Accepted Manuscript

Title: The relevance of market prices for the design of transfer programs in response to food insecurity

Authors: Alessandro De Matteis, Frank Ellis, Ivan Valdes

PII: S1062-9769(17)30068-6
DOI: http://dx.doi.org/doi:10.1016/j.qref.2017.02.001
Reference: QUAECO 1012

To appear in: *The Quarterly Review of Economics and Finance*

Received date: 6-6-2015
Revised date: 28-11-2016
Accepted date: 12-2-2017

Please cite this article as: De Matteis, Alessandro., Ellis, Frank., & Valdes, Ivan., The relevance of market prices for the design of transfer programs in response to food insecurity.*Quarterly Review of Economics and Finance* http://dx.doi.org/10.1016/j.qref.2017.02.001

Cover page

The relevance of market prices for the design of transfer programs in response to food insecurity

Authors:

Alessandro De Matteis (corresponding author)
University of East Anglia – School of International Development
a.de-matteis@uea.ac.uk dematteis.ale@gmail.com

Frank Ellis
University of East Anglia – School of International Development

Ivan Valdes
Universidad Andres Bello – Facultad de Economia y Negocios

Highlights

We investigate the effect of price changes over the efficiency of aid strategy

A classical production model is used to compare alternative strategies

The proposed approach is useful to optimize aid strategy geographically and over time

The approach can be sharpened with the inclusion of an effectiveness perspective

The simulation of price changes allows the estimation of strategy switch points

Abstract

This paper focuses on the use of market prices as discriminatory factors for the selection of strategies in response to conditions of food insecurity according to the comparative efficiency of different strategies. A classical production model has been used to define the conditions of relative advantage of different response options and to capture the effect of some contextual variables on such conditions. This type of approach can be quite useful when trying to optimize response strategy through its geographical diversification or adjustment over time.

While such analytical approach reflects mainly a static cost-efficiency perspective, it can be sharpened through the partial inclusion of an effectiveness perspective.

Keywords: cash transfers, market functioning, aid, cost-efficiency, food security

1. Introduction

According to general principles of sound project management, decision making needs to be based on a balance between the key concepts of effectiveness and cost-efficiency. However, concerns about the way in which such a balance can be put into practice are common. The choice between drastic alternatives such as a commodity-based versus a cash-based response to a situation of food insecurity is an example of such a case. Is too much attention to cost-efficiency detrimental to the selection of the most appropriate strategy? What is the trade-off between effectiveness and cost-efficiency? How relevant are localized contextual factors for decision making and for such a trade-off?

This paper considers the appropriateness and cost-efficiency of cash-based and commodity-based interventions in food insecure situations. It focuses on the comparative analysis of available options in order to support the decision making process. In particular, it examines the relevance of contextual factors, such as market prices, in choices about the composition of the package to be transferred.

It is intuitive to consider how a price decrease on the local market helps to increase the transfer value of money, while the opposite happens in case of a price increase. In the former case, since an increase in local prices has the effect of reducing the purchasing power of cash, the more the intervention relies on the use of money the greater is the effective loss suffered through the transfer.

The concern expressed above is evident in instances of high price rises or price volatility. In fact, it is known that cash transfers are not suitable in the case of price rises; not only because in such conditions they can be a very inefficient and ineffective transfer system, but also because they are likely to contribute to an exacerbation of the price rise. In fact, cash transfers increase the demand for normal goods, and if supply is not perfectly elastic, the price of these goods is expected to rise. Nevertheless, as Dreze and Sen (1989) have argued, upward pressure on food prices may in turn generate supply response. In-kind transfers, on the other hand, have a corresponding cash value and, therefore, they also have an income effect. However, in addition, an in-kind transfer programme can increase supply and therefore in a closed or partially closed economy in-kind transfers should lead to a price fall, with a consequent disincentive effect. [1]

[1] See Zant (2012) for a review of the literature on the impact of food assistance on food prices and food production. Harvey and Lind (2005) make the case that relief should not be unnecessarily criticized for failing to enable recovery or development. This is even after taking into account the potential negative effects of aid and the possible disincentive effects of relief. The matter is that humanitarian aid may be a

The soaring food price crisis experienced in recent years and the expectation that for some time food prices will remain higher than they used to be have attracted attention to this topic. Abundant research has been prompted into: (1) the underlying causes, focusing primarily on short- and long-run demand and supply side factors, and (2) some of the consequences. Abbott, Hurt, and Tyner (2011) and FAO (2009) provide an overview of the literature, while Piesse and Thirtle (2009) and World Bank (2011) provide an interesting review of food commodity price events.

The literature on the analysis of alternative forms of food assistance has repeatedly compared unit costs and considered trade-offs involved in strategy selection (e.g. Hoddinott and Margolies, 2015; De Matteis, 2014; Lentz, Passarelli and Barrett, 2013). Maxwell, Parker, and Stobaugh (2013) and Lentz et al. (2013) highlight how most donor regulations require agencies to demonstrate cost-effectiveness, presenting a cost comparison between the proposed response and alternative responses. But they also remark how, as yet, relatively little is known about the ways in which agencies actually determine the best response to a given crisis, and that response choices rarely appear to result from systematic response analysis.

Overall, this paper provides a theoretical framework to consider trade-offs between in-kind versus cash-based food assistance, completing and improving established norms in programming and evaluation. The analysis is conducted from the supply perspective and it is based on the assumption that donors and aid providers substitute between types of food assistance according to relative costs. This perspective is partly adjusted through the inclusion of a few side-effects which reflect to some extent the utility of transfer recipients.

The applicative part of the analysis in this study builds on the experience of food aid and cash-based interventions implemented in the arid and semi-arid lands (ASAL) in Kenya.

---

wholly inappropriate instrument for that purpose. As Harvey and Lind put it, the problem lies not with relief and its failings, but with the lack of other forms of international engagement with crises.

The high prices prevalent in the most remote areas make a commodity-based strategy more cost-efficient than a cash-based one. However, this is seen as a constraint to the growth of the local economy and to any attempt to overcome the current condition of semi-isolation.

The rest of this paper is organized as follows. The next section introduces the conceptual framework of this analysis. Sections 3 and 4 consider possible applications through a case-study with a comparison of unit cost estimates of alternative strategies and their relevance for decision making. Section 5 presents concluding remarks.

2. Relevance of effectiveness and cost-efficiency for decision making

2.1 A supply perspective

Market functioning can play a critical role in defining the optimum response strategy or combination of response options to a food security crisis. In general, although sometimes the decision-maker tends to emphasize a certain perspective on the basis of institutional factors such as ‘mandate’ and ‘comparative advantage’, a sound decision-making process should be based on a wider perspective if it is to lead to optimum choices. According to economic theory, in general, a certain strategy can be considered appropriate in a specific setting when, besides being feasible and responding to the specific needs previously identified, it proves to be effective and cost-efficient. When a plurality of possible options is available, a strategy or combination of strategies should be preferred on the basis of a substitution effect that reflects the preferences of the decision-maker.

Assuming that some critical deficit is identified in either monetary or in kilocalorie terms, the strategic choice is not just a matter of principle but instead should be made on the basis of a careful analysis of the context. Even if the aim of the programme is a simple nutritional transfer, the context in which the initiative is to be placed can make a difference. In particular, market prices play a major role in this regard; a role that can affect the efficiency of the intervention even more than such programme-related factors as its size and, consequently, the possibility of achieving economies of scale.

Let us define the model from a donor's perspective. We will suppose that the donor tries to optimize the quantity of the donation package (the transfer) as measured in terms of kilocalories or another type of indicator. Defining the total donation requires knowing the total cost (restraint) involved in the program. Throughout this paper the term 'total cost' refers to the sum of all costs incurred through the various phases of an intervention. We will use a classical production model (i.e. isoquant-isocost analysis) to find the optimal decision for the donor in terms of the combination of cash and food to form any donation package. While for simplicity reasons the proposed framework is limited to two components of the donation package – i.e. food and cash – the latter is used here to represent any cash-related transfer instrument where the transfer value is affected by a price change. For instance, this is the case of value-based vouchers and local procurement schemes. It is understood, that any constraint imposed on the fungibility of the transfer, as it is the case of, say, value-based vouchers and local procurement schemes, tends to reduce the change in transfer value determined by a price change. Within this framework, the concepts of total donation and total costs are defined below.

The total donation is given by:

$$D = g(F, M) \qquad (1)$$

which depends upon two inputs, food and money. The function g can be thought of as a strategic decision of the donor (i.e. it involves political, economic, and other issues). F is the quantity of food required to produce a donation package and M is the amount of money required to make a donation package. For consistency purposes both F and M are measured in terms of kilocalories.

The total cost is equal to:

$$TC = c_f * F + c_m * M \tag{2}$$

where:

TC	is the total cost
c_f	is the total cost of one unit of food in the donation package
F	is the quantity of food needed to form a donation package
c_m	is the total cost of one unit of money in the donation package
M	is the quantity of money, measured in kilocalories, required to form a donation package.

The unitary cost for each input c_f and c_m are defined as a linear combination of different costs required to produce the donation package:

$$c_f = \alpha P_g + \beta c_t + \chi c_{man} + \delta c_{oth} \tag{3}$$

with $0 < \alpha, \beta, \chi, \delta < 1$ and $\alpha + \beta + \chi + \delta = 1$

$$c_m = \alpha' M * (1 + r) + \chi' c_{man} + \delta' c_{oth} \tag{4}$$

with $0 < \alpha', \chi', \delta' < 1$ and $\alpha' + \chi' + \delta' = 1$

where:

P_g	is the consumer price of one unit of food on the international market
c_t	is the transportation cost per unit of food
c_{man}	is the management and administrative unit cost
c_{oth}	reflects any other costs per unit of transfer
r	is the interest rate, taken here as an estimate of the opportunity cost of money. In principle, r should reflect a combined measure of the rate faced by the donor and by the recipient for the effective use of M.

As such, *TC* can be expressed as the relationship between the weighted costs of the two transfer mechanisms, that is the relationship between the quantity of food transferred measured either in nutritional terms (i.e. kilocalories, metric tonnes, etc) or economic terms (i.e. USD) and the amount of cash measured in the same unit. This relationship can take different shapes which reflect different assumptions made by the donor about the rate of substitution between money and food; in other words they reflect the donor's preferences according to the estimated productivity/efficiency of the different ways in which the donation is given. Theoretically speaking, we could have at least three different donation functions: a) a straight line in which the rate of substitution between the two inputs is assumed to be constant; b) the Cobb-Douglas case in which the curve is convex from the origin, thus involving different substitution rates between food and money; and c) the Leontieff curve with fixed coefficients. These three functional forms reflect a different attitude towards the choice under discussion and each can provide the best representation of the donation curve according to initial assumptions about the donor's perspective and key contextual issues.

While the straight line identifies a condition of indifference towards one strategy or the other, a Cobb-Douglas-shaped curve identifies a certain more or less strong preference for one solution. As well known, the latter case provides a good reflection of the current diversification among donors' attitude about the use of food and/or cash, with a few convinced supporters of rather extreme positions and the bulk spread between the two sides. But it also raises the choice that each donor is confronted with when considering specific allocations of donations to interventions in different contexts. In order to optimize the efficiency of the transfer, the same donor may want to adjust the food-money combination to the specific characteristics of the context in which the package is finally transferred. In theory this means that each context may be defined by different points within the entire range of the possible combinations along a Cobb-Douglas curve. The convexity of the curve reflects the opportunity cost of moving along it: shifting from a food-predominant combination to a money-predominant one and vice-versa involves different rates of substitution and therefore opportunity costs according to the position along the curve. The upward concavity means that moving downwards along the curve allows the ratio to shift from a condition which is initially favourable to money (i.e. *ceteris paribus* it is necessary to give out more units of food against money) to the opposite one.

Despite the simplifications provided by the linear function and the higher sensitivity shown by the Cobb-Douglas curve, the Leontieff function seems to better reflect the current practice in the provision of food and money combination packages, with the ratio tending to be fixed over time within each intervention among some reference values usually expressed in terms of shares of the assumed total transfer value (e.g. 80%-20% or 70%-30%, etc). In fact, first of all, despite the high interest developed in the recent years in the increasing substitution of food in favour of money, the share of the latter remains on average modest and therefore it very rarely happens to span along the full range of possible combinations. But, in particular, the limited number of combinations among the range of possibilities that are actually implemented highlights some rigidities dictated by implementation constraints.

Along the points highlighted above it is probably impossible to find any functional form that is more appropriate in absolute terms to represent the donation function, because it will depend on such key determinants as the donor's preference, beneficiaries' preference, contextual factors of destination such as market functioning, institutional set-up, implementation bottlenecks, etc, the costs involved in the package, and so on.

In order to simplify the discussion in this case the relationship is assumed to be linear, which means imposing the simplifying assumption that the market substitution rate between the two transfer systems is constant and equal to $P = c_f / c_m$. In terms of the isoquant-isocost analysis this can be thought of as the Marginal Rate of Substitution given by the market.

The above is supported by the consideration that since $TC = c_f * F + c_m * M$ is fixed, the optimal market decision involves the differentiation of this expression:

$dTC = c_f * dF + c_m * dM$ which, under the imposition of $dTC = 0$, leads to:

$$\frac{dM}{dF} = -\frac{c_f}{c_m} \tag{5}$$

From a donor's perspective the main transfer strategy decision is related to selecting the best combination of food and money to be donated. In broad terms this is expected to reflect the preferences of each donor behind the donation, be they countries, agencies, or interest groups. In this case, considering the donation package given by (1), if the donor target is to provide a fixed package D = $\bar{D}$ (isoquant) the optimal decision involves the maximization of the donation function subject to the cost constraint. Thus:

$$\frac{\partial g}{\partial F} * dF + \frac{\partial g}{\partial M} * dM = 0 \tag{6}$$

and hence:

$$\frac{dM}{dF} = -\frac{\left(\frac{\partial g}{\partial F}\right)}{\left(\frac{\partial g}{\partial M}\right)} \tag{7}$$

where:

$\frac{\partial g}{\partial F}$ may be considered in light of the efficiency of the transfer, as well as of a certain selfish attitude of the donor. The latter may be justified by a donor interest in stabilizing an eventual surplus on the domestic market (reflected in low domestic prices), or in response to an eventual unfavourable imbalance on the international market. The aim of maximizing the transfer efficiency reflects the utility of the beneficiary, taking into account the local market price of the commodity in the donation package.

dF corresponds to the marginal change in the quantity of food measured in kilocalories.

$\frac{\partial g}{\partial M}$ may be seen in light of the beneficiary's interests and consequently is associated with a higher efficiency of the transfer. In economic terms, the use of cash allows avoidance of unnecessary losses in the eventual resale of food commodities. From a nutritional perspective, the contribution towards a higher diet diversification is regularly highlighted. Furthermore, it is appreciated that such a form of transfer is more respectful of the recipient's dignity.

dM corresponds to the marginal change in the amount of money measured in kilocalories.

Despite the various factors that may affect donor's choice of the combination of cash and food, for the purposes of this study our analysis is limited to an economic perspective. It is assumed here that this perspective is mainly aimed at the maximization of the transfer efficiency, under the constraint of a higher or lower predisposition towards a cash-based or commodity-based approach. In this case, if we assume that the total amount of the donation is given, the donor tries to maximize the amount of the transfer D – as shown in equation (1) – subject to a cost constraint shown in equation (2).

Summing up, the allocation of D is based on the ratio shown in equation (7) and the relative market prices given in equation (5).

However, no criterion is set as a general rule in this regard, with contrasting opinions expressed by different donors and the international community in general. Our opinion is that this combination is to be defined on a case-by-case basis according to the market prices prevailing in the area of destination of the transfer as well as on the degree of market functioning in the same area. In particular, the higher the local market prices, the lower the effective value of a cash transfer (either in terms of size of transfer to each recipient or in terms of number of recipients, or *ceteris paribus* in terms of the duration of the intervention). Conversely, in the case of high local market prices a commodity-based transfer would both leave the transfer unaffected in physical and nutritional terms and increase the money that a recipient could receive through eventual monetization of part of the transfer. The opposite would hold in case of low food prices on the local market.

The relevance of market functioning concerns the very nature of cash as a tool for exchange. The degree of market functioning reflects the supply capacity to respond to the increase in demand generated through the cash transfer. In a functioning market, a lower degree of price increase is to be expected, if any at all. But the opposite is expected to be the case when dealing with a malfunctioning market. In these conditions a cash injection is expected to generate an increase in the price of the food, which in turn will alter the relative price between food and other goods.

Having said the above, in our model the donor's optimal choice is obtained by equalizing equations (5) and (7):

$$\frac{dM}{dF} = \left(-\frac{\frac{\partial g}{\partial F}}{\frac{\partial g}{\partial M}} = -\frac{c_f}{c_m} \right) \tag{8}$$

which in turn means that the optimal decision is given by:

$$\frac{\left(\frac{\partial g}{\partial F}\right)}{c_f} = \frac{\left(\frac{\partial g}{\partial M}\right)}{c_m} \tag{9}$$

Equation (9) sets the condition that determines the optimal donation package for the donor. It is given by the equalization between a) the efficiency of the last US dollar contributed to the donation package in the form of food and b) the efficiency of the last US dollar contributed to the package in the form of money.

2.2 What would happen if the donor's preference is different from the combination defined by the relative price of food and money?

With reference to the straight line donation curve, the donor's preference affects the slope of the line: a higher slope reflects a preference for a higher share of the donation package to be covered by food and the opposite otherwise. In the two cases considered the optimization of the aid package would be achieved in the two corner solutions obtained by contributing the entire package in the form of food or in the form of cash. These corner solutions correspond to the following conditions:

a) corner solution with food:

$$\frac{\left(\frac{\partial g}{\partial F}\right)}{\left(\frac{\partial g}{\partial M}\right)} < \frac{c_f}{c_m} \tag{10}$$

b) corner solution with money:

$$\frac{\left(\frac{\partial g}{\partial F}\right)}{\left(\frac{\partial g}{\partial M}\right)} > \frac{c_f}{c_m} \tag{11}$$

2.3 An enlarged perspective

A more elaborated version of (3) and (4) is given by (12) and (13) which try to take into account some forms of unintended uses of the transfer.

$$c_f^* = \alpha^* \left(P_g / P_l\right) + \beta^* c_t + \chi^* c_{man} + \delta^* c_{oth} + \varepsilon \, SF_{res} * P_l \tag{12}$$

with $0 < \alpha^*, \beta^*, \chi^*, \delta^*, \varepsilon < 1$ and $\alpha^* + \beta^* + \chi^* + \delta^* + \varepsilon = 1$

$$c_m^* = \alpha^{**} M * (1 + r) + \chi^{**} c_{man} + \delta^{**} c_{oth} + \gamma (1 - \vartheta) \, SM_f * \left(P_g / P_l\right) \tag{13}$$

with $0 < \alpha^{**}, \chi^{**}, \delta^{**}, \gamma < 1$ and $\alpha^{**} + \chi^{**} + \delta^{**} + \gamma = 1$

where:

SF_{res} is an estimate of the share of food commodities received that are eventually resold by the beneficiary;

P_l is an estimate of the price at which food commodities are eventually resold. In this case, for simplicity the resale price is assumed to be equal to the local price of food;

SM_f is an estimate of the share of the cash transfer used by the beneficiary to purchase food. Therefore the quantity $(1 - \vartheta)$ measures the share of money transfer eventually used by the beneficiary for non-food related purposes.

Expressed in such a formulation, the role of relative prices is critical in defining the optimum composition of the donation package. *Ceteris paribus*, a change in P_g and/or P_l due to exogenous factors would determine a shift in the isocost.

2.4 What would happen if the relative price of food changes for exogenous reasons?

Let us assume that the donor has different preferences about the composition of the package. In this case it is better to use the Cobb-Douglas curve.

First of all, shortened c_f^* and c_m^* can be reduced as follows:

$$c_f^* = \alpha^* \left(P_g / P_l\right) + \overline{\Theta} + \varepsilon\, SF_{res} * P_l \tag{14}$$

$$c_m^* = \overline{\Phi} + \gamma(1-\vartheta)\, SM_f * \left(P_g / P_l\right) \tag{15}$$

where $\overline{\Theta}$ and $\overline{\Phi}$ are fixed:

$$\overline{\Theta} = \beta^* c_t + \chi^* c_{man} + \delta^* c_{oth} \tag{16}$$

$$\overline{\Phi} = \alpha^{'*} M * (1+r) + \chi^{'*} c_{man} + \delta^{'*} c_{oth} \tag{17}$$

As a simplification, let us make the assumption that the beneficiary can spend the money transfer only on the purchase of food – which means imposing the condition: $SM_f = 0$ in equation (13) – so that any variation of the international price just affects the unit cost of food c_f^*. Along the same lines we make also the assumption that no resale of food commodities received occurs, which means assuming that $SF_{res} = 0$. In these conditions:

$$\frac{c_f^*}{c_m^*} = \frac{\alpha^* \left(P_g / P_l\right) + \overline{\Theta}}{\overline{\Phi}} = \frac{\alpha^* \left(P_g / P_l\right)}{\overline{\Phi}} + \frac{\overline{\Theta}}{\overline{\Phi}} = \overline{\kappa} * \frac{P_g}{P_l} + \overline{\overline{\kappa}} \tag{18}$$

where $\overline{\kappa}$ and $\overline{\overline{\kappa}}$ are constant.

As c_f^* depends on $\bar{\kappa} * (P_g / P_l)$, the final impact on the combination of the donation package is related to the value of $\bar{\kappa}$. As $\bar{\kappa}$ moves between zero and one, the closer its value to zero, the lower the impact of a change in the relative price, and the opposite otherwise.

This is shown in Figure 1 where the shift in the relative prices determines an increase in the relative cost, which is reflected in a shift in the isocost: a decrease in the relative price of food – determined either by a decrease in P_g or by an increase in P_l – will determine a shift in the isocost. The isocost will move towards the origin pivoting on A. The size of the shift is determined by $\bar{\kappa}$: values of $\bar{\kappa}$ close to zero will determine small shifts, while values of $\bar{\kappa}$ close to one will determine large shifts.

Each shift in the isocost will determine a change in the point of tangency between the isocost and the isoquant; this will modify the optimum composition of the donation package. This can be clearly visualized by considering eventual shifts of the isocost line from an optimum combination equally formed by money and food, which corresponds to a point of tangency positioned along the 45 degree line. A small shift of TC, as from TC to TC', will only marginally affect the composition of the package, determining a slight increase in the share of the transfer covered by food and decreasing the share of money accordingly. Conversely, a larger shift, as from TC to TC", will be reflected in a wider gap between the point of tangency and the diagonal, determining an optimum combination package formed by a higher share of food (*f"*) and a lower share of money (*m"*).

2.5 Relaxing the assumptions

At this stage let us reconsider one of the assumptions made above. In particular we are going to focus on the assumption that all food received through the donation package is consumed by the beneficiary.[2] Such assumption is quite unlikely.

The assumption that the totality of the food commodities received is consumed by the beneficiary has allowed the consideration of these commodities only for their nutritional value and not for their economic value. This theoretical limitation can be overcome by allowing that all possible combinations which include some quantity of food can involve a certain rate of monetization (i.e. partial resale of the food received).

Under the assumption that this would happen at the local market price P_l, TC shifts, pivoting on B in response to a change in the ratio P_g / P_l and consequent change in the slope of the isocost. If $P_l > P_g$ the ratio P_g / P_l will decrease and TC will shift downwards. Conversely, if $P_l < P_g$ the ratio will increase and the isocost will shift upwards. The size of the shift would depend on the share of food commodity received which is resold: the higher the share, the higher the size of the shift.

[2] In the literature it has been considered that there are only few tools or methods that effectively incorporate recipients' preferences. See Maxwell, Parker, and Stobaugh (2013). Relaxing the assumption that all food aid is consumed by the beneficiary helps to take into account, to a certain extent, recipients' preferences.

Another major assumption made above imposes the condition that the recipient spends all money received through the donation package on food. This assumption involves the analysis of the beneficiary's utility and goes beyond the perspective adopted throughout the present study, which focuses instead on the efficiency of the provision of aid. For this purpose, this assumption is maintained, or at the maximum can be partially relaxed by imposing the condition that all money received that is not spent on food is used by the recipient for other purposes which have the same cost-efficiency of kilocalories as would have been otherwise achieved through the consumption of the same quantity of food.

The case in which $P_l > P_g$ is shown in Figure 2. The initial optimum combination is identified by the point of tangency between the donation curve D and the isocost TC which happens to fall on the point of tangency along the 45 degree line where $m = f$. Starting from this initial optimum combination, a small share of monetization will lead to a shift from TC to TC*. In this new condition the point of tangency between TC* and the donation curve D* will generate a minor change in the composition of the optimum package. Conversely, a larger share of monetization will cause the isocost to move from TC to TC**. In this case the point of tangency between the donation curve D** and TC** is farther from the 45 degree line, and this corresponds to a wider gap between food and cash, with an increase in the share of cash in the composition of the optimum donation package.

2.6 Relative advantage

Based on the above, some areas of relative advantage have been identified. These areas are identified by a series of factors considered above: donor preferences, relative price of food on the global and local market, size of eventual resale of food. The first factor determines the shape of the isoquant, while the others determine the position and movements of the isocost.

As summarized in Figure 3, the area of relative advantage of different strategies is identified by the movements of the isocost. It depends on a) whether the shift of the isocost happens by pivoting on its point of intersection with either of the two axes, and b) the direction of the shift.

When TC happens to pivot on its point of intersection with the food axis as in Figure 3a, a shift of the isocost on the right makes any combination which involves a certain component of cash transfer less efficient. In particular, the higher the relevance of the cash transfer and the reduction in the relative price P_g / P_l, the less efficient results to be the donation package. The opposite is the case if the isocost shifts leftwards. In this case, as said above, while a reduction of P_l does not affect directly the cost-efficiency of a commodity-based (i.e. mainly providing food through the donation package) programme, it makes it less efficient in comparative terms by increasing the transfer value of a cash-based transfer. In other words, while in the former case we have identified a relative loss for a cash approach – and, consequently, a relative advantage for a food approach – in the latter we have identified a relative advantage for a cash approach and, consequently, a relative loss for a food approach.

The inverse results to be the case when TC pivots on the intersection with the money axis, as in Figure 3b.
In Figure 3 light-shaded areas identify areas of relative advantage of food, dark-shaded areas otherwise.

While the movements of the isocost allow identification of the areas of relative advantage of different strategies, the estimation of the differential cost associated with each strategy requires the definition of the isoquant. This is reflected in a shift of the point of tangency between the isoquant and the isocost. As a consequence of this shift, the differential cost is measured by the transposition of the points of tangency onto the relevant axis: the M axis in 3a and the F axis in 3b.

As indicated above, the shape of the isoquant reflects the donor's *a priori* attitude towards the composition of the donation package in terms of higher preference for either food or money. Therefore, the higher the donor's preference for money (food), the closer will be the point of tangency to the M (F) axis.

In Figure 3a the estimate of the loss or advantage in case of a package composed entirely by money is given by BB' or BB" respectively. In this case the size of advantage or loss is determined solely by the change in the ratio c_m^* / c_f^* and ultimately in the ratio P_g / P_l . In view of the linear structure of the isocost, the size of the loss or advantage will decline linearly as the point of tangency moves along the isocost. Therefore the size of advantage or loss can be estimated as a function of the price ratio and of the composition of the donation package.

The same reasoning can be followed in Figure 3b with the due changes.

3. Possible applications

The estimation of relative advantage which can be eventually associated with different strategies, as well as the simulation of possible scenarios, can provide major support in different phases of an intervention. In fact, its role can be critical at the planning stage when considering alternative intervention strategies. In the same way it can also be quite helpful in a monitoring phase when reviewing the performance of an intervention and projecting it into the future through the simulation of future conditions associated with either expected or hypothetical events.

More generally, the process described above is useful for fine-tuning intervention strategy in time and space. In the first case, the change over time in the price ratio, determined by changes of either P_g and/or P_l, can help to adjust the composition of the donation package accordingly. In this case prices are the only exogenous factor allowed to change over time. In other words, the analysis maintains a comparative statics perspective. The different dynamic implications of the two types of strategies are ignored here because their discussion goes beyond the purpose of this study. In the latter case, when used in a time-invariant fashion it can help to provide a snapshot of the different values of the price ratio in different contexts, be they countries, or parts of the same country. When the comparative analysis is conducted from this static perspective, changes in P_g become irrelevant and the focus of the analysis centres on the eventual spatial differences in the relative value of P_l.

While the information presented so far is mainly focused on a cost-efficiency perspective, it may be of help to also consider the selection of intervention strategy in a wider perspective which goes beyond a project dimension and is able to take into account not only direct and positive effects, but also indirect and negative ones. The problem usually encountered with this approach is the lack of homogeneity of the issues at stake. Unfortunately, even in this case the quantification of the relative advantage of one strategy against the others does not help to answer recurrent questions, such as the estimation of the value added in terms of total effectiveness expected from an intervention which can be associated with a marginal increase of its unit cost. What, is feasible, instead, though less robust, is an ordinal approach which allows estimation of the cost associated with strategies that, on the basis of a pre-set list of principles, can be given an ordinal value. In other words, as long as we are able to identify the priority of one strategy over another, we should be able to estimate, *ceteris paribus*, the differential cost associated with the selection of the one considered more effective.

To make a simple case, let us consider the task of deciding between a cash-based and a commodity-based strategy for an intervention in a remote area chronically affected by food shortage and dependent on imports of food commodities. Assume that a preliminary assessment has indicated that local market functioning is rather mixed and that a cash-based strategy is feasible. The consideration the decision maker is confronted with is that while commodity-based assistance is vital to maintaining the commodity flow, a cash-based strategy would not only provide the same inflow of food commodities but would also be beneficial in stimulating the local economy and helping to overcome the current situation of isolation. In this case, the main objective of the strategy remains the nutritional and livelihood support to be achieved through the improvement of food availability and food access. However, the two strategies considered here (on the assumption of total reliance on either one of the two inputs) are quite different, first and foremost because of the different concerns about possible side-effects, which may be relevant to a perspective of longer duration than the intervention under discussion. This wider perspective taken by the decision maker allows consideration to be given to aspects which would be normally neglected, as they are deemed secondary to the purposes of the specific initiative. Through a simulation exercise we could try to get a reasonable grasp of the possible impact in terms of the identified side-effect, and this could eventually allow the decision maker to evaluate such an impact and include this value in the analysis of cost-efficiency. Having said that, even without making this effort, the cost-efficiency analysis will help to give a shadow value to the side-effect under discussion, in our case estimated as the difference between the unit costs of the two strategies considered. This estimate is a measure of the additional costs that need to be faced in order to achieve the side- or secondary effect identified in addition to the main aim of the intervention. In other words, such an analysis will tell us how much the unit cost of the less expensive option needs to be increased by in order to achieve, *ceteris paribus*, the additional result proposed as a side-effect. With specific reference to the case mentioned earlier, this analysis should help to estimate the increment in unit cost required to make the intervention favourable to the local economy, in addition to it being capable of properly pursuing its main objective.

A possible application of the process presented above is in helping to adjust strategies to the specific conditions of implementation by fine-tuning the combination of available options according to variables such as space and time. The former would mean that the strategy is diversified geographically according to localized characteristics such as market strength and livelihood, and the latter would involve the adjustment of strategies over time to take into account seasonal variation of relevant factors. This would allow enlargement of the scale and time frame of the analysis by drawing as many isoquants as the number of areas and periods for which estimates of both relevant project costs and contextual relevant data are available. By comparing the specific isoquant with the relevant isocost it is possible to estimate a monetary value of the comparative advantage of each option within a set of strategies for each area and period.

In more general terms, the process presented above can be expanded and inverted in order to compare the differences in cost-efficiency between a series of alternative strategies assumed – or adapted – to have similar level of effectiveness.

The following part of this paper provides a simple application of the analytical process presented above using project data from Kenya. It is aimed at providing a practical application of the approach presented above, rather than a proper comparative efficiency analysis which is beyond the scope of this paper. Nevertheless, the reference to a real context and the use of real data, combined with simulations based on reasonable assumptions, helps to better appreciate the versatilities of the analytical approach proposed.

4. The case of arid and semi-arid lands in Kenya

The critical role played by trade within the food economy of the arid and semi-arid lands (ASAL) in Kenya and consequently as a major determinant of food supply and nutritional status has been abundantly highlighted in the literature. The chronic dimension of food shortages in these areas and particularly their strong dependence on food imports from neighbouring areas make it an ideal case to underline the need to adapt development policies as well as short-term strategies in a way to provide due attention to trade issues.

ASAL areas have long benefitted of food aid and other efforts to improve food supply and livelihood in general. In terms of food aid we will refer here to the Protracted Relief and Recovery Operation 106660 (PRRO) launched by the World Food Programme (WFP) in May 2009. The PRRO included a small component of cash transfers. Although this component has been increasing over time, it is neglected here due to its small share of the overall budget, as well as in order to simplify the discussion. Since 2007 ASAL areas have benefitted also of the National Hunger and Safety Net Programme (HSNP) aimed at establishing a social protection system based on the regular provision of cash transfers.

Despite the support provided through food aid and other transfers, the gap between food requirements and supply in the district is reflected in high prices, almost double the country average. This inevitably affects the problem from both sides of the coin: while, on one side, high prices are a prerequisite to stimulate trade inflows, on the other they drastically limit access of a large part of the population.

Under an efficiency perspective, both food aid and cash transfers come at a remarkable cost. For an estimate of the cost of food aid distributed in ASAL areas, we can refer to the unit cost estimated on the basis of the official budget for the PRRO and of its revisions undergone up to April 2012. The estimate of HSNP unit cost refers to the period July 2010 – June 2011. In general, estimates of unit costs of alternative strategies are to be consistently ex-ante or ex-post. An exception is made in this case under the assumption of negligible gap between the two. The estimate of PRRO unit cost is not based on final costs, but on ex-ante costs from its original budget and budget revisions during the period under discussion (see WFP, 2011). The estimate of HSNP unit cost is based on data from NAO (2011).

The unit costs for the PRRO are estimated by dividing the total project budget by the number of MTs of food commodities expressed in terms of cereal equivalent and by the related amount of kilocalories. The unit costs for the HSNP are expressed in the same units as above and are estimated by dividing the overall unit cost by the amount of cash transfer and subsequently multiplying such ratio by the average market price at the time of the transfer for a basket of staple food commodities, composed of maize grain (40%), maize meal (40%), wheat (10%) and rice (10%).

The two estimates, reported in Table 1, are very close to each other.[3] Nevertheless, despite the similarity of unit cost estimates, the two intervention strategies are very different in nature.[4] In particular, the transfer value, for the conversion of cash into food,

---

[3] In this regard, it is interesting to consider how the geographical scope of the PRRO has been enlarged over time to include also some non-ASAL areas. While this is expected to have contributed to a certain reduction of its unit cost, this is neglected here.

[4] When linking the conceptual framework proposed in section 2 to empirical contexts it may be useful to consider the shape of the production function of cash-based and commodity-based assistance. For example, in our case, as in other common settings for food assistance, a reasonable assumption may be to have increasing returns to scale in the provision of each type of assistance. This is due to the large fixed costs to shipping in-kind food or developing an infrastructure to deliver cash benefits. Such assumption is reflected

is based on local market prices. Clearly, the higher the price of the food on the local market, the lower the effective value of the cash transfer, reducing the cost-efficiency of this strategy. Therefore, any price change in space and/or time compared to the reference price on which the unit costs have been estimated will either widen or reduce the gap between such unit costs. Since in our case the unit cost of a cash-based strategy happens to be lower than a commodity-based one, a commodity price increase on the local market will reduce the preference for the former. In particular, a simulation of price changes allows to estimate the rate of price increase which is expected to lead to a switch between preferred strategies. In our case the equalization of unit costs would happen in correspondence to a local price of 50.6 KShs of the cereal basket, and considering a base price of 50 KShs, the annual rate of price increase leading to a switch is estimated at just above one percent (1.2%).

While the above analysis has been conducted at aggregate level, the same process can be easily replicated over space and time, to capture the contextual diversities within ASAL areas or in general within the project areas, which are mainly reflected in different transport unit costs and different local market prices. For instance, focusing on the most remote and in need areas within the project coverage, specific unit costs could be estimated under the assumption of, say, 20% higher-than-average transport unit cost and 20% higher-than-average market prices. This would lead to higher estimates of unit costs shown in Table 1.

In this case only a reduction of local market prices would lead towards a switch in strategy preference. Once again a simulation of price changes can help to estimate the rate of price change expected to lead to a switch. In this case the base price is 60 KShs

---

in our choice of a classical Cobb-Douglas production function, which allows to assume the existence of economies of scale. On more general grounds, Felipe and Addams (2005) provide a good discussion about the validity of this production function for both theoretical and empirical analysis, arguing that the econometric models based on a linear identity usually show a shape that resembles a Cobb-Douglas function.

and the equalization of unit costs would happen at a local price of 53.3 KShs, corresponding to an annual rate of price decrease of -11.3%.

A graphic visualization of the unit costs estimated in Table 1 can assist in comparing intervention strategies: in Figure 4 any input combination above or on the right side of the isocost (dotted line) is in favour of a commodity-based strategy, while the opposite applies below or on the left side of the isocost line. An amount of 10 USD per MT can be estimated as the savings deriving from choosing to implement a 100% cash-based strategy rather than a 100% commodity-based strategy in ASAL areas. When shifting to a combined input approach such a saving is expected to continuously fall towards zero at any increase of the commodity component. In the same way, when considering the most remote and vulnerable part of the operation, the unit cost estimated for a cash-based strategy is mainly on the right side of the isocost, in the area that in Figure 3.a was defined as the area of commodity relative advantage. In this case the maximum average loss associated with the choice of a cash-based strategy proves to be quite high: 116 USD per MT. Under a combined strategy, this loss continuously falls towards zero at any increase of the commodity component.

If relevant data are available for various locations, using the same process it is possible to estimate the isoquant associated with the various geographical components of the PRRO and HSNP as well as the difference between the appropriate unit cost and the isocost. By comparing the localized isoquant against the isocost it is possible to estimate for each area a monetary value of the comparative advantage of a different set of strategies. In the absence of relevant data at local level, it seems reasonable to expect that the rigidity of supply increases with remoteness. For areas reasonably integrated with the national market the unit cost associated with a 100% cash-based strategy is closer to the lower end of the range identified. The opposite would apply for areas less integrated.

The unit cost of the commodity-based strategy would be affected by the price rise only with regard to the share of food aid monetized by the beneficiaries. Any monetization would lead the isocost to shift slightly downwards. In the absence of any solid knowledge of monetization in ASAL areas, some assumptions can be made here. Assuming an average rate of monetization of 20% of the food aid basket would lead to an effective unit cost of the commodity-based intervention of 0.227 USD per 1000 kilocalories and 750 USD per MT, with only a minor gap between the entire intervention and the case of the most remote ASAL area with higher than average market prices. This would lead to a modification of Figure 4 with a downward shift of isocosts along the food axis while pivoting on their intersection with the cash axis. As seen in Section 2.5, it is assumed here that food is resold by recipients at local market price P_l. Any monetization at a lower price would raise the effective unit cost.

4.1 A wider perspective

At this stage, after defining and adjusting the isoquant and estimating the unit costs associated with different strategies, it is possible to include in the analysis the side-effects that the decision maker considers worth taking into account in selecting a strategy. In a case such as that of the most remote and depressed parts within ASAL areas, characterized by a rudimentary economy and a certain degree of isolation from the rest of the country, it is relevant to consider any stimulus to the local economic growth a high priority. Therefore the selection among feasible intervention strategies should prefer any option that offers the opportunity to generate this stimulus either directly or, *ceteris paribus*, indirectly.

It is difficult to see food aid as a strategy to promote the local economy; on the contrary, it is expected to have a discouraging effect on local supply and, in general, on local initiative. At the same time, the local market capacity seems to give contradictory signs: on one side larger sums are likely to be spent on productive assets as a consequence of cash transfers (Frize, 2002), but a large share of both actual and potential demand remains uncovered due to the rigidity of supply. This condition would suggest that a strategy based on a combination of commodity and cash may prove most effective. In other words, while a strategy totally reliant on commodities is not seen as favourable to stimulate the local economy, a certain cash component is seen as an appropriate way to contribute to achieving the main objective of improving household food security whilst helping to counterbalance the unfavourable effect of a commodity-based strategy on the local economy.[5]

While the framework proposed is unable to give a value to the side-effect of supporting the local economy through the cash injection, it can help to estimate the changes in the unit costs of the alternative strategies. The knowledge of unit costs – and of their composition to account for fixed costs – allows for an easy interpolation to estimate an expanded matrix based on both input shares and price increases. A simple grid is proposed in Table 2, where for the sake of simplicity it has been assumed that: a) no additional costs are required to switch between two input combinations, and b) the rate of monetization is negligible.

In the case of the most remote and depressed part of project areas, a combination based on equal shares of cash and commodity raises the unit cost by 58 USD per MT in case of no price increase. This amount is expected to rise continuously in case of price rise, as shown in Table 2. The values estimated can be seen as the shadow values, or shadow unit costs, that can be attributed to the secondary objective of developing the local economy through an intervention whose primary aim is to increase household food security and nutrition.

Along the same line, as an average for the entire intervention, any shift from a commodity-based to a cash-based strategy is expected to make the intervention both more effective and efficient, unless market prices rise above the switch point estimated earlier on: 1.2%. At higher rates of price increase, Table 2 helps to estimate the respective shadow unit costs.

[5] De Matteis (2014) remarks that a balanced approach in supporting both demand and supply is preferable in arid and semi-arid lands in Kenya and, more in general, in remote resource-poor areas, which are usually affected by poor market functionality.

5. Conclusions

The present paper has focused on the appropriateness and cost-efficiency of intervention strategies responding to instances of food insecurity. It has been considered that even if the aim of the programme is a simple nutrition transfer, the context in which the initiative is to be implemented can make a difference. The relevance of contextual factors, particularly local market prices, in affecting the choice between cash-based and commodity-based strategies has been examined. While on general grounds, other contextual factors such as physical security, market stability, urgency of response, and others, are critical issues to be taken into account when comparing response options, they have not been included in the present analysis, which mainly focuses on the relevance of local prices for the cost-efficiency of interventions. The assumption that decision makers substitute between types of food assistance is at the base of a conceptual framework where the use of the isocost and isoquant functions has been presented as a way to strengthen the comparative analysis of feasible options. It has been shown that this analytical set-up allows for definition of the conditions of comparative advantage for each strategy and shows how such conditions vary according to some contextual variables. The estimation of comparative advantage associated with different strategies and the simulation of possible scenarios can provide major support for both planning and monitoring. Therefore, the proposed analytical approach is seen as a contribution to the economics of food assistance through the application of the classical production function theory from the microeconomics framework. While the analytical approach proposed mainly reflects a cost-efficiency perspective, how it can be adapted to incorporate an effectiveness perspective has also been examined. Since estimation of the value added in terms of total effectiveness associated with a marginal increase in unit cost of the intervention is not feasible, the proposed approach allows estimation, *ceteris paribus*, of the differential cost associated with the strategy which is considered, *a priori*, more effective than the other considered. In this case, the choice of the strategy is based on a wider perspective in which the aim of the intervention remains the same but the analysis manages to take into account relevant by-products in either a positive or a negative way.

An application of the proposed comparative approach has been presented, focusing on the choice between a commodity-based and a cash-based intervention strategy in arid and semi-arid areas in Kenya, which are chronically prone to food insecurity and dependent on food trade. The role played by local market prices in affecting the cost-efficiency of cash-based interventions, and therefore their critical role in the selection of intervention strategy has been considered. While on average a cash-based approach appears slightly more efficient than a commodity-based one on the basis of average prices, that is no longer the case in most remote and vulnerable areas, where the high prices drastically reduce the transfer value of cash interventions.

Furthermore, the presence of high prices needs to be taken into account when considering the appropriateness of a cash-based strategy, in view of its likely inflationary consequences. At the same time, the option of reliance on food aid may have disincentive effects which may discourage economic growth in the district in the long run. Under such perspective, the consideration of secondary objectives of the intervention has led to the estimation of shadow unit costs.

Finally, the simulation of possible price rises has allowed the estimation of strategy switch points.

While the proposed analytical framework is focused on a supply perspective aimed at the optimization of aid efficiency, it also takes into a certain account aid recipients' utility. The proposed framework can be expanded towards a more balanced supply-demand approach through the inclusion of household utility function; however this goes beyond the purposes of this paper and is recommended for further research.

Acknowledgments:

The authors gratefully acknowledge the valuable contribution received from Bereket Kebede and the comments on an earlier version received from Stephen Devereux and Pieter Serneels and from two unknown referees. All remaining errors are the responsibility of the authors.

References

Abbott, P. C., C. Hurt, and W. E. Tyner. 2011. *What's Driving Food Prices in 2011? Issue Report*. Farm Foundation. Oak Brook, IL.

De Matteis, A. 2014. Preferred Form of Food Assistance in Remote Resource-Poor Areas: the Case of Arid Lands in Kenya. *Journal of Development Effectiveness* 6(2): 167–195.

Dreze, J. and A. Sen. 1989. *Hunger and Public Action*. Clarendon Press. Oxford.

FAO (Food and Agriculture Organization). 2009. *The State of Food Insecurity in the World. Economic Crises: Impacts and Lessons Learned.* FAO. Rome.

Felipe, J. and F.G. Adams. 2005. "A Theory of Production". The Estimation of The Cobb-Douglas Function: A Retrospective View. *Eastern Economic Journal* 31(3): 427–445.

Frize, J. 2002. *Review of Cash for Work Component of the Drought Recovery Programme in Turkana and Wajir Districts*. Oxfam. Nairobi.

Harvey, P. and J. Lind. 2005. Dependency and Humanitarian Relief. A Critical Analysis. *HPG Report* 19. ODI. London.

Lentz, E.C., C.B.Barrett, M.I Gomez and D.G. Maxwell. 2013. On The Choice and Impacts of Innovative International Food Assistance Instruments. *World Development* 49: 1–8.

Lentz, E.C., S. Passarelli, and C.B. Barrett. 2013. The Timeliness and Cost-Effectiveness of the Local and Regional Procurement of Food Aid. *World Development* 49: 9–18.

Margolies, A. and J. Hoddinott. 2015. Costing Alternative Transfer Modalities. *Journal of Development Effectiveness* 7(1): 1–16.

Maxwell, D.G., J.W. Parker, and H.C. Stobaugh. 2013. What Drives Program Choice in Food Security Crises? Examining the "Response Analysis" Question. *World Development* 49: 68–79.

NAO (National Audit Office). 2011. *Department for International Development: Transferring Cash and Assets to the Poor*. National Audit Office. London.

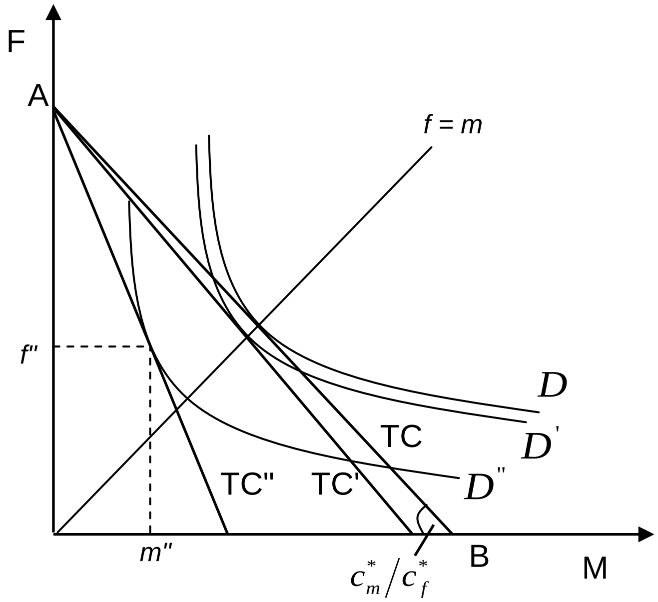
Piesse, J., and C. Thirtle. 2009. Three Bubbles and a Panic: An Explanatory Review of Recent Food Commodity Price Events. *Food Policy* 34: 119–129.

WFP (World Food Programme). 2011. *Budget Increases to Protracted Relief and Recovery Operations: Kenya PRRO 106660*. WFP. Rome.

World Bank. 2011. *Food Price Watch: August*. The World Bank. Washington, DC.

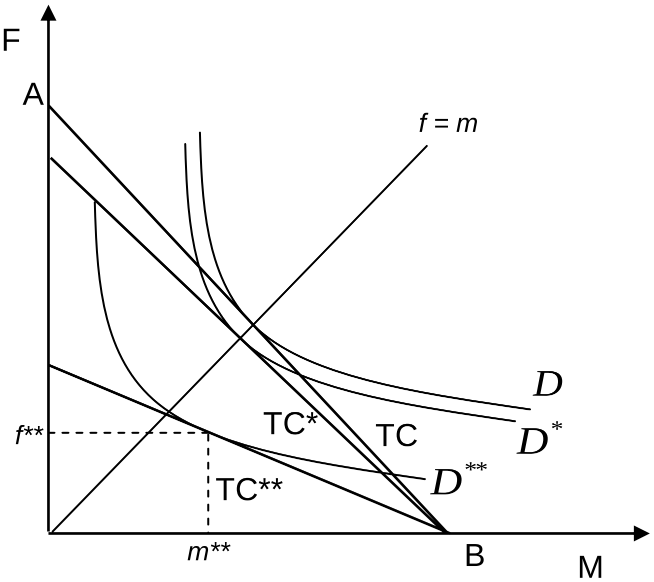
Zant, W. 2012. The Economics of Food Aid under Subsistence Farming with an Application to Malawi. *Food Policy* 37: 124–141.

Figure 1 **A direct increase in relative prices P_g / P_l determines a direct impact in relative costs**



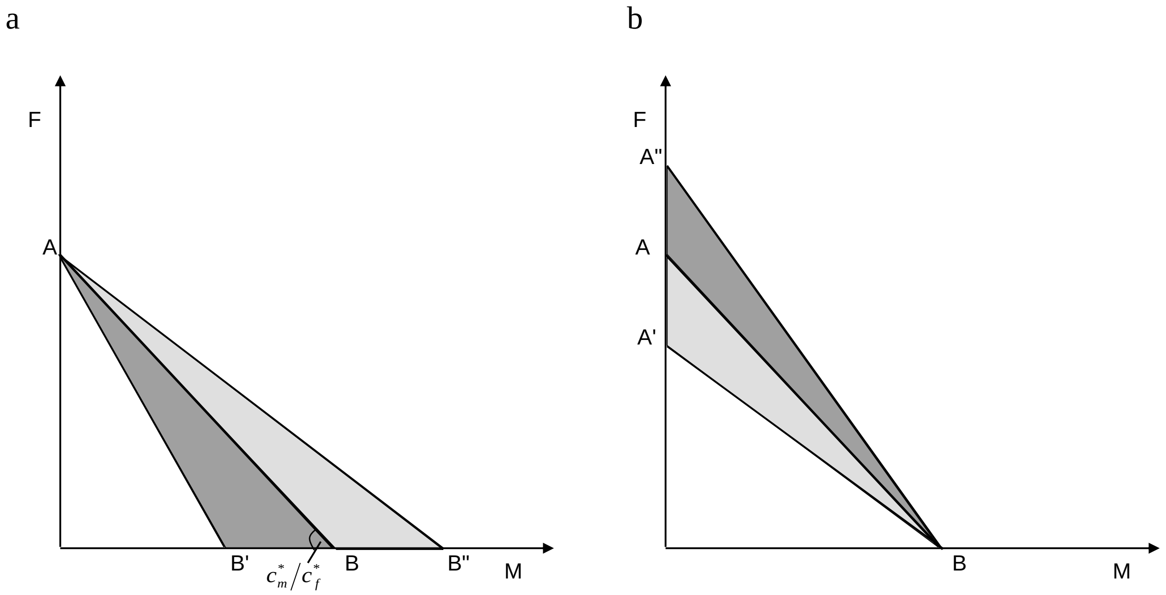
Source: Author

Figure 2 Accounting for any eventual monetization of food aid



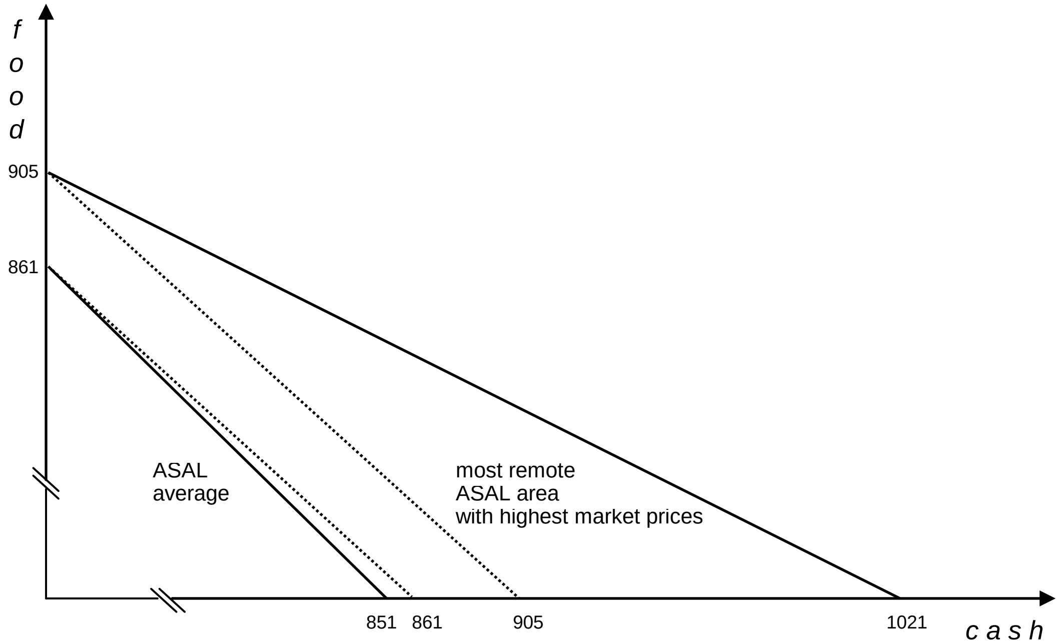
Source: Author

Figure 3 Areas of relative advantage



Source: Author

Figure 4 Preferential advantage of cash-based versus commodity-based strategies



Source: Author

Table 1 Unit costs

	average ASAL		most remote ASAL area with highest market prices	
	USD per 1,000 kcal	USD per MT of cereal equivalent	USD per 1,000 kcal	USD per MT of cereal equivalent
PRRO	0.261	861	0.274	905
HSNP	0.258	851	0.309	1021

Source: Author's elaboration of data from WFP and NAO

Table 2 Unit cost of various combinations of cash-based and commodity-based strategies

	program share (%)		local price increase: unit cost (USD / MT)											
			0%		1%		2%		3%		4%		5%	
	food	cash	average	increment to zero-cash	average	increment to zero-cash	average	increment to zero-cash	average	increment to zero-cash	average	increment to zero-cash	average	increment to zero-cash
ASAL average	100	0	861.0	0.0	861.0	0.0	861.0	0.0	861.0	0.0	861.0	0.0	861.0	0.0
	75	25	858.5	-2.5	860.6	-0.4	862.8	1.8	864.9	3.9	867.0	6.0	869.1	8.1
	50	50	856.0	-5.0	860.3	-0.7	864.5	3.5	868.8	7.8	873.0	12.0	877.3	16.3
	25	75	853.5	-7.5	859.9	-1.1	866.3	5.3	872.6	11.6	879.0	18.0	885.4	24.4
	0	100	851.0	-10.0	859.5	-1.5	868.0	7.0	876.5	15.5	885.0	24.0	893.6	32.6
most remote ASAL area with highest prices	100	0	905.0	0.0	905.0	0.0	905.0	0.0	905.0	0.0	905.0	0.0	905.0	0.0
	75	25	934.0	29.0	936.6	31.6	939.1	34.1	941.7	36.7	944.2	39.2	946.8	41.8
	50	50	963.0	58.0	968.1	63.1	973.2	68.2	978.3	73.3	983.4	78.4	988.5	83.5
	25	75	992.0	87.0	999.7	94.7	1007.3	102.3	1015.0	110.0	1022.6	117.6	1030.3	125.3
	0	100	1021.0	116.0	1031.2	126.2	1041.4	136.4	1051.6	146.6	1061.8	156.8	1072.1	167.1

Source: Author