Final Submission

A Decision Support Tool for Government Engagements in Market for Essentials – the case of Food grains in Bangladesh

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Table of Contents

List of Figures

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I. Introduction

Researchers and authors of studies on foodgrain market and on government policies and interventions apparently position themselves as neutral observers[1]. Particularly, economists tend to distance themselves from policy prescriptions at operational levels since *ceteris paribus* conditions rarely prevail and probability of prediction error is likely to be fatally high! A large bulk of the literature on food market is empirical, some of which estimate parameters useful for general policy making and several others look into institutional and administrative aspects of managing food market. There is also a segment in the literature dealing with analytical models that incorporate key characteristics of the market (such as, storage and speculative behavior of private agents) to infer on price dynamics (e.g., Derek *et al* 2006, Sivakumar *et al* 2006, Cafiero *et al* 2009, etc.). The last set of literature delves into assessing the need of government interventions in foodgrain market, but falls short of deriving the desired actions at practical levels.

At a general level, conclusions are reached to suggest that "Policy should foster the use of market-based instruments and targeted safety nets to manage the risks of adverse food market outcomes" (Derek *et al* 2006). The tools to guide "use of market-based instruments", however, failed to go beyond the accounting-type exercises, which could only set the boundaries for *ad hoc* political choices. Yet prudent acts of interventions demand *ex ante* decisions, which may only be arrived at if objectives are explicitly formalized within the setting of accounting constraints. Thus, an essential first step to construct a decision support tool is to develop an analytical framework that guides information compilation based on which decisions are to be made; and this has been attempted in this paper. It also recasts the analytics to allow compilation of consistent macro (food) accounting data in a dynamic setting. However, the paper refrains from suggesting a unique criterion to arrive at decisions. In stead, within the proposed perspective, it outlines the kind of questions that may pose dilemmas during *ex ante* decision-making.

The present paper develops a general framework to guide government actions on markets of essentials where the government has obligation to its citizens to ensure price stability and, at times, to make those essentials accessible to people at less than the market price (or, at zero price). In all such cases, inter-temporal arbitraging, or, spatial arbitraging with significant time lags (between purchase and sale) call for storage demand. Therefore, *ex ante* decisions based on expectations are unavoidable. In addition, all such instances involve producers (at home and abroad), processors (at home and abroad), consumers at home, and the government as a provider (as arbitrageur in the guise of trader and/or

* The author is a Research Director at Economic Research Group. The exercise was undertaken to fulfill a contract ERG has with IFPRI.

[1] The literature on market management (handling of both stocks and flows beyond pricing policies) is largely biased towards foodgrains. In the Bangladesh context, fertilizer market surfaced more in the context of subsidy, an element of pricing policy.

processor)[2]. Some of the commodities for which the generic approach applies are cereals, edible oil and sugar. The suggested structure of compiling data would also apply to markets for certain agriculture inputs, such as, chemical fertilizer, which are perceived essentials for production of staple food. It needs no mention that price (and/or supply) volatility in the markets of these commodities and the perceived implications of such price dynamics on political stability call for better understanding of market forces and consistent and timely response from the government. The present paper confines to developing the first building block towards informed decision making and refrains from formalizing formation of expectations on future prices.

II. General Perspective

Few basic assumptions underlie the exercises undertaken in this paper. First, government's role as a regulator and facilitator in governing the market is not looked into in this paper.[3] In stead, the government is considered an actor/provider in the market like any other provider; but having additional instruments in hand as a regulator. Second, the government recognizes that the private sector actors in the market normally deliver services incurring lower costs, yet market outcomes are often socially harmful if left completely at the whims of private sector; and it calls for strategic engagement by the government as a 'provider'. Ideally, a government claiming to uphold a 'social objective function', would make its decisions upon taking into account of all market variables, including the responses of private actors in response to those variables and government policies. That is,

$$(1) \qquad D_g = \int(X_m, D_v), \text{ and } D_v = V(X_m, D_g)$$

In other words, decision of government ought to be a function of market variables (X_m) and of decisions made by private providers (D_v). It is also important to recognize that decisions by private providers are expected to take cognizance of market variables and of decisions made by the government (D_g). Thus, final outcomes observed in the market are likely to be the end-product of the above decision processes. On the latter presumption, Figure 1 describes the basic blocks involved in a support tool to facilitate informed decision-making.

Even though far from reality, we will assume that the government is in a position to collect and process information to arrive at realistic conjectures on behavior of private sector actors, and makes its decisions in pursuit of a greater social good. It is not expected that the government will be in a position to marginalize all political economy considerations and that it will have all the relevant information to decide in accordance to the above framework. Yet, having a framework in place helps ensuring a learning process with continuity of institutional knowledge.

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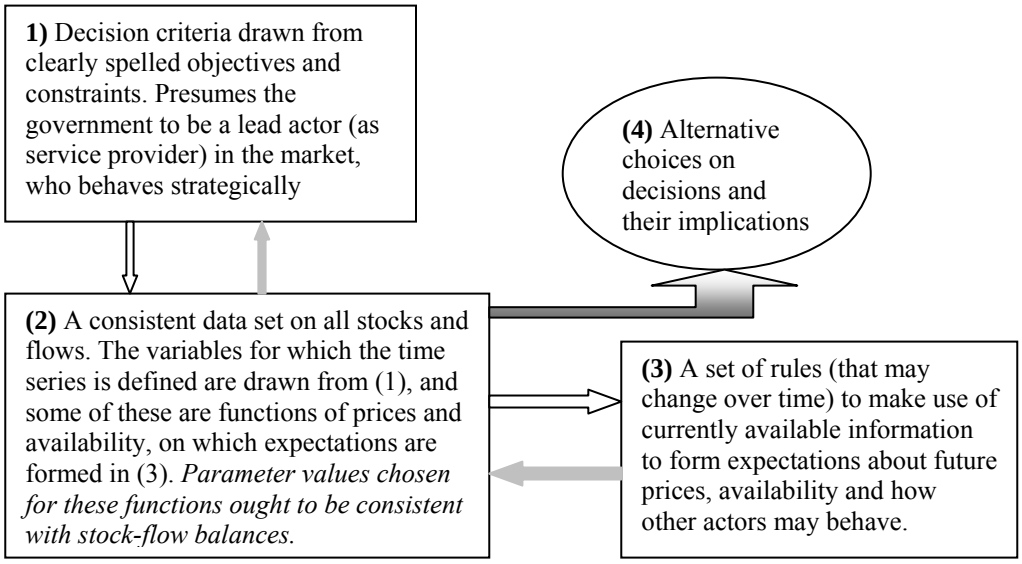
[2] The act of storage may be subsumed under the broader role of an arbitrageur.

[3] Quite unfortunately, governance has so many connotations that it is often difficult to convey a unique message. The difficulty aggravates when regulation and control are interchangeably used by many amongst policymakers. Here, we abstract from the government's role in governance of market.

Figure 1: Primary Boxes in a Decision Support Tool



With a view to operationalize the decision framework, the current exercise takes up the case of foodgrain (particularly rice and wheat) and considers the decision-making at the Food Planning and Monitoring Committee (FPMC), an inter-Ministerial subset of the Cabinet. Decisions at the FPMC on various aspects of food market interventions (see Annex 1) are normally preceded by information gathering and processing by its secretariat, a role played by the Food Policy Monitoring Unit (FPMU) of the Ministry of Food. The decision support tool subsequently developed in an excel environment is meant to serve the needs of the FPMU in supporting decisions made at the FPMC. References to various variables and analytical categories referred to in the analytical framework may draw upon the experiences of FPMU – though these apply to other commodities and corresponding government agencies as well.

III. Decision Framework

The analytical framework underlying the decision tool involves time-contingent variables though not tied to any specific notion of time. Once developed and translated into an excel-based decision frame, one needs to specify the time period over which the decision are made. For the purpose of illustration and acknowledging the seasonality in crop production, the quantitative exercise (to follow)[4] deals with national level data compiled for half-yearly periods, though the framework may be modified to accommodate shorter periods and subsequently with data compilation at sub-regional levels (if necessary). The purpose of the present exercise is to outline the basic framework around which consensus may be built amongst decision support teams within the government on practical relevance of the decision tool developed and impart the basic knowledge to the technical

[4] The excel-based template is developed along the analytics developed in this paper and is included in the second deliverable.

staff within the relevant units. In subsequent exercises beyond the current one, the author hopes to assist interested agencies within the government in extending the excel-based framework to address monthly/quarterly data that will allow decisions to be made once in every month/quarter.[5]

III.1 Constraints

The literature on foodgrain market dynamics and on government food policies aptly capture the basic accounting constraint that maintains ***Stock-Flow Consistency*** for any given unit one chooses for time periods[6]. This is captured in equation (2), which summarily states that changes in the stocks in a given territory (Bangladesh) will be equal to the net inflow during a period. In a way, it represents the segment of food balance equation, for food grains that pass through markets.

$$(2) \qquad S^{g}_{-1} + S^{v}_{-1} + M^{g} + M^{v} + M^{F} + R^{g} + R^{v} - D^{v} - D^{g} - O^{g} - X = S^{g} + S^{v} + L$$

where,
S = foodgrain stock (end period), with superscripts g and v referring to government and private respectively, and subscripts (-1) refer to previous period;
M^{g} and M^{v} = imports/external procurements by government and private sector;
M^{F} = Food aid which has two components, one of which is disbursed through INGOs directly in programs jointly approved by the government and development partners[7];
R^{g} and R^{v} = domestic procurement by government and private sector respectively;
D^{v} = Market-based domestic demand met by private sellers;
D^{g} = monetized off-take, sold through PFDS at administered price;
O^{g} = Off-take, non-monetized, which is all by the government;
X = Export.
L = Loss during storage, handling and transportation – both public and private).

We include processor/miller in the group of private arbitrageur; and the producers/ farmers are assumed to have no storage demand. We differentiate between government and private traders/processors, in case of domestic procurement – thus, retention by farmers from current production is assumed to be fully consumed[8]. In other words, the output net of seed & wastage, and after sales to government and private buyers, is consumed by the producers. This is captured in equation (3), which also sets limits to the combined size of domestic procurements by the government and the private sectors.

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[5] Several presentations have already been made though formal submission of the paper was not made. The participants addressed included mid-level government officials dealing with similar technicalities, academia engaged in policy studies on foodgrain market and consultants active in providing program supports to government agencies.

[6] Consultation with data availability and upon considering the crop cycles in Bangladesh and elsewhere, two periods are considered: 1 May till 30 October and 1 November till 30 April. The periodization roughly corresponds to the Bangla calendar year. Please read the text in the second box in Figure 1.

[7] For simplicity, the analytical exercise will assume that the whole of M^{F} passes through government channel.

[8] The last assumption may broadly agree with reality if annual data is considered. However, for shorter periods, this assumption is unlikely to hold.

(3) $D^o = (Q^v - E^v - R^g - R^v)$

where,
D^o = Consumption met out of own (local) production;
Q = Domestic Production, which is assumed to be all private; and
E = Retention on account of seed for following seasons and wastage;

Total food consumption during t-th period is given by:

(4) $FC = D^o + D^v + D^g + O^g$

Substituting equations (3) and (2) into (4) give us,

$FC = Q^v - E^v - R^g - R^v + S^g_{-1} + S^v_{-1} + M^g + M^v + M^F + R^g + R^v - X - S^g - S^v - L$
or,
(5) $FC = Q^v - E^v - (\Delta S^g + \Delta S^v + L) + M - X$
where,
$M = M^g + M^v + M^F$

Since it is a convention to report on national (total) food availability, it may be of interest to find its relation with FC defined above. In a given period t, food availability may be defined as:

(6) $A = Q^v - E^v + S^g_{-1} + S^v_{-1} - L + M - X$

The above may be expanded to show that

$A = Q^v - E^v - (\Delta S^g + \Delta S^v + L) + S^g + S^v + M - X$
$= FC + (S^g + S^v) \geq FC$ (since $(S^g + S^v) \geq 0$).

The above puts aside empirically observed inconsistency between national food balance statistics and the consumption data estimated from household income expenditure surveys. One may also note that a part of the food aid received (M^F) goes directly to INGOs in kind and is not recorded in the PFDS's inventory. Rest of the food aid goes to government stock for which the government has to make available 'counterpart funds' to Programs, equivalent to book value of the 'aid', approved jointly by the external partner and the government. Thus, food aid involves budgetary cost that is shown as allocation under the heading of social sector. While the details will be addressed during designing of the template, the minor aberrations are ignored at this stage.

Within the larger balance defined in equation (2), several relations ought to be fulfilled separately for the government and the private sectors. These are shown in equations (7) and (8):

(7) $S^g_{-1} + M^g + M^F + 8^g - D^g - O^g = S^g + L^g$ (government's stock-flow balance)

(8) $S^{v}_{-1} + M^{v} + R^{v} - D^{v} - X_t = S^{v} + L^{v}$ (private provider's stock-flow balance)

III.2 Balancing the Stocks and Flows – constraints made transparent

Equations (7), (8) and (3) capture all stocks and flows of the foodgrain market described in this paper. Information on all variables in equation (7) are known *ex post*. Unfortunately, other than M^{v} and X, no information is available on equation (8). Finally, in case of equation (3), Q^{v} and R^{g} are known. The list of unknowns cannot be uniquely determined with the information one regularly has and therefore, D^{o} and E in equation (3) are estimated exogenously using the following specifications:

(9) $D^0 / Q = e^{(a_0 + d_1)}.(p_c / cpi)^{a_1}.(p_r / p_m)^{a_2}.(p_{nf} / cpi)^{a_3}.Q^{a_4}$ and

(10) $E / Q = h_0 + h_1 \ln(time) + d_2.time$

Where,
p_c, p_r, p_m and p_{nf} are respectively prices of cereals, procurement and market prices, and prices of non-food;
cpi stands for consumer price index;
a_i's are parameters associated with elasticity parameters; and
dummies d_1 and d_2 differentiate between seasons (wet and dry).

It is important to note that one may choose any specification for determining D^{o} and E; and the two mentioned above are only for the purpose of illustration that are later used in the excel-based template. Given that government procurement (R^{g}) is known, estimated values of D^{o} and E allow one to estimate private domestic procurement by private traders each year (R^{v}) from equation (3)[9]. There still remain four unknowns in equation (8) – private stocks at the beginning and end of a period, loss incurred by the private arbitrageurs in the process of arbitraging, and demand for cereals met through market with no price supports. The current exercise proposes to identify appropriate specifications for two of these unknowns – L^{v} and D^{v}. Though the excel-based template developed can accommodate any specification, for the purpose of illustration, L^{v} is assumed to be a constant fraction (say, c) of total volume of cereals handled by the traders in a given year and D^{v} is derived from the following equation, which is a reduced form of the Linear Almost Ideal Demand System (LAIDS):

(11) $w = \alpha + d_3.dum3 + d_4.dum4 + \gamma_1 \ln(pc) + \gamma_2 \ln(pnc) + \gamma_3 \ln(pnf) + \beta_1 (gnipc / cpi)$

Where,

$w = (p_m * D^{v}) /$(gni – income from rice and wheat); and therefore,

$D^{v} = (w/p_m)*$(gni – income from rice and wheat)

[9] See earlier explanation on what are included in R^{v}.

The estimate of D^v using reasonable parameter values of a given specification of demand function (of which LADIS is one) allows one to generate a time series on private stock (S^v) with any initial value assigned using equation (8).

In summary, three important variables, D^v, D^o and E are calculated using given specifications and priors on parameter values. A relatively minor fourth variable is the private loss during arbitraging. Once the specifications are fixed, values of important parameters may be changed within intuitively reasonable ranges to generate alternative histories of all (previously) unknown variables. Some of the critical ones considered as potential indicators for verification are per capita consumption of cereals (given a population series), private and total stock, and consumption as a percentage of net domestic output. One could draw analogy with simulations based on macro numerical models. In case of the latter, model specification and parameters are validated against past actual data before considering as set of exogenous variables for projections. In contrast, the current exercise takes a part of the history (variables for which values are reported) as given and generates another part of the history against which there is no benchmark to validate. However, once a 'history' is considered acceptable[10] and the values of corresponding parameters are incorporated, the future of some of the outcome variables may be projected given a set of actions and exogenous variables.[11] The actions to be chosen however depend on the preferences of the 'decision-maker' and the assumptions the latter makes about other actors in case of strategic role – all these are taken up in the rest of this section, acknowledging that the actual choices are not attempted in the excel-based template.

III.3 Behavior of Private Sector Arbitrageur

Private sector is assumed to be motivated by profit sought by procurements at times and places of low prices and sale of the commodity when (and where) prices are high. The two aspects of this engagement are described by two arbitrage conditions.

Arbitrage condition across national boundaries (external) is normally given by the condition that domestic price is restricted to evolve in a moving band defined by world price, trade costs, and trade taxes if any:

$$(12) \qquad p^w - \tau - \nu^X \leq p^m \leq p^w + \tau + \nu^M ;$$

where,

[10] Rigors in acceptability may be introduced in several ways. An example would be, attaining least error sum of squares when one runs regression of an estimated series (say, opening private stock) on (say) future market prices. However, choice of such criterion would imply (often rigid) assumption on the behavior of agents.

[11] There is a second methodological departure the present exercise makes. The tradition among economists has been to rely upon econometric estimation of demand parameters from micro-level data. While such empirical observations were considered as priors, those are hardly put to test for consistency with aggregate data. Our exercise provides a way to do that. It also allows one to raise questions on the consistency of recorded data in given years!

p, τ and ν are respectively, price, per unit export or import cost (transport/shipping and other handling cost) and per unit taxes (positive) or subsidy (negative) on imports and exports;
Superscripts with prices, w and m, stand for world and domestic market respectively;
Superscripts X and M stand for export and import respectively; and
As before, time subscripts are omitted.

The inter-temporal arbitraging in simplified models is given by;

(13.a) $S_t \geq 0$, if $(1+r)^{-1} E_t (p_{t+1}) - p_t \geq k$;

(13.b) $S_t = 0$, if $(1+r)^{-1} E_t (p_{t+1}) - p_t < k$

Where r is the interest rate and k is fixed marginal cost of storage (assumed in some literature), and E_t is the expectation conditional on information at time t.

With positive lead time in procuring foodgrain from the world market, and given the influence of expectations in storage decisions, domestic price in equation (12) is an expected variable, and errors in expectations may lead to violation of spatial (cross-border) arbitrage condition described in the equation (12) - that is, the condition may not be fulfilled at certain times[12].

For informed decision-making, it is expected that the government as a provider in the foodgrain market will account for the size of the private providers and their behavior. The latter is assumed to generally follow the arbitraging conditions described in equations (12) and (13). By the same logic, monitoring of actions of private providers, one may make meaningful guesses on their expectation on future prices.

III.4 Government's Objective Function

The earlier review of policy objectives and decision processes revealed that there are primarily three objectives that decision-makers may like to emphasize upon while engaging in foodgrain market. These are:

- Price stabilization,
- Ensure that the engagements do not create disincentives to domestic food production; and
- The most important of all objectives in a food-deficit developing country is, attend to the (basic) needs of people who are unable to avail food from the market,

The first may be considered equivalent to reducing variance in market price, $V(p^m)$, which is difficult to be included in a recursive discrete short time decision model. It is

[12] It would be interesting to verify if such outliers were preceded by more than average share of 'market-disrupting' policies.

proposed that a proxy of it be considered, and actions in period t are taken to ensure fulfilling the following condition:

(14) $|p^m_{t+1} - p^T_t| < u;$

where u is either an absolute number or is expressed as a percentage of p^T_t, which stands for trend value of price at time t.

Fulfilling the second objective requires ensuring a minimum price to producers, given a regime of input market interventions. Historically, such a minimum price is perceived to include a markup over the cost of production. Thus, decisions during period t are expected to ensure that

(15) $p^m_t \geq (1+\alpha).c^q_t,$

where, $\alpha > 0$, c^q_t is per unit cost of production in period t (with appropriate adjustments where processing is involved).

There are potential conflicts between (14) and (15). For instance, with sudden increase in cost of production, fulfilling (15) may lead to violation of (14). If such price increases are perceived temporary having no or insignificant positive effect on subsequent production, the government may choose to protect the interest of the consumers, in which case (14) will over-ride (15). There may however be times when general price level increases are expected to sustain; and there is a need to ensure supply side incentives in the market of essentials. In such cases, the government may forego short term interests of consumers for their long term benefits. Barring for such fine-tuning, government's objective function may be captured by the third objective, subject to several constraints, which may include (14) and (15) as well, with a conditional statement on the operational validity of each in setting. At an operational level, the two conditions may be put up as one algorithm defined as follows:

(16.1) if $(1+\alpha).c^q_t \leq p^T_t$, $(1+\alpha).c^q_t \leq p^m_t \leq p^T_t$ and $(p^T_t - p^m_t) \leq u$.
And
(16.2) if $(1+\alpha).c^q_t > p^T_t$:
$p^m_t = p^T_t$; if consumer' interest is emphasized; and
$p^m_t = (1+\alpha).c^q_t$; if producers' interests are emphasized[13].

One may note that in both cases, the range within which p^m ought to lie is defined by common end points. The difference however lies in the inflexible choices (corner solutions) offered to decision-makers under (16.2) when costs of producing cereals increase at a faster pace than that of the price of cereals.

[13] As will be noted later, switch in priority over the two concerns is seasonal in nature, and may not arise in case of annualized decision framework. For instance, the government normally engages in OMS to stabilize prices when price hikes are observed during months prior to harvest; and no off-takes occur during harvest seasons.

In order to formalize the third (and the most important) objective, let us express access to food as a proportion (or, percentage) of some perceived requirement. One may note that such an approach has historically dominated thinking within national government as well as among international agencies (such as, FAO and WFP) engaged in promoting food security (or, reducing the extent of food deprivation). Given the four different types of food consumption identified above, one may define such a proportion as,

(17) $z = FC/(N.q) = (D^o + D^v + D^g + O^g)/(N.q)$

where, N is the number of people and q is a pre-determined average consumption need per capita (or some other proxy to capture state obligation).

In the above, z may be considered a proxy for the effective proportion of people[14] able to get the average required amount of food from market and non-market sources. Note that z is a measurable number and different political authorities may associate different ordinal value to those numbers. For some, attaining z=1 may over-ride all other priorities in resource allocation, while others may not feel that way. At a general level, such a valuation, benefits perceived from increase in z (or, equivalently, cost perceived from increase in z) may be expressed as,[15]

(18) $V(z) = B(z,\theta) - C(z,\theta)$

where, z is defined in equation (17) and θ is a measure of distribution (say, one minus Gini coefficient in consumption) taking values between 0 and 1 with higher value associated with higher equity. Without further elaboration, signs of the partial derivates denoted with subscripts are given below[16]:

$B_1 > 0,\ B_{11} < 0,\ B_2 > 0,\ B_{22} < 0,\ B_{12} = B_{21} \geq 0$
$C_1 > 0,\ C_{11} > 0,\ C_2 > 0,\ C_{22} > 0,\ C_{12} \leq 0,\ C_{21} \leq 0,$

Under the extreme assumption of uniform distribution in consumption, all people would get the required basic amount of foodgrain if z equals unity. Alternatively expressed, given a distribution in consumption, increase in z is associated with increased fulfillment

[14] Eventually, one would like to formally include a given distribution of consumption. However, as a first step, working with averages and considering (1-z) as proxy for food deprivation allows one to avoid complicacies.

[15] V(z) representing government's engagement in food market is relevant only beyond a (positive) proportion the society and economy can attain independent of government intervention; and the threshold is identified as z^p in Figure 1. In a more meaningful version, one may consider $V(z, \theta, p_m)$ and allow the government to strategically influence p_m so as to raise z^p (and thereby reduce government's disbursement to attain a given z) which would call for using stock (at a cost) to deter undesired increases in market prices.

[16] The first derivative (B_1) is assumed to be positive since an increase in the value of z reduces the extent of (national level) 'food deprivation', thus increasing the value of perceived benefits ('feel good' factor within the government or for reasons of enhanced stability and peace translated to economic benefits). As the size of z continues to increase approaching unity, there may be fewer voices raised in favor of the deprived ones and therefore perceived marginal benefit from an additional unit of z may also be on decline – thus, $B_{11} < 0$.

of government's commitment to provide basic (food) needs to people.[17] Once formally recognized and addressed, the tradeoffs may be brought to fore in choices made on food market interventions. Subsequently, one may fine tune specifications and translate those into numerical exercises for incorporation in templates.

III.5 Cost of engaging in food grain market

The cost incurred by the government is given by,

(19.1) $C_t = D^g.(c^g - p^g) + O^g.c^g$

where,

$c^g = (c^R_{-1} + c^S_{-1}).(1+r)$; and

$c^R = \{(p^w .M^g) + (p^R .R^g) + (c^F.M^F)\}/(M^g + R^g + M^F)$

Equation (19.1) may be rewritten as,

$C = D^g.c^g - D^g.p^g + O^g.c^g$

Or, $C = c^g (D^v + D^o + D^g + O^g) - D^g.p^g - c^g (D^v + D^o)$

Or,

(19.2) $C_t = c^g.N.q.z - p^g_t D^g - c^g.(D^v + D^o) = C(z)$

Note that at $z = (D^v + D^o)/Nq$, there is no government involvement, and $D^g = O^g = 0$. Thus, C = 0 if one ignores the fixed cost associated with storage (not formally included in this exercise). Let us define this threshold as $z^p = (D^v + D^o)/Nq$, and the government does not have to incur any cost to attain this level of z (see Figure 1 below).

Beyond $z = z^p$, concavity of the cost function with respect to z is implicit in the relation between c^g and z. Given a θ, per unit cost ($=c^g$) is expected to increase at an increasing pace as z approaches unity.

III.6 Government decisions – selected questions on allocations

Given equations (17), (18), (19.2) and the identities identified earlier for balancing stocks and flows of cereals in government and private hands, the government's decision problem may be summarized as follows:

(20) Maximize *V(z)*

Subject to, fulfillment of equations (16.1), (16.2), (17), (19.2) and subject to the budgetary constraint (if any)[18].

[17] Equation (17) is newly introduced and the author is not aware of its inclusion in the existing literature. There is a trade-off between budgetary expenses on off-takes and benefits from higher z. One may use (1-z) as a proxy for the extent of "food deprivation" prevailing in a country, which is also contingent upon having a given distribution in consumption.

[18] One may consider an absolute figure below which the total expense should be confined.

Figure 1 describes solution in a choice set that considers all other things as given and the government is a passive actor. If however, as mentioned in footnote 15, the government intends to act strategically, all the above conditions as well as how the private sector reads government's action (such as, stocks) need to be duly considered. A simple equilibrium is illustrated below with brief extension on comparative static. The last part raises selected questions on instruments at the disposal of the government and relative merits in their usage.

Figure 1 describes an interior solution at z^* with $B_1 = C_1$, and MC > MB at $z > z^*$. There is no guarantee that such an equilibrium solution exists. However, government's choice set is bounded, $1 \geq z^* \geq z^P$. In an extreme situation, if social cost is perceived to outweigh total benefit at $z = z^P$, and all attempts by government to increase z beyond z^P lead to increase in the net cost, the optimal solution will be at the corner $z^* = z^P$, that is, government will refrain from any intervention in the food grain market. Alternatively, z may equal unity if society values highly all citizens' right to food and a government chooses to translate that aspiration to reality.[19]

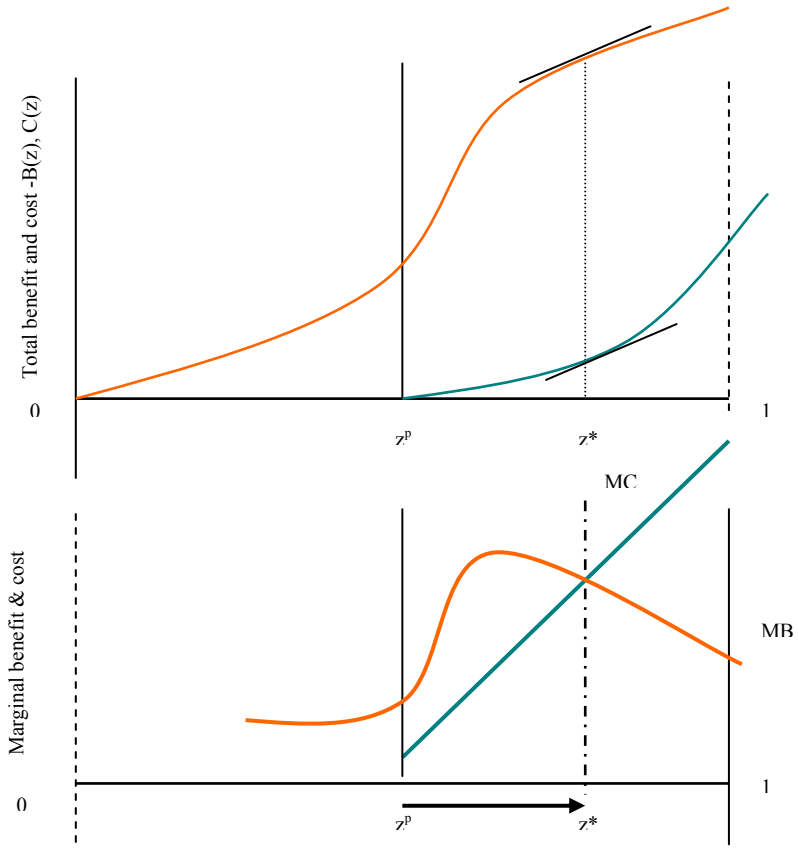
Given that $V(z) = B(z) - C(z)$
$= B((D^o + D^v + D^g + O^g)/(N.q)) - C((D^o + D^v + D^g + O^g)/(N.q))$,

One may make use of the following additional information to derive the comparative static related to change in optimal choice of z as a result of change in any of the independent variables[20],

(18.1) $D^v = f^v(p_m, p, I)$; $\quad f^v_m < 0, f^v_{11} > 0, f^v_2 < 0, f^v_3 > 0$
(18.2) $D^o = f^o(p_m, p_g, p, Q, I)$ $\quad f^o_1 \leq 0, f^o_2 < 0, {}^o_3 > 0, f^o_4 > 0, f^o_5 \leq \geq 0$
(18.3) $D^g = f^g(p_m, p_g, p, I)$ $\quad f_g{}^1 > 0, f_g{}^2 < 0, f_g{}^3 > 0, f_g{}^4 \leq \geq 0$

[19] Note that realized z may often be higher than unity, and we abstract from such empirics.
[20] In (19.1) to (19.3) and elsewhere, superscript 'i' to a functional notation implies first-order partial derivative with respect to the i-th argument in the function under consideration, while superscript 'ii' implies second-order derivative with respect to the i-th argument.

Figure 2: Finding an Optimal z



Since the cost of procurement is perceived same, the most cost-effective choice of government distribution would be zero off-take at zero price (that is, $O^g = 0$) and emphasis on monetized sale close to perfect discrimination if market segmentation with adequate supply is feasible. However, the historical evidence does not lend support to such behavior from the government. In stead, one observes certain patterns in the timing and mix of monetized and non-monetized distribution. For example,

- Monetized sale is meant to stabilize potential price increases during months preceding the two major harvests. Thus, monetized off-takes occur during mid-September – mid-December and during February – May periods.
- Bulk of non-monetized off-take is during February – June when development work (such as, FFW) can take place. Such disbursements (often in cash out of food account) are also made to complete committed project activities before the budget year is over, and thus, coincides with the period of development work. In all such development programs, cash payment is a perfect substitute of payment in kind, and is quite often resorted to.
- Disbursements through both the channels are also guided by the urge to ensure outflows that will allow fresh inflows of post-harvest grains through procurements upon ensuring a minimum level of stock.[21]

[21] For all imported rice, a maximum of six months holding period is considered; while it is nine months for grains produced locally.

Thus, for planning purpose, attempts to increase z may follow any (or a mix) of the following three means[22]:

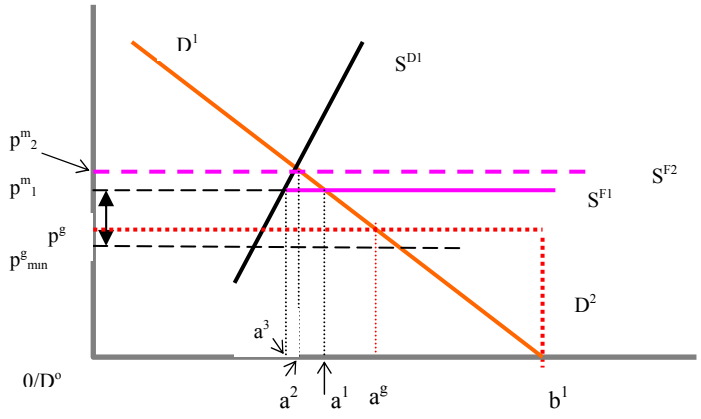
(1) Open Market Sales (OMS),
(2) Emergency relief, and
(3) Program supports/development work (such as, VGD, VGF, FFW); regular relief (such as, GR and TR) and supports in kind to LE and disbursements through EP/OP to support essential and other priority agencies.

Two primary concerns of the government are:

- Ensure that there is adequate foodgrain to meet the needs of the population. It is safe to assume that the private sector will be driven by profit motive and will sell at prices that are not affordable by all people. Thus, the government would supplement the private supply so that non-market routes may be availed (if necessary) to provide food to the needy.
- Unanticipated shocks arising from either domestic or external sources may not be adequately handled by the private sector. And, even if it does, a high risk premium may be tagged to it that is borne by the consumers. Thus, the government may like to ensure that it has sufficient leverage to address emergency situations.

Figure 2 illustrates various static scenarios on government interventions in the food grain market, which are equally applicable to other essentials[23]. The demand curve D^1 is assumed to remain stable, and domestic and foreign supplies are represented by S^{D1} and S^{F1}. Initially the import parity price is at p^{m1} which is below the domestic equilibrium price under a protected regime. In such a situation, domestic production is $0a^3$, private import is a^3a^1, and demand equivalent to a^1b^1 will remain unfulfilled.

Figure 3: Illustration on alternative government choices



[22] It is necessary to recognize that a part of 'emergency cereal' is often sold through OMS if there is no major need. Moreover, a part of the grain in stock, initially allocated for non-monetized off-take, may also have to be sold (through OMS) and the proceeds go for program support.

[23] Figure 2 assumes that an individual demands only one unit of the commodity so that the axis in the Figure also represents number of people. Since D^o is implicit in the supply function, the axis originates from D^o. Thus, the total population is assumed to be equal to $D^o + 0b^1$, though it is likely to be more.

Within the above scenario, the government faces several decision problems:

- if it intends to ensure food to all of $0b^1$, what are the options to avail?
- If there is a supply shock, what choices does the government have?

On the first, the government may,

(1) Procure the a^1b^1 amount and distribute those through non-market routes and upon ensuring that those left out of the market are the only ones receiving the transfer.
(2) Sell some amount at a price, say p^g, such that $p^m_t > p^g \geq p^g_{min}$ = production cost. However, this covers (in Figure 2) only a^1a^g number of people. Thus the government has to find a way to reach rest of the population who are unable to buy food grain at prices p^g or above.
(3) The government may undertake targeted development programs to transfer resources in kind to the poor (such as FFW), or undertake (targeted) development programs where cash transfers are made to the poor who may then buy the grains at going market prices.

Ideally, if the production incentives are not to be tampered with, the second choice is less-distorting for the grain market. The problem of segmenting the market in ensuring transfers to the desired ones remain, and design of development programs provide additional instruments to segregate markets. In the presence of adequate supply of food grains in the domestic private market, cash transfers (in stead of transfers in kind) through targeted development programs will be desirable. However, at other times, such transfers may push the prices up and may fail to ensure poor's access to food. Thus a mix of three initiatives to increase z is found to be more rational an approach to adapt: (i) OMS, (ii) targeted programs with resource transfers in kind, and (iii) targeted development programs with cash transfers to increase purchasing power of the poor so that they may avail the grains from private market. A decision tool (going beyond the current decision support tool) that also links with the budgetary planning ought to take these into cognizance and develop appropriate algorithms to make *a prior* allocation under the three heads.

Figure 2 assumes stable demand in the short term, which is in conformity with current food planning practices. The second question is thus most relevant, and two important sources of supply shocks are: sudden shortfall in domestic production, and sudden increase in international price (and therefore import parity price having positive influences on domestic price). In the presence of former risk, the choice would be procurement from external sources. In the latter case, providing adequate incentive to local production and thereby reduce dependence on imported cereals is the obvious choice.

Ex ante decisions on all the above-mentioned matters need prior information and structured decision-making in a strategic manner. The template developed draws upon the earlier analytics and does not directly address the actual choices, but helps in understanding the implications of alternative choices.

References

Agrimarket Weekly world and the CIS, (No. 18, May 9, 2011; APK- Inform Agency.

Basu, Kaushik, (2010). "The Economics of Foodgrain Management in India", Ministry of Finance, Government of India, September 2010.

Begum M.E.A. and Luc D'Haese; "Supply and demand situations for major crops and food items in Bangladesh", Journal of Bangladesh Agriculture. University, 8(1): 91–102, 2010.

Block, C. (?). "A Decision Support System for Market Mechanism Choice in e-Procurement", Universität Karlsruhe (TH), Karlsruhe, Germany

Cafiero, C., E.S.A. Bobenrieth, J.R.A. Bobenrieth H., B.D. Wright (2009). "The empirical relevance of the competitive storage model", *Journal of Econometrics*, 2009.10.008.

Cafiero, C., E.S.A. Bobenrieth, J.R.A. Bobenrieth H., B.D. Wright (2011). "Storage arbitrage and commodity price volatility", Chapter 15, *Safeguarding Food Security in Volatile global markets*, edited by Adam Prakash, FAO.

Carter C. and Revoredo-Gihay C (2009). "Eastham's commodity storage model in a modern context", *Oxford Economic Papers*, 61: 801–822, Oxford University Press.

Chi-Chung Chen, Bruce A. McCarl and Ching-Cheng Chang (?). "Spatial Equilibrium Modeling with Imperfectly Competitive Markets: An Application to Rice Trade".

Chowdhury N. (2010). "Price Stabilization, Market Integration and Consumer Welfare in Bangladesh", Bangladesh Rice Foundation, February.

Chowdhury N., Farid N., Roy D. (2006). "Food Policy Liberalization in Bangladesh: How the Government and Markets Delivered?", MTID Discussion Paper No. 92, March.

Gouel, Christophe and Sébastien Jean (2010). "Optimal food price stabilization in a small open developing Country" April 13.

Gouel, Christophe (2010). "Food price stabilization for risk-averse consumers", November 30.

David Dawe, ed. (2010). *The Rice Crisis: markets, policies and food security*, FAO and Earthscan.

Deb U., M. Hossain and S. Jones (?). "Rethinking Food Security Strategy: Self-sufficiency or Self-reliance", mimeo.

Derek, B., Jayne T.S., Myer J. R. (2006). "Managing food price risks and instability in a liberalizing market environment: Overview and policy options", *Food Policy*, 31, pp. 275–287, International Food Policy Research Institute.

Headey, Derek (2011). "Rethinking the global food crisis: The role of trade shocks", *Food Policy*, 36, pp. 136–146, International Food Policy Research Institute.

Goletti F., R. Ahmed, N. Farid (1995). "Structural Determinants of Market Integration: The Case of Rice Markets in Bangladesh", *The Developing Economies*, XXXIII-2, June.

Keil, B. and B. Kleinhenz (?). "AgmedaWin – a tool for easy and flexible management of meteorological data, ZEPP-Central Institution for Decision Support Systems and Programmes in Crop Protection", Rüdesheimerstr. Germany.

Khan, M. and A. Jamal (1997). "Market based price support program: an alternative approach to large scale food procurement and distribution system", *Food Policy*, Vol. 22, No. 6, pp. 475–486, International Food Policy Research Institute.

Majumder, M.A. (2006). "Inflation in Bangladesh: Supply Side Perspectives", Policy Note Series 0705, Policy Analysis Unit, Bangladesh Bank, November.

Alam, M.J., I.A. Begum, J. Buysse, A.M. McKenzie, E.J. Wailes and G.V. Huylenbroeck (2010). "Testing Asymmetric Price Transmission in the Vertical Supply Chain in De-regulated Rice Markets in Bangladesh", Paper prepared for presentation at the American Association of Agricultural and Applied Economics 2010 AAEA, CAES, & WAEA Joint Conference, Denver, Colorado, USA, July 25-27.

Poulton C. , J. Kydd, S. Wiggins, A. Dorward (2006). "State intervention for food price stabilization in Africa: Can it work?", *Food Policy*, 31, International Food Policy Research Institute.

Quddus M. and C. Becker (2000). "Speculative Price Bubbles in the Rice Market and the 1974 Bangladesh Famine", *Journal of Economic Development*, Volume 25, Number 2, December.

Rashid S. (2011). "Intercommodity Price Transmission and Food Price Policies An Analysis of Ethiopian Cereal Markets", IFPRI Discussion Paper 01079, April.

Shahabuddin Q. and P. Dorosh (1998). "Rice Markets In the 1997-98 Aman Season: A Rapid Appraisal Analysis", FMRSP Working Paper No. 1, June, Bangladesh.

Shahabuddin Q., M. Asaduzzaman, E. Clay and S. Jones (2009). "Price Support, Domestic Procurement Programme and Public Stock Management", BIDS, May.

Shahabuddin Q. & P. Dorosh (2002). "Comparative Advantage in Bangladesh Crop Production", MSSD Discussion Paper No. 47, October.

Sivakumar,B., N. Anbazhagan, G. Arivarignan (2006). "Two Commodity Continuous Review Perishable Inventory System", *Information and Management Sciences*, Volume 17, Number 3, pp. 47-64.

Technical Committee (2011). Technical Committee on Food Security, Bangladesh National Road Map for Addressing Climate Change Impacts on Food Security, May 19.

Timmer, C.P. (2009). "Rice Price Formation in the Short Run and the Long Run: The Role of Market Structure in Explaining Volatility", Working Paper No. 172, Center for Global Development, May.

Timmer, C.P. and D. Dawe (2010). "Food Crises Past, Present (and Future?): will we ever learn?", in Dawe (2010).

Timmer, C. Peter (2010). Reflections on food crises past, *Food Policy*, Vol. 35, pp. 1–11, Elsevier Ltd.

Timmer C. P., W.P. Falcon and S.R. Pearson (1983). *Food Policy Analysis*, published for the World Bank, The Johns Hopkins University Press Baltimore and London.

Yanliang Miao, W. Wu, and N. Funke (2011). "Reviving the Competitive Storage Model: A Holistic Approach to Food Commodity Prices", IMF Working Paper WP/11/64, March.

"Variation in Staple food prices in Eastern and Southern Africa: A synthesis"; (Prepared for the COMESA policy seminar on "Variation in staple food prices: Causes, consequence, and policy options", Maputo, Mozambique, 25-26 January 2010)

World Bank (2005). *Managing Food Price Risks and Instability in an Environment of Market Liberalization*, Agriculture and Rural Development Department, 2005.