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*Cap and Food Security*

**Abstract:** Although the food security discussion has given more emphasis to the individual (household) level as the proper unit of analysis, it still suffers from applying inappropriate indicators, which are mostly quantity oriented, instead of relying on more recent results of the literature that it is purchasing power or real income that matters. In addition, it has not been made clear so far how food security corresponds to the welfare status of agents. Since food security can more or less be associated with an uncertain world, this should at least be reflected in the value function of individuals who are generally risk averse. Therefore, it is proposed in the paper that the measurement of both food security and welfare should be based on the probability distribution of adjusted real household income over time on a daily basis. Food security can then be defined as the probability of any agent's real income exceeding a critical level, whereas the welfare status is measured as the agent's expected utility of this real income. Special formulas are developed in this context which allow one to calculate producer's and consumer's welfare under price uncertainty and risk aversion separating the risk response effect from the mean income moving effect of price fluctuations. In addition, an alternative measurement of protection in a stochastic world, the so called real protection rate, is proposed which simultaneously covers protection against low prices and volatile prices. All these indicators should be used when comparing and evaluating food security or food insecurity of any agent in whatever region. In the paper the concept is utilized to answer the raised question of how the EU contributes to worldwide food security.

## INTRODUCTION

The representatives and advocates of the Common Agricultural Policy (CAP) of the European Union (EU), a major exporter of food and agricultural commodities, claim that (a) food security has already been achieved domestically for a long time as an unambiguous result of a well-defined and successful agricultural policy design, and that (b) their countries even provide abundant food for needy regions in the developing world, thus alleviating food insecurity abroad. Looking at the tremendous production, export, and stock volumes in these countries this statement seems to be supported at a first glance. In this paper it is argued that EU's agricultural policy has, in fact:

- contributed little if at all to domestic food security and is obviously not able to avoid newly arising poverty and hunger for some minorities;
- aggravated the efforts of providing people with enough food at reasonable prices in the developing world.

Before starting the discussion of these hypotheses in Section 3 it is worthwhile to give a precise definition of what is meant by food security, to develop an indicator with which one can measure food security, and finally to derive a conceptual framework for evaluating different degrees of food security. All three aspects will be discussed and analyzed as

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general a way as possible in order to make the food security approach applicable for rural and urban poor in both developing (LDCs) and developed countries (DCs). The paper neither provides any quantitative estimates of food security levels (see Weber, 1993), nor discusses policy options for coping with the food security issue (see Koester, 1986; Thimm, 1993). Rather, it attempts to improve the theoretical foundation, to develop some alternative indicators, and to apply both to the mentioned hypotheses. More specifically, some more recent developments in the field of applied welfare economics are introduced which, in the author's view, have been underutilized in food security research. This kind of analysis might especially be useful for comparisons of food security levels between households, regions, and countries as well as for giving a basis on which national and supranational funds can be allocated to the poor.

## DEFINITION, MEASUREMENT AND EVALUATION

'Food security is access by all people at all times to enough food for an active and healthy life' (World Bank, 1986). This definition which seems to reach the highest rate of acceptance among concerned researchers implies that (see Phillips and Taylor, 1990, p.1304):

- food is available, accessible, affordable — when and where needed — in sufficient quantity and quality;
- an assurance is given that this state of affairs to can be reasonably expected to continue.

Moreover, this widely accepted definition reflects the shifts from:

- a production orientation to a consumption and health focus;
- country-level, to household or individual-level analysis;
- a soley quantity point of view, to both quantity and quality issues;
- static or cross-section analysis, to dynamic analysis over time;
- merely transitory, to transitory and chronic malnutrition.

It has been noted that national food security does not imply household or individual food security (Staatz, D'Agostino and Sundberg, 1990, pp.1312–1316), that food security today does not imply food security tomorrow and that household food security does not automatically ensure nutritional security. Nutritional security is defined as the appropriate quantity and combination of inputs such as food, nutrition and health services, and caretaker's time needed to ensure an active and healthy life at all times for all people. Food security, therefore, is a necessary but not sufficient condition for nutritional security (Haddad, Hennedy and Sullivan, 1994, pp.329–330; Hahn and Bellin, 1993, p.21; Babu, 1994, pp.211–217; Babu and Pinstrup-Andersen, 1994, pp.218–233; Eele, 1994, pp.218–233). The most important result from previous research, however, has been the observation that hunger is caused by a lack of individual purchasing power or real income (see also Chisolm and Tyers, 1982, p.5) rather that by a deficiency in the total supply of food. Hence, individual poverty is the driving force behind hunger and malnutrition. This makes it clear, why food insecurity is not restricted to poor countries. Even in rich

countries small but growing groups of the population do not have access to sufficient food (Allen and Thompson, 1990, pp.1162–1163; Phillips and Taylor, 1990, p.1304) because their real income falls below the poverty threshold.

With this causal relationship in mind, the question arises; under which preconditions could real individual income or real household income be an adequate basis for the measurement of food security? Obviously, some minimum income is required to meet an individual's needs. A minimum level of real income can also be interpreted as a minimum right to resources in the sense of Atkinson (1991, p.8) which enables individuals to participate in a particular society, as a guarantee of 'positive freedom'. As a rule of thumb the poverty or the food security line in developed countries is estimated to be that disposable household income which is less than 40 to 50 percent of the national average, thus implying a relative measure. In developing countries it would make more sense, however, to define a fixed amount of real purchasing power which would enable individuals to have access to enough healthy food.

When calculating this real purchasing power, it has to be kept in mind that income in-kind has to be added (i.e., home produced goods and services) and a discount for non-available or rationed food should be subtracted. But even when these problems are solved, three additional aspects warrant further attention; the relevant time period considered, the choice of equivalence scale in case of different household sizes and how food intake corresponds to income. Whereas the measurement of poverty is generally based on cross-section analysis (Atkinson, 1991, pp.5–17), the proposal here is to use time series analysis of real household income in order to capture seasonal variability and life cycle variations, including complete breakdowns of income (see also Ravallion and Huppi, 1991, pp.57–82). A further advantage of time series based food security measurement is that one can gradually and exactly measure food insecurity, thus overcoming the simple dichotomy between chronic and transitory malnutrition. The choice of the time unit (daily, weekly, monthly, annually) should depend on whether different options of dissaving, borrowing or participating in income streams of related people are available. If there aren't any risk sharing private or official institutions, then a daily-based income report would be the best. The required minimum household income (food security line) differs widely with the size of the household; the age structure of its members, the distribution between male and female, the degree of handicaps of people, and their nutritional health status. Buhmann *et al.* (1988, pp.115–142) therefore propose an adjusted income indicator ($y_{adj}$) to make food security or poverty levels of households comparable and to take into account the above mentioned aspects:

$$y_{adj} = \text{total real household income} / n^s$$

where $n$ denotes the number of members of the household and $s$ is the elasticity of family need with respect to family size. The equivalence scales are based on subjective evaluation and in the poverty literature this ranges from 0.25 to 0.72 (Atkinson, 1991, p.15). Finally, what can be said about the correlation of real income with food intake and the nutritional and healthy status of individuals? Fortunately, recent contributions in the literature show a strong positive relationship between income and nutrition implying that nutrition and health are improving with income growth (Schiff and Valdés, 1990, p.1320; von Braun, 1990, p.1323). Given a lack of data about the determinants of the nutrition and health production functions, real household income might therefore provide an

acceptable basis for the measurement of food security (an example of how to calculate this real income indicator for sub-Saharan Africa is given in Sahn and Sarris, 1991, p.262).

So far only the level aspect of food security has been addressed. The level of real household income should not fall below a certain target or minimum level. However, food insecurity reflects the adverse effects of an uncertain world as well. Hence, we should also look at the fluctuations of real household income around its mean trend. Formally, it is the probability distribution of real income over time that matters and it should be the objective of any food security policy to keep the probability of real income falling below the target level as low as possible at reasonable opportunity costs. Then one can measure food insecurity *(FIS)* as the probability of real income falling below the critical level $y^*$:

$$(1)\quad FIS = F(y^*) = \phi\left[\frac{y^* - E[y]}{(\mathrm{var}[y])^{0.5}}\right] = \left[\frac{(\beta - 1)}{cv_y}\right]$$

where

| | | | |
|---|---|---|---|
| $\phi$ | probability | $E$ | expectation operator |
| $var$ | variance | $y$ | $y_{adj}$ adjusted real income (random variable |
| $cv$ | coefficient of variation | $y^*$ | minimum income |
| $\beta$ | $y^*$ in percent of mean income | | |
| $F(y)$ | standard normalized cumulative distribution function | | |

For practical purposes the first (mean) and second (variance) moments of the probability distribution can be used to calculate the degree of food insecurity which ranges from zero to one. In that case the implicit assumption is made that real income fluctuations are normally distributed.

So far we have only addressed the positive questions of measurement. Nothing has been said about the evaluation of different probability distributions in welfare terms or how food security corresponds to individual welfare measures. Does the individual prefer one probability distribution over the other? The answer to this question depends on the weights the individual gives to mean, variance, skewness, and other moments in his/her preference function. The most common practice in economic analysis in such cases has been to apply the expected utility approach or the stochastic dominance approach (see Dillon and Anderson, 1990, pp.120–157). In the following analysis we'll use the former, assuming a normal (log-normal) distribution of real income which leads to a simple mean-variance (mean-coefficient of variation) formula of expected utility of income (Newbery and Stiglitz, 1981, p.85–89):

$$(2a)\quad E[U(y)] = E[y] - \frac{1}{2}A\,\mathrm{var}[y] \quad \text{normal distribution}$$

$$(2b)\quad E[U(y)] = E[y]\left[1 + cv_y^{\,2}\right]^{-1/2R} \quad \text{log - normal distribution}$$

$A$ coefficient of absolute risk aversion

$R$ coefficient of relative risk aversion

$U$ utility

Alternatively, a safety first decision rule can be formulated, where a decision maker maximizes expected profits subject to the constraint that the probability (*FIS*) of real income falling below the critical level ($y^*$) does not exceed a certain level (Barry, 1984, p.63):

$$\text{(2c)} \quad E[U(y)] = E[y] - dFIS$$

where $d$ is the absolute discontinuity of the utility function at $y = y^*$ which expresses the preference for food security or the risk aversion with respect to food insecurity.

These equations are especially useful as a complementary tool for the evaluation of food security because they:

- contain both mean and variance of income as arguments, thus considering the stochastic nature of the problem;
- can be applied to all types of vulnerable groups, i.e. producers, consumers, and other agents such as taxpayers and politicians (for the concept of vulnerability see Bohle, 1993, p.193–95);
- contain the risk attitudes of market agents;
- allow comparisons over time and among agents of situations with a different extent of food insecurity;
- provide a reasonable money measure of food security costs and benefits.

We are now in a position to define, to measure, and to assess food security or food insecurity, respectively. Hence, the question can be answered, what is the contribution of the CAP to domestic food security and to food security in LDCs?

## Common Agricultural Policy and Food Security

*Domestic food security* Agricultural Price Policy in the EU implies an average increase of producer prices over their free market levels, a considerable stabilization of prices compared to the world market (see Table 1), and finally a distortion of the price pattern in favor of grains, milk, beef, and sugar beets, so-called northern products, at the expense of Mediterranean products. These market interventions will be evaluated from a producer's and consumer's point of view.

The impact of this price policy on producer's welfare can be measured by the expected utility of an indirect profit function (see Just, Hueth and Schmitz, 1982, p.349):

$$\text{(3)} \quad E[U(\pi)] = E[U(p\{\pi, v, K\})]$$

which is homogenous of degree 1 in prices and has the following properties (Hoteling's lemma):

$$\frac{\partial \pi}{\partial p} = q_s > 0; \quad \frac{\partial^2 \pi}{\partial p^2} > 0; \quad -\frac{\partial \pi}{\partial v} = x_D > 0; \quad \frac{\partial^2 \pi}{\partial v^2} > 0$$

where

| | | | |
|---|---|---|---|
| $\pi$ | indirect profit | $p$ | producer prices |
| $v$ | factor prices | $K$ | quantity vector of fixed inputs |
| $q_s$ | output supply | $x_D$ | input demand |

Using the simple mean-variance approach of Equation (2a) and the approximation procedure for both moments following Mood, Graybill and Boes (1974, p.181) one can easily derive a money measure (certainty equivalent of indirect profit) for the expected utility of profits leaving the variance of input prices unaffected by policy.

**Table 1** *Variability[a] of German Food Import Prices 1970–1985*

| Products | Price Variability (%) | |
|---|---|---|
| | Imports from EC-Member Countries | Imports from Third Countries |
| Aggregates | | |
| Grains and Cereal Products | 5.6 | 17.9 |
| Milk and Dairy Products | 3.4 | 6.5 |
| Swine and Pork | 9.5 | 7.7 |
| Cattle and Beef | 7.3 | 16.4 |
| Poultry and Poultry Meat | 6.0 | 4.9 |
| Eggs and their Derivatives | 11.5 | 17.2 |
| Single Products | | |
| Wheat | 5.8 | 24.5 |
| Barley | 6.4 | 21.3 |
| Corn | 6.1 | 17.9 |
| Soymeal | 18.3 | 21.4 |
| Rice | 9.3 | 21.6 |
| Raw Sugar | 4.3 | 62.2 |
| Cattle | 6.2 | 13.5 |
| Swine | 8.1 | 14.4 |
| Butter | 4.3 | 32.2 |

*Source:* Own calculation on basis of German Agricultural Statistics (see Schmitz, 1987, p.366).
*Note:* Measured as trend-corrected coefficient of variation following the approach of Cuddy and Della Valle, 1978, pp.79–85.

$$(4) \quad E[U(\pi)] \approx \pi(\bar{p}, \bar{v}, K) + \frac{1}{2} cv_p^2 \varepsilon Rev - \frac{1}{2} R \cdot cv_p^2 \frac{Rev^2}{\pi(\bar{p}, \bar{v}, K)}$$

where

| | | | |
|---|---|---|---|
| $\bar{p}$, $\bar{v}$ | mean prices | $cv$ | coefficient of variation |
| $\varepsilon$ | supply elasticity | $Rev$ | Revenue |

The first term on the RHS of Equation (4) is that level of profit where prices are at their mean. A mean preserving spread of producer prices, however, creates two additional terms in Equation (4). The second term on the RHS is equivalent to an increase of the expected profit under fluctuating prices from which the producer obviously benefits, whereas the third term addresses the producer's risk attitude. A risk averse producer, i.e., would face a loss of welfare under fluctuating prices. The producer gains from pure price stabilization under the Common Agricultural Policy if, and only if

$$(5)\quad R > \varepsilon \frac{\pi}{Rev}$$

which is likely to be the case assuming plausible parameter values. Since the mean profit change is also positive, the producer's welfare position has been clearly improved by the CAP.

Referring to the food insecurity status of producers under the CAP, it has to be stated that the probability of real profit to fall below the critical level has unequivocally been decreased since the mean is up and the variance is down. Hence, price support as well as price stabilization under the CAP have improved both the welfare position and food security of farmers although the benefits seem to be very unevenly distributed among different farms and regions (see von Witzke, 1979; Tarditi and Croci Angelini, 1982). Especially, farmers in the southern parts of the community producing Mediterranean commodities have benefitted less from the CAP since price support is lower and price stabilization takes place over a wider range between floor and ceiling prices compared to the case for northern products.

Unfortunately, traditional indicators of the rate of protection only refer to the level effect of price policies and ignore the price stabilizing effect. In fact, agricultural price policies in DCs aim at protecting farmers against both low world market prices and volatile world market prices. This kind of real world protection can only be calculated on basis of the expected utility approach, measuring the percentage increase of the expected utility of income or of the certainty equivalent of income, respectively. Using the mean-variance approximation again one can derive the following formula:

$$(6)\quad \text{Real Protection Rate } = (1+z)\left[\frac{1-RL_1}{1-RL_0}\right]-1$$

where

| | |
|---|---|
| $z$ | effective rate of protection |
| $RL = \frac{1}{2} Rcv_y^{\,2}$ | relative risk loss (= relative risk premium) |

Under certain assumptions the effective rate of protection in Equation (6) can be replaced by the nominal rate of protection and in the risk loss equation the coefficient of variation of prices can be used instead of incomes thus having an empirically sound indicator of real world protection.

Analogous to the producer case, the impact on consumers should be measured as the expected utility of equivalent income or money metric (MM). Money metric itself can be defined as that level of income needed at some vector of reference prices ( $p_0$) in order for the consumer to attain the same utility of level he/she enjoys from income $y_0$ when faced with price vector ( $p_1$). In other words money metric is the sum of the initial income ( $y_0$) and the equivalent variation ( $EV$ ). Since the equivalent variation from a pure price change can be derived from an expenditure function $(e[\cdot])$ as (see Boadway and Bruce, 1989, p.205):

$$(7)\ EV = e(p_0, u_1) - e(p_1, u_1)$$

for the money metric it follows:

$$(8)\ MM = Y_0 + \Delta\, e(p,\ u)$$

where the expenditure function is increasing with prices and utility, is homogeneous of degree 1 in prices, is concave in p, and has the following property (Shepard's Lemma):

$$\frac{\partial e(p,\bar{u})}{\partial p} = q_D{}^C \qquad \text{(compensated demand function)}$$

Using again the simple mean-variance approach of Equation (2a), the Mood, *et al.* (1974) approximation procedure for the mean and the variance of the money metric, and rearranging some terms, yields:

$$(9)\ E[U(MM)] \approx Y_0 + \frac{1}{2} cv_p^2 |\eta^c| EX - \frac{1}{2} R\, cv_p^2\, \frac{EX^2}{Y_0}$$

where

- $\eta^c$ compensated demand elasticity $(= \eta + s\lambda)$
- $s$ budget share of products with fluctuating prices
- $\lambda$ income elasticity
- $\eta$ (uncompensated) demand elasticity
- $EX$ mean expenditures for products with fluctuating prices

The interpretation of Equation (9) is analogous to that of Equation (4) for the producer. In accordance with the considerations of Helms (1985, pp.93–100), the expression in Equation (9) could be called the ex-ante equivalent income. The consumer finally gains from pure price stabilization if and only if:

$$(10)\ R > |\eta^c| / s$$

which is again likely to be the case as Turnovsky, *et.al.* (1980) state, although the relative gains seem to be negligible (Wright and Williams, 1988, pp.616–627) due to the low food share in consumer's budget. Thus, even with equal coefficients of risk aversion, producers might be more heavily affected by fluctuating prices than consumers.

**Table 2** *Variability[b] of German Food Prices at Different Stages in the Food Chain 1970–1985*

| Product | Price Variability (%) | Product | Price Variability (%) |
|---|---|---|---|
| Swine | 8.1 | Cattle | 6.2 |
| Roast pork | 9.4 | Roast beef | 4.2 |
| Lard | 3.1 | Fillet of beef | 4.1 |
| Ham | 2.7 | | |
| | | Poultry | 5.3 |
| Calf | 6.5 | Broiled chicken | 3.6 |
| Veal cutlet | 8.4 | | |
| | | Raw milk | 4.8 |
| Eggs from producer | 6.4 | Fresh milk | 4.4 |
| Eggs packing incl. | 5.7 | Butter | 4.3 |
| | | Cheese | 4.6 |
| Wheat | 5.8 | Sugar beets | 6.9 |
| Wheat flour | 3.2 | White sugar | 4.3 |
| White bread | 3.2 | | |
| Rye | 6.4 | White cabbage | 33.1 |
| Rye bread | 2.5 | Cabbage with trade-mark | 14.0 |
| | | Cabbage in cans | 4.9 |
| Potatoes from producer | 42.2 | Red cabbage | 42.8 |
| Potatoes packing incl. | 24.5 | Cabbage with trade-mark | 15.5 |
| Potato salad | 5.0 | Cabbage in cans | 4.8 |
| Potato chips | 2.4 | | |
| | | Grape must | 20.3 |
| Apple from producer | 36.6 | Red wine | 2.8 |
| Apple with trade-mark | 15.2 | German champagne | 6.8 |
| Apple juice | 7.2 | Brandy | 4.2 |
| Apple purée | 5.6 | | |

*Source:* Own calculation on basis of German Agricultural Statistics (see Schmitz, 1987, pp.363–364).
*Notes:* [b]Measured as trend-corrected coefficient of variation following the approach of Cuddy and Della Valle, 1978, pp.79–85.

However, the central question of how the CAP affects mean and variance of consumer prices has been left unanswered so far. The answer depends on the transmission of price impulses from the wholesale to the retail level. Empirical studies show the EU consumers to shoulder the full burden of the price support at the wholesale level because the potential for replacing price increasing intermediate food or for substituting final food consumption is very limited (i.e., Schmitz, 1987, pp.368–370) and the CAP covers nearly the whole range of food items. In addition, the CAP contributes little to consumer's price stability. The statistically observed stability already exists due to high proportions of stable non-

food inputs in food value added, to a partly anticyclical margin behaviour over time, and to risk transferring mechanisms for which consumers are obviously willing to pay. Surprisingly, the level of stability of final food prices hardly differs among products, irrespective of the fact that some wholesale prices or producer prices are the subject of the CAP and others not (see Table 2). Hence, the CAP has not only weakened the welfare position of consumers but has also increased the level of food insecurity.

This is in contrast to policymakers' claims. It holds especially for those consumers who spend a large portion of their budget on food, namely the older generation, families with many children, and unemployed people. The low real income of those minorities is eroded further by the CAP.

Nevertheless, some advocates might still argue that for a vast majority of people food security has already been provided. That is true. But this has not been caused by the food and agricultural policy. Rather, it originates from the overall performance and efficiency of the economy. Thus, it is fair to say that food security for most people exists despite the CAP.

## Food Security in LDCs

How does the CAP affect food security and welfare of individual producers and consumers in developing countries? The answer to this question very much depends on:

- how the CAP distorts world market prices of agricultural commodities with respect to their level and volatility;
- how distorted world market prices are transmitted into domestic markets within the developing countries; and
- how this adjustment of domestic prices affects the real income of domestic agents.

**Table 3** *Impact of Food Policy Liberalization in OECD Countries on World Market Prices of Selection Commodities*

| Commodities | Change of Price Level (%) | Coefficient of Variation of Prices (%) | |
|---|---|---|---|
| | | Before liberalization | After liberalization |
| Wheat | 25 | 58 | 33 |
| Coarse grain | 3 | 53 | 47 |
| Rice | 18 | 38 | 28 |
| Ruminant meat | 43 | 24 | 7 |
| Non-ruminant meat | 10 | 8 | 8 |
| Dairy products | 95 | 26 | 11 |
| Sugar | 22 | 36 | 25 |
| Weighted average | 30 | 34 | 23 |

*Source:* Anderson and Tyers (1990), pp.67 and 70.

A vast literature exists on the impact of the CAP or similar agricultural policies of other industrialized countries on world markets and on developing countries (i.e. Anderson and Tyers, 1990; Hartmann and Schmitz, 1991, 1992). The focus has been on price level and price risk effects as well as on price level induced welfare effects in the third world. Less attention has been given to the risk benefits and risk losses of various policy options. Table 3 summarizes the world market price effects of food policy liberalization in OECD countries. The first result is that if food policies in those countries were completely liberalized, international food prices would rise by 30 percent on average and the degree of price instability would decline from 34 percent to 23 percent on average. Thus, the food policies of OECD countries are responsible for historically low world market prices and for about one third of the current price risk on international food markets, and considerably more in the wheat, beef and dairy product markets. The price level induced welfare effects in LDCs differ depending on:

- the level of protection and/or discrimination (which is most often the case) of the farming sector in developing countries;
- the degree of insulation of domestic agricultural markets from world markets, which is extremely high in LDCs as response to DCs food policies;
- the price responsiveness of productivity growth in agriculture;
- the extent to which LDCs liberalize their own trade and exchange rate policies and thereby remove indirect distortions affecting food prices.

In an optimistic scenario with a world-wide food policy liberalization and assuming incomplete price transmission in LDCs as well as price responsive productivity growth, developing countries would gain US$58 Billion (1985) per year and would in addition benefit from facing a reduced price volatility of about one-third (= 11 percent) of the current level; see Anderson and Tyers, 1990, p.66–70).

Using Equation (6) one can derive the percentage income gain from higher and stabilized world market prices for LDCs. The pure price level effect raises the income by about 33 percent whereas both effects together (price level increase and risk reduction) improve the income by 40 percent or 49 percent respectively depending on the relative risk aversion coefficient ($R = 1$ or $R = 2$). These figures may be convincing enough to prefer the real protection rate over the traditional rates of protection whenever there are price fluctuation effects by policy interventions.

Whereas uncertain world market prices affect exporting and importing countries' border prices more or less equally, the domestic price, welfare and food security effects differ with; the way LDCs transmit those fluctuations to their own domestic markets (see Schmitz, 1991 and Hammer and Knudsen, 1990), how risk averse consumers, producers, and taxpayers are, and how the world market price risk interacts with other risk sources within the country (see Valdés, 1981).

Considering an average elasticity of price transmission in LDCs of 0.39 (see Sullivan, 1990) under current food and non-food policies and assuming full price transmission (elasticity of 1.0) under liberalized policies, domestic producer and consumer prices in LDCs would significantly increase due to a liberalization and would fluctuate to a similar extent (one third of the current level). Hence, consumers would lose and producers would gain from free markets in welfare terms. In addition, some hidden benefits are likely to occur from reduced budget (tax) fluctuations which generally has been used as buffer for

stabilizing domestic food prices and which is borne as risk burden by other members of the society. It is especially worth noting that external risks (i.e. world market price risks) do not simply disappear even if trade policy completely isolates the domestic market. Although consumers and producers are then prevented from facing external price risks, risk is nevertheless reflected in the government budget in that case, thus throwing the burden on taxpayers. Hence, market insulation generally implies simple redistribution of risk.

With respect to food security one can state that producers in LDCs suffer from the CAP since their mean income is lowered and the variance is raised, at least in cases where the price stabilization capacity of the domestic insulation policy is lower than the world market price destabilization capacity of the CAP. The rural poor are therefore most adversely affected by the EU policy. In contrast, the urban poor's food security increases due to the CAP unless price risks are fully transmitted to the domestic markets. In that case food insecurity might even increase depending on the magnitude of the variance term of real income and its adjustment. With high food shares in total household expenditures and a comparative low marketing margin as stabilizer the impact of price fluctuations on the income variance might be quite important.

Finally the question arises whether recent CAP reforms and other agricultural policy adjustments in DCs (i.e. GATT-results) reverse or at least weaken the above mentioned effects on food security and welfare in LDCs. At first glance one might get the impression that partial food policy liberalization and the tariffication of non-tariff trade barriers contribute a lot to an improvement of the situation. Going into more detail, however, one has to admit that:

- important surplus markets are excluded from the CAP reforms;
- new price distortions among agricultural commodities have been created;
- there is a tendency towards managed or regulated trade;
- special safeguard provisions (i.e. additional duties in case of declining world market prices) erode the stabilization potential of the tariffication strategy to a large extent.

Taking these aspects into account the recent agricultural policy reforms in DCs seem to be of limited value for developing countries, especially with respect to the risks engaging in international trade (see also Hartmann, 1995).

## CONCLUSIONS

Although the food security discussion has given more emphasis on the individual (household) level as the proper unit of analysis, it still suffers from applying inappropriate indicators, which are mostly quantity oriented, instead of relying on the more recent result of the literature that it is purchasing power or real income that matters. In addition, it has not been made clear so far how food security corresponds to the welfare status of agents. Since food security can more or less be associated with an uncertain world, this should at least be reflected in the value function of individuals who are generally risk averse.

Therefore, it is proposed in the paper that the measurement of both food security and welfare should be based on the probability distribution of adjusted real household income over time. Food security can then be defined as the probability of any agent's real income

exceeding a critical level, whereas the welfare status is measured as the agent's expected utility of this real income. Special formulas are developed in this context [Equations (4) and (9)] which allow one to calculate producer's and consumer's welfare under price uncertainty (assuming some degree of risk aversion and separating the risk response effect from the mean income moving effect of price fluctuations. In addition, an alternative measurement of protection in a stochastic world, the so callled real protection rate, is proposed [Equation( 6)] which simultaneously covers protection against low prices and volatile prices. All these indicators should be used when comparing and evaluating food security or food insecurity of any agent in whatever region.

Applying this concept to the paper's question of how the EU contributes to food security one can conclude that despite recent agricultural policy reforms in DCs:

- EU producers are affected directly by higher and stabilized producer prices inducing an improved welfare and food security position of the small group of farm households;
- EU consumers, as a large group, suffer from EU's price policy in welfare and food security terms because the price increasing effect is fully transmitted from the wholesale to the retail level and stable consumer prices for food occur even without any producer price stabilization;
- the CAP with its strongly isolating character (low price transmission elasticities) has decreased and destabilized world market prices of agricultural commodities eroding at least potentially the most important source of real income earnings in LDCs, namely agricultural production;
- the CAP-induced negative income and food security effects for producers have been aggravated by the fact that most LDCs apply sector-specific and macroeconomic policies which, in addition, heavily discriminate against agriculture and severely endangers the access to enough and healthy food;
- the potential welfare and food security gains of price level reductions for consuming and for importing agents might be compensated to a certain extent by increasing price and income risks.

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