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Abbott, P.C. and McCarthy, F.D.

IIASA Collaborative Paper
March 1981

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Philip C. Abbott
F. Desmond McCarthy

March, 1981
CP-81-8

INTERNATIONAL INSTITUTE FOR APPLIED SYSTEMS ANALYSIS
A-2361 Laxenburg, Austria

PREFACE

The aid given to some developing countries often has conditions attached. This is particularly true in the case of food aid. These conditions are often referred to in the literature as tied aid. This paper analyses various tying techniques. It estimates the type of losses which ensue and some of the strategies that may be adopted by the recipients.

The Welfare Costs of Tied Food Aid

by

Philip C. Abbott and F. Desmond McCarthy

It is now generally understood that aid-tying, whether by source or project, imposes an excess cost when the tying is effective.1/ However, the analysis of such restrictions has not been integrated into a general equilibrium framework in the developmental literature. Hence, it is insufficiently appreciated that the problem of assessing the benefits (and possibly losses) from the receipt of tied aid is essentially one of constrained maximization.2/

The inadequacy is particularly evident in the analysis of P.L. 480 aid. The classic articles by Schultz (1960) and Fisher (1963) focussed exclusively on the impact of P.L. 480 aid on domestic food production. On the other hand, even if such an effect were present, the welfare impact of the receipt of food aid could be positive. It is the purpose of this note to develop the analysis of the latter question systematically.

In doing this, we note that P.L. 480 aid comes to a country not entirely as a grant. The constraints posed by the food aid (vis-a-vis

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Philip C. Abbott is with the Department of Economics, Northeastern University, F. Desmond McCarthy is with the International Institute for Applied Systems Analysis, Laxenburg, Austria. The authors wish to acknowledge the helpful suggestions of Professors J.N. Bhagwati and L. Taylor of M.I.T.

1/ For the project-tying, see Singer (1965), for source tying see Haq (1965) and Bhagwati (1968).

2/ However, the general equilibrium approach has earlier been developed in the trade-theoretic, as distinct from the developmental literature, by Bhagwati (1968).

cash aid) may relate to domestic consumption or production or imports -- and that the loss resulting from meeting such constraints may not be the minimal one, since second-best policies may be utilized to meet the constraints.

We utilize the usual trade-theoretic model, which assumes two tradables (one being food) and fixed international policies, with the food aid then constituting a "transfer" receipt. The key difference from standard trade-theoretic analysis is that the post-transfer equilibrium must reflect the <u>additional</u> constraints that P.L. 480 aid legislation may require.[3/]

While each constraint will be treated diagrammatically, we also analyze it algebraically. The notation used for the latter will be as follows:

C_i	:	Domestic consumption of good_i, $i = 1,2$
Y_i	:	Domestic production of good_i, $i = 1,2$
A	:	Aid received, in the form of good 1
p	:	World Market Price of good 1 denominated in terms of good 2
$U(C_1, C_2)$	:	Social Utility Function
$F(Y_1, Y_2)$	:	Production Possibility Frontier
$1 - \alpha$	:	Grant component of aid.

Hence, there are two goods in this world, the aid good 1 (food) and all

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3/ The usual transfer problem analysis, of course, is also of interest when the terms of trade can vary. By contrast, we are assuming here that the terms of trade are fixed, since aid recipients generally meet the requirements of the small country assumption.

other goods. It is assumed that U (C_1, C_2) and F (Y_1, Y_2) satisfy conditions for differentialbility as required, and U_i and F_i denote partial derivatives with respect to C_i and Y_i, respectively. Throughout the analysis non-specialization in consumption and production will be assumed, and trade is allowed, except when specific constraints are introduced. We will therefore be concerned only with interior maxima.

I. Consumption Constraint

It is assumed that prior to receiving aid, the recipient country, a small open economy,[4/] maximizes its social utility U and this results in a level of consumption $\overline{C}_1$ for the aid good. After receiving aid, the consumption level of good 1 is constrained to be $C_1 = \overline{C}_1 + A$. (This is the constraint of "additionality" which is often thought to be applied in US P.L. 480 donations.) In addition, the country now seeks to maximize U subject to this constraint and also the production and foreign exchange constraints. The problem faced by this country can, therefore, be specified as follows:

$\text{Max } U\ (C_1, C_2)$	Social Utility
$\text{s.t. } F\ (Y_1, Y_2) = 0$	Production Possibility Frontier
$p \cdot \left[C_1 - (1 - \alpha)A - Y_1\right] + C_2 - Y_2 = 0$	Foreign Exchange Constant
$C_1 = \overline{C}_1 + A$	Additionality Constraint

A geometric interpretation of the problem is given in Fig. 1.

4/ This implies that its behavior does not effect p, the world price of good 1.

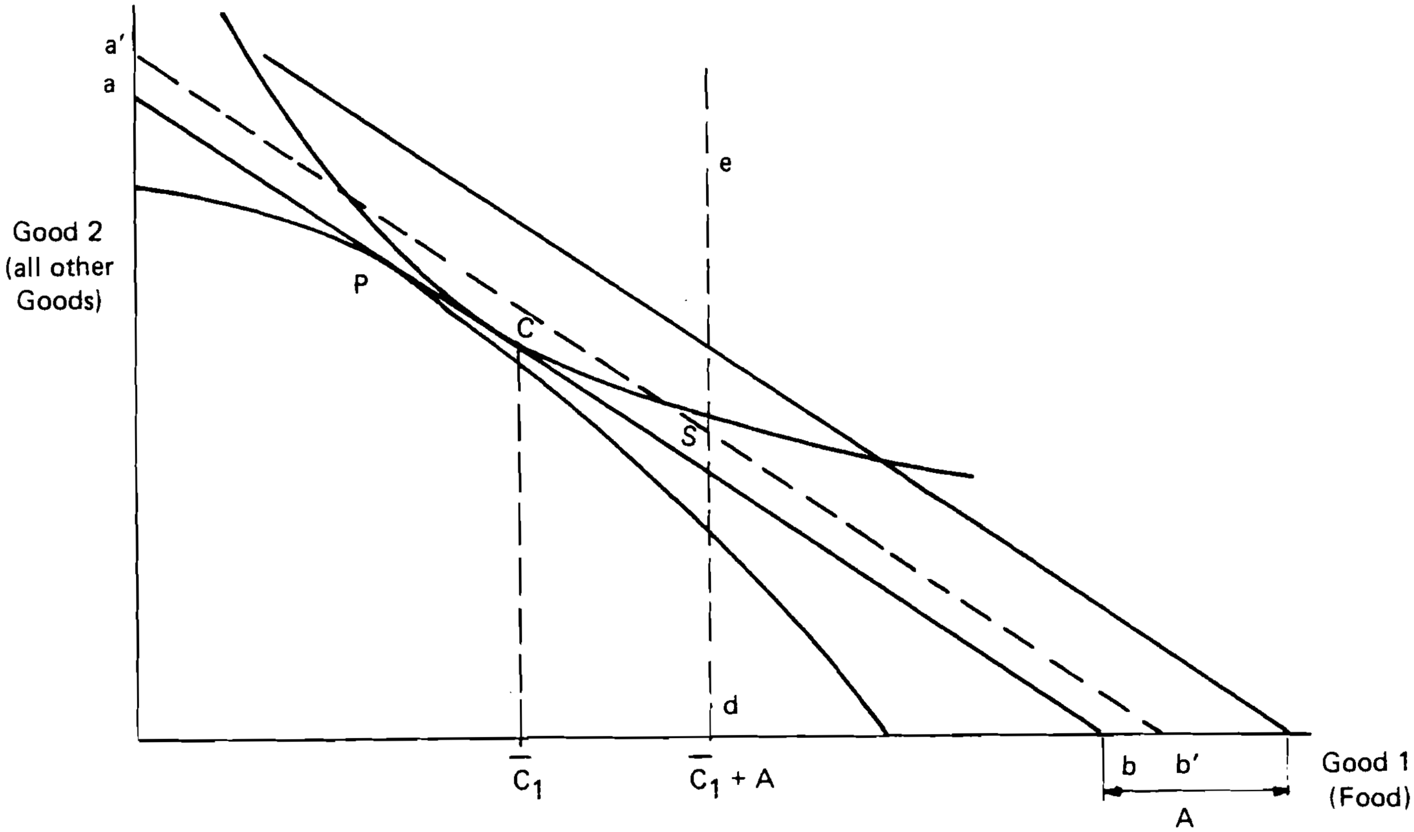

Figure 1. Consumption Constraint on Aid Recipient

Initial production is at P and consumption at C, giving maximum utility U_1. After the influx of aid the grant component moves the foreign exchange constraint to a'b' yielding the primary gain. If one now imposes the additionality constraint $C_1 = \overline{C}_1 + A$ then a solution must also lie on the line ed. The optimum outcome for the case illustrated (with $\alpha > 0$) is at s where the utility is below pre-aid level U_1. A primary gain moves ab to a'b' and then the concommitant loss occurs due to the binding consumption distortion. It is evident that if the consumption constraint were not binding a gain would result; as a'b' passes above U_1 for some portion of that curve. It should also be noted that the outward shift of the budget constraint a'b' is determined by α . If $\alpha = 0$, a'b' shifts by an amount A, and so C_2^1 equals C_2 prior to the aid transfer. In that case, no loss occurs. If α exceeds 0, however, then a'b' shifts out by an amount less than A, so that C_2 is reduced and a loss in utility may result. In the extreme case where $\alpha = 1$, then ab does not shift, and a loss is obvious.

The optimum solution under the consumption additionality constraint may also be obtained analytically. The change in social utility, du, obtained is given by:

$$dU = U_1 d\, C_1 = U_2 \left[- pdC_1 + (1 - \alpha)\ pdA \right]$$

(see appendix 1 for the derivation ; the case where the additionality constraint is not binding is also treated there)

If the additionality constraint is binding, then it follows that $dC_1 = dA$. Production is kept at the optimum by maintaining the pre-aid prices to the producer. A consumption tax cum subsidy is required to insure consumption at s (Fig. 1.). The change in U is given by:

$$dU = U_1 dA - \alpha pU_2 dA$$

also:

$$U_1 = pU_2 - \lambda_3$$

so that:

$$dU = ((1 - \alpha) pU_2 - \lambda_3) dA$$

where λ_3 can be thought of as the shadow price of the additionality constraint. Since C_1 is fixed, the other constraints and first order conditions also fix C_2. U_1 and U_2 are evaluated at this point, where $U = U(\overline{C}_1 + A, C_2)$. Note that when the additionality constraint did not apply, optimality conditions required that the country always gain. The constrained solution, however, allows $U_2 > U_1/p$ which is why the country may lose. One should note that in Fig. 1, the social utility function is no longer tangent to the budget constraint (line a'b') at point s, the constrained outcome.

Some observations are relevant at this juncture. The above conditions imply that if a country is following optimal production policy, price to farmers <u>will not equal</u> prices to consumers. This occurs because of the presence of a free resource - the food aid. This is then allocated between farmers and consumers by appropriate prices to each. The aid inflow will be used to subsidize lower food prices to consumers (and in effect, higher food prices to producers than would otherwise obtain). Hence, the constraints considered here do not necessarily impose the

Schultzian disincentive effect. Hence, if appropriate policy is followed there will not be any change in domestic production. By use of an appropriate wedge, incentive to produce is not reduced, since the producer faces the same (pre-aid) relative prices. Thus, a consumption externality is best handled by a consumption policy of tax and subsidy.

II. Production Constraint:

It is assumed here that the recipient is required by the aid donor to produce an additional amount of the aid good 1 equal to βA above the pre-aid level of $\overline{Y}_1$. The problem may be stated as follows:

$\text{Max } U(C_1, C_2)$	Social Utility
$\text{s.t. } F(Y_1, Y_2) = 0$	Production Possibility Frontier
$p\,[C_1 - (1 - \alpha)A - Y_1) + C_2 - Y_2 = 0$	Foreign Exchange Constraint
$Y = \overline{Y} + \beta A$	Production Constraint

Again a geometric interpretation is shown in Fig. 2. Before aid one is constrained by the world market to ab with aid good production at $\overline{Y}_1$. If production of good 1 is now forced to $\overline{Y}_1 + \beta A$ the resulting foreign exchange constraint is a b. The primary gain from the aid will move a'b' out by an amount $(1 - \alpha)A$ to a' b'. One should also note that a country constrained to produce at the same level as before receipt of the aid (i.e., $\beta = 0$) will always gain from the aid inflow, though the value of that aid is reduced by the effects of the constraint.

Also, if the aid is all grant, then a country will gain once β is less than unity. For this constraint the domestic food production (good 1) increases. The optimum (second best) policy requires a <u>producer</u> tax cum subsidy. Such changes in production require advance notice of the aid availability, however.

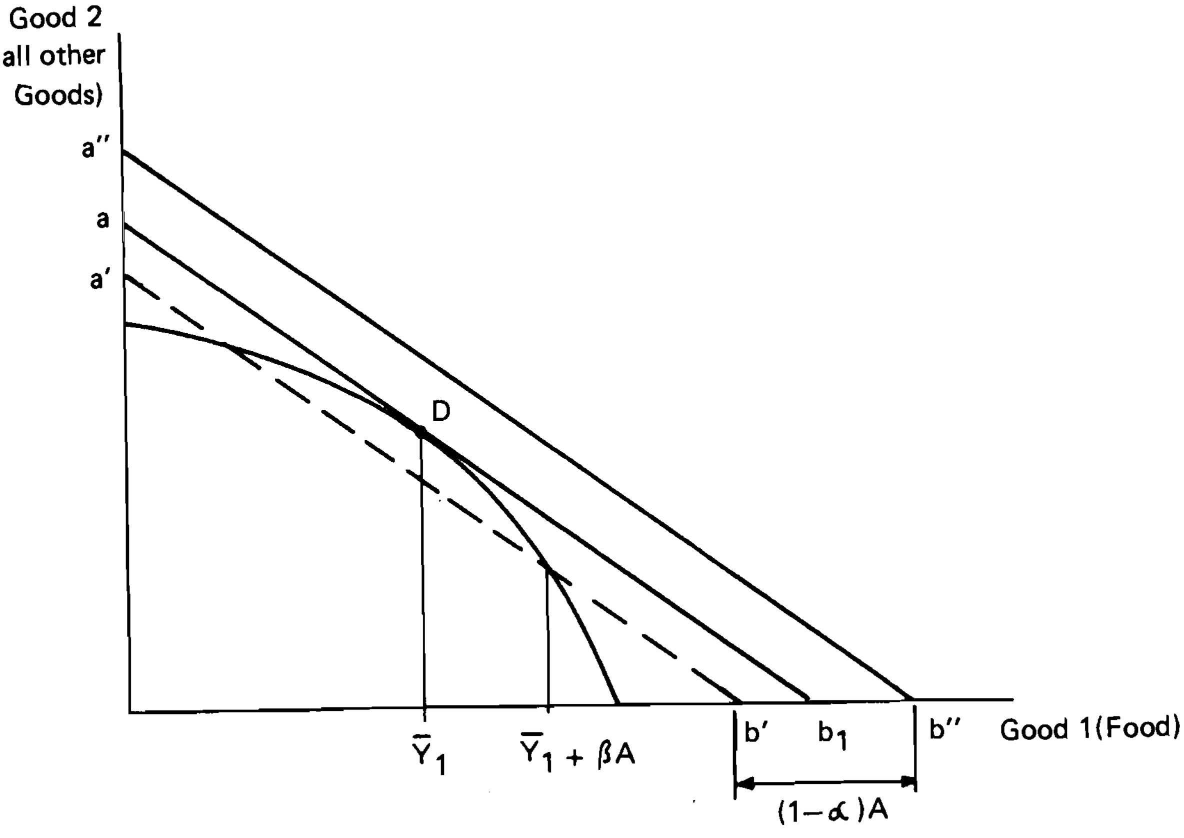

Figure 2. Production Constraint

III. <u>Import Constraint</u>

In this instance the country is required to import some given amount of food. This may arise where business interests in the donor country seek to insist on the recipients of their commercial imports continuing those commercial imports or at least some specified fraction of the pre-aid level of commercial imports. The problem may be stated:

$\text{Max } U(C_1, C_2)$	Social Utility
$\text{s.t. } F(Y_1, Y_2) = 0$	Production Possibility Frontier
$P(C_1 - Y_1) + C_2 - Y_2 = 0$	Foreign Exchange Constraint
$C_1 - Y_1 = \gamma(\bar{C}_1 - \bar{Y}_1) + A$	Import Constraint

The mathematical solution obtained follows along similar lines to I and II. (See appendix 3 for details.) Results again indicate that constraints come with a cost, and a severe enough constraint may induce a loss from the receipt of tied aid.

A similar problem has been analyzed by Bhagwati (1968) for the case $\gamma = 1$. This is shown in Fig. 3 and it illustrates the points outlined in Appendix 3. Initial production and consumption are at Y_1 and C_1 giving utility U^1. For food aid A and no constraints consumption is at C_1 giving U^2. If the recipient is now constrained to imports at the pre-aid level ($\gamma = 1$) in addition to the aid A then one possible solution is to consume at C_1 yielding utility U^1. This may be realized by a consumption tax cum subsidy. This would, however, be an inefficient policy. The recipient could also satisfy the constraint and do better if consumption were at C_1^* yielding U^*. To achieve this level, U^* (higher than U^1)

requires producing at Y_1^*.

Thus, to achieve the optimum solution (under the imposed pattern of trade), the recipient is obliged to interfere in both consumption and production markets. This requires a production tax cum subsidy to drive production to Y_1^*, lowering the relative food price to the producer together with a consumption tax cum subsidy to drive consumption to C_1^* (assuming that the associated U^* is the maximum that can be achieved).

The two taxes should be equal for a lowest cost solution. This point was not highlighted by Bhagwati. Analytical details are given in Appendix 3. It is noted in this instance that the import constraint results in the recipient producing less food domestically than in the pre-aid situation by making food production less attractive. Hence, the Schultzian, disincentive effect is operating in this case.

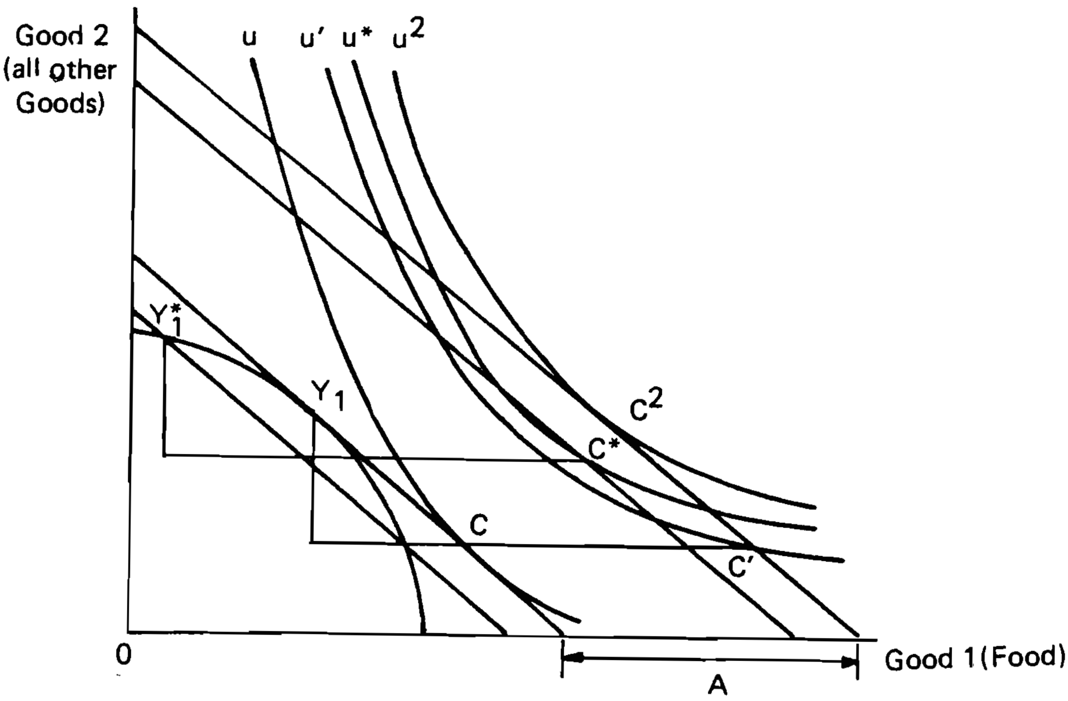

Figure 3. Import Constraint on Aid Recipient

IV. Distributional Effects

In this section the model is modified to analyze the effects on a country's welfare when all individuals within the country are not the same. In order to focus on this aspect of the problem it is assumed that the country consumes all the output and also any aid. The usual caveats about normative utility functions apply.

The analysis of the effects is based on a model of a country with two classes of worker. The L_1 members of the first produce only food (Good 1) while the L_2 members of the other produce only machines (Good 2). These may be typically rural and urban populations. Each class, i, consumes both goods. Individuals have utility functions $U^i\ (C_{1i}, C_{2i})$, $i = 1,2$ where C_{ji} is the quantity of food j consumed by a member of class i and $C_j = C_{j1} + C_{j2}$, $j = 1,2$. The production functions are assumed to have the form:

$$Y_j = F_j(L_j) \qquad j = 1,2$$

with the usual properties. A social utility function U for the country is assumed of the form:

$$U = L_1U^1(C_{11}, C_{21}) + L_2U^2(C_{12}, C_{22})$$

Before food aid arrives it is assumed that a general equilibrium exists with all markets in equilibrium and all income consumed.

Let a quantity dA of food aid arrive in the country; the question of how it is distributed is discussed later. It is assumed that structural rigidity of the economy is such that workers cannot change from prdoucing one good to another so that the physical output of goods remains the same. (This distortion is necessary to make commodity tying of the aid important. Otherwise, shifts of labor between occupations will mitigate the redistributive effects of the aid transfer). However, the money wage of workers in food will typically fall, in effect reducing their ability to trade for other goods. It is assumed that all face the same price for food p, with the price for machines being 1.

The change in utility for a member of class i is given by

$$dU^i = U_1^i \, dC_{1i} + U_2^i \, dC_{2i} \qquad i = 1,2$$

$$= U_2^i \, (pdC_{1i} + dC_{2i})$$

where

$$U_j^i = \frac{\partial U^i}{\partial C_j}$$

The change in utility for the country is given by:

$$dU = L_1 dU^1 + L_2 dU^2$$

It is of interest to examine when du may be negative (i.e., the aid induces a net loss in social utility). (The details are given in Appendix 4.)

The analysis suggests that sufficient conditions to produce a net loss in social utility are:

(a) The distribution of food aid to the food producing class does not outweigh its loss in marketed surplus.

(b) The marginal utility of food (machines) of the food producers is sufficiently higher than that of the machine producers.

(c) Factor markets are rigid so that food producers will not shift to producing machines.

The typical situation where one might anticipate such a result would be a country receiving food aid when a large segment of its population is involved in agriculture.

The optimum (second best) policy in this instance necessitates a redistributive mechanism. This would require different consumption and production tax cum subsidy for each class.

V. Conclusions

The analyses of constraints placed on US P.L. 480 food aid presented here have shown that the value of that aid to a recipient country can be sharply reduced and may in fact result in a net loss if that aid is accompanied by sufficiently severe constraints.

The results are summarized in Table 1 for the particular models discussed. In addition, if the aid causes sharp redistributional effects, then the net social utility of an aid receiving country may also decrease. These results follow from the effects of distortions in allocations of resources in the receiving country as a result of the constraint which accompanies the aid.

Further, it is also important to realize that a recipient may meet these constraints in a number of ways, and for each situation there is an optimum (second best) policy. The departure from unified exchange rates requires active government participation to minimize the loss.

The lessons from US food aid, which was considered explicitly here, can be easily extended to other forms of aid which come with strings attached. Hence, one should not assume that aid with conditions attached will benefit a recipient, and even if there is benefit, the real value of the aid to a recipient may well be less than its nominal value.

Table 1.

SUMMARY OF EFFECTS ON RECIPIENT OF AID WITH CONSTRAINTS ATTACHED OR WHEN MALDISTRIBUTION EXISTS (4)

Cause of Loss	Optimum (second best) Policy	Can net loss occur if aid is all grant?	Post Aid Domestic food production
1. Consumption Additionality $C_1 = \bar{C}_1 + A$	Consumption Tax cum subsidy	NO	Unchanged
2. Domestic Production Increase $Y_1 = \bar{Y}_1 + \beta A$	Production Tax cum subsidy	YES if $\beta < 1 - \alpha$	Increase
3. Import Level Maintenance $C_1 = \gamma(\bar{C}_1 - \bar{Y}_1) +$ [illegible] A	Equal Consumption and Production tax cum subsidy	NO	Decrease
4. Maldistribution of purchasing power	Different Consumption and Production tax cum subsidy for each class	YES	Unchanged (short-run)

*Note: for 1,2 and 3 it is assumed that no distribution problems exist.

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Appendix 1 Optimum policy for an aid recipient under a consumption addition constraint

Consider Lagrangian multipliers λ_i i= 1,2,3 for these constraints, the problem becomes:

$$\text{Max } U(C_1, C_2) + \lambda_1 F(Y_1, Y_2) + \lambda_2[p(C_1 - (1-\alpha)A - Y_1) + C_2 - Y_2]$$
$$+ \lambda_3(C_1 - \bar{C}_1 - A)$$

First order conditions for this problem are:

$$U_1 + \lambda_2 p + \lambda_3 = 0$$

$$U_2 + \lambda_2 = 0$$

$$\lambda_1 F_1 - \lambda_2 p = 0$$

$$\lambda_1 F_1 - \lambda_2 = 0$$

plus the original constraints

Using these four conditions together with the three constraint conditions, one may evaluate the seven unknowns: C_1, C_2, Y_1, Y_2, λ_1, λ_2, λ_3.

The change of U

$$dU = U_1 dC_1 + U_2 dC_2$$

Note also that:

$$dC_2 = -pdC_1 + (1 - \alpha) pdA + pdY_1 + dY_2$$

$$F_1 dY_1 + F_2 dY_2 = 0$$

$$p = F_1/F_2$$

$$dU = U_1 dC_1 + U \left[-pdC_1 + (1 - \alpha) pdA \right]$$

It is now of interest to analyze the various possiblities. If the "additionality" constraint is not binding then for a maximum U one has $\lambda_3 = 0$ and so $U_1 = U_2$. This yields:

$$\frac{dU}{dA} = (1 - \alpha) U_1$$

In this instance a country always gains by accepting aid ($0 \leq \alpha < 1$). Hence, the requirement that some of an aid good be paid for cannot, by itself, induce a loss in this instance.

Appendix 2. Optimum Policy for an aid recipient under a production Constraint.

For this instance the problem is:

$$\text{Max } U(C_1, C_2) + \lambda_1 F(Y_1, Y_2) + \lambda_2(p(C_1 - (1 - \alpha)A - Y_1 + C_2)$$

$$+ \lambda_3 (Y_1 - (\bar{Y}_1 + \beta A))$$

First order conditions from the analytic formulation are:

$$U_1 + \lambda_2 p = 0$$

$$U_2 + \lambda_2 = 0$$

$$\lambda_1 F_1 - \lambda_2 p + \lambda_3 = 0$$

$$\lambda_1 F_2 - \lambda_2 = 0$$

plus the original constraints.

Change in utility is given by;

$$dU = U_1\, dC_1 + U_2\, dC_2$$

Noting that:

$$dC_2 = -p dC_1 + (1 - \alpha)\, p dA + p dY_1 + dY_2$$

one may evaluate the various subcases.

If the constraint on production is not binding, then

$$\lambda_3 = 0,\ F_1 = pF_2 \text{ and } U_1 = pU_2$$

This yields:

$$\frac{dU}{dA} = (1 - \alpha)\, U_1$$

as before.

That is, production is allowed to remain at point D in Figure 2, which is the optimum point, so that the primary gain from aid will be all that occurs.

If constraint is binding, however, then $p = U_1/U_2$ and dU becomes

$$dU = ((1 - \alpha)\, p dA + p dY_1 + dY_2) U_2$$

also

$$F_1/F_2 = p - \frac{\lambda_3}{\lambda_1 F_2} = p\,(1 + \delta)$$

and

$$\frac{dY_2}{dY_1} = \frac{-F_1}{F_2}$$

This yields

$$dU = U_1 \left[(1 - \alpha) \, pdA - \delta\beta \, dA\right.$$

Note that for $\alpha = 1$ (all 'aid' paid for) $dU < 0$. This is simply that a binding production constraint will produce a loss, since it moves the recipient from the optimal prodcution point D.

For $\alpha = 0$, (no payment for aid) gain (loss) requires $p - \delta\beta$ to be positive (negative). This says that a recipient of completely "free" aid may incur a loss if that aid is tied to a sufficiently restrictive production constraint.

Appendix 3 Optimum Policy for an aid Recipient under an Import Constraint

In this instance, the problem faced by the recipient country is:

$$\text{Max } U(C_1, C_2) + \lambda_1 F(Y_1, Y_2) + \lambda_2(p(C_1 - (1-\alpha)A - Y_1) + C_2 - Y_2)$$
$$+ \lambda_3 \, (C_1 - Y_1 - \gamma(\bar{C}_1 - \bar{Y}_1) + A)$$

First order conditions for this problem are:

$$U_1 + \lambda_2 p + \lambda_3 = 0$$

$$U_2 + \lambda_2 = 0$$

$$\lambda_1 F_1 - \lambda_2 p - \lambda_3 = 0$$

$$\lambda_1 F_2 - \lambda_2 = 0$$

plus the original constraints. Using these conditions, one may evaluate the seven unknowns: C_1, C_2, Y_1, Y_2, λ_1, λ_2, and λ_3.

Since the change in utility is given by

$$dU = U_1 dC_1 + U_2 dC_2$$

and, from the above conditions:

$$F_1/F_2 - p = \frac{\lambda_3}{U_2}$$

$$U_1/U_2 - p = \frac{-\lambda_3}{U_2}$$

Note that for an optimum (lowest cost) solution production and world prices should be separated by an amount $\frac{\lambda_3}{U_2}$ while consumption and world prices should be separated by $\frac{-\lambda_3}{U_2}$. This tax package together with an appropriate subsidy yields the optimum (second best) solution.

$$\frac{dU}{U_2} = [(\frac{U_1}{U_2}) - p)dY_1] + (1 - \alpha)pdA + (p - \frac{F_1}{F_2}) \; dY_1$$

Once again, if the constraint is not binding, $\lambda_3 = 0$ and $\frac{dU}{dA}$ reduces to $\frac{dU}{dA} = U_2(1 - \alpha)p = (1 - \alpha)U_1$

However, with the constraint, changes in production (dY) are induced, and this can counteract the primary gain from the aid. In that case:

$$\frac{dU}{U_2} = (\frac{2\lambda_3}{U_2}) \; dY_1 + (1 - \alpha)pdA$$

Again, λ_3 is interpreted as the cost of the constraint, and its value can be calculated from the first order conditions discussed earlier. Those conditions and, hence, the constraint, also imply a relationship between dA (the aid inflow) and dY , the induced change in production.

Appendix 4 The distribution effect for an aid recipient

In the text it is shown that the change in utility for a two class society after receiving aid is given by dU where

$$dU = L_1 dU^1 + L_2 dU^2$$

It is of interest to consider a number of cases.

Egalitarian Society

If one makes a common assumption that all members of the society have similar marginal utility (for each good) i.e.,

$$U_1^1 = U_1^2; \quad U_2^1 = U_2^2$$

then it follows that:

$$dU = U_2^1 \, [p(dC_{11}L_1 + dC_{12}L_2) + L_1 dC_{21} + L_2 dC_{22})$$

since the net increase in food consumption is dA while the net increase in machine consumption is zero one obtains:

$$dU = U_2^1 \, p dA > 0$$

Accordingly one concludes that an egalitarian society will increase its welfare by acquiring aid.

In many countries there is a sharp difference between various classes this may be viewed as a difference in marginal utility between, say, a rural food producing and an urban machine producing class. Consider this somewhat more general situation. The change in the country's utility dU is given by

$$dU = p(U_2^1 dC_{11}L_1 + U_2^2 dC_{12}L_2) + U_2^1 dC_{21}L_1 + U_2^2 dC_{21}L_2$$

Noting that:

$$dC_{11}L_1 + dC_{12}L_2 = dA \text{ and } dC_{21}L_1 + dC_{22}L_2 = 0$$

one obtains:

$$dU = L_1(U_2^1 - U_2^2)(pdC_{11} + dC_{21}) + pU_2^2 dA$$

$$= L_1(U_1^1 - U_1^2)(pdC_{11} + dC_{21}) + U_1^2 dA$$

The question is then whether dU can be negative. The second term will be positive. It remains to analyze the first term. For a typical situation $U_1^1 - U_1^2$ can be < 0. This occurs when classes have different taste but similar endowments, or similar tastes with different endowments, or both. The changes in wages (money) for members of Class 1, dU , is given by:

$$dU_1 = \Delta p \frac{\partial F_1}{\partial L_1} + f_1 pdA = (\Delta p \frac{C_1}{L_1} + pda)$$

where f_1 is the fraction of food aid given to class 1 and da is aid/capita in class 1. Since each consumes total income one also obtains (ignoring 2nd order effects);

$$\frac{1}{L_1} dU_1 = pdC_{11} + dC_{21} + C_{11}\Delta p$$

Hence,

$$p_1 dC_{11} + dC_{21} = \Delta p \frac{C1}{L_1} - C_{11}\Delta p + pda$$

$$= (\frac{C_1}{L_1} - C_{11})\Delta p + pda$$

This last term is the difference between the marketed surplus of a class one member (a loss) and the value of the food aid received (gain). Thus the net effect can be negative - and so a net welfare loss can result to class 1. If in addition $U_1^1 - U_1^2$ is sufficiently negative then one obtains the result that dU can be negative, i.e., the country as a whole loses by aid.