample size for these cases was increased to 11 or 12 years.

2002), but we have a non-linear transform of a non-linear function, for which it is difficult to find a linear approximation. Therefore even when subsistence and commercial agriculture are modelled separately, lack of information about the transformation process can restrict the gains to modelling effort to improve projections in the middle term, while longer term projections could still remain unreliable.

When there is no transformation, there is no need to introduce a shift parameter and it is easier to obtain reliable results by increasing the sample size. Nevertheless, it has been demonstrated that there exists an exact representation of the behaviour of the agricultural production system, in which subsistence and commercial are modelled separately and their behavioural parameters are adjusted to reflect the interactions between them. This can lead to the conclusion that a model of no transformation can approximate transformation cases, which contradicts our results. The latter can however only be true in the general case when no functional forms are specified. Accounting for the effects of the interactions between subsistence and commercial in this case however can not be done by retaining constant elasticities. In the models presented the transformation is approximated by a trend and the ambiguous results about the effect of the transformation rate follow from the linear approximation of a non-linear function.

4.3. Implications of the Simulation Experiments

The simulation experiment shows that ignoring significant patterns of heterogenous economic behaviour in subsistence farming in countries in transition, can invalidate results of analysis. As a quantitative implementation of the general case developed earlier, we can define some necessary conditions, if conventional modelling is to provide a reasonable approximation of the underlying process of a dualistic economy. It has been demonstrated that, even in a simplified framework, ignorance about the true underlying process can generate complex dynamics. Insofar as heterogeneity in an economy is the rule rather than the exception, detailed analysis of different behavioural patterns and their determinants can provide valuable information for analysis. In the case of subsistence farming, this information has to be extracted from its interactions with commercial agriculture. Therefore the challenge is in understanding and assessing the process under which subsistence farming is transformed into commercial farming.

The main factors influencing the bias introduced by ignoring the dualistic structure are:

- relative share of the alternative patterns of economic behaviour (that is relative importance of subsistence farming)
- stability of the economic environment
- nature and form of the interactions between the sub-sectors

Some conditions under which ignoring subsistence will not lead to serious consequences for the efficiency of the estimated parameters and the forecasting capabilities in the case of constant elasticities are listed but these are restrictive and inappropriate for most countries in transition. The conditions are:

- sufficient length of data period

To estimate a full production elasticities matrix in the case of constant elasticities production functions requires at least 30 years data. That is the cost of ignoring subsistence can be partially offset by increasing the length of the data set.

- stable relationships between subsistence and commercial

It is difficult to provide a formal definition of this requirement. It means that interactions between subsistence and commercial agriculture should be free of structural breaks or can be approximated from the data. This means that the process of transformation of subsistence into commercial has to be correlated with some of the parameters used to identify the model or the process has to exhibit a constant trend. There is thus a trade-off between the above two requirements. Lack of any interactions between subsistence and commercial for example can decrease the length of data required to 20 observations.

- stable prices

Relative price changes have to be small. Under constant elasticities production functions these have to be within 10% per year. While this is usually the case in developed countries, the CEECs experienced massive price changes at the beginning of transition.

The above conditions have to hold simultaneously in the time periods used for both estimation and forecasting in order for conventional models to provide reasonable approximations of the performance of the total agricultural economy. Unfortunately they are all violated in most countries in transition. Elaboration of more realistic approximations requires ever more severe restrictions.

5. Using the block diagonal representation in modelling dualistic agriculture

5.1. General description of the approach

It is thus necessary to explicitly model the dualistic agricultural structure in order to obtain reliable results about future agricultural performances. The main tool used here is the SCAPAM (Structural Change Agricultural Policy Analysis Model) methodology. We present a general description of the main principles of this approach with regard to the block diagonal representation of a dualistic agricultural economy and its implications for modelling. Detailed functional description can be found in Mishev et al. (2002). SCAPAM is a partial equilibrium, dual structure, small country, agricultural simulation model constructed on the assumption that agricultural policies result in changes in prices of agricultural products. That is domestic prices quantitatively express agricultural policies and are the main instruments to generate production and consumption responses. In the case of Bulgaria, a small country, world prices are not influenced by domestic policies. Consequently domestic and world prices are exogenous to the model.

The partial equilibrium assumption is needed to make the model workable and means that markets are at equilibrium in the base and following periods, other commodity markets outside the agricultural sector being in equilibrium too, and changes in these other markets have no direct influence on agricultural markets. The latter effects are not excluded from the model but are assessed through some macroeconomic variables. Therefore developments of other sectors of the economy are implicitly included in the model. Every individual product market is cleared through foreign trade. The total crop area is constant and price movements and other variables affect the distribution of this area between the different crops. Liberalised exports and imports are also assumed - that is, if no specific agricultural policies are assumed, the price of each product equals the world price, corrected for any discrepancy due to price transmission.

The basic idea is that commercial and self-sufficient production have different objectives and their outcomes will have different characteristics. Thus the products of subsistence and commercial agriculture are intrinsically different and should be treated as such. As a result one can expand the existing agricultural product structure by splitting every product into market and subsistence components and then treat these components as different products.

The split of agricultural production and consumption into subsistence and commercial components significantly increases data requirements for estimation of the behavioural parameters and represents a two fold increase in the number of products. However we can obtain an exact block diagonal, with regard to the subsistence and commercial representation of the behavioural parameters. This allows both subsistence and commercial sectors to be modelled by incorporating the cross effects between them in separate models for subsistence and commercial products. It would be appropriate to base the modelling on invariant with regard to subsistence and commercial sector measures of production and consumptions, that is a measure which provides the same cross effects between those two sectors. SCAPAM uses constant elasticities functions to represent the production and consumption components of agriculture. The behavioural parameters are the elasticities. An invariant with regard to the subsistence/commercial division measure of agricultural crop production is land area. A unit of land can belong to only one of the two sectors. Therefore crop production can be represented via area/price elasticities, which reflect the area re-allocation between the different products within the subsistence or commercial sectors. Different yield functions for subsistence and commercial farming, applied to this land then give total production. An invariant measure of livestock production is the number of animals, which allows the same approach to be applied.

Consumption is modelled similarly, based on "consumption units". While subsistence consumption is equal to subsistence production, commercial consumption is determined in terms of the division of the total population into "commercial" and "subsistence". This division is done separately for each product, according to the size of subsistence. Commercial consumption for a given product is obtained by applying consumption elasticities to the "product population".

Thus far subsistence and commercial sectors are presented separately, ignoring the interactions between them. The essence of the block diagonal representation is to incorporate these interactions into the separate models for subsistence and commercial production and consumption. In terms of SCAPAM this is achieved by using a parameter which simulates the process of interaction between subsistence and commercial production, by transforming area (or number of animals) from subsistence into commercial use and vice versa, according to real income changes. One can define this as the elasticity of substitution between subsistence and commercial production. Real income is selected as a proxy for the economic opportunities (incomes, job opportunities, overall economic development). Mishev et al. (2002) present a detailed description of an optimisation algorithm for estimating the values of the elasticities of substitution, based on Sato (1972). The interaction is highly non-linear and Kostov (1999) states that such an elasticity-like parameter can be reliable only in the medium term. The transformation process thus drives resources in and out of the subsistence sector thereby changing its size. In terms of consumption, this change means change in the product specific "populations", that is transforming some production from subsistence into commercial use, drives people out of the subsistence sector and enlarges product markets.

SCAPAM can be used to obtain projections about the future performance of the agricultural sector. Our objective here is to evaluate the impacts of the existing dualistic structure on the overall agricultural economy. These effects can be expressed as the difference between the total production and consumption responses with and without subsistence and can be calculated by constructing an additional model in which we pool subsistence and commercial product components. The behavioural parameters of this additional model should be the same as those of commercial components in the main model. This is equivalent to allowing subsistence to exhibit the same behaviour as commercial agriculture. The difference in projections of these two models at aggregate level will be a measure of the impacts of subsistence on total agriculture. This is not a comparison between modelling the agricultural sector by accounting for and ignoring its dualistic structure, which is a different aspect of the problems posed by subsistence farming and has been analysed in the simulation experiment. The impacts of subsistence, calculated here, assume that the model parameters, i.e. elasticities for commercial and subsistence sectors are correctly specified. Moreover the approach adopted to model the interaction process between subsistence and commercial sectors could over or underestimate the effects in the long run. Due to this we present results of the comparison for the medium term, seven years ahead forecasts.

5.2. SCAPAM results

Several scenarios with liberalised agricultural policies and gradual implementation of CAP 2000-like policies, as well as different rates of economic growth are assumed. The price scenarios of CAP Agenda 2000 policies consist of gradual price adjustments over three years and application of quantitative restrictions in the year of accession. The liberalised agricultural price scenario is expressed by imposing world prices[3] in the domestic market. The above two price scenarios are combined with moderate (2%), high(3-5%) and explosive (5-8%) annual real income growth. In the first two cases, the higher figure is applied for the first two years with the lowest figure for the rest of the projected period. As a result six scenarios are obtained. In the scenarios that simulate possible EU membership, the year of comparison is the year of joining the EU.

Although production and consumption response vary by scenario, the estimated impacts of subsistence on total agricultural production and consumption, which are the ratio of the forecasts of the two models, appear to be robust with regard to the modelled price policies and income growth[4]. The results are the likely impacts of subsistence on overall agriculture in the period before possible accession into the EU. The process of joining the EU could induce structural breaks that are likely to change the rate of transformation of subsistence into commercial (Kostov and Lingard, 2000). It is however difficult to make reliable assumptions about the nature and the intensity of future structural breaks. Nevertheless the robustness of the results to the chosen price scenarios, confirms the conclusions of Mishev et al. (2002) and Beckmann and Pavel (2000) that price policies do not have a considerable influence on the development of a dualistic agricultural economy.

It can be expected that subsistence represents an aggregate loss of efficiency and should reduce the expected agricultural output. This reduction is shown in figure 2.

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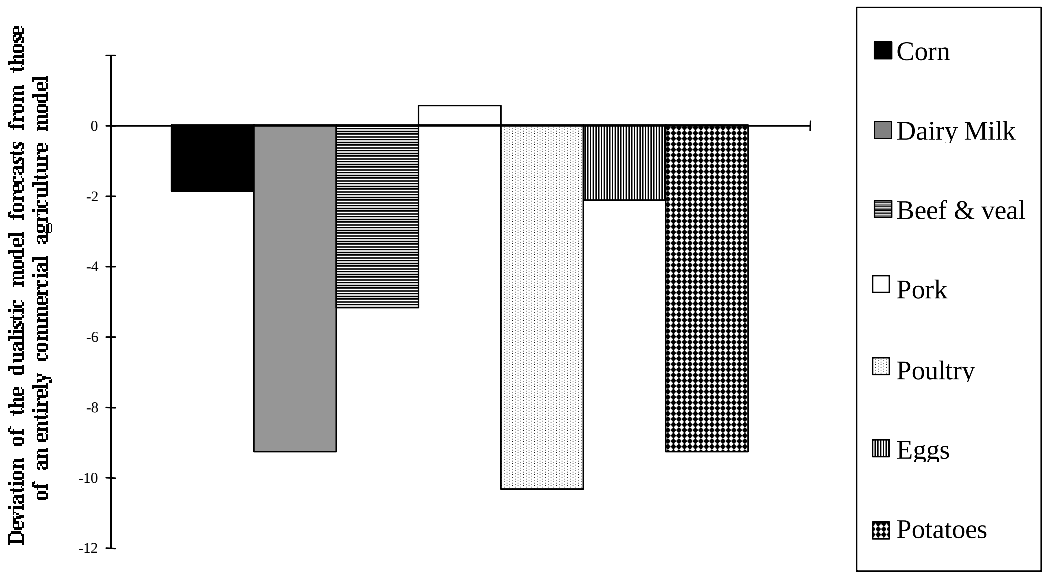
[3] USDA 1998 world price projections are used. Domestic prices are corrected for price transmission between world and domestic prices.

[4] Income growth is positive in all scenarios which means a one way transformation of subsistence into commercial. Therefore the robustness of the results is conditional on positive income growth.

Figure 2.

Impact of subsistence on production (in %) - seven years ahead forecasts

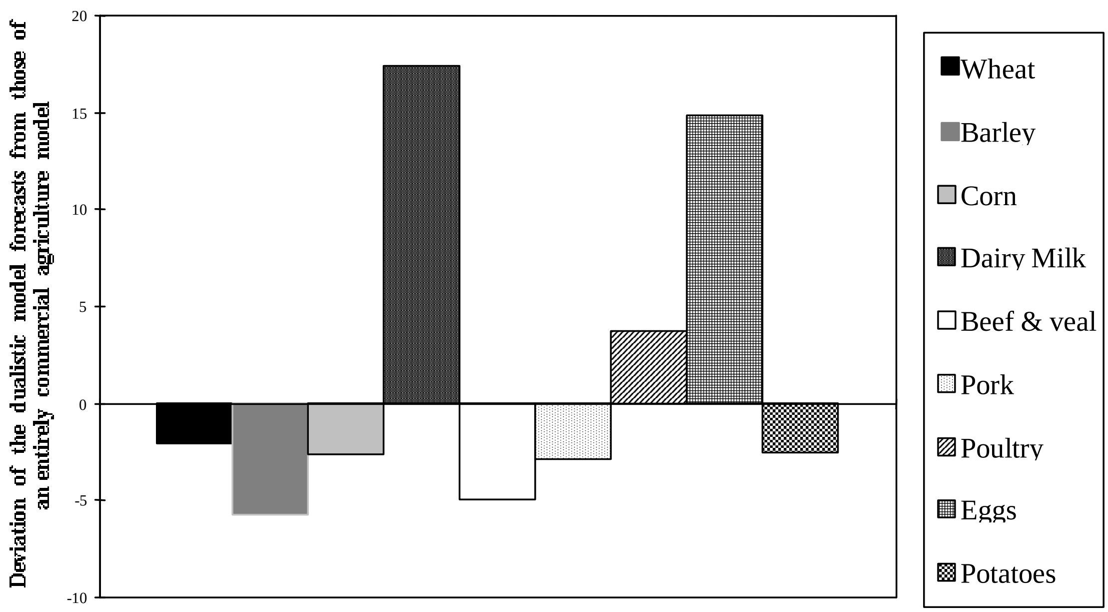


Pork does not seem to be affected by subsistence. This may seem surprising, bearing in mind the significant share of subsistence in total pork production. The current relative price for pork is high, which means that in all scenarios it is assumed to decrease which restricts the potential growth of commercial pork production. Consequently the subsistence effects on pork production are insignificant. The effects of subsistence for milk, poultry and potatoes are large. These products have a considerable share of subsistence. The result for beef and veal appear low, given that the price increase in EU scenarios is significant. However, Bulgaria has traditionally been a net importer of beef and the pre-conditions for effective beef production are lacking.

It has to be stressed however that subsistence is predominantly a consumption phenomenon and consumption effects are our main interest. In terms of consumption, the results are mixed; there is an increase for some products, a decrease for others.

Figure 3.

Consumption impacts of subsistence (in %) - seven years ahead forecasts



There are considerable positive effects for consumption of milk and eggs, but otherwise the consumption effects of subsistence are relatively low. The large share of household milk production should lead to considerable subsistence effects. There are significant technological differences between subsistence and commercial egg production, which explains the considerable consumption effects of subsistence for eggs. The negative effects in consumption for cereals are due to the negative production effects for livestock, expressed in lower relative feed consumption for cereals. Consumption effects of subsistence are a combination of the impacts of the relative share of subsistence for a given product, technological differences between subsistence and commercial production and different demand functions in the subsistence and commercial sectors. These effects all have the expected direction. The only exception seems to be pork. This is surprising given the significant share of subsistence in pork consumption and production and its low price responsiveness. The subsistence effects are derived from a seven years ahead comparison, which includes some dynamic effects particularly economic growth which results in a relative increase in commercial consumption.

The calculated impacts of subsistence agriculture are the future impacts of the current dualistic agricultural structure which are path and time dependent. The low magnitude of the negative consumption effects, given the increase in incomes, means that the contemporary consumption effects of subsistence are positive. The contemporary effects include the current differences between subsistence and commercial consumption functions. One could regard the contemporary effects of subsistence as short term effects, because they are deduced by keeping incomes relatively stable. The long term effects of subsistence are impossible to calculate since they depend on the specific configuration of many factors, such as incomes, economic growth and market development. Subsistence is an income related phenomenon and income opportunities are a major factor in its developments. Subsistence farming has significant welfare effects. It restricts the fall in consumption due to price and income shocks during transition and its impact on production is not necessarily negative. When the relative market price decreases, the lower price response of subsistence leads to a smaller fall in total production compared to when there is no subsistence. Therefore unless there is considerable improvement in incomes and employment, subsistence agriculture will retain its significant share, because its existence is consistent with utility optimisation.

This view reveals why subsistence effects are price inelastic. Subsistence and commercial price elasticities, though evolving over time according to the transformation process of subsistence into commercial, remain relatively stable. They are almost constant in relative terms. Assumed income growth has substantial effects on commercial consumption via its behavioural parameters and the "population" base. Hence the main effects of subsistence relate to food consumption. Even if the production functions of subsistence and commercial agriculture were identical, there would be significant dynamic consumption effects.

Both production and consumption effects are time dependent and the main factor influencing them is the process of transformation of subsistence into commercial. The factors that determine this process are instrumental in assessing the impacts of subsistence. One factor is economic growth. These factors are external to agriculture and exogenous to the model. Some of the assumptions employed by the SCAPAM approach, namely the constant elasticity of transformation and the similar pattern of the transformation process for all products appear restrictive. A product specific representation of the process of agricultural commercialisation would aid further understanding and assessment of the impacts of subsistence agriculture.

6. Conclusions on the role and place of subsistence agriculture

It has been shown that subsistence has positive impacts on total food consumption. On the other hand, its impacts on total production are negative. The positive consumption effects can be regarded as a response to the worsened income situation during transition. Therefore in terms of consumption, subsistence farming is compatible with the optimisation hypothesis. However the perceived loss of total production efficiency leads many economists to believe that subsistence is an "inefficient" and "unacceptable" phenomenon. Our results confirm this conclusion. Nevertheless, one of the assumptions employed in SCAPAM was the clearing role of foreign trade. For many agricultural products, foreign market access is questionable. In this case subsistence reduces supply pressure on the domestic market by decreasing the "efficiency" of agricultural production. Therefore subsistence farming has a stabilising effect on the domestic food market. Its expansion during transition is a logical outcome of economic conditions and it is unlikely to vanish unless a radical improvement in incomes takes place. The foreign market could influence the process of agricultural commercialisation and can be handled within the SCAPAM framework by introducing an additional demand for exports and allowing domestic market clearing via additional transformation of subsistence into commercial. This will result in a dualistic agriculture model, which will still be consistent with the main principles developed. Such an extension will allow the effects of agricultural commercialisation to be decomposed according to their sources.

We have demonstrated the challenge that subsistence agriculture in countries in transition presents for quantitative analysis. We have established the impossibility of conventional modelling approaches obtaining consistent and unbiased estimates for future agricultural performance. The formal analysis of a dualistic agricultural economy has provided us with the block diagonal representation, an important tool for modelling subsistence agriculture. We have also quantitatively analysed the nature of the bias introduced into analysis by ignoring subsistence behaviour. In this way one can define the conditions under which the impacts of subsistence on total agriculture will be small. By quantitatively assessing these impacts we were able to define the market role of subsistence agriculture. Subsistence agriculture in transition countries is not only an employment and income related phenomenon. Subsistence is a direct consequence of constrained domestic and foreign markets opportunities and markets are the key to agricultural commercialisation.

References:

Agency for Economic Co-ordination and Development (AECD) (1997) *Annual Report*, (Sofia, AECD).

Aghion, P. & Howitt, P. (1998) Market Structure and the Growth Process, *Review of Economic Dynamics*, 1, pp. 276-305.

Beckmann, V. & Pavel, F. (2000) The Logic and Future of Subsistence Farming in Transition Economies: The Case of Bulgaria, 70th EAAE Seminar, Thessaloniki, 9-11 June.

Caskie, P. (2000) Back to Basics: Household Food Production in Russia, *Journal of Agricultural Economics*, 51(2), pp. 196-209.

Frisch, R. (1959) A Complete Scheme for Computing All Direct and Cross Demand Elasticities in a Model with Many Sectors, *Econometrica*, 27(2), pp. 177-196.

FAO (1999) Strategy for Agricultural Development and Food Security in Bulgaria, Main Report, July.

Kostov, P. (1995) Employment in Bulgarian Agriculture During Transition, Working Paper No2, Project 94.5, Sofia, PAU, MAFI.

Kostov, P. (1999) Overview of Economic Developments in Bulgaria During Transition and Emergence of Subsistence Farming, Working Paper, Dept. of Agricultural Economics and Food Marketing, University of Newcastle.

Kostov, P. & Lingard, J. (2000) Modelling the Effects of Subsistence on Bulgarian Agricultural Performance, Manchester, AES Annual Conference.

Kwasnewski, A. (1999) Address of the President of the Republic of Poland to the 9th European Congress of Agricultural Economists, Warsaw, August 26.

Mishev, P. (1997), Financial Support Schemes for Bulgarian Agriculture, Working Paper, World Bank Project "Review of Bulgarian Agriculture", Sofia.

Mishev P., Ivanova, N. & Kostov, P. (2002) Analysing Agricultural Policy Options Under Transition in View of Future Accession to EU: Partial Equilibrium Dual Structure Sector Model for Bulgaria, in: G. Mergos (ed.) *EU Enlargement and the CAP. A Quantitative Analysis for Slovenia and Bulgaria*, Kiel: Wissenschaftsverlag Vauk.

Mishev, P. & P. Kostov (2000) Subsistence Farming in Bulgaria - Trends and Prospects, Scientific Conference "Subsistence Production in Central and Eastern Europe", 7th East-West Agricultural Forum , Berlin.

OECD (1999) *Agricultural Policies in Emerging and Transition Economies* (Paris, OECD).

Ozanne, A. (1999) Perverse Supply Response in Peasant Agriculture: A Review, *Oxford Development Studies*, 27(2), pp. 251-270.

Sarris, A. H., Doucha, T. & Mathijs, E. (1999) Agricultural Restructuring in Central and Eastern Europe: Implications for Competitiveness and Rural Development, *European Review of Agricultural Economics*, 26(3), pp. 305-329.

Serova, E., von Braun, J. & Wehrheim, P. (1999) The Impacts of Financial Crisis on Russia's Agro-food Sector, *European Review of Agricultural Economics*, 26(3), pp. 349-370.

Sato, K. (1972) Additive Utility Functions and Double-log Consumer Demand Functions, *Journal Of Political Economy*, 80, pp. 102-124.

Tho Seeth, H., Chachov, S., Surinov, A. & von Braun, J. (1998) Russian Poverty: Muddling Through Economic Transition with Garden Plots, *World Development*, 26(9), pp. 1611-1623.

Todorov, T. (1998), The Role of the Agricultural Sector During the Transition: Country Study - Bulgaria, Part: SAM Analysis, Workshop "The Role of the Agricultural Sector in Transition" Halle, June.

Wharton, C. R. (ed.) (1970) *Subsistence Agriculture: Concepts and Scope*, (Chicago, Aldine).