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How Land-Based Targeting Affects Rural Poverty

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Under ideal conditions, and not allowing for administrative costs, redistribution from land-rich to land-poor households would reduce poverty in rural Bangladesh by only a small amount. By itself, land-based redistribution would be an inadequate attack on rural poverty.

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Summary findings

Transfers to the rural land-poor are widely advocated and used in attempts to reduce rural poverty. Such transfers are believed to be productive, in that the final gain to the poor exceeds the initial transfer. The evidence cited most often to support this view is the negative correlation between output per acre and the size of the holding. In other words, small farms appear to be more productive.

There are reasons to question that evidence, however, say Ravallion and Binayak Sen. It is unclear, for example, how much differences in productivity are really attributed to unmentioned differences in land quality (someone might be given a larger plot of poor land so that a living can be made from it). Other factors also constrain the impact on poverty of land-based targeting, notably incentive constraints (whereby the "land-rich" alter their behavior to gain from the policy) and political economy constraints (whereby the land-rich undermine the policy by creating political pressure for tradeoffs).

To inform the debate, Ravallion and Sen quantify the *potential* gains from land-based targeting under seemingly ideal conditions, incorporating only a limited set of constraints on such a policy. Their aim is to quantify gains to the poor from a benchmark policy designed to characterize the probable upper-bound on real-world outcomes.

A key constraint on such schemes is that targeting is done on the basis of landholding class alone. Ignoring productivity differentials, the relevant indicator in making transfers is a suitably defined poverty measure for each landholding class.

The more general formulation Ravallion and Sen offer calls for two indicators: the marginal productivity of transfers (assumed to be proportional to current output per acre on owned land) and a poverty measure (derived from a standard poverty profile).

After applying this approach to new data for rural Bangladesh, they find that landholding class is a relevant indicator for targeting. Under ideal conditions, redistribution from land-rich to land-poor households will reduce aggregate poverty in rural Bangladesh (even without productivity effects). And transfers from an external budget would have the greatest impact on poverty if they were concentrated on landless, marginal farmers. Moreover, productivity effects (consistent with the relationship between farm size and productivity in Bangladesh) imply an additional impact on rural poverty when transfers are made from land-rich to land-poor households.

But the gains are modest, even if one postulates virtually unheard-of powers of redistribution across landholding classes. Depending on the initial conditions of agricultural technology, and the relative productivity effects among the landless, they estimate that the *maximum* impact on rural poverty from land-based targeting under revenue neutrality is equivalent to a uniform lump-sum transfer of between Tk 10 and Tk 20 per person per month — or between 2.5 percent and 5 percent of rural mean consumption.

This is under ideal circumstances, putting aside the constraints mentioned, and with no consideration for administrative costs. Real-world circumstances will entail even less impact on poverty. One must hope, for the sake of Bangladesh's poor, that targeting the land-poor with such redistribution is not all that is done to attack rural poverty.

This paper — a product of the Poverty and Human Resources Division, Policy Research Department — is part of a larger effort in the department to provide policymakers with better information on the likely benefits to the poor from targeted schemes for fighting poverty. Copies of the paper are available free from the World Bank, 1818 H Street NW, Washington, DC 20433. Please contact Patricia Cook, room N5-057, extension 33902 (34 pages). March 1994.

Impacts on Rural Poverty of Land-Based Targeting

Martin Ravallion and Binayak Sen

Contents

1 Introduction

Landholding class has been a widely advocated indicator for targeting transfers aimed at reducing rural poverty in circumstances in which living standards cannot be observed directly without incurring prohibitive administrative costs. Examples range from land-reform to cash or food hand-outs to the landless.

What are the key questions to address in evaluating such proposals? A number of observations can be made:

i) Leakage to the non-poor, and imperfect coverage of the poor, are surely inevitable in such a policy; not all of the rural poor in a country such as Bangladesh are landless, and there are poor amongst those with ample land. Lack of land and poverty are not perfectly correlated. This fact will dampen the poverty impact. The extent to which it does so will depend in part on how fine is the partition of landholding classes; policies found in practice typically identify only a few classes ("landless", "medium", "large") and so imperfect targeting is to be expected.

ii) There will surely be behavioral responses to land-based redistribution; households with larger holdings will simply sell, or hide, their holdings if the transfers demanded are large enough. These incentive constraints will almost certainly reduce the gains to the poor from such policies.

iii) The political process may also be used by those with large landholdings, or their representatives, to counteract such policies, such as by compensatory changes in other public spending or taxes, or simply by "bending the rules" in the policy's implementation. It is difficult to predict such responses, as they will be highly contingent on the balance of power in quite particular circumstances. However, the most likely presumption is that these political-economy constraints will - if anything - reduce the impacts on poverty of land-based redistribution.

iv) While all three of the above considerations will diminish likely gains to the poor, other factors can be identified which may actually enhance them. It has been argued by supporters of such policies that transfers from the land-rich to the land-poor will have positive productivity effects. The main evidence cited for this is the claim that land productivity (output per acre) declines with farm size.[1] Pointing to evidence of higher productivity on small farms, it has often been argued that land-based redistributions (for example, directly transferring land from the land-rich to the land-poor) can yield sizable pro-poor productivity effects (see, for example, Dorner, 1972).

The last point is contentious. The transfers (even if made in the form of land) may not be used as land, but sold for other purposes; the farm-size productivity relationship may then be a misleading guide to the productivity effects, if any. But even aside from this problem, it has been argued that this relationship may actually be spurious, reflecting differences in soil quality (Sen, 1975; Bhalla and Roy, 1988); for example, in the inter-generational process of land fragmentation, poorer quality land may be handed down in larger holdings so that households can make an adequate living from that land. Nonetheless, there are other explanations for the relationship which are consistent with the claim that redistribution will have positive productivity effects, based on the claimed existence of rural market failures, particularly concerning farm inputs; credit is rationed, and family labor (for both farm work and the supervision of hired labor) is not a traded commodity, so that its opportunity cost may be well below the wage rate for hired labor, as is generally presumed to be the case.[2] Only for the large farms do these constraints not bite. However, for medium and small farmers, there will be potential gains from using the transfer to help relax the constraints arising from the missing or imperfect input markets. More land could be acquired, or more spent on irrigation and modern seed varieties (which would otherwise require access to credit), thus bringing input proportions closer to their efficient levels. In our view, these arguments are not yet to a point of being sufficiently well resolved empirically to confidently inform policy, but they have certainly had influence in the past.

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[1] Berry and Cline (1979) survey the evidence for a number of countries, and conclude that there is support for the view that output per acre decreases with size of farm. A qualified, but broadly supportive, view is found in the survey by Binswanger et al. (1993). Evidence for Bangladesh can be found in Hossain (1977, 1988), Mandal (1980) and Boyce (1987).

[2] This has been a common explanation for the farm size-productivity relationship; see, for example, Sen (1975), Berry and Cline (1979) and Feder (1985).

In previous work, Ravallion (1989) estimated the impact of land-based targeting in Bangladesh without allowing for possible productivity effects; depending on the position one takes on this contentious issue, one may consider this omission to be either inconsequential or a major limitation. (We have heard both views.) The fact that the earlier study found only seemingly modest net gains to the poor from land-based targeting (largely reflecting the importance of the first point above) has been questioned by readers who believe that productivity effects are likely to be important. However, the data available at the time of Ravallion's study had a limitation, namely that the survey data on land-holding had been tabulated against household income, unadjusted for household size (and the primary household level data were not publicly available). This is likely to over-estimate the gain to the poor from land-based targeting.

It is thus of interest to go further into quantifying the impact on poverty of this type of policy. Since many of the determinants of that impact are not feasible to measure, we will follow Ravallion (1989) in deliberately assuming ideal conditions for some of the factors described above, though (unlike the earlier study) including productivity effects. We deliberately make the (probably unrealistic) assumptions that there are no adverse incentive effects, no mitigating political-economy constraints, and that there are positive productivity effects, consistent with the observed empirical relationship between land-size and land productivity. The constraints we do incorporate are fundamental to such a policy, namely public-budgetary constraints and the informational constraint that poverty is not directly observed, and an imperfect indicator is used instead. This experiment should be able to approximate well the best outcome one could reasonably expect from this type of policy.

It is important to our task that we can calculate the optimal allocation of land-contingent transfers for any given budget under these idealized conditions; "optimal" in the sense that no other allocation would have a greater impact on a suitable measure of aggregate poverty. This allocation is of interest not because one believes it is implementable, but rather because it allows one to measure the potential impact on poverty of this policy instrument. As there are real-world constraints on anti-poverty policies which are not included in our characterization of the optimal allocation, one can think of our optimum as "unconstrained". The role of the unconstrained optimum here is to provide a benchmark by which this class of policies can be judged; it tells us what the best is that we can reasonably expect. It is thus important that the benchmark is measured well, and plainly the existence of productivity effects could matter to the outcome.

The following section characterizes optimal unconstrained land-contingent targeting for poverty reduction, with and without productivity effects, and shows how the optimal solution can be calculated. This is followed in section 3 by a description of our data, and results of our estimate of the poverty profile by landholding class for Bangladesh in 1988/89. Section 4 presents our simulation results, which are discussed further in section 5. Our conclusions are then summarized in section 6.

2 Optimal Targeting with Productivity Effects

For the reasons discussed above, our aim is to (if anything) over-estimate the productivity effects of land-based redistribution; we want to quantify an "upper-bound" to the effects. To do so we assume that the empirical land-size productivity relationship is not spurious (due to omitted land-quality differences). Since land-quality differences must presumably play at least some role, this assumption will probably lead us to overestimate the real productivity effects.

The commodity form in which land-based transfers are received and (more importantly) used by recipients will probably also matter. For the sake of the argument, let us agree that transfers used to buy land will raise output of the land-poor more than the output loss to the land-rich. That does not imply that transfers consumed as (say) food, or used to invest in non-farm enterprises, will also have such differential productivity effects.[3] The farm size-productivity relationship may be a fair

[3] For example, Hossain (1984) found that most of the non-farm petty self-employment projects routinely financed by the Grameen Bank and similar schemes targeted to the landless earned very low (even negative) rates of return. However, the valuation of the opportunity cost of the labor inputs in such calculations has often been based on agricultural wages, which could easily over-estimate that cost; for evidence in a similar setting see Datt and Ravallion (1992).

guide to the productivity effects when land is transferred, with restrictions on re-sale, or transfers of cash (say) are used to buy land, but not otherwise. Granted, there are other arguments that have been made to the effect that redistribution can have positive output effects (such as efficiency-wage models) but they are not intrinsic to the case for land-based targeting.[4] Again we probably err on the side of over-estimating the gains to the poor by assuming that land-based transfers (in whatever form) to the land poor raise income by the same amount as a direct increment to land owned, consistent with current output per acre.

We thus study the following model. A transfer in amount x_i $(i=1,..,m)$ to each member of the i'th landholding class (the transfer may be positive or negative) generates an income gain to the recipient of $k_i x_i$, for some non-negative number k_i, which we term the "productivity weight."[5] The values of k_i $(i=1,..,m)$ will be above one for the small farmers, and one for the large farmers. With adequate farm-household data, one could estimate the productivity weights econometrically; in the most elementary formulation this would entail regressing income or consumption on transfers received, and relevant exogenous variables (such as fixed factors in production). We do not have access to such data. However, one important clue to likely differences in the potential productivity of transfers is readily available, namely outputs per acre of land. We will assume that each k_i is directly proportional to the mean output per acre of land in that landholding class. Assuming that the value of k_i does not fall below unity for the land-rich (since recipients retain the option of taking the transfer as cash, losing none of it through any wasteful investments), and that output per acre declines monotonically with the size of the holding, it follows that the productivity weights can be derived as

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4 For a survey of the arguments see Lipton and Ravallion (1993, section 5.1).

5 Generally the value of k_i will be a function of x_i. Provided that one knows the parametric form of that function, and it is monotonic (presumably decreasing), then the methodology we outline here can allow this generalization. However, in the empirical work we shall treat each k_i as independent of x_i, and (to simplify the exposition) we will also do so here.

the ratios of output per acre for each landholding class normalized by the output per acre of the largest landholding class. That is the method we use of assigning the productivity weights.

In studying the impact of productivity gains on an optimal unconstrained anti-poverty scheme, we shall follow recent literature in assuming that the policy objective is to have the greatest impact on a distribution-sensitive measure of aggregate poverty, for a given budgetary allocation to this task (for surveys of this literature see Besley and Kanbur, 1993, and Lipton and Ravallion, 1994). Kanbur (1987) has studied this problem at a theoretical level, and derived some relatively simple rules for targeting, based on the information available in a poverty profile. Ravallion and Chao (1989) have proposed an algorithm for solving for the optimal allocation in this class of problems, and Ravallion (1989) has implemented the method in simulating the effects on poverty of various land-contingent poverty alleviation schemes for Bangladesh without productivity effects. Our task here is to reformulate this problem in a tractable way which can permit simulations of the poverty impacts of targeting, when there are effects on the productivity of the target groups.

We shall consider three aggregate poverty measures in this paper, all of which are members of the class of measures proposed by Foster, Greer and Thorbecke (1984). They are:

i) The head-count index H: the proportion of the population living in households with mean consumption below the poverty line;

ii) The poverty-gap index PG: the population's mean aggregate shortfall below the poverty line (counting the non-poor as having zero shortfall), expressed as a proportion of the poverty line; and

iii) The squared poverty gap index P_2: as for PG except that proportionate shortfalls relative to the poverty line are weighted by those shortfalls in forming the aggregate measure.

The head-count index is interpretable as a measure of the prevalence of poverty, the poverty-gap index as a measure of the depth of poverty, while the P_2 reflects the severity of poverty, in that it is also sensitive to the extent of the disparities amongst the poor. (For a non-technical exposition of the properties of these measures, and a more detailed discussion of the pros and cons of the approach to poverty measurement used here see Ravallion, 1993a). Clearly, H and PG are easier to interpret than P_2, and have been more popular for this reason. However, unlike H or PG, P_2 satisfies the principal axioms of poverty measurement, as outlined in (for example) Foster (1984). We shall use P_2 as the objective function in characterizing an optimal anti-poverty policy.

The method used in simulating the effects of optimal unconstrained land-contingent targeting with productivity effects is as follows. A budgetary allocation for poverty alleviation across m land-holding classes, given by the vector $\mathbf{x}=(x_1,...,x_m)$, is considered to be optimal relative to poverty line z and fixed budget $\bar{x}$ when it minimizes aggregate poverty, as measured by P_2, which we can write as the following function of $\mathbf{x}$:

$$P_2(x) = \sum_{i=1}^{m} n_i \int_0^{z - k_i x_i} [1 - (y + k_i x_i)/z]^2 \, dF_i(y) \tag{1}$$

where n_i is the proportion of the total population in landholding class i and F_i is the cumulative distribution function of living standards in landholding class i. The solution is only constrained to satisfy the additively absorbed budget constraint:

$$\sum_{i=1}^{m} n_i x_i = \bar{x} \tag{2}$$

This problem will have a unique interior solution denoted $\mathbf{x}* = (x_1^*,..,x_m^*)$ satisfying the condition that the productivity-weighted post-transfer poverty deficit given by

$$k_i \int_0^{z - k_i x_i} [1 - (y + k_i x_i)/z] \, dF_i(y) \tag{3}$$

is equalized across all landholding classes. (Notice that the formulation in Ravallion, 1989, is now obtained as the special case in which $k_i = 1$ for all i, thus requiring that poverty gaps are equalized at the optimum.) This problem cannot be solved analytically, so we use a numerical method (summarized in the Appendix).

It can be readily verified that, when comparing optimal allocations, a higher value of k_i for any i will be associated with a lower value of all three poverty measures in group i. However, the comparative static effect of a change in k_i on the optimal x_i is ambiguous, and will depend on data-specific properties of the distribution functions (and in no readily interpretable way). Note also that the poverty profile by landholding class can be altered quite radically by the pattern of optimal land-based transfers. In particular, there is nothing in theory to preclude the possibility that there will be a rank reversal once the optimal policy is implemented; there could be less poverty among the land-poor than the land-rich post-reform. Such a rank reversal was found in Ravallion (1989), and has been observed in other formulations of optimal policy problems. (See, for example, Atkinson and Stiglitz's, 1980, Lecture 13, discussion of the Mirrlees optimal tax problem.) In the present context, the rank reversal in the relationship between P_2 and landholding class at the optimum occurs whenever the productivity-weighted poverty-gap index falls sufficiently rapidly with landholding class.[6]

Our interest here is not so much in what the optimal unconstrained allocation will look like, but in how much impact it will have on poverty, relative to some alternative policy. The natural benchmark is the outcome under a uniform "un-targeted" allocation of the same budget, whereby everyone receives the same amount, whatever their landholding class. A natural money metric of the gains from optimal targeting is the equivalent gain from targeting (Ravallion and Chao, 1989), which is the number η defined implicitly by

[6] This follows from the fact that the productivity weighted PG is directly proportional to minus one times the derivative of P_2 with respect to x. Thus (treating P_2 as a differentiable function of landholding) the absolute value of the slope of PG with respect to landholding indicates the sign and size of the second cross-partial derivative of P_2 with respect to land and x, which determines (in part) the sign of the derivative of P_2 (at the optimum) with respect to landholding.

$$P_2(x_1^*,...,x_m^*) = P_2(\bar{x}+\eta,...,\bar{x}+\eta) \quad (4)$$

The value of η will be a strictly decreasing function of the optimal post-transfer value of P_2.

3 Rural Poverty by Landholding Class in Bangladesh

The household surveys done at regular intervals by the Bangladesh Bureau of Statistics (BBS) have often asked how much land each household owns, though the primary data tapes are not publicly available, and the results have not been published in any form since those from the 1978/79 survey, as used by Ravallion (1989). We asked BBS to produce tabulations of consumption by landholding class from the 1988/89 survey, which they kindly did, and these have subsequently been published by BBS (1991). They are the data used in this study. These new data also rank households by a better indicator of living standards, namely consumption expenditure per person, rather than total household expenditure, as in BBS's tabulations of the 1978/79 survey.

Before we discuss the potential poverty alleviation benefits of land-contingent transfers, some remarks on the pre-transfer poverty profile in rural Bangladesh are in order. The 1988-89 household expenditure survey (HES) provides information on the distribution of household consumption expenditures for six landholding classes, namely, landless (0.0-0.04 acres), near landless (0.05-0.49), marginal (0.50-1.49), small (1.50-2.49) medium (2.50-7.49) and large (7.50 acres and above).

The poverty line was determined by costing a normative minimum consumption bundle for the population, yielding a per capita daily intake of 2,112 calories; see Muqtada (1986). The cost of basic non-food necessities was then added; this was estimated to equal 35 percent of the cost of the normative minimum diet. The prices used for costing the minimum diet were derived from the HES data on the consumption of goods in quantities and values. (See Hossain and Sen, 1992, on the method of costing the minimum diet using the implicit HES prices.) This gave a poverty line of Tk

370 per person per month in 1988/89 prices.[7] Because of the non-availability of household level data, no allowance has been made for household composition effects or household specific prices.

Table 1 gives the estimated poverty profile by landholding class. The normalized poverty deficit PG declines with increases in landholding. (The negative correlation between land and poverty in the context of Bangladesh has been observed by earlier works as well; see Ravallion 1989, and Hossain and Sen 1992). This implies that the additively absorbed budgetary allocations which minimize P_2 (without productivity effects) tend to also decline with landholding (noting that the poverty deficit is the relevant first-order indicator for this objective; see Kanbur, 1987). The precise allocations that would be required, and the quantitative gains from targeting, will depend on the nature of the constraints on the revenue side of the policy problem, as well as the land-contingent consumption distributions (Ravallion, 1989). The budgetary rule for allocating transfers must be modified if there are differential productivity effects, as discussed in more detail in section 2. The solution will then depend on the valuation of the productivity gains which may accompany transfers.

4 Simulation of the Optimal Unconstrained Policy

The necessary data for implementing the approach described in section 2 are: i) distributions of the living standards indicator by landholding class (selected values of F_i for all i, and the corresponding means); ii) the budget available, and iii) the set of values of the productivity weights k_i for all i. The first set of data are derived from the same source as Table 1. The second is hypothetical, and discussed below. The third are derived from Hossain's (1988) estimates of rice yields per acre for various farm sizes as reproduced in Table 2a. These are based on annual yields of

[7] It may be noted that the poverty line thus derived by costing a fixed bundle with implicit HES prices is found to be virtually identical to the poverty line reported by Bangladesh Bureau of Statistics (1991) which applied a graph fitting method to the empirical food energy-consumption expenditure relationship.

the principal crop, rice (thus allowing for differences in cropping intensity as well as yields for a given crop).

One problem is that Hossain's (1988) results do not provide disaggregated data for the near-landless and marginal landholding classes; Hossain's results combine all landholdings under 2.5 acres together (Table 2a). For lack of better data, landless, near landless, marginal and small landholding classes are assumed to display the same land-productivity levels. We will, however, test the sensitivity of our results to that assumption using alternative "low-case" and "high-case" productivity weights. The productivity weights we have used are summarized in Table 2b. To test sensitivity, we consider three possibilities for the landless and functionally landless groups: the base-case, which is the weight implied by the point estimate of yield per acre from Table 2a, the "low-case", which assumes that there are no productivity gains for this group, and the "high-case", which is set at one standard error above the point estimate of yield per acre for small farms, from Table 2a.

As is evident from Hossain's results, the inverse relationship between farm size and land productivity cuts across various factors; it holds irrespective of the rice varieties grown, and the stage of diffusion of the new modern variety (MV) technology (Table 2a). The difference in productivity between the small and large farmers is less pronounced (though the difference is statistically significant) for the technologically developed villages than for technologically underdeveloped ones, and it is most pronounced for adopters of MV's in technologically underdeveloped villages.[8] In the more technologically developed villages, the average productivity for small farmers is found to be about one-fifth higher than for large farmers. The matched figure with respect to modern variety rice cultivation in early stages of adoption (i.e., in technologically underdeveloped villages) is a good deal higher (about 44 percent). The land productivity differential between small and large farmers appears to increase considerably during early stages of adoption, as one switches from the production of local varieties of rice to modern varieties. By contrast, the relative land productivity between small and

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[8] Hossain (1988) classified the villages according to the proportion of area under modern varieties. A 20 percent irrigated area was used as the cut-off mark for classifying the villages into two groups.

large farmers does not show any perceptible change as one moves from traditional to new technology in the developed villages. However, beyond these observations, further analysis of the determinants of the relationship between farm size and land productivity requires a more detailed investigation, and as such falls beyond the scope of this paper.

For our analysis, we have taken this inverse relationship as an empirically established fact for Bangladesh agriculture, and considered it as the point of departure in our simulations of optimal unconstrained land-contingent transfers for reducing rural poverty.

Table 3 gives our simulations of optimal land-contingent redistributions. These are pure land-based redistributions, in that aggregate revenue is zero, and the policy-makers have complete control over the distribution of income between landholding classes. The unrestricted taxing power of the government assumed in this near-totalitarian scenario is clearly politically unrealistic, but it represents a natural benchmark for assessing the potential for poverty alleviation by the redistribution of existing aggregate income.[9] It is the best that could be done, knowing only landholding class. Note also that the government in all the scenarios presented in Table 3 does not have information as to who has which consumptions <u>within</u> each landholding class, and is thus restricted to the use of an imperfect targeting variable (such as landownership category in our case). Hence, the tax burden may be found to be high for some consumption-poor households in the land-rich subgroups, and vice-versa. This is an intrinsic problem in any indicator targeting scheme.

Scenario 1 in Table 3 ignores the productivity effects, that is, the result is obtained by setting $k_i = 1$ for all i. This is the case considered by Ravallion (1989) using the 1978/79 data. We then present results for four other cases, corresponding to the "base-case" productivity weights in Table 2b. In all cases, there is an extra impact on aggregate poverty associated with land-based redistribution, though that is to be expected. More interesting is the magnitude of the extra impact.

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[9] Though such schemes are widely thought to be politically unrealistic, they have been for decades a major point of departure in the agrarian programs of many left-leaning political parties and groups, advocating massive land-based redistributive measures in the countryside for poverty alleviation.

Consider the case of technologically underdeveloped areas (scenarios 2 and 3), which are typical of the agrarian situation of Bangladesh. The impact of land-contingent transfers with productivity effects brings down the P_2 measure to 3.3% under local variety, from 3.5% recorded in the case of transfers without productivity effects (scenario 2). The equivalent gain from targeting rises from Tk 11 without productivity effects (2.5% of mean rural consumption) to Tk 14 with productivity effects under the base-case. The extent of poverty reduction is slightly higher when such land-contingent transfers are made in villages which have adopted the MV's. The P_2 measure in this case declines further down to 3.3% (scenario 3).

Notice that the introduction of the productivity effects leads to lower transfers to the landless and near landless, though (given the productivity effects of those transfers) the impact on the sub-group poverty indices is greater than in scenario 1. It may also be noted that, with the productivity effects, the net tax burden on richer landholding classes actually rises. This is because, with the introduction of the productivity effects, the marginal farmers (a large group; see Table 1) emerge as beneficiaries under optimal targeting. The increased tax burden on the largest landholding group is needed to release additional internally-generated resources to finance those transfers.

The impact on poverty of optimal land-contingent transfers with productivity effects is lower in technologically developed areas than in underdeveloped areas. This tendency cuts across the local and modern varieties. This appears to be because in later stages of adoption, the productivity gap across farm-sizes narrows considerably; larger farms use more capital-intensive technology, thereby eroding some of the initial advantages which the smaller farms have had in early stages of adoption when the technology is still quite labor-intensive. Still, even in the developed areas, the P_2 measure is lower when productivity effects are included than is the case without them (ranging from 3.36 to 3.42%, as compared to 3.49%). Also note that, compared to the scenario for underdeveloped areas, the incidence of tax burden on medium and large landholdings classes is lower in the scenario for developed areas, but it stipulates some increases in the net tax burden on the small landholding class, and a net reduction in budgetary allocation to marginal farms.

So far we have assumed that the productivity weights for the lower landholding classes are considerably higher than those for the richer landholding groups, as in Table 2b. What happens if this assumption does not hold, at least for the two lowest landholding classes? It has been argued, for example, that the inverse relationship between farm size and productivity breaks down at very low land size. Table 4a considers the outcome of a modified "low-case" scenario. The underlying productivity weights differ from those relating to Table 3 in only aspect: the land-productivity levels in the landless and near landless groups remain restricted to the level attained by the largest landholding group (Table 2b). The inverse relationship between land-size and productivity holds only in the restricted range (i.e. only the marginal, small and medium farmers have higher land-productivity than the largest landholding group). As expected, the impact on poverty of optimal unconstrained targeting is now diminished, so much so that the positive extra impact of land-contingent transfers with productivity effects no longer holds true. The case for believing that productivity effects will enhance the potential impact on poverty of this type of policy thus hinges quite critically on there being productivity gains amongst the landless and near landless.

For completeness, Table 4b considers an alternative "high-case" scenario, in which we have assumed markedly higher productivity weights for the landless and near landless groups (Table 2b). We see a more pronounced impact on aggregate poverty though land-based redistribution; depending on the conditions of technology, the P_2 index now falls to 3.0-3.3, and the equivalent gain from targeting rises to Tk 14-20, representing 3.3-4.6% of mean rural consumption. Though the absolute impact on poverty of the higher productivity weights for landless and near landless households varies a good deal over initial conditions, the elasticity of that impact (that is, the proportionate change in P_2 divided by the proportionate change in k_1 and k_2) is remarkably constant, varying from -0.32 to -0.33 over the range of stages in technological development. Thus we suspect that this elasticity will give readers a good indication of the likely impacts of higher or lower productivity for the landless on the aggregate poverty impact of land-based redistribution.

Table 5 gives further results for a series of specific policy simulations focusing on different scenarios relating to the revenue side of the policy problem. Part of our motivation here is also to see whether or not the conclusions of the earlier study (Ravallion, 1989) are robust to the use of this improved data set, so we will closely follow that study. To assure comparability we will also ignore the productivity weights (that is, set them all to unity), though this matters little to our main conclusions.

Scheme 1 in Table 5 reproduces the result already reported (Table 3), simulating the effect of unconstrained redistributions across landholding classes. Scheme 2 is also a poverty minimizing revenue-neutral redistribution of the existing aggregate income. However, compared to the unrestricted redistributive powers of the government assumed in scheme 1, this scheme is sensitive to 'political economy' constraints. It assumes that the government's redistributive powers are constrained to preclude tax burdens exceeding Tk 20 per person per month (which represents about 5 percent of average per capita rural income during 1988/89). Scheme 3 is another variant of scheme 2 with the difference that it assumes that the government can impose a tax burden up to Tk 40 per person per month (amounting to nearly 10 percent of average rural income in 1988/89). Scheme 4 is another variation on this theme; in this case the tax burden is not allowed to exceed Tk 80 per person per month. The choice of constraints in schemes 2, 3 and 4 is, of course, arbitrary, but they give an indication of how sensitive the results of scheme 1 may be to political economy constraints on the government's power to tax.

In contrast, the scenario represented in scheme 5 rests on the assumption that the government does not have the power to tax rural landholders. An example would be when the government is exclusively dependent on the availability of foreign aid for financing the rural poverty alleviation programs.[10] Note that only positive land-contingent transfers from this budget are now possible.

[10] Strictly speaking, the solution under scheme 5 may stipulate taxing the urban sector to finance the rural poverty alleviation program. However, in many developing countries, the 'political economy' constraints on the government's power to tax the more articulate and powerful urban sector would be even less than compared to imposing a tax burden on rural landholders.

The calculations for scheme 5 are carried out for the minimum budget necessary to eliminate poverty with complete information on household living standards. This would require Tk 46 per month per person in rural areas (being the product of aggregate poverty gap PG and the poverty line z). Once the size of the aggregate minimum budget for poverty eradication is determined, optimal transfers across various landownership groups are estimated and the level of post-transfer poverty is assessed. Examples of such positive land-contingent transfers may be diverse in nature. These include the promotion of various external aid-sponsored self- and wage- employment programs for rural areas that use land-contingent targeting.

Finally, scheme 6 in Table 5 focusses on the potential for poverty reduction from an un-targeted program underwritten by foreign aid. If the policy-makers do not possess any information to permit targeting, they would simply have to give the mean budget to all rural households. Of course, in reality the policy-makers have a certain notion as to who constitute the poor and who do not, but the case in point emerges as a natural benchmark against which the gain from a targeted allocation of aid resources can be measured.

5 Discussion

A number of points are notable about the results presented in Tables 3-5. First, the allocation needed to equalize the post-transfer poverty deficit - whether productivity weighted or not - across landholding classes (and hence minimize the aggregate value of P_2 for a given budget) is negatively correlated with landholding. This tendency cuts across the various schemes where transfers are revenue-neutral. Note that in Table 1, the subgroup value of P_2 prior to the transfer is higher for the lower end of the landholding classes; indeed, all three poverty measures decrease with increases in the size of the landholding. This ranking is almost totally reversed under the impact of the revenue-neutral poverty alleviation scheme with unrestricted tax powers across landholding classes in Table 3. The pattern of poverty-minimizing transfers under the revenue-neutral unrestricted tax regime leaves the lowest landholding class with the lowest poverty level rather than the highest. As noted in section

2, this is theoretically possible, and was also observed by Ravallion (1989). This virtually complete reversal of the rank correlation between poverty and landholding does not hold for any of the schemes with hypothetically restricted tax powers (Table 5, schemes 2-4). Neither does it hold in the case of positive land-contingent transfers, underwritten by foreign aid (Table 5, schemes 5 and 6). As evident in schemes 2 through 6 in Table 5, post-transfer poverty of lower landholding classes (although less than the pre-transfer level) is still higher than for the land-rich group.

Notice, however, that the monotonically increasing relationship between average landholding size and average consumption is preserved under the poverty minimizing allocations; this can be verified by adding the optimal allocations from Table 5 to the mean incomes in Table 1.

The optimal allocation is targeted sharply toward landless and functionally landless households. This property holds quite generally (Tables 3-5). It cuts across the various scenarios, regardless of whether or not one imposes revenue-neutrality. The cut-off point between donors and recipients is at a landholding size of 0.49 acres for all revenue-neutral transfer schemes. For aid-sponsored poverty alleviation programs, however, the cut-off point shifts to 1.5 acres, implying that marginal farmers also merit strong consideration in aid-financed land-contingent transfer programs.[11]

Thus, in so far as revenue-neutral land-based redistribution for Bangladesh is concerned under these idealized conditions, the policy should be targeted solely at households with less than one half an acre of land for maximum impact on poverty. These groups should receive the entire transfer amount obtainable under both unrestricted and restricted tax power based policy regimes. But the incidence of transfer-burden among the land-donor classes under scheme 1 is not uniformly distributed. Incidence of burden is only less than 1 percent of mean consumption for the marginal landholding class between 0.5 and 1.49 acres, while it increases to 8 percent of mean consumption for

[11] It may be recalled that the main focus of most poverty alleviation programs under NGO and governmental arrangements is on landless and functionally landless households. While this is quite in line with the poverty-minimizing allocation pattern as depicted by our results, the targeting emphasis has been somewhat lopsided. The necessity for increased focus on the marginal landholding class can hardly be overemphasized. Thus, according to scheme 5 (Table 5), there is clearly a case for advocating positive transfers for marginal landholding classes under aided poverty alleviation programs.

the small landholders (between 1.49 and 2.49 acres). The highest incidence of burden is recorded for the largest landholding group followed by the medium landholding group, the matched figures being 11 and 9 percent, respectively.[12] The results thus confirm the desirability of the broad pattern of redistribution pursued by advocates of land-based targeting.

However, this does not imply that targeting in favor of the landless or near landless will significantly reduce rural poverty. The results only show that, in so far as policy-makers decide to go for a radical land-based redistribution program, the targeting of benefits should be aimed solely at landless and functionally landless households in order to achieve the maximum poverty-alleviating impact of such a program. As regards the issue of the potential impact of such a land-based redistribution on aggregate rural poverty, there are hardly grounds for great optimism. With or without productivity effects, the P_2 index would be reduced to about 3.5, relative to its pre-transfer level of about 4.5. The extent of this reduction is, however, difficult to interpret. Ignoring productivity effects, the mean poverty gap falls from Tk 46 to Tk 39 and the head-count index drops from 48% to 44%. Including productivity effects consistent with Table 2a, the poverty gap falls to Tk 37, while the head-count index falls to 45% (for modern varieties in technologically underdeveloped areas; the declines are lower for other cases).

A more revealing measure is the equivalent gain from targeting (defined implicitly by equation 4). This is estimated at Tk 11 per person per month without productivity effects and Tk 13-15 with them (Table 3). The optimal (poverty minimizing) tax/transfer policy based on land-based targeting would achieve a level of poverty reduction equivalent to that achievable by giving this amount to each household irrespective of its landholding. If one assumes no productivity effects then the equivalent gain from targeting with unrestricted land-contingent tax powers is thus only 2.5 percent of mean income for rural Bangladesh; with productivity effects, these figures rise to 2.8-3.4

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[12] It is of interest to note that Ravallion (1989) found that the incidence among the donors in 1978/79 to be in the high order of over 20% of mean income for all landholding over 2.5 acres. The 1988/89 data show that the average incidence of transfer (tax) burden under such a radical land-based redistribution program would be around 10 percent for all landholding classes over 1.5 acres.

(depending on the initial conditions). It should be emphasized again that these are the maximum impacts from land-contingent targeting across these six landholding classes; incentive and political-economy constraints will almost certainly further reduce the impact on poverty.

These figures are lower than the previous estimates (Ravallion, 1989). The earlier paper using the 1978/79 data found the equivalent gain from targeting under unrestricted land-based tax powers to be in the order of 10 percent of the mean rural income and about 20 percent of the mean poverty deficit of the poor. The potential impact of land-contingent targeting may have declined over time, though the differences in data (particularly the fact that the 1988/89 distributions have been normalized by household size, but also that a larger sample size had permitted a finer poverty profile in the earlier study) appear to have played a large part.

Schemes 2 and 3 in Table 5 show that the gain from optimal targeting can be considerably less when the government's tax powers are further restricted. For scheme 2, the equivalent gain from targeting is reduced by about 46 percent. As one would expect, the impact on aggregate poverty obtainable by optimal targeting under restricted tax powers (although lower than the pre-transfer poverty level) is lower than with unrestricted land-based tax powers.

The poverty reduction possibilities increase considerably when revenue for the policy is available from external sources. Scheme 5 in Table 5 illustrates this variant. The results again emphasize targeting toward landless and functionally landless households (together they account for 85 percent of the total amount transferred). But, as noted above, households belonging to the marginal-landholding group are also recipients under this scheme: about 15 percent of total transfers go to them. The optimal allocation by landholding class tapers off fairly rapidly as the size of landholding increases, reaching zero at about 1.5 acres. The need for focusing poverty reduction efforts on marginal farmers along with the landless and near landless is thus strongly emphasized by the results for scheme 5.

The aggregate value of P_2 is drastically reduced under scheme 5, as compared to the pre-transfer situation, as well as to other scenarios discussed earlier. P_2 declines to 1.55% under scheme

5 from 4.45% recorded for the pre-transfer situation. The lowest landholding class experiences the largest reduction in poverty, followed closely by the functionally landless and marginal farmers groups. However, while a general pattern of decline in poverty compared to the pre-transfer situation is noted, the situation of the small farmer does not improve under scheme 5.

For scheme 5, the equivalent gain from targeting is estimated to be Tk 10, which represents nearly 22 percent of the poverty alleviation budget. Note that the equivalent gain from targeting under an unrestricted tax power regime is also assessed to be of a similar order (see Table 5). Under situations where governments have no tax powers due to severe political economic constraints, the mean external budget of Tk 46 turns out to be approximately the amount necessary to achieve the same equivalent gain as that attainable without an external budget, built with unrestricted powers (and also for scheme 4) to tax by landholding class. The aggregate poverty-minimizing size of public expenditure under land-based targeting, as implied by the mean external budget of Tk 46, is assessed to be Tk 3638 million in 1988/89. This represents about 4 percent of aggregate public (current plus development) expenditure or 36 percent of the annual development plan allocated for the agricultural sector (including livestock, forestry and fisheries) in 1988/89.

So far, we have compared scheme 5 with the pre-transfer poverty situation and found the poverty reduction possibilities to be considerable if revenue for the policy is available externally. A point of considerable interest is to assess the size of incremental poverty reduction associated with the optimal targeting of an externally available budget relative to an un-targeted transfer of that budget. Un-targeted transfers apply to a situation when policy-makers have inadequate information to permit even imperfect targeting, and decide simply to give the mean budget to all rural households. This is an obvious bench-mark for evaluating the effects of any attempt at targeting. As evidenced from the results for scheme 6 in Table 5, the un-targeted allocation would reduce P_2 to 1.89 compared with 1.55 achieved under the optimally targeted budgetary allocation. This implies that even an un-targeted allocation of external aid can achieve a sizeable reduction in rural poverty in Bangladesh. Even though a further gain is derived from optimal (land-contingent) targeting, the size of the incremental gain is quite modest. This is because, even the un-targeted allocation will make (for the given distribution of income) a significant dent on poverty amongst the poorest households.[13]

The desirability of targeting towards landless and functionally landless households is borne out by a wide range of alternative budgets and poverty lines. From Table 6, it may be seen that the proportion of the budget received by the two lowest landholding classes varies from 63% to 75%, and this budget proportion tends to increase for smaller budgets and higher poverty lines. It may be noted that the equivalent gain from optimal targeting as a proportion of the budget also tends to increase the lower the poverty lines (for a given budget) and tends to decline the larger the size of the mean budget (for a given poverty line).

Why would unrestricted redistribution across landholding classes not reduce aggregate poverty more significantly? The underlying reason is that landholding - while providing a good proxy for the living standards of rural households (as can be seen in all our simulations, the target groups should be the land-poor) - remains an imperfect indicator. Poor households in larger holding classes would be adversely affected by such programs, and there will be leakage to non-poor households among land-poor groups. As the burden of tax incidence increases disproportionately in the larger landholding classes, the living standards of households in and around the poverty line within these categories also decline. As a result, the aggregate P_2 measure of poverty does not show a marked decline under the revenue-neutral schemes.

6 Conclusions

It is widely believed that transfers targeted to the rural land-poor can be productive, in that the final income gain to the poor exceeds the initial transfer. The most widely cited evidence to

[13] This, of course, assumes that external aid resources under the un-targeted allocation would eventually reach the poor. Given the widespread leakages in aid allocations, this should not be readily accepted. Programs with explicit objectives to target the land-poor would probably have less leakages than the un-targeted programs. If one takes the likely incidence of leakage into consideration, the poverty minimizing effects of an un-targeted allocation would be still lower than those attainable under the optimal targeting of external aid.

support this view is the negative correlation between the output per acre of land and the size of holding. There are, however, a number of reasons to question that evidence; it is unclear. for example, how much the relationship is really due to omitted differences in land quality. There are also a number of other factors which will constrain the impact on poverty from this type of policy, notably incentive constraints (whereby the "land-rich" alter their behavior to gain from the policy) and political-economy constraints (whereby the "land-rich" undermine the policy by political means).

We have not tried to resolve all these issues, but rather to inform the debate by quantifying the potential gains from this type of policy under seemingly ideal conditions, incorporating only a limited set of the constraints that such a policy would actually face. Thus our aim has been to quantify gains to the poor from a benchmark policy, designed to characterize the likely upper-bound to real-world outcomes. The key constraint we consider is intrinsic to such schemes, namely that the targeting is done on the basis of landholding class alone. Ignoring productivity differentials, the relevant indicator in making transfers is a suitably defined poverty measure for each landholding class. That was the approach of Ravallion (1989). The more general formulation we have offered here calls for two indicators: the marginal productivity of transfers (assumed to be proportional to current output per acre on owned land, though recognizing that this may well entail an over-estimation of the impact on poverty) and the poverty measure (as derived from a standard poverty profile).

On applying this approach to new data for rural Bangladesh, we have found that landholding class is a relevant indicator for targeting. Under these idealized conditions, redistributions from land-rich to land-poor households will reduce aggregate poverty in rural Bangladesh (even without productivity effects). And transfers from an external budget would have greatest impact on poverty if concentrated on the landless and marginal farmers. Furthermore, productivity effects (consistent with the farm size-productivity relationship in Bangladesh) do imply an additional impact on rural poverty from land [illegible] redistributions

However, our more interesting findings concern the quantitative impact on poverty of this type of policy. We have tried to err on the side of over-estimating the impact on poverty, by ignoring constraints which would reduce that impact. Yet we find that the gains are modest, even when one postulates virtually un-heard of powers of redistribution across landholding classes. Depending on the initial conditions of agricultural technology, and the size of the productivity effects among the landless, we estimate that the maximum impact on rural poverty from this type of policy under revenue neutrality is equivalent to that of a uniform lump-sum transfer of between Tk 10 and Tk 20 per person per month - around 2.5-5% of mean rural consumption. The conclusions of the earlier study (Ravallion, 1989) are reinforced by these new results; indeed, the impact on poverty of land-based targeting is even lower on the more recent and improved data set used here.

The various factors that we have omitted from the analysis will further constrain the impact. Differences in the way land-based transfers are used, and in land quality, will dampen it, as will plausible political-economy constraints and incentive effects on landholding behavior. And we have said nothing about the administrative costs. These considerations lead us to suspect that, on balance, our simulations may not be far off the mark in quantifying the best one could expect from this type of policy. For the sake of Bangladesh's poor, one must hope it is not all that is done to attack rural poverty.

Appendix: The Numerical Method of Solving for the Unconstrained Optimal Allocation with Productivity Effects

The problem is solved by linearizing the first-order conditions at each iteration around the previous estimate of the optimal allocation x^* and the Lagrange multiplier on the budget constr`int λ. The algorithm estimates these variables at each iteration t by solving the following system of linear approximations to first-order conditions (generalizing the Ravallion, 1989, algorithm to include the productivity weights):

$$\begin{bmatrix} (K_{t-1}) & zi \\ n & 0 \end{bmatrix} \begin{bmatrix} \hat{x}^*_t \\ \hat{\lambda}_t \end{bmatrix} = \begin{bmatrix} g_{t-1} \\ \bar{x} \end{bmatrix}$$

where (K_{t-1}) is the m^2 diagonal matrix with diagonal elements given by the values of $k_i^2.H_{it-1}$ for $(i=1,...,m)$ as implied by the values of x^* obtained at iteration $t-1$; g_{t-1} is the column vector of m elements formed by $k_i(z-\bar{y}^p_{it-1})H_{it-1}$ for $i=1,...,m$, as obtained at $t-1$ (where $\bar{y}^p_i$ is mean income of the poor in landholding class i), while $n=(n_1...,n_k)$, and i is an m row vector of ones. Having solved for x^* to the desired degree of accuracy, the problem can be repeated, constraining the solution to non-negative values of x_j^* for all j if this does not already hold.

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Table 1: ***Poverty profile by landholding class, rural Bangladesh, 1988/89***

Land-holding class (acres of owned land)	Percent of population	Mean expenditure per person (Tk/mm)	Head-count index of poverty (%)	Poverty gap index (%)	Squared poverty-gap index (x100)
1. Landless (0-0.04)	13.9	377	61.4	17.7	6.9
2. Near landless (0.05-0.49)	31.5	404	53.9	14.6	5.4
3. Marginal (0.50-1.49)	19.2	438	43.4	10.2	3.5
4. Small (1.50-2.49)	11.3	498	34.2	6.2	1.5
5. Medium (2.50-7.49)	18.8	545	26.6	5.2	1.5
6. Large (7.50+)	5.3	790	10.1	2.1	0.8
Rural Bangladesh	100.0	435	47.5	12.2	4.5

Source: The poverty estimates are based on the distributions of household consumption per capita constructed by the Bangladesh Bureau of Statistics; see BBS (1991).

Table 2a: ***Farm size and land productivity in Bangladesh***

Farm size (acres)	Technologically developed villages			Technologically underdeveloped villages		
	Local varieties	Modern varieties	All rice varieties	Local varieties	Modern varieties	All rice varieties
Small (under 2.5)	0.63 (0.09)	1.53 (0.38)	0.73 (0.10)	0.72 (0.08)	1.29 (0.13)	1.10 (0.11)
Medium (2.5-5.0)	0.53 (0.07)	1.37 (0.41)	0.58 (0.09)	0.71 (0.09)	1.13 (0.13)	0.93 (0.08)
Large (over 5.0)	0.51 (0.12)	1.06 (0.77)	0.57 (0.13)	0.61 (0.14)	1.09 (0.24)	0.86 (0.20)
All farms	0.58 (0.06)	1.43 (0.26)	0.64 (0.07)	0.71 (0.06)	1.23 (0.09)	1.03 (0.08)

Note: Productivity in annual metric tons of rice per acre; figures in parentheses are standard errors.
Source: Hossain (1988), based on a 1982 field survey done by Bangladesh Institute of Development Studies and the International Food Policy Research Institute.

Table 2b: ***Productivity weights***

Landholding class (acres of owned land)	Technologically developed areas		Technologically underdeveloped areas	
	Local varieties	Modern varieties	Local varieties	Modern varieties
Landless (0 - 0.04) and near landless (0.05 - 0.49)	B: 1.23 L: 1.00 H: 1.41	B: 1.44 L: 1.00 H: 1.80	B: 1.18 L: 1.00 H: 1.31	B: 1.18 L: 1.00 H: 1.30
Marginal (0.50 - 1.49) and small (1.50 - 2.40)	1.23	1.44	1.18	1.18
Medium (2.50 - 7.49)	1.04	1.29	1.16	1.04
Large (7.50 +)	1.00	1.00	1.00	1.00

Note: B = "base-case" weights for landless and near landless
L = "low-case" weights for landless and near-landless
H = "high-case" weights for landless and near-landless

Table 3: ***Land-contingent poverty alleviation schemes with and without productivity effect under alternative technological regimes ("base-case" productivity weights from Table 2b)***

Landholding class (acres of owned land)	Pre-transfer poverty P_2 (x100)	Optimal transfers without productivity effects under unrestricted land-based taxation (Scenario 1)		Optimal transfers with productivity effects under unrestricted land-based taxation							
				Technologically underdeveloped areas				Technologically developed areas			
				Local variety (Scenario 2)		Modern variety (Scenario 3)		Local variety (Scenario 4)		Modern variety (Scenario 5)	
		Optimal transfer (Tk/mn/ person)	Post-transfer poverty	Optimal transfer (Tk/mn/ person)	Post transfer Poverty	Optimal transfer (Tk/mn/ person)	Post-transfer Poverty	Optimal transfer (Tk/mn/ person)	Post-transfer Poverty	Optimal transfer (Tk/mn/ person)	Post-transfer poverty
1. Landless (0 - 0.04)	6.95	48.91	3.12	44.55	2.80	38.54	2.76	43.18	3.01	45.19	2.88
2. Near Landless (0.05 - 0.49)	5.45	29.48	3.38	29.05	3.04	25.34	3.00	26.82	3.26	28.96	3.12
3. Marginal (0.50 -1.49)	3.49	-2.88	3.49	2.71	3.15	2.84	3.11	-0.61	3.37	1.51	3.24
4. Small (1.50 - 2.40)	1.53	-42.60	3.45	-29.58	3.11	-24.74	3.07	-34.27	3.33	-32.14	3.19
5. Medium (2.50 - 7.49)	1.53	-60.53	3.77	-66.57	4.29	-48.83	3.91	-51.54	3.73	-64.50	4.16
6. Large (7.50+)	0.83	-158.44	5.49	-175.17	6.48	-195.20	7.86	-176.08	6.54	-172.22	6.30
Rural Bangladesh	4.45	0	3.49	0	3.32	0	3.28	0	3.42	0	3.36
Equivalent Gain (Tk/month/person)	-	10.77	-	13.85	-	14.68	-	12.00	-	13.04	-

Table 4a: ***Land-contingent poverty alleviation schemes with and without productivity effects under alternative technological regimes ("low-case" scenario)***

Landholding class (acres of owned land)	Pre-transfer Poverty P_2 (x100)	Optimal transfers without productivity effects under unrestricted land-based taxation		Optimal transfers with productivity effects under unrestricted land-based taxation							
				Technologically underdeveloped areas				Technologically developed areas			
				Local variety		Modern variety		Local variety		Modern variety	
		Optimal transfer (Tk/mn/ person)	Post-transfer Poverty	Optimal transfer (Tk/mn/ person)	Post transfer poverty	Optimal transfer (Tk/mn/ person)	Post-transfer poverty	Optimal transfer (Tk/mn/ person)	Post-transfer poverty	Optimal transfer (Tk/mn/ person)	Post-transfer poverty
1. Landless 0 - 0.04	6.95	48.91	3.12	43.05	3.46	35.75	3.93	41.78	3.54	43.94	3.41
2. Near Landless (0.05 - 0.49)	5.45	29.48	3.38	23.24	3.75	15.59	4.24	21.90	3.83	24.19	3.69
3. Marginal (0.50 -1.49)	3.49	-2.88	3.49	6.84	2.89	9.81	2.62	3.23	3.13	5.01	3.02
4. Small (1.50 - 2.40)	1.53	-42.60	3.45	-25.46	2.85	-17.63	2.56	-30.43	3.08	-28.65	2.97
5. Medium (2.50 - 7.49)	1.53	-60.53	3.77	-60.98	3.94	-40.17	3.30	-47.39	3.46	-60.04	3.88
6. Large (7.50+)	0.83	-158.44	5.49	-167.20	6.00	-178.13	6.67	-169.10	6.11	-165.87	5.91
Rural Bangladesh	4.45	0	3.49	0	3.55	0	3.65	0	3.59	0	3.54
Equivalent Gain (Tk/month/person)	-	10.77	-	9.76	-	7.91	-	8.92	-	9.83	-

Table 4b: ***Land-contingent poverty alleviation schemes with and without productivity effects under alternative technological regimes ("high-case" scenario)***

Landholding class (acres of owned land)	Pre-transfer Poverty P_2 (x100)	Optimal transfers without productivity effects under unrestricted land-based taxation		Optimal transfers with productivity effects under unrestricted land-based taxation							
				Technologically underdeveloped areas				Technologically developed areas			
				Local variety		Modern variety		Local variety		Modern variety	
		Optimal transfer (Tk/mn/ person)	Post-transfer Poverty	Optimal transfer (Tk/mn/ person)	Post transfer poverty	Optimal transfer (Tk/mn/ person)	Post-transfer poverty	Optimal transfer (Tk/mn/ person)	Post-transfer poverty	Optimal transfer (Tk/mn/ person)	Post-transfer poverty
1. Landless 0 - 0.04	6.95	48.91	3.12	44.84	2.37	38.61	2.09	43.66	2.68	45.55	2.57
2. Near Landless (0.05 - 0.49)	5.45	29.48	3.38	31.69	2.59	28.52	2.30	29.23	2.90	31.10	2.80
3. Marginal (0.50 -1.49)	3.49	-2.88	3.49	0.96	3.27	0.83	3.27	-2.42	3.49	0.02	3.33
4. Small (1.50 - 2.40)	1.53	-42.60	3.45	-31.33	3.22	-26.75	3.22	-36.08	3.45	-33.63	3.29
5. Medium (2.50 - 7.49)	1.53	-60.53	3.77	-68.95	4.45	-51.33	4.10	-53.50	3.86	-66.40	4.28
6. Large (7.50+)	0.83	-158.44	5.49	-178.55	6.70	-200.12	8.24	-179.36	6.75	-174.92	6.47
Rural Bangladesh	4.45	0	3.49	0	3.16	0	3.01	0	3.30	0	3.25
Equivalent Gain (Tk/month/person)	-	10.77	-	16.97	-	19.93	-	14.24	-	15.21	-

Table 5: ***Simulated effects of land-contingent poverty reduction schemes for Bangladesh, 1988/89***

Landholding class (acres)	Pre-transfer P_2 index (x100)	Scheme 1		Scheme 2		Scheme 3		Scheme 4		Scheme 5 ($\bar{x}$=46)		Scheme 6 ($\bar{x}$=46)	
		x^*	P_2^*	x^*	P_2^*	x^*	P_2^*	x^*	P_2^*	x^*	P_2^*	x^*	P_2^*
1. Landless (0-0.04)	6.9	48.9	3.1	31.2	4.2	39.1	3.7	46.3	3.3	85.3	1.5	46.0	3.3
2. Near landless (0.05-0.49)	5.4	29.5	3.4	10.8	4.6	19.2	4.0	26.6	3.5	68.0	1.7	46.0	2.5
3. Marginal (0.50-1.49)	3.5	-2.9	3.5	-20.0	4.6	-13.2	4.1	-5.7	3.7	36.4	1.7	46.0	1.4
4. Small (1.50-2.49)	1.5	-42.6	3.5	-20.0	2.3	-40.0	3.3	-45.4	3.6	0	1.6	46.0	0.5
5. Medium (2.50-7.49)	1.5	-60.5	3.8	-20.0	1.9	-40.0	2.7	-63.5	3.9	0	1.4	46.0	0.5
6. Large (7.50+)	0.8	-158.4	5.5	-20.0	1.1	-40.0	1.4	-80.0	2.3	0	0.8	46.0	0.4
Rural Bangladesh	4.5	0.0	3.5	0.0	3.8	0	3.6	0	3.5	46.0	1.6	46.0	1.9
Equivalent gain (Tk/month/person)	-	10.8	-	5.8	-	8.3	-	10.0	-	10.2	-	-	-

x^* denotes the poverty minimizing transfer (Tk/month/person), P_2^* denotes the post-transfer poverty index (x100).

Table 6: ***Sensitivity of scheme 5, Table 5, to alternative poverty lines and budgets***

Landholding class (acres)	Alternative poverty lines ($\bar{x}$=40)			Alternative budgets (z=370)		
	z=270	z=400	z=470	$\bar{x}$=20	$\bar{x}$=60	$\bar{x}$=80
1. Landless (0-0.04)	68.4	78.7	80.6	50.5	101.1	119.7
2. Near landless (0.05-0.49)	60.9	59.3	59.0	31.1	85.7	106.8
3. Marginal (0.50-1.49)	33.9	26.9	25.5	0.0	54.0	75.3
4. Small (1.50-2.49)	0.0	0.0	0.0	0.0	15.0	36.4
5. Medium (2.50-7.49)	0.0	0.0	0.0	0.0	5.5	21.7
6. Large (7.50+)	0.0	0.0	0.0	0.0	0.0	0.0
Post-transfer P_2 (x100)	2.3	2.6	5.3	2.7	1.1	0.7
Equivalent gain (% of budget)	11.3 (28.3)	8.6 (21.5)	6.9 (17.2)	5.9 (29.7)	11.6 (19.3)	11.4 (14.3)

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