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Peasant Response to Price Incentives in Tanzania

A Theoretical and Empirical Investigation

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Preface

This report is a revised and updated version of a study undertaken at the Department of Economics, Uppsala University, in 1989. It was later—in 1991—printed in the Minor Field Study series at the Department of International Economics and Geography, the Stockholm School of Economics.

There are three persons to whom I owe special gratitude: Professor Mats Lundahl at the Stockholm School of Economics, Professor Benno J. Ndulu at the Department of Economics, the University of Dar es Salaam and Assistant Professor Yngve Andersson at Uppsala University. Their support during various stages of this study has been invaluable to me. I also wish to thank the Swedish International Development Authority (SIDA) for making this study possible by financing a three month visit to Tanzania in 1988.

Introduction

Since the 1950s, there has been a discussion within development economics about the rationality of peasant behaviour in developing countries. The debate actually concerns how peasant supply of agricultural output responds to economic incentives, particularly prices. To begin with, there was a widespread belief, among economists, public officials and others, that peasants in developing countries are irrational in the sense that they are unresponsive to economic incentives. Since their decisions were considered to be primarily motivated by traditions, peasants were not assumed to be economic men in the neoclassical sense. (Johnson, 1978:209–210; Lundahl, 1987:108; Oyejide, 1990:14–15) This implied that orthodox microeconomic theory was considered to be inapplicable to the study of peasant behaviour in these countries. In addition, prices were considered to be an inefficient means of stimulating agricultural supply.

This view was gradually partly abandoned, as a result of both theoretical developments and empirical investigations in the field. In the mid-1960s, Theodore Schultz (1964) initiated a theoretical discussion when he argued that although Third World peasants were poor, they were indeed profit maximising and efficient.¹ Several economists estimated own price elasticities of supply,² and found them to be positive for various crops in different countries.³ Nevertheless, many of the empirical studies displayed a fairly weak supply response, and it was argued, by Schultz and others, that in many developing countries agricultural incentives had been distorted by extensive government interventions (Schultz, 1978). Incentive distortion was viewed partly as a result of the lack of faith in the price mechanism and market forces—one of the main elements in what Deepak Lal (1983) has called the ‘dirigiste dogma’. According to Schultz’ line of reasoning, peasants do not remain at low income levels as a result of a failure to respond to price incentives. It is rather that incentives to produce and sell have been poor. There would now seem to be a fairly widespread consensus that peasant supply in developing countries is responsive to price incentives, at least for individual crops.

¹ For a survey of Schultz’ theory, see Lundahl (1987).

² Supply response to price incentives is usually measured by elasticities, which thus are measures of responsiveness. The own price elasticity of supply measures the percentage change of supply (of a good - or crop) in response to a one percent change in its own price.

³ See Askari and Cummings (1977) for a survey.

Peasant supply response, however, remains a topic of current concern, although the emphasis has shifted away from the issue of whether peasant supply is responsive to price incentives at all. Today, attention is instead geared towards issues such as the responsiveness of total agricultural supply to price incentives, the relative effectiveness of price incentives in comparison to that of other factors that influence agricultural supply, and to the importance of the preconditions given by the institutional set-up,⁴ infrastructural network etc. for price incentives to be effective.⁵

In Sub-Saharan Africa (SSA), the issue of peasant supply response has gained renewed actuality in relation to the current processes of economic reform.⁶ Because of the dominant role of the agricultural sector in these economies, agriculture has been the focus of the structural adjustment programmes (SAPs) adopted. By improving agricultural incentives—both prices and non-price factors—the programmes have aimed at increasing agricultural production and exports. According to Ademola Oyejide (1990:18), these reform attempts have assumed strong supply responses to changes in prices and other incentives. The actual response has not, however, been as strong or as quick as expected.

A realistic assessment of the effect of SAPs on the growth performance of the agricultural sector in specific countries requires that the supply response to changes in the incentive structure can be determined. It is particularly in this context that the direction, magnitude and speed of the response of aggregate supply become relevant. If aggregate agricultural supply responds positively to changes in the agricultural terms of trade—the price of agricultural products relative to the price of products from other sectors in the domestic economy—prices may have a role to play as policy instruments that promote agricultural growth. There is, however, a view that supply response

⁴ The term 'institutions' may refer to organisations and organisational structures as well as 'rules of the game'. Since organisational structures are often associated with specific rules of the game, the two are closely interrelated. In this study, however, the concepts 'institutions' and 'institutional' are used in the sense of 'organisations' and 'organisational'.

⁵ The response of aggregate agricultural supply is discussed in e.g. Amani & Ndulu (1987:6-7), Brown (1978:84-89) and Fones-Sundell (1987:8-9); the relative effectiveness of price incentives in Ellis (1982:270), Fones-Sundell (1987:1-2, 5, 12-15) and Johnson (1978:210-212); the importance of institutional and infrastructural conditions in Amani et al. (1987:6-7), Johnson (1978:211-212) and Lundahl & Ndulu (1987:198). For particular reference to Tanzania, see Amani et al. (1987), Amani & Ndulu (1987), Ellis (1982) and Lundahl & Ndulu (1987). Fones-Sundell (1987) refers to Africa; Brown (1978) and Johnson (1978) to developing countries in general.

⁶ Supply response in the context of structural adjustment in SSA countries has been studied by Oyejide (1990), who demonstrates the need for further research on the issue.

to price incentives is constrained by institutional factors, such as 'inadequate infrastructure, poorly developed markets, rudimentary industrial sectors, and severe institutional and managerial weaknesses in the public and private sectors' (World Bank, 1988:3, quoted in Oyejide, 1990:10). Consequently, the effectiveness of supply response is also relevant in this policy context.

In Tanzania the issue of peasant supply response to price incentives has also a direct bearing on certain practical issues. Problems of food security and agricultural exports have been severe during a large part of the post-colonial period. Moreover, since the mid-1980s, Tanzania has, by adopting structural adjustment programmes, embarked on a market oriented economic reform process.⁷ Considerable efforts have been made to stimulate agricultural production. Supply response to price incentives has, however, been weak in certain respects, particularly as regards export crops (World Bank, 1991:II:1:32–33). The understanding of peasant behaviour in terms of supply responsiveness at the microeconomic level is crucial for an understanding of the effect of policies and other changes at the macroeconomic level. This issue is accordingly of current interest in our attempts to understand the role and effectiveness of price incentives and the impact of economic reform on the agricultural sector, in particular, and structural adjustment and economic growth, in general.

The general developments in the view on peasant supply response can also be observed in the case of Tanzania. When the general outlines of agricultural development in independent Tanzania were laid down in the 1960s, the prevailing view was that peasant supply of agricultural crops was unresponsive to market signals. Smallholder peasants were believed to have rather low target levels of income. Once this income level was reached, peasants would not aspire to higher levels of income. Since traditional agricultural production was considered to be mainly concerned with satisfying basic subsistence requirements, market incentives were deemed to be an inefficient means of stimulating agricultural production (Amani & Ndulu, 1987:4; Lundahl & Ndulu, 1987:193). Consequently, price incentives were thought to be a quite inadequate policy instrument for raising agricultural supply. This was one of the fundamental assumptions on which Tanzanian post-colonial agricultural policy, with extensive regulation, came to be based for more than a decade (Lundahl & Ndulu, 1987:194).

⁷ An account of the reform process falls, however, outside the scope of this study. The literature is vast. For a recent, brief presentation of the reform process, see Eriksson (1992).

A number of empirical studies on peasant supply response to price incentives in Tanzania were eventually carried out. These studies were made with respect to various crops, firstly by Gwyer and Kighoma Malima, appearing in 1971 (Gwyer, 1971; Malima, 1971). Positive own price elasticities of supply were obtained in several studies—indicating that prices do indeed matter to the Tanzanian smallholder peasant in relation to decision making on crop supply, and that positive responses were made to changes in own crop prices. These empirical results suggested that, in the case of Tanzania, the hypothesis on peasant unresponsiveness and irrationality might be rejected.

Although the results have, in many cases, shown a positive supply response to own price changes, the results have not been unambiguous. In some cases, supply response seems to be weak. In several of the empirical studies, the estimated price elasticities of supply were fairly low (less than 0.5) or even statistically insignificant.⁸ Hence, the results of the empirical studies seemed to present economists with a dilemma: supply response to own price changes is positive but weak. This finding raised a number of new questions for the subsequent analysis of peasant supply response to price incentives in Tanzania: questions related to the relative importance of price incentives, and the role of institutions in relation to the strength of supply response.

Since the mid-1980s, both theoretical developments and empirical studies have cast new light on the analysis of peasant supply response to price incentives in Tanzania. Most of the earlier studies focused on the supply response of individual crops, and concentrated solely on behaviour within the agricultural sector. However, the response of total agricultural supply to changes in the agricultural terms of trade had not been previously analysed. This is one of the issues that, in the light of the reform process, has received further attention. Moreover, in what may be seen as an attempt to explain moderate and weak supply response, consideration has been given to specific institutional conditions, such as the dual market structure for food crops and the periodically limited supply of consumer goods in Tanzania.

The objective of this study is to survey and illustrate the theoretical developments—and empirical findings—that have been produced by studies of peasant supply response to price incentives in Tanzania. It does not claim, however, to give a detailed or complete survey of the analysis of peasant supply response to price incentives in Tanzania, but merely intends to depict the main lines of development. For the purpose of illustrating the theoretical development, use is made of a simple behavioural model of the smallholder

⁸ See, for example, Lipumba and Ndulu (1987) and Mabele (1987).

peasant household that emphasises the role of price incentives for peasant behaviour. The method adopted to derive peasant supply response, is that of comparative static analysis. We begin by taking a closer look at the agricultural sector in Tanzania: its structure, the government policy towards agriculture and the performance of marketed supply and prices.

Tanzanian Agriculture

The Tanzanian economy is largely agrarian, as indicated by the large shares of agriculture in production and exports. During 1976–1990, agriculture was responsible for between 40 and 46 per cent of official GDP (Van Arkadie et al. 1991:66), while, during the 1980s, the sector accounted for some 70–84 per cent of total exports (BoT 1991a; b).

Agricultural policy

Because of its dominance in the domestic economy, agriculture is also the sector on which, according to the Arusha Declaration in 1967—the blueprint for Tanzanian socialism—the development of independent Tanzania was to be based (Hedlund & Lundahl, 1987:54).⁹ During the first fifteen years of independence,¹⁰ the Tanzanian government relied, according to Mats Lundahl and Benno Ndulu (1987:193), on a traditional control model in its attempts to promote the agricultural sector. The control model may be considered traditional in by its colonial heritage and in its beliefs about peasants. The model was based on two central assumptions, the first being the conventional view that peasant smallholders were unresponsive to market signals, such as prices. The second assumption was that commercial production in African agriculture could only be ensured by a ‘monopsonistic/monopolistic integrated organization’, since traditional subsistence agriculture itself was considered unable to provide the stimulus to commercial development (Lundahl & Ndulu, 1987:193)¹¹ Modernisation of the poorly developed physical infrastructure and production technology could thus only be realised through subsidisation, financed by state or parastatal bodies.¹²

The model was reflected in the neglect of market oriented incentive schemes, notably the price mechanism, and in the central role given to public institutions and government controlled organisations in directing agriculture

⁹ The Arusha Declaration was a political programme where the strategy for development of the Tanzanian economy and society towards socialism was put forward.

¹⁰ The Republic of Tanganyika gained independence from British rule in 1961, and merged with the Republic of Zanzibar, which became independent in 1963, to the United Republic of Tanzania in 1964.

¹¹ Monopsony prevails when there is one single buyer in a market; monopoly, when there is one single seller.

¹² Majority owned state enterprises and other organisations, such as the marketing boards, are, in Tanzania, often referred to as parastatals.

(Lundahl & Ndulu, 1987:194). The attitude towards peasants was paternalistic, and a central role was given to the state in economic development in general, and in agricultural development in particular. Agricultural policy consequently came to be characterised by 'statism' (van Cranenburgh, 1990:16)—corresponding to Lal's dirigiste dogma.

Institutional set-up

The set-up of the institutional structure was closely related to the socialist strategy. The so-called *Ujamaa* programme, adopted after the Arusha Declaration, provides an example. *Ujamaa*, which means familyhood, was to be extended to the whole society. The programme aimed at restructuring the rural areas in a socialist direction. In order to promote collective production principles, the scattered population was to be transferred into larger so-called *Ujamaa* villages. Initially, the villages were to be formed on a voluntary basis. The actual results of the program were, however, limited: few *Ujamaa* villages were formed. Eventually—after several campaigns of persuasion had been launched—the so-called villagisation policy was introduced, in 1973. It made the resettlement of all Tanzanians into registered villages by the end of 1986 compulsory, and was finally completed by military force.¹³

An institutional infrastructure was created in the form of a single-channelled official marketing system for the agricultural sector. An ideological motive for replacing private middlemen in the distribution chain was the removal of one of the sources of exploitation of the peasants (Hedlund & Lundahl, 1987:58). The system—partly inherited from the colonial power—consisted of a set of institutions; integrated either vertically around a certain crop, or horizontally for particular regions. Through this system, agricultural supply was to be marketed and processed, and inputs, credit, extension services and physical infrastructure, principally transportation, to be provided (Amani et al., 1987:19; Amani & Ndulu, 1987:5; Lundahl & Ndulu, 1987:194).

To begin with, a three-level system was adopted, with primary and secondary cooperatives for particular regions, and crop specific marketing boards at the top. Single-crop monopsonies/monopolies were created for export crops, while the marketing of all food crops has been handled, since

¹³ See, for example, Hedlund and Lundahl (1989:34-44), Hydén (1980:96-155) and van Cranenburgh (1990:139-143) for an account of the *Ujamaa* and villagisation programmes.

1973, by one single authority: the National Milling Corporation. In 1976 the cooperatives were abolished, and a two-level system was created. Registered villages took over the cooperatives' role as primary agents. The functions of the marketing boards, which were reformed into so-called crop authorities, were expanded. (Lundahl & Ndulu, 1987:194–195; van Cranenburgh, 1990:16–17).

The official marketing system had severe efficiency problems, however, and agricultural performance was discouraging. By the late 1970s and early 1980s, the country found itself in a deep economic crisis. In order to reduce marketing costs and improve the general efficiency of the distribution system, the government decided, in 1982, to reinstate the cooperatives (van Cranenburgh, 1990:17). They were eventually reintroduced in 1985/86 (MDB 1987d:51).

Since the initiation of the economic reform process in the mid-1980s, considerable changes have taken place within agriculture—as well as throughout the entire economy. With the eventual extension and deepening of the reforms, there has been a gradual liberalisation of agriculture. In particular restrictions on private trade in major food grains have been relaxed. The policy change may be partly interpreted as a response to the economic crisis—as a means by the government to restore its legitimacy—partly as a response to increased pressure from the donor community and domestic agents (Eriksson, 1992:7–13; van Cranenburgh, 1990:17–18). In 1986, a three year structural adjustment programme, supported by the donors (including the World Bank and the International Monetary Fund), was adopted: the Economic Recovery Programme (ERP) (URT, 1986). The ERP gave particular emphasis to the removal of transport bottlenecks, and the monopoly/monopsony of the state controlled marketing system has been gradually weakened. Trade in export crops has not, however, been liberalised to the same extent. (Eriksson, 1992:12)

Agricultural price policy

In Tanzania the official producer and consumer prices of the main agricultural crops have not been determined by the market forces of supply and demand. They have instead been administratively determined: controlled by the central government, and guaranteed by the organisations within the official marketing system. Producer prices are set annually and announced in advance of the crop season (Amani & Ndulu, 1987:6; Ellis, 1982:265).

During most of the 1970s and the 1980s, official producer prices were fixed at low levels. The main reason for maintaining low producer prices for food, has been the government's ambition to provide the urban population with cheap food, by keeping consumer prices low (Lundahl & Ndulu, 1987:196). Low prices for export crops, often far lower than world market prices, have resulted from both the explicit and implicit taxation of agricultural exports. Implicit taxation of cash crops has partly been due to overvaluation of the Tanzanian shilling;¹⁴ partly to the high marketing costs of the crop authorities (Skarstein & Wangwe, 1986:236–237; Ödegaard, 1985:133–134).¹⁵

Hence the importance of the price mechanism in agriculture was for long neglected. Most agricultural producer prices were subject to controls, and the use of price incentives to stimulate agricultural production was limited. Instead of market incentives, extensive use has been made of political campaigns, moral suasion, exhortation and even coercion, such as by-laws on minimum acreage, to promote agricultural development (Amani & Ndulu, 1987:4; Lundahl & Ndulu, 1987:193).¹⁶

Until 1973 the importance of producer prices as incentives for agricultural production does not seem to have been recognised by the Tanzanian government at all (Hedlund & Lundahl, 1987:70). However, there has subsequently been an increasing recognition of the importance of prices. This may be interpreted as a reaction to the failure of previous agricultural policies. A more active use of producer prices as a policy instrument in order to stimulate agricultural output has been adopted. For a long time, however, it was only the general level of agricultural prices (the nominal prices) that was adjusted, rather than the relative prices between food and cash crops and between agricultural and other products. (Hedlund & Lundahl, 1987:70)

During the 1980s, particularly the latter half, there has been a further change in attitude towards the Tanzanian farmers' rationality as regards supply response. Price incentives are now recognised as being of central importance to

¹⁴ The world market price for cash crops in Tanzanian shillings (TSh), the domestic price, is the world market price multiplied by the official exchange rate, for instance the price of US dollars in TSh. If the TSh is overvalued, the official exchange rate is lower than its equilibrium level, and consequently the domestic price is lower than had the TSh not been overvalued. The difference in price may be defined as a tax. See Ödegaard (1985:130–133) for an indication of the relative size of the implicit tax on export crops due to overvaluation of the TSh.

¹⁵ See Ödegaard (1985:115–130) for developments in the marketing margin and marketing costs, and for developments in agricultural export taxes, during the second half of the 1960s and the 1970s.

¹⁶ The impact of ideology on agricultural incentives has been described by Hedlund and Lundahl (1989).

agricultural output. Consideration has eventually been given to the importance of relative prices for the composition and level of agricultural supply. The ERP stipulated that agricultural producer prices were to be raised by 5 per cent annually in real terms, or to be set at 60 to 70 per cent of FOB prices,¹⁷ whichever was higher (URT, 1986:15).

The liberalisation of agricultural markets has been reflected in price policy. At the micro level, this has been expressed in attempts to bring the official producer (and consumer) prices of food closer to the levels that reflect the relative scarcity of the crops, and thereby to raise them. Moreover, a number of agricultural prices have been deregulated and are now determined by the market. At the macro level, policy measures, particularly the devaluation of the Tanzanian shilling, have been taken in order to improve the relative prices of agricultural products. The purpose has been to stimulate agricultural production, particularly that of cash crops. Other attempts have also been made to improve agricultural incentives, particularly increases in the supply of consumer goods. (Eriksson, 1992:11–13)

Agricultural structure

In terms of cultivated area and output the agricultural sector in Tanzania is dominated by the small scale farming sector, or the peasant sector. The peasant sector probably accounts for no less than 90 per cent of the cultivated land, and during the 1970s, the sector provided some 70–75 per cent of the total deliveries to the official markets. (Ödegaard, 1985:6, 15–19)

The average cultivated area per rural household is small. At the Population Census in 1978, the average holding was estimated to be less than 2 hectares, and within the peasant sector alone, the average was about 1.26 hectares, according to the Agricultural Census of 1971/72. (Skarstein & Wangwe, 1986:228)

There is also a large scale farming sector, consisting of both private and state farms. It is unclear, however, how Ödegaard and the mentioned censuses distinguish it from the peasant sector. Ödegaard (1985:15) appears to define the two sectors according to forms of land tenure.¹⁸ However, farms

¹⁷ FOB is the abbreviation for free on board, which is 'a term applied to the valuation of goods up to the point of embarkation' (Bannock et al., 1978:187).

¹⁸ 'Practically all land in the peasant sector is used under the customary land tenure form that gives a usufruct right to the land. Communal land tenure is also held in the peasant sector, but ... this accounts for only a small share of land use. In the large scale farming

over 20 hectares account for only 0.1 per cent of all mainland farms (World Bank, 1990:11).

In Tanzania, agricultural production is largely carried out by women. According to Hannan-Andersson (1985; quoted in Rafferty, 1988:129), they 'are the main productive force in rural communities... They have almost total responsibility for subsistence farming and play a not unimportant role in cash-crop production.' Agricultural output is predominantly produced by the use of hand-tools. In 1980 about 85 per cent of the total area was cultivated in this way (Skarstein & Wangwe, 1986:228).

Despite strong efforts to foster collective production, particularly via the villagisation programme, a major part of agricultural production is carried out on private plots. According to Haidari Amani et al. (1987:16), communal farming never accounted for more than 0.5 per cent of the total land under cultivation. So-called block farms, where the land within the village has been divided into private plots, now dominate agricultural production of both food and cash crops (Amani et al., 1987:16; Hedlund & Lundahl, 1987:58).

Agricultural crops in Tanzania are usually classified as either food crops or cash crops in the following way: Food crops are those predominantly produced for sale on the domestic market, and for consumption within the peasant household, while cash crops are those mainly produced for export. The preferred (main) staple food grains are maize, wheat and rice; the main export crop is coffee. Cotton, tea and tobacco are also produced for export. (Ellis, 1982:266–267; Ödegaard, 1985:5–6).

During most of the 1970s and the 1980s, agricultural markets in Tanzania have been characterised by their dual structure. Firstly, there is the official market, where practically all cash crops and part of the food crops are sold. For food crops, however, markets parallel to the official ones have been common.¹⁹ The government has controlled the prices of scheduled food crops.²⁰ By keeping prices low—below the equilibrium level that would

sector land is used under either right of occupancy land tenure or leasehold land tenure.' (Ödegaard, 1985:15)

¹⁹ Official purchases of cash crops are often considered to be more or less equivalent to total production, since practically nothing is consumed by the peasants themselves, and no parallel market of any importance is considered to exist (MDB, 1987a:13). This view has partly been challenged by Maliyamkono and Bagachwa, however, in a study of the so-called second economy in Tanzania. They considered illegal exports (partly in terms of under-invoicing of exports), including that of cash crops, to be quite substantial (1990:101–108).

²⁰ Scheduled crops are those where delivery to the crop authorities is made compulsory by the issue of a so-called Compulsory Marketing Order (Ödegaard, 1985:7). All cash crops and most food crops, except vegetables and fruit, have been scheduled during most of the

prevail in a free market—excess demand, at the prevailing official prices, was created for these crops. This excess demand tended to spill over into traditional local markets, and so-called parallel markets, partly illegal,²¹ were established for scheduled food crops. (Ödegaard, 1985:156–157) As a result of the state control of agricultural prices the monopolistic/monopsonistic position of the official marketing system was thereby rendered partly ineffective.

The parallel food markets in Tanzania started to expand beyond their traditional levels in the mid-1970s. Excess demand for food crops grew as a result of a severe drought in 1973/74. Partly as a result of the first oil price chock in 1973, there was, however, a growing inability to cover the shortfall with imports. This led to an upward pressure on prices, and to the expansion of the parallel markets. Parallel market prices, determined by the market forces of supply and demand, have been considerably higher than the official ones throughout most of the period of study. Partly as a result of the higher food prices in the parallel markets, a major part of the food trade takes place in these markets (Lundahl & Ndulu, 1987:207; MDB, 1986d:1–2; Ödegaard, 1985:156).

Agricultural prices and marketed supply

The main focus of this study is on the effects of changes in relative prices on the marketed supply of crops. We therefore look at movements in real prices of agricultural crops, i.e. the relative price of agricultural crops in terms of the prices of other goods, and at relative prices within agriculture. We shall simultaneously consider the performance of marketed supply, both in absolute and in relative terms.

One reason for focusing on marketed supply—instead of output produced—is that it is of major interest to society as a whole. In the case of cash crops, marketed supply is what can be exported. Since Tanzanian exports mainly consist of cash crops, their marketing is of crucial importance for the foreign exchange earnings of the country. The main food problem in Tanzania concerns the marketed supply of food crops, particularly the preferred staple grains. Although the rural population in general has been able to feed itself, providing the growing urban population with food has proved difficult

time since independence. Drought resistant crops (sorghum, millet and cassava) and pulses, did not become scheduled until the mid-1970s (Ellis, 1982:266-267).

²¹ In the traditional local market, trade in non-scheduled crops was allowed. Trade in scheduled crops was allowed only directly from producer to consumer (Lundahl & Ndulu, 1987:207; Ödegaard, 1985:154-155).

(Lundahl & Ndulu, 1987:192). Regional shortages of different food crops have also been difficult to overcome because of large distributional problems. The poor availability of production data constitutes another reason for studying marketed supply. Furthermore, because of poor availability of parallel market data, the focus is almost entirely on official producer prices and officially marketed supply.

Indices of officially marketed supply, and indices of real official producer prices have been constructed and plotted against time, for food, cash crops and all agricultural crops respectively. When constructing the indices, the so-called Laspeyres formulas have been used. The crop year 1969/70 has been used as a base year. It should be noted that the indices may be very sensitive to changes in the base year; the figures below should thus be read with caution. The National Consumer Price Index (NCPI), excluding the food component, has been used as a deflator, in order to allow the real price indices to reflect the relative price of agricultural crops in terms of other goods. Note that the figures below plot index values for crop years, for example 1969/70, and not for calendar years, although this is not clear from the figures.²²

Tables 1 to 3 show how indices of officially marketed supply—in quantity terms—vary with indices of official producer prices. We start by looking at food crops in Figure 1. A quick look shows that the index of officially marketed supply of food, IQFOOD, has fluctuated considerably over time. Since 1975/76, food supply movements seem to have followed the changes in the index of real food price, IPFOOD, except after 1984/85, with a one or two year time lag. In the early 1970s, official food purchases dropped to their lowest level

²² For the Laspeyre formulas for weighted aggregative price and quantity indices, see Yamane (1973:303-304, 335-336). Quantities and prices from the base year 1969/70, the first common year for the food and the cash crop indices, have been used as weights in the price and quantity indices respectively. The base year should ideally be chosen as a representative year, although in practice it may be difficult to find any normal year. Although more refined methods could be used, that has not been the ambition of this paper. Therefore, it is most likely that a better base year than 1969/70 could be found. See Yamane (1973:305-312) for a brief treatment of the issue.

The food crops used in the indices are maize, paddy, wheat, sorghum, millet, cassava and beans; the cash crops are cotton, tobacco, pyrethrum, coffee, tea and cashew nuts. However, the number, categories and classes of crops included have been restricted by lack of data.

Most of the data on official producer prices of food and cash crops and on officially marketed supply has been collected from various Marketing Development Bureau (MDB) reports. Some data, mainly for the 1960s and early 1970s, come from Ödegaard, and to a limited extent from Skarstein & Wangwe. The following sources have been used: Ödegaard (1985:232, Table A.1; 233, Table A.2; 238, Table B.1), Skarstein and Wangwe (1986:223, Table 7.1; 224, Table 7.2) and MDB (1986a:10, Table 5; 1986b:3, Table 1; 1986c: Appendix 1; 1987a:17, Table 8; 45, Appendix IIIA; 46, Appendix IV A; 1987b:12, Table 2; 15, Table 3; 1987c:5, Table 1; 6, Table 2; 1987d:22, Table 12).

in 1974/75 which coincided with the severe drought in 1973/74. The Tanzanian government responded by raising nominal food prices, and the index of real food prices increased to a peak level in 1975/76. From 1974/75 until 1977/78 official purchases rose dramatically. (Some of them even had to be exported at a loss.) From the mid-1970s, real food prices fell back almost to the levels of the early 1970s, but have recovered somewhat lately. The index of official food purchases fell by some 69 per cent between 1978/79 and 1983/84, and then increased sharply again.

Figure 1. *Food crops: Indices of officially marketed supply and real price*

Since Tanzanian agriculture is mainly rain-fed, it is highly vulnerable to climatic variations (Amani et al., 1987:6). Accordingly, during years with bad harvests, the country has to rely on food imports and food aid. Imports of staple grains peaked in 1973/74 mainly because of the severe drought. They were persistently large during 1980/81–1983/84, when dependence on food aid was also at its highest level (MDB, 1987d:18).

In the case of cash crops, see Figure 2. There seems to be a clear downward trend in official purchases, IQCASH, since the early 1970s, although the trend is not quite as clear for the index of the real price, IPCASH. During the 1960s and early 1970s there was a sharp decline in the price index. It is difficult to determine a trend since then, although there have been minor fluctuations. However, over the whole period the price index has been declining.²³

Figure 2. *Cash crops: Indices of officially marketed supply and real price*

Figure 3 depicts the behaviour of an index of the total officially marketed agricultural supply (food and cash crops), IQALL, and an index of the agricultural terms of trade, IPALL, over time. The indices indicate a development that is partly unexpected, and contradicts the findings of others in some respects. While a clear downward trend in the agricultural terms of trade is observable until the late 1970s, the trend since then seems to be

²³ This result may differ from those calculated by others: Ellis (1982), MDB (various), Skarstein and Wangwe (1986), and Ødegaard (1985). A possible explanation is that other crops and weights may have been used in the indices, as well as other deflators and base years.

positive. This does not, however, correspond to the calculations of others. (See e.g. Banda, 1988: Appendix II; Ödegaard, 1985:244; MDB, 1987a:25.)²⁴ According to calculations by the Marketing Development Bureau, the real producer prices of all agricultural crops fell between 1977/78 and 1982/83, and did not begin to increase until after that period (MDB, 1987a:25). According to the quantity index, aggregate officially marketed supply fell sharply during the 1970s, and stayed at low levels during the 1980s. There seems to have been a tendency to a minor increase in the second half of the 1980s, however, when officially purchased quantities of several important crops increased substantially (MDB, 1987a:14, 17).

Figure 3. *All crops: Indices of officially marketed supply and real price*

Let us now take a look at changes in relative prices within agriculture and the composition of agricultural output. In Figure 4, the relative price of food to that of cash crops, PREL, and the relative share of food in total official purchases, QREL, have been plotted against time.²⁵ One of the most characteristic changes in the officially marketed supply during the 1970s has been in the crop mix. When the relative price of food to cash crops, PREL, increased sharply during the first half of the 1970s, the relative share of food in total official purchases, QREL, followed a couple of years later. According to these figures, the share of (officially purchased) food increased from some 11 per cent in 1974/75 to some 97 per cent in 1979/80. In the late 1970s both the relative price of food and the relative share of food purchases declined, however, until the early 1980s. Since 1983/84, the relative price of food to cash crops has increased slightly, while the share of food in total official purchases has risen more substantially.

Figure 4. *Food to cash crops: Relative price and share of total supply*

²⁴ The reason for the divergence in the results will not be explored here, but is most probably to be found in the way the indices have been constructed. By choosing 1969/70 as the base year a considerable weight is given to a crop such as cashew nuts. Official purchases of cashew nuts were at considerably higher levels during the late 1960s and the first half of the 1970s than was subsequently the case. Cashew nuts experienced extremely large price increases in the late 1970s and early 1980s, which might have had a marked effect on the price index due to the heavy weight given to the crop.

²⁵ PREL is computed as the ratio between IPFOOD in Figure 1 and IPALL in Figure 3. QREL is the relative share of food in total official purchases, valued at the official producer prices.

This simple comparison of aggregated data—however blunt—suggests that there may be a positive relationship between relative prices and the marketed supply of crops. This relationship appears to be particularly strong within the agricultural sector, as shown in Figure 4. However, the picture is not unambiguous. In Figure 3 there is a suggestion of a perverse relationship. Certain problems are also related to the aggregation of data. Therefore, excessive attention should not be given to the findings here. Nevertheless, on the basis of these data, the importance of relative prices for agricultural output cannot be ignored.

Finally let us look at the parallel market prices, supply to the parallel market and total production. Although data on parallel market producer prices are only available from 1982, there is a general view that they have been considerably higher than the official ones also prior to that (Amani et al., 1987:38). However, the relative difference between the producer prices in the two markets declined during the late 1980s, for example in the case of maize. The official price rose from 46 per cent of the parallel market price in 1984/85 to some 76 per cent in 1986/87.²⁶ The reason was firstly, a dramatic decline in the parallel market price, due to bumper harvests. The second reason was the conscious policy to raise official producer prices.

As regards the quantities traded, official purchases of maize increased their share from 25 to 36 per cent of total marketed supply, during the same period. Total marketed supply was, in turn, estimated to have increased its share of total production from 20 to 25 per cent. (MDB, 1987d:6–7)

The difficulty of determining food quantities sold in the parallel market stems from the lack of data on total production and subsistence consumption. Food production estimates before 1982/83 are not very reliable. Since then a systematic approach to estimating production has been adopted by the Ministry of Agriculture and Livestock Development, however, with the set-up of the Early Warning and Crop Monitoring Bureau. According to the existing estimates, total production of staple grains and drought resistant crops have increased practically every year since the early 1960s. Since 1973/74, however, the growth rate appears to have been slightly higher than during the 1960s.²⁷

²⁶ The official relative to the parallel market producer price of maize (TSh/kg) in 1984/85 was $4.0/8.61 = 0.46$, and $6.3/8.25 = 0.76$ in 1986/87. (MDB, 1987d:22, Table 12; 1988; Ødegaard, 1985:238, Table B.1; 239, Table B.2)

²⁷ Food production estimates are provided by MDB (1987a:17, Table 7; 1987d:10, Table 4) and Ødegaard (1985:234, Table A.3).

Theoretical Analysis

The main theoretical developments within the study of peasant supply response to price incentives in Tanzania are first surveyed, and thereafter illustrated.

Theoretical development—a survey

Most of the empirical studies of peasant supply response to price incentives in Tanzania, that indicate a positive but weak supply response, have concerned individual crops. They have been based on theoretical models that are solely concerned with the agricultural sector. These models are suitable for studying the effects of changes in relative prices between crops—hence within agriculture—on the supply of an individual crop, and thus on the crop mix within the sector. They are not very useful, however, for analysing the effects of changes in agricultural prices relative to the prices of other sectors, nor for analysing the effects on total agricultural supply.

In response to the observed weak supply response, attempts to gain a better understanding of the factors that determine peasant supply response to price incentives and the degree of responsiveness have been made. The focus of study has shifted. Attention is now geared towards the responsiveness of total agricultural supply to changes in the agricultural terms of trade, and towards the importance of institutional conditions for the effectiveness of price incentives. These considerations have had a direct bearing on the theoretical framework of the analysis.

Two tendencies which imply a broadening of the perspective of the theoretical analysis may be observed. Firstly, agriculture is no longer analysed in isolation, but account is taken of the relations between agriculture and other sectors. By including additional variables into the theoretical models, allowance has been made for intersectoral flows of capital and labour. This enables a study of the long-run response of aggregate agricultural supply—and thus the expansion potential of the sector—to changes in the terms of trade between agriculture and other sectors (Amani & Ndulu, 1987:33).

In the case of Tanzania, an attempt has been made by Lundahl and Ndulu (1987) to analyse the response of agricultural supply to changes in the relative price between the sectors in the short and/or medium term. By

introducing off-farm wage labour as a choice variable in a neoclassical behavioural model of the smallholder peasant household, they consider the opportunity cost of agricultural production,²⁸ and thus, implicitly, the relative profitability between the sectors.

The other tendency reflects an increased understanding of the importance of institutional factors for economic behaviour. This is expressed by an explicit consideration of the specific institutional conditions prevailing in Tanzania. One such condition is the official marketing system, with price fixing and monopoly/monopsony power in the marketing of crops and provision of certain goods and services. This system has created a dual market structure for food crops and generated a periodically limited supply of consumer goods. When due attention is paid to these factors, explanations of the seemingly weak peasant supply response to prices are offered, and a deeper understanding of economic behaviour provided.

A consideration of institutional factors often implies allowing for the existence of market imperfections in the theoretical analysis. Whereas most models have been based on neoclassical assumptions about equilibrium prices and clearing markets, David Bevan et al. (1987a; 1987b; 1988) introduce quantitative rationing in the consumer goods market. By assuming fixed prices and non-clearing markets, they employ a so-called disequilibrium approach.

In conclusion, peasant supply response to price incentives in Tanzania (as well as in general) has become the subject of new theoretical analysis. There has been a shift away from neoclassical one sector models. Instead, models with intersectoral linkages, and models that explicitly consider specific institutional conditions, have been increasingly used. Attention is focused on the aggregate supply response to changes in the agricultural terms of trade, and on the role of institutions in explaining the relatively weak supply response.

In the remainder of this chapter, we illustrate this theoretical development and its implications for the study of peasant supply response. This is done with the aid of a simple behavioural model of the peasant smallholder household. The model emphasises the role of price incentives for peasant behaviour, and is a modification of a model by Lundahl and Ndulu (1987). Two approaches, based on different assumptions about the consumer goods market are taken: a neoclassical and a disequilibrium one. The distinction between the two is clarified. Firstly, the neoclassical version of the

²⁸ The opportunity cost is the value of the best alternative resource use foregone. In this case, the opportunity cost of agricultural production is the highest income the peasant would have earned if working outside agriculture.

model is presented, and thereafter—after dropping the assumption about Walrasian equilibrium²⁹ and clearing markets—the disequilibrium version introduces consumer goods rationing.

In order to determine and compare the supply response under the two different assumptions about the institutional set-up, a comparative static analysis is performed. Both the effects of changes in own prices on the supply of individual crops, and the effect of a change in the agricultural terms of trade on aggregate marketed supply, are studied. Thereafter, certain aspects of the disequilibrium approach are further elaborated.

A neoclassical model of peasant behaviour

The typical Tanzanian farmer is a peasant smallholder and the peasant household is that of a semi-subsistence kind. Lundahl and Ndulu (1987:198–202) have developed a simple neoclassical model of such an economic agent, which they apply to the Tanzanian case.³⁰ The model emphasises the role of price incentives for peasant behaviour. It focusses on the effects of changes in *relative prices* on both production and consumption, and thus implicitly on the marketed supply (which is the difference), of agricultural crops. This is done by the inclusion of two (more than one) cash earning crops, and two consumer goods (one being leisure). In addition to studying the effects of a partial change in the price of a single crop, they specifically set out to study the effect of a change in the relative price between farm products and non-agricultural goods: the so-called agricultural terms of trade.

Lundahl and Ndulu include off-farm wage labour as a choice variable for the peasant household, thus offering it the possibility to divert some of its labour time to income earning activities in other sectors. This makes the production and consumption decisions independent of each other: they can accordingly be analysed separately. In the model used here, however, the peasant's opportunity to choose work outside the farm is disregarded, in order to make the decisions about production and consumption mutually dependent. The very same model can then be used when the assumption of

²⁹ The concept Walrasian equilibrium is explained below.

³⁰ The literature on semi-subsistence agricultural household models is extensive. See for example Nakajima (1970) and Barnum and Squire (1979).

Walrasian equilibrium is dropped in the following section. The reason for modifying the Lundahl and Ndulu model is therefore strictly pedagogical.

We now look at the modified version of model. Whereas the complete formal model is available in Appendix A, the presentation here is purely verbal. Any significant divergence from the original model is explicitly stated. The analysis is throughout confined to one period: the agricultural season.

The peasant household, in the following also referred to as the peasant, is assumed to maximise its utility, which is a function of food, purchased commodities and leisure. The peasant enjoys higher utility the more he/she consumes of each of these 'goods', but the utility increases at a declining rate.³¹

The peasant produces two types of crops which are substitutes in production: food crops and cash crops. Food crops may be both consumed on the farm and/or sold, while cash crops are produced for sale only. Agricultural output is primarily produced with the inputs of land and labour. Land is considered to be in abundant supply,³² not to be leased,³³ and assumed to be cleared by further inputs of labour. Land is thereby implicitly included in the variable factor labour.³⁴ Inputs of physical capital are limited and therefore disregarded,³⁵ as are inputs such as fertilisers and pesticides.³⁶ The production

³¹ Although women play an important role—perhaps the most important—in agricultural production, the peasant is, in the following, referred to as a male. This is partly out of convention, partly because the peasant represents a household. The distribution of responsibility, decision making power and labour within the peasant household is disregarded here.

³² Uncleared land may, on the whole, be considered to be in abundant supply in Tanzania (Lundahl & Ndulu, 1987:199; Skarstein & Wangwe, 1986:228). According to Khamisi (1983, referred to by Msambichaka, 1984:48), only about 17 percent of the arable land was cultivated by the end of the 1970s. Ødegaard, by contrast, argues that, 'shortage of land has become more and more a constraint on production' (1985:67). In fact, the enforced villagisation policy, in the middle of the 1970s, created local shortages of arable land close to the concentrated villages (Amani et al., 1987:18; Bevan et al., 1988:1). Nevertheless, according to Lundahl and Ndulu (1987:221), local scarcity of land is not typical for the country as a whole. Besides, resettlement in and movement to areas with land abundance is allowed.

³³ The main form of land tenure within the peasant sector in Tanzania is, as mentioned above, customary land tenure, which gives the peasant a usufruct right to the land (Ødegaard, 1985:15).

³⁴ In this model, we consider labour to be variable to a certain extent: within the peasant household. We omit migration into and out of the agricultural household, however. Land is also a variable factor. Hence, as labour is a partially fixed factor of production, the time perspective is that of a short and a medium term.

³⁵ As indicated before, the capital intensity within the peasant sector is low, although it may have increased somewhat recently (Lundahl & Ndulu, 1987:221).

of food and cash crops is consequently a function of the labour time devoted to each of the crops. Production increases with additional inputs of labour, but at a declining rate.³⁷

The peasant allocates his time between farm work (the production of food and/or cash crops) and leisure. Utility is thereby maximised subject to a time constraint: the sum of the time spent on work and leisure cannot exceed the total amount of labour time available.³⁸ The peasants utility maximisation is also subject to another restriction: a budget constraint. Expenditure on purchased commodities may not exceed income. Peasant income is determined by the marketed quantity of food and cash crops, which in turn depends on the quantity produced and on the amount of food that is retained for consumption.³⁹ The income further depends on the prices of food, cash crops and purchased commodities.

Since, in this model, the peasant acts as a consumer and a producer simultaneously, he faces a joint optimisation problem. The decisions on production and consumption are connected via leisure and are thereby interdependent. The production decision involves the allocation of time between different income-generating types of production (food and cash crop production), food production for own consumption, and leisure. The consumption decision, on the other hand, consists of allocating consumption between food, purchased commodities and leisure.

Given the prices, the technology expressed in the production functions, the time and budget constraints and the utility function, the peasant chooses the combination of production and consumption that yields the highest utility. The peasant is, once he has reached this optimum, unwilling to change his behaviour: he is in equilibrium. This equilibrium, derived in Appendix A, has certain characteristics: The peasant's marginal valuation of one unit of food is the same, whether consumed by the peasant himself, or

³⁶ Fertilisers and pesticides are used to a limited extent, but here they are regarded as substitutes for land, and can thus be included in the factor land (Lundahl & Ndulu, 1987:221).

³⁷ This is where the model in this study diverges from the Lundahl and Ndulu original, where the peasant can also divert his time to off-farm wage labour. In fact, the Lundahl and Ndulu model seems to picture Tanzanian conditions more realistically. Different empirical studies show that off-farm work constitutes an important source of cash income for the typical peasant smallholder (Amani & Ndulu, 1987:14-15; Lundahl & Ndulu, 1987:199-221).

³⁸ The time constraint in the Lundahl and Ndulu model is different. See footnote 75 in Appendix A.

³⁹ The budget constraint is also different in the original model. See footnote 76 in Appendix A.

sold to purchase commodities. In equilibrium, the peasant also allocates his time so that he obtains the same utility at the margin from one unit of time, whether spent on food production, cash crop production or leisure.

An implicit assumption in the neoclassical model is that equilibrium prevails in the market. This kind of equilibrium (as compared to other definitions) is often referred to as Walrasian equilibrium, after Léon Walras, who established a model of general equilibrium on which the neoclassical approach is based. Equilibrium implies that markets are clearing: prices are flexible and adjust to equal supply and demand. Since all the prevailing prices are equilibrium prices and the peasant only reacts to prices, he is assumed to be able to optimise in all markets: given the existing prices, he cannot reach a higher level of utility. This implies that the peasant's optimum is also an equilibrium: given the existing prices, he is unwilling to change his chosen combination of consumption and production. This assumption is now to be partly dropped.

The non-Walrasian version of the model

Deriving the peasant supply response to price changes in the neoclassical model implies that the results derived are based on the assumption of equilibrium. If the equilibrium assumption is dropped, we cannot be sure that the conclusions about peasant supply response hold. It has been claimed, by Bevan et al. (1988:2–3, 8, 12–14), that during part of the 1970s and the 1980s, consumer goods markets in Tanzania were not clearing. They were instead characterised by excess demand, and peasants were subject to quantitative rationing of consumer goods.

We therefore now assume that the market for purchased commodities, where the peasant is a consumer, does not clear, but is characterised by disequilibrium. Further assume that this disequilibrium consists of an excess demand for consumer goods, at the given prices. This excess demand is caused by the price being fixed below its equilibrium level. Consequently, the peasant is *rationed* in terms of consumer goods: he is unable to buy the entire quantity that he demands at the existing price. The peasant's decision making is therefore affected by quantitative impulses, rather than by price signals alone. The reason underlying rationing is that prices are not freely flexible in the market, but, for one reason or another, are kept fixed below the level that clears the market.

Before studying peasant supply response to price incentives, we shall see how the introduction of rationing in the consumer goods market affects the theoretical model of peasant behaviour. The basic difference between this version of the model and the neoclassical one is that the peasant is now unable to reach equilibrium in the consumer goods market. He would, at the given price of consumer goods, prefer to buy more than he is able to. Consequently, he is quantitatively constrained, and thus optimises under an additional constraint, the rationing constraint: he cannot purchase more commodities than given by the quantitative ration. We assume that this constraint is always binding. In other respects, this version of the model parallels the neoclassical one.

Whereas the peasant optimising under the rationing constraint is unable to reach an equilibrium, he does, however, reach an optimum. This optimum is derived in Appendix B and has the following characteristics: At an optimum, the peasant would, at the given prices, wish to consume more consumer goods, if this opportunity were open to him. The reason is that his marginal valuation of consumer goods is higher than his marginal valuation of food and leisure. This implies that he would like to trade some units of food or leisure consumed for some additional purchased commodities. Another implication is that in optimum, the peasant's marginal valuation of food is lower when consumed by himself than when sold to purchase commodities. He allocates his time in such a manner that, at the margin, he indirectly obtains more utility from the time spent on food and cash crop production, than from time spent on leisure.

Supply response to changes in relative prices

Having presented the theoretical framework, we are now able to study the effects of relative price changes on the marketed supply of agricultural crops under the different assumptions about the operation of the consumer goods market. We first trace peasant response, in terms of the supply of an individual crop, to a partial change in its own price, in the neoclassical case. Thereafter, the corresponding supply response under consumer goods rationing is examined, and a comparison of the effects under the two different assumptions is made. Finally, the effect of a change in the agricultural terms of

trade on the total agricultural supply—the ‘terms of trade effect’⁴⁰—is studied. Whereas the original Lundahl and Ndulu model would have been appropriate for this purpose, our version of the model turns out not to be very useful.

The neoclassical case

Let us first study the effect of a partial change in the price of food crops on the marketed supply of food. This is done by adopting a so-called comparative static analysis: We first assume that the peasant is at the equilibrium level characterised above, and then introduce a change—an increase—in one price; all other things being held constant. It is thereafter assumed that the peasant will adapt to the new set of relative prices—caused by the change in one price—by adjusting his production and consumption until he reaches a new optimum: an new equilibrium. It is the change in crop supply from the old to the new equilibrium that constitutes the peasant supply response.

Suppose that the price of food crops increases,⁴¹ while other prices, those of cash crops and purchased commodities—so-called consumer goods—are held constant. To determine the effect of this change on the marketed supply of food, we must consider both the effect on production and the effect on subsistence consumption. Firstly, the effects of a partial increase in the food price on labour time devoted to production of food crops, and on consumption of food, is derived. Thereafter, the effect on food production is given by the effect on labour time devoted to food production, multiplied by the marginal productivity of labour in food production. This comparative static analysis is performed in Appendix C.

The total effect of a partial change—here an increase—in the price of food on the marketed supply, may be separated into two major effects: the so-called substitution and income effects.⁴² The substitution and income effects

⁴⁰ The expression seems to be coined by Lundahl and Ndulu, and refers to the effect of a partial change in the agricultural terms of trade on the agricultural supply (1987:215). Note that reference is made to the terms of trade between agriculture and other sectors - here the sector for consumer goods - in the domestic economy.

⁴¹ In this model, we are only dealing with one single price of food, which constitutes both the producer and the consumer price. When this price changes, this implicitly amounts to the assumption that the relative changes in the producer price and the consumer price are the same: the consumer price is formed on a mark-up basis of the producer price, so that the relationship between them is constant.

⁴² If two goods are substitutes in production (such as food and cash crops are here), an increase in the relative price of one of them tends to increase the supply of that crop - because it has become relatively more profitable - at the expense of the other, which is now relatively

operate simultaneously and sometimes in different directions. It is the net result of these two effects that determines the total effect of a price change.

We start by looking at the substitution effect. The total substitution effect on the marketed supply of food is complex: it consists of many partial effects that work in different directions on both production and consumption. Firstly, a partial increase in the price of food changes the relative profitability between food and cash crop production. Since food and cash crops are substitutes, this is likely to lead to the substitution of a certain amount of food production for cash crop production. Secondly, the rise in the price of food also implies changes in the relative prices within consumption. Hence, substitution tends to also take place in consumption. Finally, there is a tendency to substitute between leisure and production. The different partial substitution effects do not have to be accounted for in any further detail here. Their complexity is due to the interdependence of production and consumption via leisure, the relative price of which is also affected. Nevertheless, the total substitution effect on the marketed supply of food is unambiguously positive, which follows from the assumption of utility maximisation, as shown in Appendix E.

The income effect is less complicated. Provided that neither leisure nor food are inferior goods,⁴³ the income effect (of a partial increase in the food price on the marketed supply of food) is negative. As long as the production of food exceeds own consumption, the food price increase leads to an rise in the peasant's net income. The rise in income tends to increase leisure, and to reduce the time spent on agricultural production, including that of food. When his income rises, the peasant also tends to consume more goods, including food. Consequently, with food production tending to decline, and food consumption tending to increase, marketed supply of food tends to decline because of the income effect.

There is reason to believe, however, that the income effect is rather weak, due to variations in the income elasticities of demand for the different

less profitable. If the goods are substitutes in consumption (such as food and consumer goods in this case), an increase in the relative price of one of them tends to reduce the demand for that good - because it has become relatively more expensive - to the benefit of the other, which has become relatively cheaper. These are examples of the substitution effect. The simultaneously operating income effect may be understood in the following way: Since the nominal income remains unchanged, a partial change in a price always has an effect on real income, which either tends to rise or to decline. This change in the peasant's income tends to affect both his production and his consumption, as discussed in the text.

⁴³ Inferior goods are those goods, the demand of which declines when income increases.

items consumed.⁴⁴ Consumer goods may be expected to have a higher income elasticity of demand than food, due to their relatively more luxurious character.⁴⁵ Higher incomes then tend to increase the consumption of consumer goods relatively more than the consumption of food, and perhaps also relatively more than leisure. A moderate tendency to increase leisure corresponds to a moderate tendency to reduce production, including that of food. Together with the moderate tendency to increase food consumption, this would imply that the income effect on the marketed supply of food is not very strong.

Having established that the substitution effect of a partial increase in the price of food on the marketed supply of food is positive, and the income effect is negative, does not mean that the direction of the total effect can be determined theoretically. The total effect on marketed supply depends on the relative strength of the two effects, which cannot be predicted by our model.⁴⁶ If the income effect is weak, however, the probability that the substitution effect would outweigh the income effect is greater. Whichever dominates is, however, an empirical question.

In the case of cash crops, everything that is produced is also marketed, which simplifies the analysis considerably. Let us assume that the price of cash crops rises, while the other prices remain unchanged. The total effect on labour time devoted to cash crop production is derived in Appendix C. When the price of cash crops increases, the substitution effect tends to increase labour time in cash crop production. The reason is, firstly, that there is a substitution of income earning production for the relatively more expensive leisure (in terms of foregone income). The second reason is the decline in the relative profitability of food crop production. The income effect, on the other hand, tends to reduce labour time in cash crop production, since the peasant tends to trade a certain amount of income for leisure. Furthermore, the negative income effect is likely to be small. The income rise probably tends to increase

⁴⁴ The income elasticity of demand of a good measures the percentage change in demand for that good in response to a one percent change in the income of the consumer.

⁴⁵ Goods are defined as luxuries when their income elasticities of demand are above one. Food may instead be characterised as an essential good, with a low income elasticity of demand.

⁴⁶ Our model is unable to determine the total effect of a price increase on the production of food. It has been shown by Barnum and Squire (1979:36-38), however, that if the peasant household participates in the labour market, food production always responds positively, while the total family labour supply responds negatively, to a partial increase in the price of food. This is also the result that Lundahl and Ndulu (1987:203-204) obtain in their model. In their case, there is no substitution effect in agricultural production, neither between leisure and production nor between food and cash crop production. There is, however, a tendency to substitute food production for wage labour.

consumption of consumer goods more than consumption of food and leisure. If leisure only tends to increase moderately, cash crop production will accordingly tend to fall moderately. Provided that the substitution effect is stronger than the income effect, the total effect on labour time devoted to cash crop production is positive, and the marketed supply of cash crops will increase.

We have thus shown that in the neoclassical case, when the peasant is able to buy the quantity of consumer goods that he wants at the given price, the following conclusion can be drawn about peasant supply response: Provided that the substitution effect dominates the income effect, supply response, in terms of marketed food or cash crops, to changes in the own price of crops is positive. We shall now see what happens to supply response when the peasant is rationed in consumer goods.

The non-Walrasian case

The peasant now faces an additional constraint: the rationing constraint. At the given prices, he always wants to buy more consumer goods than he is able to. This implies that he has fewer substitutes in consumption, which affects his response to a price change, not only in consumption, but also in production, due to the interdependency between the two.

In the case of consumer goods rationing, a partial change in the price of a crop generates the same kind of effects as in the neoclassical case. These are derived in Appendix D. The fundamental difference, however, lies in the relative strength of the different effects. It can be shown that in the case of rationing, and hence with fewer substitution possibilities in consumption, the positive substitution effect is weaker. Due to the interdependency between the production and consumption decisions, fewer opportunities in consumption also affect production. The negative income effect, on the other hand, is stronger.

We first consider the substitution effect. When the food price increases partially, food consumption can only be replaced by leisure, since the peasant is unable to increase his consumption of purchased commodities. The tendency to switch from consumption of food to other items is reduced, when there are fewer items to choose between.⁴⁷ The reason is the decreasing

⁴⁷ The so-called Le Chatelier Principle may be used to mathematically show that the substitution effect is smaller in the rationed case. According to Dixit (1976:93), 'when some goods are rationed, the demands for the remaining goods will become more inelastic'. A

marginal utility of consumption: the more is consumed of the other items—only leisure may be varied—the less additional utility, this consumption yields. When the rationed item has a relatively high price elasticity of demand, such as consumer goods are likely to have, the tendency to substitute between items is reduced relatively more.⁴⁸ Due to the limited substitution possibilities in consumption, the substitution effect in production is also smaller. The tendency to shift labour time to the relatively more profitable food production is weaker. Thus, with a weaker substitution effect, food production tends to increase less and food consumption tends to decline less in response to a given increase in the food price, in the case of rationing.

Whereas the substitution effect is weaker, the income effect on the marketed supply of food is stronger with fewer choices in consumption. A rise in net income (due to the increase in the price of food and provided that food production exceeds food consumption) can now only be spent on food and leisure. The consumption of the latter tends to increase relatively more than when more consumer goods can also be purchased. Consumption is accordingly more income elastic under rationing than under non-rationing. Because leisure increases relatively more, agricultural production—including that of food—tends to decline relatively more. The negative income effect—tending to reduce the marketed supply of food—is consequently stronger.

To sum up: Because there are fewer substitutes in consumption, the positive substitution effect on the marketed quantity of food is weaker, and the negative income effect, stronger, in the rationed than in the non-rationed case. Peasant supply response of food to a partial increase in its own price is consequently weaker. The same applies for cash crops. Supply response may still be positive, but the probability that it be negative is greater. This would be the case if the negative income effect were to dominate the positive substitution effect.

The terms of trade effect

survey of the theorem and its applications, e.g. to economic theory, is given by Samuelson (1965:36-46, 163-171) and Dixit (1976:84-93).

⁴⁸ The price elasticity of demand measures the responsiveness of the demand for a good to a change in its price. A good with high price elasticity of demand experiences a substantial drop in demand when its own price increases. As in the case with income elasticities of demand, consumer goods may be expected to have higher price elasticities of demand than food: to be more sensitive to price changes.

We will now study the effect of a partial change in the agricultural terms of trade on the aggregate supply of agricultural crops. A partial change in the price of food or cash crops certainly implies a change in the agricultural terms of trade, while at the same time, the relative price between the two crops is altered. Here we want to study the effect of a change in the agricultural terms of trade separately, keeping the relative price between crops constant. This may be done by allowing for the price of consumer goods to change partially.

For the purpose of studying the effect on the total agricultural supply, our model is however of limited usefulness. The analysis can certainly be performed, but is not very meaningful. When studying the effect of a change in the relative price between agriculture and other sectors, it is the allocation of resources between sectors that is of interest. Our version of the model does not allow for this transfer of resources. In the original model by Lundahl and Ndulu, however, the peasant is provided with an alternative source of income to agricultural production. Wage labour, representing the other sectors of the economy that compete with agriculture for the scarce resources, is introduced. In order to illustrate the importance of off-farm labour for the terms of trade effect on agricultural supply, our discussion is conducted on the basis of the two models, our version and the original one.

We start by considering the neoclassical case, and first look at the terms of trade effect in our version of the model. A partial fall in the price of consumer goods—corresponding to a rise in the agricultural terms of trade—implies a rise in peasant real income. Given certain conditions, the *production* of food and cash crops will decline. See Appendix C, where the effect is derived. This is because the income effect tends to increase leisure. There is, in fact, no substitution effect on production, since the relative price between crops, and between leisure and income, remains unchanged. In the case of food *consumption*, there is an income effect tending to raise, and a substitution effect tending to reduce the consumption of food. In Tanzania, however, the substitution effect is, according to Lundahl and Ndulu (1987:205), not likely to outweigh the income effect in food consumption, because the general level of food consumption is rather low. On the other hand, the consumption increase is not likely to be very large, as the demand for food (in Tanzania, as elsewhere) is not very income elastic.⁴⁹ Hence, with falling

⁴⁹ The Food and Agriculture Organization of the United Nations (FAO) has estimated that the income elasticities of demand for food crops, in Tanzania, range from 0.4 to 1.0 (MDB, 1983:13). Estimations made by Kapunda (forthcoming, referred to by Amani et al., 1987:35) show a gross income (expenditure) elasticity of demand for food of 0.87, and a corresponding elasticity for the rural areas alone of 0.83. Gerrard and Roe estimated the per capita elasticities with respect to private consumption expenditure in real terms for maize, wheat

production, and rising food consumption, the marketed supply of both food and cash crops tends to decline in response to an increase in the agricultural terms of trade.

In the Lundahl and Ndulu model (1987:205–206), however, the effect of improved agricultural terms of trade on the marketed supply of crops becomes quite different. Provided that the real wage—the wage rate in terms of the price of consumer goods—is unchanged,⁵⁰ the marketed supply of both food and cash crops is likely to increase. The income effect, tending to increase leisure, only takes place at the expense of wage labour and not at the expense of agricultural production.⁵¹ There is consequently no negative income effect on production. The substitution effect tends to substitute agricultural production for wage labour because of the increase in its relative profitability. With constant real wages, agricultural production consequently tends to increase. The effect on food consumption is the same as in our version of the model: most likely moderately positive. Given increasing production of both food and cash crops, and with a moderate rise in food consumption, the marketed supply of both crops is likely to increase.

We summarise: If the peasant is only allowed to allocate his labour time within the agricultural sector, his aggregate supply response to improved agricultural terms of trade is negative. If, on the other hand, he has access to other sectors for income earning activities, in which wages follow the price of consumer goods, his supply response is likely to be positive. The diametrically opposed results achieved in the two different versions of the model indicate the crucial importance of the underlying assumptions in the model specification. The opportunity to transfer resources between sectors is a central assumption for achieving a positive response of total agricultural supply to

and rice to be 0.85, 1.46 and 1.10 respectively (1983:120). These results are questioned by Ødegaard, however, who also estimated expenditure elasticities for several major food crops. He obtained very low elasticities for maize, which rather indicates that maize may be an inferior good (1985:146–147, 183–184).

⁵⁰ The assumption that the real wage is unchanged, while the price of consumer goods declines, at first glance seems like a strong violation of reality. A closer look, however, shows that it might reflect the real conditions fairly well. What is termed wage labour in the Lundahl and Ndulu model, may be conceived of as all income earning activities apart from agricultural production, including petty trade and handicrafts. If the price of consumer goods also represents the price of goods sold in petty trade and from handicrafts, then the declining price of these goods might off-set the increasing real wage induced by the falling consumer goods price.

⁵¹ The reason is that wage labour is assumed to have the lowest marginal productivity. Lundahl and Ndulu (1987:201) assume that the peasant diverts his labour time to agricultural production up to a point where the marginal product of labour has declined to the level where it equals the off-farm wage rate. At this point, wage labour becomes relatively more productive at the margin, in terms of income.

changes in the agricultural terms of trade. By including off-farm wage labour into their theoretical model, Lundahl and Ndulu thus contributed to the analysis of peasant supply response to changing agricultural terms of trade.

Finally, we consider the case with consumer goods rationing. When the price of purchased commodities falls, and induces a rise in real income, the income effect is stronger under rationing, since the marginal rise of income is spread over fewer consumer goods than in the non-rationed case. In our model, without wage labour, leisure and food consumption both tend to increase more than when the consumption of consumer goods can also be varied. Therefore, in response to improved agricultural terms of trade, the marketed supply of both crops tends to decline even more under rationing. When wage labour is introduced, the analysis becomes more complex and is left out here.

Some aspects of the disequilibrium approach

In this section we elaborate on certain aspects of the disequilibrium approach. We will allow for alterations in some of the underlying assumptions, and analyse how these changes, by affecting the degree of rationing, affect peasant supply response to price incentives.

Rationing in an intertemporal model

In the theoretical analysis, we have—until now—implicitly assumed that the peasant household consumes all of its income within the time period studied. Using an atemporal model, a one-period analysis has been performed. By allowing the rationed peasant to transfer money holdings from one time period to another, we now shift to an intertemporal perspective. A brief verbal account is provided of an intertemporal model of the behaviour of the peasant household under consumer goods rationing. The impact of the introduction of saving opportunities on peasant supply response to price incentives is subsequently discussed.

The model presented here has been developed by Bevan et al.⁵² It examines the optimal monetary behaviour of the peasant. The analysis focuses primarily on how desired money holdings respond to changes in the expected

⁵² The formal model is presented in Bevan et al. (1987a:55-62; 1987b:433-436).

quantity of consumer goods purchased. It correspondingly studies how the marketed supply of cash crops responds to changes in the degree of rationing of consumer goods. The model does, however, allow for an analysis of the supply response to price changes—which is also performed by Bevan et al.

As in the model used in the previous sections, the peasant household is assumed to produce food and cash crops, and to consume food, leisure and consumer goods. Food, however, is assumed to be produced solely to meet the households own consumption requirements, and therefore has no monetary implications. The allocation of time between leisure and food production can therefore be disregarded. Only the peasant's allocation of time between cash crop production and leisure (implicitly assumed to include food production) is of relevance here. The peasant generates money holdings solely by producing and selling cash crops. He is further assumed to be paid for his crops at the end of the harvest. He consumes goods evenly throughout the year and only holds money balances to finance his consumption.

With rationing in the consumer goods market, the money stock chosen by the peasant depends critically on the prevailing rationing regime. When the ration is known to the peasant, the desired maximum money stock, that is to be transferred from one time period to another, equals the expected annual expenditure on rationed consumer goods. The ration may, however, be unknown to the individual peasant. There may be variations around an average degree of rationing, and if the peasant is fortunate, he might be able to purchase an above average quantity, and thus be subject to less rationing. If the degree of rationing is a matter of chance, the peasant wants—in order to be able to profit from above average availability—to hold a money stock that is larger than one that is sufficient for buying the mean quantity available. He consequently has an incentive to save. The desired money holdings will exceed the expected consumption of consumer goods, where the difference consists of savings.

The effects of changes in the availability of consumer goods on the marketed supply of cash crops are the following: A partial increase in the degree of rationing, and a consequent reduction in the availability of consumer goods, does, when the level of rationing is known, tend to lead to a proportionate decline in the desired money stock. In this case, the production and supply of crops would consequently decline in the response to the reduced availability of consumer goods.

When rationing is uncertain, however, there is also another effect, that works in the opposite direction. There is then a tendency to increase the desired money holdings in order to reduce the probability of being constrained.

This effect is particularly strong if the change is from a non-rationed to a rationed situation. If this second positive effect on desired money holdings outweighs the first negative effect, supply response to a change in the degree of rationing would be perverse: an increased degree of rationing would then stimulate agricultural supply. Bevan et al. (1988:18–20) have shown, however, that any accumulation in money stocks only partially offsets the reduction in labour supply. The supply response to a change in availability (degree of rationing) is therefore positive (negative), or more precisely: significant, positive (negative) and less than unity.

We now consider the effect of a partial increase in the price of cash crops. In the case of a known degree of rationing, the effect on the supply of cash crops is negative. Given the level of expenditure and at the prevailing price of consumer goods, the peasant does, at a given quantitative ration, only have to produce and sell a smaller amount of cash crops to earn the same income. The supply of cash crops declines and peasant supply response is accordingly negative. The same result is obtained if the price of consumer goods is lowered, in response to improved agricultural terms of trade.

In the case when the degree of rationing is unknown, however, we may also obtain an additional effect. When the price of cash crops rises, some of the increased income might be saved (although once rationing has become permanent, the stock of savings has already been built up). The initial stock of savings is optimal for the given level of rationing—which remains unchanged. Nevertheless, when the consumer goods availability is uncertain, there may, since the price increase raises income, still be a positive income effect on savings. The impact of this effect on the marketed supply is thus positive, reducing the impact of the first, negative effect. Provided that leisure (including food) is not an inferior good, cash crop production still tends to decline, but to a lesser extent than when there is no possibility, or incentive, to save. In this case, the introduction of an additional choice variable in consumption: savings, tends to make the supply response more elastic. (Cf. the previous argumentation of Le Chatelier Principle in footnote 47.) The reason is that savings—by providing the possibility to consume an above average quantity of consumer goods—reduces the degree of rationing.

We conclude that, in an intertemporal model with consumer goods rationing, Bevan et al. show that peasant supply response to price incentives is negative. When, however, the degree of rationing is uncertain, supply response is less negative than when the ration is known. The opportunity to save introduces an additional choice variable, in terms of consumption, and therefore increases the responsiveness.

Rationing and a Dual Consumer Goods Market

Disregarding the savings opportunities, we now instead assume that the consumer goods market has a dual structure. This is done by the introduction of a parallel market, operating alongside the official one. Under this assumption, we discuss to what extent rationing may still be considered to prevail—or be effective—and analyse how this affects peasant supply response to price incentives.

The characteristic distinction between the two markets is that in the official market, the prices of consumer goods are still fixed, whereas prices on the parallel market are free and market clearing. At the official market, rationing—excess demand at the given prices—thus persists because of the stickiness of the prices. This excess demand spills over to, and creates the parallel market, where the flexible prices matches supply and demand.

When examining the extent to which rationing prevails, we now have two markets to consider, the official and the parallel market for consumer goods. The fact that there are two different markets for one good, implies that the good traded in the official market and the good traded in the parallel may be regarded as two different goods. To a large extent, the goods are certainly still the same in both markets, although certain properties such as accessibility differ. Not all consumers are likely to demand the good in both markets. To what extent the consumer, our smallholder peasant household, is rationed, depends on in which market he buys the good, i.e. on which of the two goods he demands at the prevailing prices.

First assume that the parallel market operates smoothly. The individual consumer may trade either in the official market, in the parallel market or in both. If he trades in the official market alone, he would like to buy more at the official price, but is not willing to pay the higher parallel market price. The consumer is then, what Bevan et al. calls, 'fully rationed' (1987b:431). He is rationed in the official market, but does not demand the parallel market good. The consumer might, on the other hand, be rationed in the official market, but also demand the parallel market good, and thus be willing to pay the higher price. This consumer is 'partially rationed' (Bevan et al., 1987b:431). Finally, if the consumer only trades in the parallel market, he does not demand the official market good. He is consequently not rationed at all, since the parallel market is a clearing market.

Now suppose that the parallel market does not function satisfactorily. Prices are still free, but the consumers don't have reliable access to the market. This may be due to the market being successfully suppressed, or due to sporadic supply, caused by transport bottlenecks etc. Unreliable access to the parallel consumer goods market primarily affects those consumers who demand parallel market goods. At those moments when there is no supply in the parallel market, those consumers who trade in both the official and the parallel market have to resort to the official market. Consequently, they are now fully rationed. Consumers who only trade in the parallel market are not rationed, however, since they do not demand the official market goods.

It is only in the official market that rationing prevails, since prices in the parallel market adjust to clear the market. The reason that the consumer is fully rationed in the absence of supply in the parallel market, is thus entirely explained by the fact that he is then obliged to resort to the rationed official market. It has been claimed, however, by Bevan et al., that rationing may also prevail in the parallel market, if supply is sporadic.⁵³ It may, however, be questioned whether limited and sporadic supply ought to be interpreted as an indication of excess demand, non-clearing markets and quantitative rationing. The mere fact that supply is sporadic does not necessarily imply that rationing prevails. If, at a certain moment in time, there is no supply of consumer goods to the parallel market, this may simply imply that there is no market for them at that particular moment. Although there may be a potential demand for the goods, the equilibrium price may be so high that no consumer is prepared to pay the price necessary to attract supply to the market. Consumers are, consequently, priced out of the market. In a free parallel market, there is, per definition, no rationing as long as the price clears the market, regardless of whether it is well functioning or only functioning sporadically. For rationing to prevail, an assumption of rigid prices is necessary.

Now consider peasant supply response to a partial increase in the price of the crops he sells.⁵⁴ The introduction of a parallel market for consumer goods may be expected to affect supply response in the following way: If the peasant is fully rationed—only purchasing consumer goods in the

⁵³ Bevan et al. (1988:8-14) explicitly claim that not only the official consumer goods market, but also the parallel one, was rationed during the late 1970s and first half of the 1980s. The parallel markets are claimed not to have been clearing, and accordingly, excess demand to have arisen. Rationing was, according to Bevan et al., expressed in the sporadic supply and the patchy character of the market, which was due to transport bottlenecks etc.

⁵⁴ The price change considered here is a change in a weighted average of the official and the parallel market price, since we are interested in the peasant supply response in general, and not in a particular market.

official market—he is just as rationed as when there is no parallel market, and supply response is just as weak. If, on the other hand, he purchases consumer goods in both the official and the parallel market, he is now only partially rationed. The introduction of the option to buy consumer goods in the parallel market makes him rationed to a lesser extent than before. The former rationing, in the single consumer goods market, is thereby partly offset. Presenting the possibility to purchase parallel market consumer goods implies giving the peasant an additional choice variable in consumption. Hence, supply response is stronger than in the fully rationed case, but still weaker than if there was no rationing at all. Finally, the peasant who has chosen only to buy parallel market consumer goods, is now not rationed at all, as compared to the situation with only one consumer goods market, when he was fully rationed. His supply response has regained all the strength from the non-rationed case.

Theoretical summary

This theoretical section commenced with a brief survey of the theoretical developments within the study of peasant supply response to price incentives in Tanzania. We first established that there has been a tendency to move from theoretical models studying the agricultural sector in isolation, to models that examine the relations between sectors and allow for intersectoral flows of resources. There has also been a tendency for theoretical models to give explicit consideration to specific institutional conditions. This approach allows for the existence of market imperfections, and offers explanations for a seemingly weak supply response.

The implication has been that models were developed which extended the analysis beyond the examination of the supply response of individual crops to changes in the relative price within agriculture. Instead, attention has been increasingly focused on the response of total agricultural supply to changes in the agricultural terms of trade, and to peasant supply response under consumer goods rationing. This theoretical development was illustrated with the use of a simple behavioural model of the smallholder peasant household. First a neoclassical version was presented; thereafter, by the introduction of quantitative rationing in the consumer goods market, a disequilibrium version of the model was discussed.

Firstly, peasant supply response of individual crops to changes in their own prices was derived, by a comparative static analysis, under the two different assumptions about the consumer goods market. In both cases, the

substitution effect on marketed supply was shown to be positive, whereas the income effect was negative. Provided that the substitution effect dominates the income effect—which, it was argued, is likely at least in the neoclassical case—the total effect is positive.

In the case of rationing, the substitution effect is weaker, while the income effect is stronger than in the neoclassical case. Peasant supply response is consequently weaker. The fundamental difference between the two approaches lies consequently in the relative strength of the different effects. Supply response in the rationed case is thus more likely to be negative—although not necessarily so—while it is more likely to be positive in the non-rationed case. What tends to reduce the peasant's responsiveness are the fewer substitutes in consumption that rationing in consumer goods implies.

Subsequently, the terms of trade effect was derived. The crucial importance of the assumptions regarding the peasant's opportunity to transfer resources between sectors for the outcome was demonstrated. Our model, which is confined to the agricultural sector alone, proved inadequate for analysing the effects of a change in the agricultural terms of trade on aggregate agricultural supply. For this purpose, the original Lundahl and Ndulu model is more appropriate, since it allows the peasant to choose off-farm labour, which is also a more realistic assumption. In this case, the terms of trade effect is likely to be positive, whereas in our model it is negative. This suggests that unless peasants have alternative income opportunities to agricultural production, they may tend to respond negatively to improved relative prices for agriculture.

Hence, it has been shown that both the strength and the direction of peasant supply response to price incentives is extremely sensitive to changes in the underlying assumptions. The critical dependence of the outcome on the assumptions is one of the conclusions that can be drawn from the theoretical development. Furthermore, we have shown that weak or negative peasant supply response peasants may well be in accordance with economically rational behaviour.

In the final section of the theoretical section, the analysis of peasant supply response under consumer goods rationing was extended. Some of the assumptions in the disequilibrium version of the model were changed, one at a time, and the effects on rationing and supply response were then analysed. Firstly, we demonstrated how peasant supply response to price incentives becomes negative in an intertemporal model with rationing by Bevan et al. It was subsequently shown, however, that the inclusion of savings

opportunities—when the supply of consumer goods is uncertain—increases the alternatives (the substitution possibilities) in consumption. The same happens when a parallel market for consumer goods is introduced. Both of these changes tend to reduce the degree of rationing, and thereby strengthen peasant supply response to price incentives.

Empirical Examination

We will now examine how the empirical results correspond to the predictions of the theoretical models. An account is therefore given of the empirical studies of peasant supply response to price incentives in Tanzania. Since we are concerned with two basically different approaches—one neoclassical and one disequilibrium approach—an empirical assessment, not only of the predictability of the models, but also of the underlying theoretical assumptions would be appropriate. In order to enable such an assessment, different interpretations of the characteristics and operation of the Tanzanian consumer goods market are presented. We are thus concerned with the arguments of equilibrium versus quantitative rationing and consequently of the relevance of the two approaches.

Empirical studies of peasant supply response

Within the empirical analysis, developments corresponding to these occurring in the theoretical field have allowed the new theoretical models to be tested empirically. Most of the empirical studies, however, have been based on theoretical models which are solely concerned with the agricultural sector. They analyse the effects of changes in the relative prices within agriculture on the supply of individual crops and are discussed first.⁵⁵ Thereafter, the empirical estimates of peasant supply response to a partial change in the agricultural terms of trade are presented. The disequilibrium approach, reflecting the tendency to explicitly consider specific institutional conditions, has led to the empirical estimation of peasant supply response under the assumption of consumer goods rationing. These findings are presented at the end of this section.

Before we start to examine the empirical results, there is another institutional condition of particular relevance in this context, to which I would like to draw the readers' attention. This is the segmented Tanzanian food

⁵⁵ The main interest is usually on the own price elasticity, although cross price elasticities are also often estimated. (Cross price elasticities measure the responsiveness of supply of one crop to a change in the price of another crop.) Anyway, although a partial change in the price of a crop, own or competing, also implies a change in the agricultural terms of trade, the price changes considered always imply changes in relative prices within agriculture.

market, accounted for in the background section on Tanzanian agriculture, but disregarded in the theoretical analysis in this study.

The dual market structure constitutes a problem mainly in connection with the empirical studies. Whereas we generally only have access to data from the official market, our real interest may be in the response of the total marketed supply (official plus parallel market) to changes in a weighted average of the official and the parallel market price. (This is actually what our theoretical model may be considered to have studied.) In most of the empirical studies, it is the response of officially marketed supply to changes in official producer prices that has been estimated. The elasticities therefore only tell us what is happening in the official market, whereas we don't know how the parallel market is affected. Lundahl and Ndulu (1987:208–210) show, in a theoretical model of the dual food market, that we are unable to determine whether an increase in the official producer price will lead to a rise or a fall in the parallel market price. Consequently, it remains unknown whether the supply in the parallel market—and therefore total supply—will increase or decline.⁵⁶ These problems actualise the limitations associated with studying a market in isolation under the prevalence of specific institutional conditions that are disregarded.

In some of the empirical studies, attempts have been made, however, to take the parallel food market into consideration in one way or another. Nevertheless, the readers should bear in mind the limitations mentioned above when interpreting the empirical results reported on below. In the case of cash crops, there is no corresponding problem—at least not of the same magnitude—since no parallel market of any significance is considered to exist.

The empirical studies performed all involve econometrical methods of estimating price elasticities of supply. In many cases, neither the basic assumptions nor the underlying theoretical model on which the empirical analysis is based, is explicitly expressed, but merely implicitly hinted. In most studies, however, the estimated supply function is based on a Nerlovian partial adjustment model, where desired supply (actually production) is a function of expected prices. The price expectations are assumed to be adaptive, and supply is assumed to adjust partially over time. This allows for the

⁵⁶ In fact, Roemer (1986:429–433) shows that when there is a parallel market for food, an increase in the official food price need not increase the total marketed output of food substantially, if at all. He thus provides another example of how institutional conditions have been explicitly considered in the theoretical analysis of peasant supply response. Roemer also offers a theoretical explanation of the observed low price elasticities of supply. The reason for disregarding this aspect here is simply to keep the theoretical analysis within reasonable dimensions.

estimation of both short-run and long-run elasticities.⁵⁷ Most of the empirical studies are based on aggregated time-series data, and official prices and officially marketed supply have been used throughout, unless explicitly expressed otherwise.⁵⁸

Individual crops and price changes within agriculture

The empirical evidence on peasant supply response of individual crops to price incentives is fairly ample in the Tanzanian case. Several separate studies have been undertaken for both food and cash crops. Ten different studies, that estimate the supply response of individual crops to changes in the relative prices within agriculture, based on a neoclassical theoretical approach, have been identified. The studies and the estimated own price elasticities of supply are listed in Table 1. In all studies, the dependent variable is officially marketed supply. The supply functions formulated differ, however, but supply is typically regressed on variables such as competing crop price, weather and time, in addition to the own price. Moreover, different price variables, although mostly the own official producer price, have been used. Some use nominal prices, while others use real prices, where the deflators also differ. Knut Ödegaard (1985), however, uses the parallel market producer price in terms of the price of a competing crop, thus explicitly considering the dual market structure for food crops.

Table 1. *Supply Response of Individual Crops: Studies and Estimated Own Price Elasticities*

We may, on the basis of these empirical studies, conclude that for all food and cash crops that have been studied—except for tea—the own price elasticities of supply obtained are significantly positive.⁵⁹ In several cases, however, the

⁵⁷ For the Nerlovian model, see e.g. Nerlove (1958).

⁵⁸ There are a number of problems associated with the estimation of supply elasticities, which will not be discussed here. Some of these are examined by Fones-Sundell (1987) and Oyejide (1990:11-13).

⁵⁹ The insignificant own price elasticities of supply of tea, indicated by two studies, might be partly explained by the fact that because the planted area allowed was fixed by the government, tea producing farmers had a limited opportunity to vary output (Mabele, 1987:173, 189). With the area fixed, output could only increase by higher yields from the

elasticities are rather weak, ranging between 0.06 and 0.43. In addition to own price elasticities, cross price elasticities were estimated in several of the studies, and found to be significantly negative in some cases.⁶⁰

These results indicate that different crops compete for scarce resources within agriculture, and further support the hypothesis of our theoretical model that peasants are responsive to changes in relative prices. Additional support is provided by the results of the Lundahl and Ndulu (1987) and Ödegaard (1985) studies, where estimates were also made of the effect on supply of a change in the parallel market price relative to the official price. They both found them to be significantly negative for supply in official markets, for Ödegaard in the case of maize, and for Lundahl and Ndulu in the case of paddy.

On the basis of this brief presentation—of the fairly extensive empirical analysis of peasant supply response to price incentives for individual crops in Tanzania—the Tanzanian peasant would certainly appear to be price responsive. This definitely seems to be the case when official prices are changed, and probably also applies when parallel market prices are altered. The estimated own price elasticities of supply obtained in the studies are all positive, thus strongly supporting the predictions of our theoretical model. The manifestation of positive supply response to own price changes thus appears fairly conclusive in the general case. However, we have noted that, in several cases, the estimated elasticities are quite small—below 0.5—or even insignificant, implying a fairly weak supply response.

Total supply and agricultural terms of trade effect

Whereas the empirical demonstration of positive supply response for individual crops is fairly convincing, due to the numerous studies that have been carried out, the effect of changes in the agricultural terms of trade on total agricultural supply has not yet been subject to such thorough analysis. However, a couple of empirical studies have been carried out. One of these was made by Lundahl and Ndulu (1987), who thereby subjected their model to empirical examination.

existing plantations. During the 1970s, a major part of the tea plants were still immature, which meant that the yield would increase over time, even if prices and labour input did not, simply because the tea plants were maturing. This explanation is supported by the Lipumba and Ndulu (1987:40-42) study, where tea production responds positively to time, but insignificantly to its own real price.

⁶⁰ See, for example, Lipumba and Ndulu (1987) and Lundahl and Ndulu (1987).

In this context, the main interest is the effect on total agricultural supply. Lundahl and Ndulu examined this effect by simply regressing the total officially marketed agricultural supply on the agricultural terms of trade. The analysis included all scheduled cash and food crops, except legumes other than beans. The aggregate price used was a weighted average of official producer prices, with the marketed quantities used as weights. This nominal price was deflated by the National Consumer Price Index (NCPI), representing the price level of other sectors, in order to derive the agricultural terms of trade. Fitting a regression-line to the time series gave a price elasticity, or terms of trade elasticity, of total supply, of 0.88. The whole equation explained as much as 93 per cent of the total variation in supply. The period studied was 1972/73–1982/83. (Lundahl & Ndulu, 1987:213)

The effect of a partial change in the agricultural terms of trade on agricultural supply was also estimated for two individual crops, paddy and maize. Short-run supply functions were estimated for the two crops respectively, where the NCPI was one of the explanatory variables. In the case of paddy, the terms of trade effect was strong and highly significant (at the 0.5 per cent level). A one per cent partial decline (increase) in the NCPI corresponded to an increase (decline) in the officially marketed supply of 1.75 per cent. In the case of maize, however, the elasticity was -0.23, but not statistically significant (Lundahl & Ndulu, 1987:214–217).

In addition to the study by Lundahl and Ndulu, there is another empirical study where aggregate supply response in Tanzania has been estimated. It is a study by Marian Bond (1983), and considers the period 1972–1981. The results of the Bond study are fairly poor, however. She estimated an elasticity of aggregate agricultural supply, with respect to the aggregate real producer price, of 0.03. However, it was not statistically significant. (1983:721) The Bond study has been criticised for various reasons, however, among others by Melinda Fones-Sundell for using ‘notoriously unreliable data’ (1987:9).⁶¹

⁶¹ The poor quality of the data used by Bond is recognised by her (1983:720). Aggregate agricultural supply was measured by data on total per capita agricultural production from the FAO. The aggregate real producer price was measured by the average producer prices of the major agricultural products, deflated by the Consumer Price Index and weighted by the relative share of each crop in overall agricultural production. The price data were obtained from various International Monetary Fund staff papers, and are together with the FAO production data, difficult to check (Hedlund and Lundahl, 1987:61–62).

Fones-Sundell also criticises Bond for using a method that ‘overestimates the responsiveness of production as it ignores substitution effects among different crops’ (1987:9). The argumentation of Fones-Sundell is not very convincing, however, as she does not provide any foundation for her statement. Partial changes in the agricultural terms of

Although the empirical analysis of the response of total agricultural supply to changes in the agricultural terms of trade, is rather scarce, certain conclusions may be drawn. Considering the results of the study by Lundahl and Ndulu, the possibility that supply response—the terms of trade effect—is positive, can certainly not be ruled out. The results of the Lundahl and Ndulu estimations do in fact correspond to the predictions given by their theoretical model.

Evidence in support of a disequilibrium approach

As in the case of the terms of trade effect, the empirical analysis of supply response based on a disequilibrium approach is not very extensive. Only one study that provides empirical estimates of supply response under consumer goods rationing was found. The non-Walrasian approach has been strongly advocated by Bevan et al., who also provided the empirical analysis. The main purpose of their study has been to estimate the importance of quantitative signals, rather than to estimate price elasticities, however. We therefore provide a brief account of the different empirical results in support of their hypothesis on the Tanzanian peasant being rationed in the consumer goods market.

We first take a look at their estimated price elasticities of supply. The approach adopted was to regress the real value⁶² of officially marketed peasant smallholder supply of the most valuable cash crop in 15 (out of 17) regions in Tanzania on its own real official price, and on different rationing indices.⁶³

trade do not imply changes in the relative prices within agriculture, and consequently there is no substitution between crops.

According to Bevan et al. (1987a:24), the weak and insignificant effect obtained by Bond is consistent with their hypothesis that there was a switch from positive to negative supply response in the 1970s.

⁶² It is not entirely clear from the Bevan et al. (1988:37-45, 58-63) study whether the dependent variable in these estimations is in real value or in quantitative terms. My interpretation is, however, that the supply of the most valuable cash crop in each region is measured in real value terms, where the NCPI has been used as deflator, with 1978 as base year.

⁶³ Two major types of rationing indices were constructed: availability indices and distribution indices. The availability indices show which proportion of a desired basket of commodities an agent can expect to purchase at official prices. It was constructed by first measuring the probability of making a successful purchase for a group of key commodities, and then by giving weights to the different goods. The distribution indices try to measure the absolute level of supply of consumer goods. They were constructed by observing all factory gate departures of certain commodities, and by giving weights to the different goods. Bevan et al. used three different weighting schemes, thus resulting in six different

These rationing indices were constructed in order to quantify the degree of rationing in the consumer goods market. The analysis was based on panel data, constructed by pooling time-series and cross-section data, i.e. by disaggregating time-series data to a regional level. Different econometrical models were applied, and several regressions using different rationing indices were run. In practically every regression, the own price elasticities of supply were negative, although they were never statistically significant. The supply of cash crops was also regressed on the price-series alone, which rendered a positive elasticity for the 1978–83 period, and a negative elasticity for the 1981–85 period, but none of them was significant. (Bevan et al., 1988:9–10, 58–63)

According to the predictions of the Bevan et al. model, the elasticity of supply with respect to the availability of consumer goods should be significant, positive and less than unity. The desired money stock should increase at the onset of rationing, if rationing was unknown. The empirical study set out to analyse how an evolving pattern of consumer goods shortages influenced peasant supply of marketed crops. This was done by regressing the real value of officially marketed supply of cash crops on the different rationing indices, using different econometrical methods. The obtained elasticities of supply with respect to the rationing indices were in many cases significantly different from zero, and indicated a positive supply response to increased availability of consumer goods. (Bevan et al., 1988:46–64)

Bevan et al. also referred to monetary data in support of their hypothesis. According to them, ‘monetary data suggest that peasants did indeed increase their money holdings. Cash not held in banks increased from Tsh. 2.4 billion in 1977 to Tsh. 6.6 billion in 1981, a rise in the ratio to GDP from 11 to 24 per cent.’ Bevan et al. concluded that ‘peasants must account for the bulk of this change’, since other groups, such as urban wage earners and black marketeers, had less incentive to accumulate money. (Bevan et al., 1987a:41–42)

The estimated price elasticities of supply obtained by Bevan et al. were indeed negative as predicted by their theory, but they were not statistically significant. Nevertheless, the insignificant elasticities may certainly indicate a weak supply response to price incentives, and do then correspond to the outcome of the theoretical analysis performed in the non-Walrasian version of the model. The relative insignificance of price incentives is further supported by the significantly positive elasticities of supply with respect to consumer

rationing indices. For a more detailed description of how the indices have been constructed, see Bevan et al. (1988:21–37).

goods availability. This would appear to suggest that during the period of study (1978–85), quantitative signals may have played a more important role than price signals in influencing the supply of cash crops.

Whereas Bevan et al. at least suggest that there might have been such a tendency, we should be aware of the fact that a positive supply response to changes in the availability of consumer goods may also be explained theoretically by a neoclassical approach. Adopting a neoclassical approach, we assume that all markets are clearing. A reduction in availability, i.e. the supply, of consumer goods, will induce an increase in the equilibrium price of consumer goods. This does correspond, *ceteris paribus*, to a decline in the agricultural terms of trade, which, in the Lundahl and Ndulu model tends to reduce agricultural supply. Hence, the empirical evidence in support of the disequilibrium approach is—in my opinion—too weak to enable us to draw any conclusions about the predictability of the Bevan et al. model, and thus about the relevance of the non-Walrasian approach as opposed to the neoclassical one.

Observations and interpretations of the consumer goods market

Hitherto, we have described how the theoretical predictions have been tested empirically and how the results of empirical studies correspond to the predictions of theoretical models. However, as pointed out above, some of the empirical results may be compatible with the predictions of different theoretical models. For that reason, and for a better understanding of the underlying mechanisms in operation, empirical testing of the assumptions in the theoretical models may be justified.

The basic assumption that distinguishes the neoclassical and the disequilibrium approach from each another, that of equilibrium or rationing in the consumer goods market, could be tested empirically. Bevan et al.'s claim, or interpretation, that Tanzanian peasants have been rationed in the consumer goods market from late 1970s until the middle of the 1980s, is certainly not indisputable. An alternative interpretation would be that the market has been more or less in equilibrium. Although not always explicitly expressed, we may consider this view to be held by the proponents of a neoclassical approach. Certain observations of the characteristics and operation of the Tanzanian

consumer goods market, and the alternative interpretations, ought therefore to be discussed.⁶⁴

There seems to be a consensus about the conditions prevailing since independence and during a major part of the 1970s. Bevan et al. consider the consumer goods market in Tanzania to have been largely a free market during this period, with prices determined by the market forces of supply and demand (1988:2, 9, 11). Private trading seems to have been predominant and the availability of consumer goods appears to have been satisfactory. As a control regime was gradually implemented, replacing the market as a mechanism for the allocation of most consumer goods, competition in the wholesale and retail trades was eroded. Monopoly power was granted to a few agencies, mainly Regional Trading Companies, in selling consumer goods. Until 1978, government controlled prices still appeared to be close to their equilibrium level, however (Bevan et al., 1988:2, 9, 11).

With a falling volume of export crops, deteriorating terms of trade and the second oil price shock in 1979, by the late 1970s, the growing shortage of foreign exchange became acute (Lipumba & Ndulu, 1987:25). As a result of decreasing import capacity, as well as the heavy priority given to imports of capital goods, the allocation of foreign exchange to the importation of consumer goods had been gradually reduced. The supply of consumer goods was reduced both directly, via imports, and indirectly, as the production of domestically manufactured consumer goods was hampered by the declining imports of intermediate goods and spare parts.⁶⁵

At the national level, the foreign exchange allocation was both item and firm-specific, and many types of consumer goods ceased to be imported. The imported consumer goods were allocated among regions, but there was no formal rationing system at the household level. Instead consumers had to queue up in order to be able to purchase the scarce goods (Amani & Ndulu, 1987:16).

⁶⁴ The description of the Tanzanian consumer goods market is mainly based on two sources: Amani et al. (1987:12-28) and Bevan et al. (1988:1-17). Whereas Bevan et al. obviously adopt a non-Walrasian approach, we allow Amani et al. to represent the neoclassical view. Other sources used are referred to as usual.

⁶⁵ The share of consumer goods in total imports fell drastically during the second half of the 1970s: from 37.0 percent in 1974 to 10.1 percent in 1982 (Lipumba & Ndulu, 1987:17). As an illustration of the reduced availability of imported consumer goods, it may be noted that deliveries of Matsushita radios declined by some 40 percent between 1977 and 1982 in urban areas, and by some 73 percent in rural areas (Bevan et al., 1987b:41). The supply of domestically produced consumer goods was also rapidly contracted, due to lack of inputs, inefficient resource allocation and low capacity utilization. Manufacturing value added fell by some 63 percent from 1978 to 1984 (Bevan et al., 1987b:7-9; 1988:7).

When consumer goods shortages became acute in 1978, official prices would have had to increase substantially in order to clear the market. Since they were administratively fixed, this did not take place, and official prices rapidly fell below the market clearing level. This created an excess demand for consumer goods at the existing official price, which led to the development of illegal, so-called parallel, markets for these goods.

The consumer goods available in the parallel markets originated to a large extent in the official markets, predominantly at the wholesale level.⁶⁶ The existence of excess demand created an incentive for traders in the official market to leak some of the supply to the parallel market, where there were large profits to be made (Bevan et al., 1987a:40).

However, despite the development of the parallel markets, supply of consumer goods was also limited in these markets, particularly in the rural areas. The parallel markets had a 'patchy' character, being temporally and spatially fragmented 'because of the penalties (for illegal trading; my remark) and because the attempt by the state to control prices was supported by its monopoly of the rural transport system and of consumer goods imports and manufacture.' (Bevan et al., 1988:13–14) Thus, at times there was no supply of certain consumer goods even in the parallel market.⁶⁷

Prices in the parallel markets were considerably higher than the official ones, and highly flexible. The variation in the parallel market prices was substantial between periods and regions subject to different supply conditions (Bevan et al., 1987a:12). Prices were particularly high in the rural areas, where the shortage of consumer goods was severe. This shortage was partly due to the high costs of transport, storage and spreading of information; partly to the rule of pan-territorial pricing⁶⁸ which 'created a powerful

⁶⁶ According to Bevan et al. (1988:31-33), only approximately one quarter of the soap distributed from the factory gate reached the official village shops, while the rest presumably leaked into parallel markets.

⁶⁷ Bevan et al. present some evidence on the shortage of consumer goods, based on a survey of peasant households in four regions conducted in 1983. Peasants were asked about the availability of 21 basic consumer goods, such as cooking oil, soap, sugar, cloth etc. 90 percent of the households reported that there were times when they had wanted to buy the items at the official prices, but had been unable to. The same was reported about the availability of goods at the black markets. A similar survey was undertaken in 1986 by Cooksey et al., but did not distinguish between the official and the parallel market. Consumer goods in villages were on average found to be always available 10 percent of the times; sometimes or rarely available 60 percent; and never available 10 percent of the times. (Bevan et al., 1988:12-14)

⁶⁸ The rule of pan-territorial pricing implied that goods were to be sold at the same price in all regions, thus disregarding differences in transport costs (Hedlund & Lundahl, 1987:71-72).

disincentive to incurring the transport costs necessary to supply rural areas'. (Bevan et al., 1988:11–12)⁶⁹

This description of the consumer goods market after 1978 appears to correspond to the observations made both by Bevan et al. (1987a; 1987b; 1988) and by others, such as Amani et al. (1987), Amani and Ndulu (1987) and Lundahl and Ndulu (1987). A general notion seems to be that excess demand prevailed in the official market, at fixed official prices; that a parallel market with highly flexible prices developed; and that supply in the parallel market was sporadic. It is rather in relation to the interpretation of these conditions—particularly in the parallel market, but, to some extent, also in the official market—that the proponents of the two approaches differ.

Bevan et al. clearly interpret the sporadic supply in the parallel market as a sign of rationing, since they explicitly claim that excess demand prevailed and that the parallel market was not clearing (1988:2, 8, 12–14). They support their interpretation by citing a number of rural household surveys of goods availability and by observations based on monetary data. While those taking a neoclassical approach do indeed acknowledge the sporadic supply in the parallel markets, they do not appear to interpret the situation as a sign of excess demand and quantitative rationing. Their major argument is that prices at the parallel market were highly flexible and therefore tended to equal supply and demand. There was no effective rationing mechanism. Rather, they interpret the situation as a simple lack of supply and a lack of a parallel market at times (Ndulu, 1988).

Some disagreement also prevails on how to interpret the situation in the official consumer goods market. Bevan et al. would appear to interpret the situation at the official market as being wholly characterised by rationing (1988:2, 8, 12–14). Queuing would be a sign of rationing. However, it is not entirely clear how the others, adopting a neoclassical approach, interpret the situation. A common view seems to be that although excess demand prevailed at official prices, it was at least partly off-set by the existence of a free parallel market, thus reducing the degree of rationing.

The effectiveness of rationing in the official market has, however, also been questioned on theoretical grounds, by Ndulu (1988). The fact that consumers had to spend a lot of time queuing at the official market has been taken as an indication of high and increasing opportunity costs, raising the

⁶⁹ In MDB (1986d:49), several constraints facing the parallel market trade, making it inefficient, are described.

effective official price actually paid. Ndulu therefore considers the official market to have been at least near a kind of equilibrium.⁷⁰

The rate of inflation, as measured by the non-food NCPI, may represent changes in the prices of consumer goods. According to this index, price increases were fairly moderate before 1973/74; around 6.0 per cent per annum on average. However, during the 1974/75–1978/79 period, the annual inflation rate rose to some 13.6 per cent. Since then, and during the 1980s until 1987/88, the rate of inflation was on average around 30.1 per cent.⁷¹ There is reason to believe that these figures reflect fairly well the price changes that also apply to the parallel market.⁷² It has been shown, however, that price increases have been higher in rural than in urban markets between 1976 and 1983.

During the end of this period, strong efforts were made to suppress the parallel markets for consumer goods. The intensification of parallel market activities made the government declare a 'war against economic saboteurs and racketeers' in 1983 (Amani et al., 1987:27). The government did not succeed, however, in suppressing trade in the parallel market.⁷³

An important policy measure to improve the supply of consumer goods was finally taken in 1984 when imports of a number of goods were

⁷⁰ This argument is fairly thoroughly presented and partly questioned in the original version of this report (Eriksson, 1991:39-41), but has been excluded here.

⁷¹ The main source of the non-food NCPI is Hyuha and Ndulu (1989:24; 1988). Up to 1965/66 the Hyuha and Ndulu series has been linked to the minimum wage earners retail price index (URT, 1969:46). From 1984/85 the Hyuha and Ndulu series was linked to the rate of change given by TET (1988:78). The non-food NCPI between 1963/64 and 1987/88, with 1969/79 as the base year, is as follows: 74.0, 77.6, 81.8, 85.8, 90.5, 95.9, 100.0, 103.6, 110.0, 120.1, 131.8, 152.1, 179.1, 201.9, 223.2, 249.0, 305.0, 397.3, 509.7, 644.0, 885.5, 1,274.5, 1,690.8, 2,157.4, 2,804.6.

⁷² Ndulu and Hyuha (1989:21, 23) present empirical results indicating that the NCPI might give a fairly good approximation of the price movements, not only at the official, but also in the parallel market, although the absolute price level has differed between the markets. If we only consider consumer good prices, this appears likely, since price changes in the two markets to a large extent are determined by the same factors. Assume that the parallel market price consists of the official price and of a parallel market premium, which is partly determined by the excess demand at the official market, partly by the government efforts to suppress the market. Firstly, changes in the official price will also affect the parallel market price. Secondly, a change in the supply of goods will affect excess demand, and thus also the equilibrium level of the parallel market price. However, it has been shown that when capacity utilisation fell during the period in question, thus reducing domestic supply of consumer goods, and unit production costs consequently rose, this tended to also raise official prices, since they were determined on a cost-plus basis. (Ndulu, 1988) Note that this refers to price changes *within* periods with more or less *constant* institutional conditions, i.e. the 1977-83 period.

⁷³ The cost of the risk associated with trading in the parallel market increased, however, and prices shot up in response. This was actually one of the reasons for the eventual government policy change towards liberalisation of the consumer goods market, according to Ndulu (1988). See also Amani et al. (1987:25-26).

liberalised. Individuals who owned foreign exchange were allowed to import so-called incentive goods and to sell them at a free price. This policy led to a volume of such imports totalling over 400 million US\$ in 1985 and 1986 separately, exceeding official export earnings (Amani et al., 1987:54). Surveys conducted in 1986 show that the availability of imported consumer goods had improved significantly, even in the rural areas (Hyuha & Ndulu, 1989:27–29). Trade liberalisation also implied a substantial reduction in the number of price controlled goods.

The consumer goods market has been characterised by the official market that trades mainly domestically produced goods and the parallel (open) market that mainly trades imported goods. Liberalisation policy increased the importance of the parallel market, which now strongly dominates the consumer goods market. (Hyuha & Ndulu, 1989:28) Since 1985, there seems to have been a tendency towards convergence between the official and the parallel markets for consumer goods and towards an equalisation of prices.⁷⁴ This development would appear to be interpreted as a return to pre-1978 conditions by those taking a neoclassical view (Ndulu, 1988). Bevan et al. are more cautious in this respect, however, and consider instead the 'quantity-constrained phase' (1988:14) to at least include 1986 as well.

To sum up, it would appear that the proponents of a neoclassical and those of a disequilibrium approach agree on the description of the operation and characteristics of the Tanzanian consumer goods market. Where they do differ, however, is in the interpretation of post-1978 conditions, especially in the parallel market.

Since 1978, administratively fixed official prices, kept below equilibrium levels, led to excess demand in the official market and to the development of a parallel market through leakage of supply. Parallel market prices were considerably higher than the official ones, and characterised by their flexibility. Supply was sporadic in both markets, particularly in rural areas.

These conditions tend to be taken as an indication of rationing in both the official and the parallel markets by those adopting a non-Walrasian view. The proponents of a neoclassical approach, on the other hand, seem to interpret the parallel market situation as one of periods of equilibrium

⁷⁴ Decontrol of prices for the bulk of consumer goods has removed the price difference between the two markets. Now only one price prevails. For goods still subject to control there is also a tendency towards equalisation of prices. At least at the retail level, traders tend to raise the price of domestic goods to the level of their imported substitutes. (Hyuha & Ndulu, 1989:28, 33)

followed by periods when there was no supply and markets did not exist. To some extent, they also seem to consider rationing in the official market to be at least partly off-set.

The effects of the liberalisation policy in the mid-1980s, with increased supply and a tendency towards a convergence of markets and an equalisation of prices, have been interpreted by neoclassical proponents as a return to pre-1978 conditions. Bevan et al., however, consider rationing to have continued for at least a couple of years.

Empirical summary

This chapter has dealt with the empirical evidence on peasant supply response to price incentives in Tanzania. We first examined the extent to which the results of the empirical studies correspond to the predictions of the theoretical models.

The evidence on the effects of changes in relative prices within agriculture on officially marketed supply of individual crops, is, in terms of the number of empirical studies, fairly ample. This is the case with respect to both food and cash crops, and shows that the Tanzanian peasant would certainly appear to be price responsive. Positive (statistically significant) own price elasticities of supply have been estimated for practically all crops, as predicted by our theoretical model. Nevertheless, the results also indicate that supply response appears weak in several cases.

Whereas the empirical evidence in this case is quite conclusive, empirical studies that analyse the effects of partial changes in the agricultural terms of trade are scarce. There is a study, however, by Lundahl and Ndulu, which indicates that both total agricultural supply and individual crops would appear to respond positively to improved agricultural terms of trade. These findings correspond to the predictions of the Lundahl and Ndulu model.

In order to examine their theoretical model, Bevan et al. have carried out an empirical analysis of supply response to price incentives on the basis of a disequilibrium approach. Their results suggest that supply response might have been not only weaker, but insignificant for supply, during the 1978–85 period. This outcome is in accordance with the predictions of the non-Walrasian version of our model. Evidence in support of negative supply response, was, however, not possible to find. There are certain other empirical findings in favour of the model by Bevan et al., but these should nevertheless be interpreted with caution. Some of the results might also be explained by a

neoclassical approach. The empirical results of Bevan et al. are, in my opinion, not sufficiently conclusive for us to be able to confirm the predictability of their model in the Tanzanian case.

In order to establish the relevance of a disequilibrium as opposed to a neoclassical approach, an empirical analysis of not only the predictions but also the basic assumptions of the theoretical models might be justified. To facilitate such an analysis, and accordingly obtain a better understanding of the mechanisms at work, the characteristics and varying interpretations of the official and parallel consumer goods market was presented. We found that whereas the proponents of the two approaches would appear to agree on the description of the market, they tend to interpret the situation in Tanzania from the late 1970s differently. According to Bevan et al., consumers would have been rationed in both official and parallel markets. Those who adopt a neoclassical view tend, on the other hand, to interpret the situation, at least in the parallel market, as one which comes close to equilibrium.

Concluding Remarks

This report has surveyed and illustrated the principal theoretical and empirical developments that have occurred within the analysis of peasant supply response to price incentives in Tanzania. Following the presentation of certain background information on the agricultural sector, the main theoretical trends were briefly surveyed. These trends were illustrated with the aid of a simple behavioural model of a smallholder peasant household. By adopting the method of comparative static analysis, peasant supply response could be derived under different assumptions. Finally the empirical analysis related to these theoretical models was presented.

A seeming dilemma—positive but weak supply response to price incentives—encountered in the early empirical studies, stimulated theoretical developments within the study of peasant supply response in Tanzania. Two main trends have been identified. First of all, there has been a movement from single sector models, which analyse the supply response of individual crops to changes in relative prices within agriculture, towards models that contain intersectoral linkages, and allow for the transfer of resources between sectors. This development allows us to study the response of total agricultural supply to changes in the agricultural terms of trade. Secondly, there has been a tendency to take explicit account of specific institutional conditions. This enables account to be taken of the existence of market imperfections, and offers potential explanations to the seemingly weak supply response. One method has been to adopt a disequilibrium approach, as opposed to a neoclassical one, assuming rationing in the consumer goods market.

With the use of our theoretical model, in its neoclassical version, it was shown that peasant supply of individual crops is likely to respond positively to partial changes in own prices. Furthermore, the opportunity to transfer resources between sectors, and thereby to earn income outside the farm, proved to be of crucial importance to the peasant, if aggregate supply is to respond positively to partial changes in the agricultural terms of trade. It was also demonstrated that if the peasant is subject to rationing in the consumer goods market, his supply response to price incentives tends to be weaker, and is, accordingly, more likely to be negative than in the neoclassical case. The analysis within the disequilibrium approach was slightly extended to reveal how sensitive the degree of rationing is to changes in the underlying assumptions. When savings opportunities and parallel markets for consumer

goods are introduced, the degree of rationing decreases, and strengthens peasant supply response.

The overall conclusion to be drawn from the theoretical analysis is that both the strength and the direction of peasant supply response to price incentives is extremely sensitive to changes in the underlying assumptions of the model. The outcome depends critically on the choices available to the individual peasant, and on the behavioural constraints with which he is confronted. Consequently, not only positive, but also weak and negative supply response to price incentives may well be compatible with economically rational behaviour. This sensitivity stresses the importance of the careful specification of the theoretical model and the need to adapt it to the specific situation and problem to be studied.

The different theoretical models and approaches have been subjected to varying degrees of empirical examination. It was fairly conclusively established that the empirical support in favour of a positive supply response to price incentives among Tanzanian peasants is substantial. This is the case for individual crops, as regards changes in the relative prices within agriculture, at least with reference to the official market. Hence, the early single sector models have been tested relatively thoroughly, whereas the newer models have not yet undergone such thorough empirical analysis. Some empirical testing has been pursued, however, and there are indications that agricultural supply, aggregate as well as of individual crops, responds positively to partial changes in the agricultural terms of trade. Nevertheless, this is one of the fields where there is a need for further research, particularly empirically, but also most likely theoretically.

Not only neoclassical, but also the disequilibrium approach has been subjected to empirical analysis. There are indeed certain indications that peasant supply response may have been weaker during part of the 1970s and the 1980s. However, the empirical evidence in support of the approach is not convincing. Besides, some of the results may also be explained by a neoclassical approach. Therefore, there is a strong case for further empirical examination of the theoretical predictions, as well as of the theoretical assumptions. One task would be to examine whether peasant supply response to price incentives in Tanzania has been significantly different between periods with different institutional conditions, notably between the 1978–84 period as well as in previous and subsequent periods. This could be done with respect to both individual crops and total agricultural supply.

Whereas the empirical analysis has been concentrated on testing the predictions of the theoretical models, little effort appears to have been made to

examine the underlying assumptions of equilibrium or rationing in the consumer goods market. Considering that some of the empirical results may be explained theoretically by the two different approaches, an empirical examination of the rationing assumption—and thus the relevance of the neoclassical versus the disequilibrium approach—might be justified. Moreover, such an examination could be justified on the grounds of seeking to gain a better understanding of the mechanisms at work in peasant supply response. The Tanzanian consumer goods market was therefore described, and the different interpretations of its characteristics were presented.

It ought to be pointed out that the analysis of peasant supply response might be further developed if both theoretical and empirical consideration could be given to an institutional condition such as the dual food market. The empirical analysis is, however, severely restricted by the limited availability of parallel market data.

This study shows that the neoclassical approach has something to say about the responsiveness of Tanzanian peasants. The empirical results show that peasant supply does seem to respond positively to price incentives. The neoclassical approach, moreover, provides a basic framework for analysing how price changes affect peasant supply. One of its strengths lies, in my opinion, in its separation of the impact into different effects that can be studied separately. It thereby reveals that the degree of supply response may vary due to substitution and income effects working in opposite directions.

However, the model can only indicate the direction of the different partial effects. Their relative strengths, and thus the net effect, cannot be determined theoretically, but have to be established empirically. The neoclassical model is thus a fairly blunt analytical tool, in that it may be compatible with both weak and strong, positive and negative supply response. Consequently, the neoclassical approach cannot on its own explain the extent and variability of the supply response. It needs to be complemented by institutional considerations—the importance of which has also been recognised in this study.

Nor is the disequilibrium approach, which introduces specific institutional factors, able to establish the degree of supply response. By establishing that in the case of consumer goods rationing, supply response is relatively weaker, it does, however, present a possible explanation for variations in the degree of response. (Changes in the positive substitution and negative income effects, supplied by the neoclassical framework, can now be studied.) Thus, the importance of institutional factors—disregarded in the neoclassical approach—for the degree of peasant supply response are

recognised. This is, in my view, considering its weak empirical support, the major virtue of the disequilibrium approach presented here.

Although the two approaches differ regarding certain basic assumptions, they are not wholly incompatible. As illustrated by the non-Walrasian version of our model, where rationing was introduced as an exogenous constraint, institutional factors may well be incorporated into the neoclassical framework. By introducing institutional factors, the disequilibrium approach does in fact complement and enrich the neoclassical one.

By pointing at certain strengths and weaknesses, this study offers several insights into the usefulness of orthodox microeconomic theory for the analysis of peasant supply response. My conclusion is that the neoclassical approach to the study of peasant supply response in a developing country like Tanzania is, despite its limitations, useful. For more accurate predictions and a better understanding of the actual conditions and mechanisms in operation, due attention must, however, be paid to the institutional factors of relevance to peasant behaviour. Walrasian assumptions about clearing markets need, especially in the prevalence of extensive government regulation and non-operating market mechanisms, particular scrutiny.

In the context of economic policy and the reform process, the effect of any price change will depend on the responsiveness of peasant supply. However, as is shown by Bevan et al., it is not only price changes that affect agricultural supply. It may also depend on the availability of consumer goods. It is in fact likely to depend on the entire institutional set-up, including the dual market structure for food crops, cultural factors etc. Prices do matter as incentives to Tanzanian peasant smallholders. However, they are probably not all that matters.

APPENDIX A. Derivation of the Peasant Equilibrium in the Neoclassical Case

The peasant household maximises a *utility function*:

$$U = U(F, M, L_e); \quad U_i > 0, U_{ii} < 0, i = F, M, L_e$$

where U is strictly quasi-concave
 $F =$ food
 $L_e =$ leisure
 $M =$ purchased commodities

Its *production functions* are:

$$Q_f = Q_f(L_f); Q_f' > 0, Q_f'' < 0$$

$$Q_c = Q_c(L_c); Q_c' > 0, Q_c'' < 0$$

where $f =$ food crops
 $c =$ cash crops
 $L_f =$ time devoted to food production
 $L_c =$ time devoted to cash crop production

The peasant household faces a *time constraint*.⁷⁵

$$L_e = L^0 - L_f - L_c$$

where $L^0 =$ the total amount of labour time

It also faces a *budget constraint*, expressed in terms of purchased commodities:⁷⁶

$$M = (P_f/P_m)[Q_f(L_f) - F] + (P_c/P_m)Q_c(L_c)$$

where $P_f =$ price of food
 $P_c =$ price of cash crops
 $P_m =$ price of purchased commodities

The *optimisation problem* is:

⁷⁵ The time constraint in the Lundahl and Ndulu model is $L_e = L^0 - L_f - L_c - L_w$, where L_w is the time dedicated to wage labour.

⁷⁶ In the Lundahl and Ndulu model, the budget constraint is $M = (P_f/P_m)[Q_f(L_f) - F] + (P_c/P_m)Q_c(L_c) + (W/P_m)L_w$, where W is the wage rate, which is assumed to be given over the agricultural season.

$$\begin{aligned}
&\text{Maximise} && U = U(F, M, L_e) \\
&\text{subject to} && L_e = L^0 - L_f - L_c \\
&\text{and} && M = (P_f/P_m)[Q_f(L_f) - F] + (P_c/P_m)Q_c(L_c)
\end{aligned}$$

Reformulating the budget constraint and formulating a *Lagrangian function*:

$$L = U(F, M, L^0 - L_f - L_c) + \$ (P_f[Q_f(L_f) - F] + P_c Q_c(L_c) - P_m M)$$

yields the following *first order conditions* for optimum:

$$\begin{aligned}
\text{(A.1)} \quad & U_f - \$P_f &= 0 \\
\text{(A.2)} \quad & U_m - \$P_m &= 0 \\
\text{(A.3)} \quad & -U_{Le} + \$P_f Q_f' &= 0 \\
\text{(A.4)} \quad & -U_{Le} + \$P_c Q_c' &= 0 \\
\text{(A.5)} \quad & P_f[Q_f(L_f) - F] + P_c Q_c(L_c) - P_m M &= 0
\end{aligned}$$

where $Q_f' = dQ_f/dL_f$, $Q_c' = dQ_c/dL_c$, and \$ can be regarded as the marginal utility of money.

The equilibrium is characterised by the conditions (A.1) and (A.2), which give:

$$U_f = U_m P_f / P_m$$

and by conditions (A.2) to (A.4), which give:

$$U_m (P_f / P_m) Q_f' = U_m (P_c / P_m) Q_c' = U_{Le}$$

Taking total differentials, rearranging and using a *matrix form* gives:

U_{ff}	U_{fm}	$-U_{fLe}$	$-U_{fLe}$	$-P_f$
U_{mf}	U_{mm}	$-U_{mLe}$	$-U_{mLe}$	$-P_m$
$-U_{Lef}$	$-U_{Lem}$	$U_{LeLe} + \$P_f Q_f''$	U_{LeLe}	
$P_f Q_f'$				
$-U_{Lef}$	$-U_{Lem}$	U_{LeLe}	$U_{LeLe} + \$P_c Q_c''$	
$P_c Q_c'$				
$-P_f$	$-P_m$	$P_f Q_f'$	$P_c Q_c'$	0
	dF		$\$ dP_f$	
	dM		$\$ dP_m$	
	dL_f	$=$	$-\$ Q_f' dP_f$	

$$\begin{array}{ll} dL_c & -\$Q_c' dP_c \\ d\$ & -(Q_f-F) dP_f - Q_c dP_c + M dP_m \end{array}$$

Since the utility function is continuously differentiable $U_{ij} = U_{ji}$, i and $j = F, M, L_e$, and we now have a symmetric matrix. The *second order conditions* for an optimum are fulfilled if the determinant D , of the matrix above, is greater than zero, i.e. $D > 0$, and the principal minors are changing sign, i.e. $D_{ii} < 0$, where $i = 1...5$ (Glaister, 1986:200).

APPENDIX B. Derivation of the Peasant Optimum in the Non-Walrasian Case

As compared to the neo-classical case, the peasant household now faces an additional constraint: a *rationing constraint*.

$$M = M^0.$$

where $M =$ the quantity of consumer goods available
 M is a binding constraint

The *optimisation problem* is:

$$\begin{array}{ll} \text{Maximise} & U = U(F, M, L_e) \\ \text{subject to} & L_e = L^0 - L_f - L_c \\ \text{and} & M = (P_f/P_m)[Q_f(L_f) - F] + (P_c/P_m)Q_c(L_c) \\ \text{and} & M = M^0 \end{array}$$

Reformulating the budget constraint and formulating a *Lagrangian function*:

$$L = U(F, M, L^0 - L_f - L_c) + \$ (P_f[Q_f(L_f) - F] + P_c Q_c(L_c) - P_m M) + \S (M^0 - M)$$

yields the following *first order conditions* for optimum:

$$\begin{array}{lll} \text{(B.1)} & U_f - \$P_f & = 0 \\ \text{(B.2)} & U_m - \$P_m - \S & = 0 \\ \text{(B.3)} & -U_{L_e} + \$P_f Q_f' & = 0 \\ \text{(B.4)} & -U_{L_e} + \$P_c Q_c' & = 0 \\ \text{(B.5)} & P_f[Q_f(L_f) - F] + P_c Q_c(L_c) - P_m M & = 0 \\ \text{(B.6)} & M - M^0 & = 0 \end{array}$$

where $Q_f' = dQ_f/dL_f$, $Q_c' = dQ_c/dL_c$, $\$$ can be regarded as the marginal utility of money, and $\S$ as the marginal utility of the quantitative ration.

The optimum, which is not an equilibrium, is characterised by conditions (B.1) and (B.2), which give:

$$U_f = (U_m - \$)P_f/P_m$$

and by conditions (B.2) to (B.4), which give:

$$U_{Le} = (U_m - \$)(P_f/P_m)Q_f' = (U_m - \$)(P_c/P_m)Q_c'$$

Taking total differentials, rearranging and using a *matrix form* gives:

U_{ff}	U_{fm}	$-U_{fLe}$	$-U_{fLe}$	$-P_f$	0
U_{mf}	U_{mm}	$-U_{mLe}$	$-U_{mLe}$	$-P_m$	-1
$-U_{Lef}$	$-U_{Lem}$	$U_{LeLe} + \$P_fQ_f''$	U_{LeLe}	P_fQ_f'	0
$-U_{Lef}$	$-U_{Lem}$	U_{LeLe}	$U_{LeLe} + \$P_cQ_c''$	P_cQ_c'	0
$-P_f$	$-P_m$	P_fQ_f'	P_cQ_c'	0	0
0	-1	0	0	0	0

dF	$\$ dP_f$
dM	$\$ dP_m$
dL_f	$= -\$Q_f' dP_f$
dL_c	$= -\$Q_c' dP_c$
$d\$$	$-(Q_f - F) dP_f - Q_c dP_c + M dP_m$
$d\S$	$= -dM^0$

Since the utility function is continuously differentiable $U_{ij} = U_{ji}$, i and $j = F, M, L_e$, we now have a symmetric matrix. The *second order conditions* for an optimum are fulfilled if the determinant D^0 , of the matrix above, is smaller than zero, i.e. $D^0 < 0$, and the principal minors are changing signs, i.e. $D^0_{ii} > 0$, where $i = 1...4$ (Glaister, 1986:200).

APPENDIX C. Comparative Statics in the Neoclassical Case

Solving the system of equations, given in matrix form in Appendix A, with respect to L_f, F and L_c , e.g. by the use of Cramer's rule, gives:

$$dL_f = \$dP_f D_{13}/D + \$dP_m D_{23}/D - \$Q_f' dP_f D_{33}/D - \$Q_c' dP_c D_{43}/D$$

$$- [(Q_f - F)dP_f + Q_c dP_c - M dP_m] D_{53} / D$$

$$dF = \frac{\$dP_f D_{11}}{D} + \frac{\$dP_m D_{21}}{D} - \frac{\$Q_f' dP_f D_{31}}{D} - \frac{\$Q_c' dP_c D_{41}}{D} - \frac{[(Q_f - F)dP_f + Q_c dP_c - M dP_m] D_{51}}{D}$$

$$dL_c = \frac{\$dP_f D_{14}}{D} + \frac{\$dP_m D_{24}}{D} - \frac{\$Q_f' dP_f D_{34}}{D} - \frac{\$Q_c' dP_c D_{44}}{D} - \frac{[(Q_f - F)dP_f + Q_c dP_c - M dP_m] D_{54}}{D}$$

Let $dP_c = dP_m = 0$, and study the effect of a partial change in P_f on L_f and F respectively:

$$dL_f / dP_f = \$D_{13} / D - \$Q_f' D_{33} / D - (Q_f - F) D_{53} / D$$

$$dF / dP_f = \$D_{11} / D - \$Q_f' D_{31} / D - (Q_f - F) D_{51} / D$$

The effect on production of food is given by the effect L_f multiplied by the marginal productivity of labour in food production (Q_f'). The total effect on the marketed supply of food of a partial change in P_f is thus given by:

$$Q_f' dL_f / dP_f - dF / dP_f = \$ / D [-D_{11} + 2Q_f' D_{31} - Q_f'^2 D_{33}] - [(Q_f - F) / D] (Q_f' D_{53} - D_{51})$$

where the first term on the right hand side can be identified as the substitution effect, and the second term as the income effect.

Now, let $dP_f = dP_m = 0$, and analyse the effect of a partial change in P_c on L_c :

$$dL_c / dP_c = -\$Q_c' D_{44} / D - Q_c D_{54} / D$$

Now, let us examine the effect of a partial change in P_m on L_f and L_c simultaneously, while $dP_f = dP_c = 0$:

$$dL_f / dP_m + dL_c / dP_m = \$D_{23} / D + M D_{53} / D + \$D_{24} / D + M D_{54} / D$$

Or expressed differently;

$$dL_f / dP_m + dL_c / dP_m = \$[(D_{24} / D) - (D_{23} / D)] + M[(D_{53} / D) - (D_{54} / D)]$$

where D_{23} etc. are minors instead of cofactors as before, and where the first term on the right hand side can be identified as the substitution effect, and the second term as the income effect.

It can easily be shown, by comparing the minors, that if $Q_c''/Q_c' = Q_f''/Q_f'$ then D_{23} equals D_{24} in the equation above, and the substitution effect becomes zero.

The effect of a partial change in P_m on F is:

$$dF/dP_m = D_{21}/D + MD_{51}/D$$

APPENDIX D. Comparative Statics in the Non-Walrasian Case

Solving the system of equations, given in matrix form in Appendix B, with respect to L_f , F and L_c , e.g. by the use of Cramer's rule, gives:

$$\begin{aligned} dL_f &= \frac{dP_f D_{13}^0}{D^0} + \frac{dP_m D_{23}^0}{D^0} - \frac{Q_f' dP_f D_{33}^0}{D^0} - \\ &\quad \frac{Q_c' dP_c D_{43}^0}{D^0} - [(Q_f - F)dP_f + Q_c dP_c - M dP_m] D_{53}^0 / D^0 - dM^0 D_{63}^0 / D^0 \\ dF &= \frac{dP_f D_{11}^0}{D^0} + \frac{dP_m D_{21}^0}{D^0} - \frac{Q_f' dP_f D_{31}^0}{D^0} - \\ &\quad \frac{Q_c' dP_c D_{41}^0}{D^0} - [(Q_f - F)dP_f - Q_c dP_c + M dP_m] D_{51}^0 / D^0 - dM^0 D_{61}^0 / D^0 \\ dL_c &= \frac{dP_f D_{14}^0}{D^0} + \frac{dP_m D_{24}^0}{D^0} - \frac{Q_f' dP_f D_{34}^0}{D^0} - \\ &\quad \frac{Q_c' dP_c D_{44}^0}{D^0} - [(Q_f - F)dP_f + Q_c dP_c - M dP_m] D_{54}^0 / D^0 - dM^0 D_{64}^0 / D^0 \end{aligned}$$

Let $dP_c = dP_m = dM^0 = 0$, and study the effect of a partial change in P_f on L_f and F respectively:

$$dL_f/dP_f = D_{13}^0/D^0 - Q_f' D_{33}^0/D^0 - (Q_f - F) D_{53}^0/D^0$$

$$dF/dP_f = D_{11}^0/D^0 - Q_f' D_{31}^0/D^0 - (Q_f - F) D_{51}^0/D^0$$

Now, let $dP_f = dP_m = dM^0 = 0$, and analyse the effect of a partial change in P_c on L_c :

$$dL_c/dP_c = -Q_c' D_{44}^0/D^0 - Q_c D_{54}^0/D^0$$

APPENDIX E. Analysis of the Substitution Effect

The substitution effect of a partial increase in P_f on the marketed supply of food in the neoclassical case, derived in Appendix C, is:

$$S/D (-D_{11} + 2Q_f'D_{31} - Q_f'^2 D_{33})$$

Multiplying this expression by D_{11}/D_{11} , and adding and subtracting the expression $Q_f'^2 D_{13}^2$ into the parenthesis, i.e. completing the square, gives:

$$S/DD_{11} (-D_{11}^2 + 2Q_f'D_{13}D_{11} - Q_f'^2 D_{13}^2 - Q_f'D_{11}D_{33} + Q_f'^2 D_{13}^2)$$

The sign of the total substitution effect above will depend on the following expression, obtained after rearrangement:

$$[(D_{11}/D)(D_{33}/D) - (D_{13}^2/D^2)]$$

It can be shown that, if the bordered Hessian matrix is negative definite, which is the case here if the second order condition for a maximum in Appendix A is fulfilled, then the inverse bordered Hessian matrix is negative semi-definite. This follows as a consequence of the assumption of utility maximisation. This is only valid, however, for the matrix of order $(n-m)$, where n is the order of the unbordered Hessian matrix, and m is the number of constraints, i.e. in this case of the third order. (Samuelson, 1965:378-379)

The expression above is in fact a determinant of the second order to the inverse bordered Hessian matrix, which in matrix form is written:

$$\begin{array}{cc} D_{11}/D & D_{13}/D \\ D_{31}/D & D_{33}/D \end{array}$$

The determinant is semi-definite, i.e. can take the value zero, because it is the determinant of an inverse matrix that is negative semi-definite. Since the determinant is not of the third order, whether it is positive or negative semi-definite has to be determined by another rule than the one to which Paul Anthony Samuelson refers. The inverse of the bordered Hessian matrix is unbordered, and so is the determinant. For an unbordered matrix to be negative semi-definite, the determinant has to be non-negative, i.e. positive or zero (Glaister, 1986:104). We may hence conclude that:

$$[(D_{11}/D) - (D_{13}^2/D^2)] \geq 0$$

and the whole substitution effect is consequently positive.

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