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ON THE TARGETING AND REDISTRIBUTIVE EFFICIENCIES OF ALTERNATIVE TRANSFER INSTRUMENTS

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ABSTRACT

We show how the so-called *distributional characteristic* of a policy instrument can be additively decomposed into two components: one that captures the *targeting efficiency* of the instrument, the other its *redistributive efficiency*. Using these measures, we provide an interpretation of the commonly used *leakage* and *undercoverage* rates (and other indices based on these concepts) within standard welfare theory. Essentially, one can interpret such indices as special (and restrictive) cases of the targeting efficiency index. As well as failing to capture the relative redistributive efficiencies of policy instruments, they also implicitly assume a set of value judgments consistent only with the commonly used poverty gap. For illustrative purposes, we present an empirical application of the decomposition approach to Mexican data.

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1. INTRODUCTION

In response to a tightening of government finances in the wake of structural adjustment reforms and other budgetary "shocks" in developing countries, the desire to design more efficient poverty-alleviation (or transfer) programs has become central to the policy debate. In terms of policy choices, there has been a movement toward policy instruments that "target" the budget more efficiently to the "target group," e.g., the poor.[1] A common approach to evaluating the relative efficiency of alternative programs has been to compare *leakage* and *undercoverage* rates (Baker and Grosh 1994), or the closely related concepts of E-mistakes and F-mistakes (Cornia and Stewart 1995), as well as ROC curves (Wodon 1997). While such indicators capture some aspects of the welfare impacts from better targeting, they also have obvious shortcomings. For example, the undercoverage (U) and leakages (L) approach focus on the identity of the recipients, i.e., poor or nonpoor, ignoring the size and distribution of the budget.

This paper has four objectives. After this introduction, Section 2 sets out a simple general equilibrium model for the evaluation of alternative transfer programs (or policy instruments). Using this model, we derive the total welfare impact for a range of policy instruments as the sum of the *direct* effect on welfare plus the *indirect* welfare effect arising from the need to restore equilibrium in product and factor markets as well as to

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[1] Examples include the PROGRESA program in Mexico, the PRAF program in Honduras, and programs under consideration in a number of other Latin American countries. All these programs have a poverty-alleviation cash transfer component, and all are in part motivated by the desire to move to better-targeted policy instruments.

public finances. Most analyses of the distributional impact of programs focus on the direct impact on welfare, and in this paper we are concerned exclusively with this component. Section 3 derives the so-called *distributional characteristic* of a policy instrument as the welfare-weighted sum of transfers across households divided by the unweighted sum of transfers, i.e., the transfer budget. We show how one can additively decompose this statistic into two terms, one that captures the *targeting efficiency* of the instrument, the other its *redistributive efficiency*. Section 4 uses this decomposition to provide an interpretation of the conventional leakage and undercoverage rates. Essentially, these can be seen as special (and restrictive) cases of the targeting efficiency index. Finally, for purely illustrative purposes, Section 5 presents an empirical application of the decomposition using Mexican data, showing that the welfare gains associated with moving away from universal subsidies arise mainly from improved targeting—as opposed to redistributive—efficiency. Section 6 provides a summary and conclusions.

2. A GENERAL EQUILIBRIUM MODEL

In this section we set out a simple general equilibrium model that helps to highlight the important ingredients in any welfare evaluation of alternative policy instruments. The model presented draws heavily on the work of Drèze and Stern (1987), which in turn owes much to Guesnerie (1979).

The impact of any policy instrument (e.g., the introduction, or change in the level, of a tax or cash transfer) on social welfare can be separated into its direct impact on welfare and its indirect impact arising from the need to restore equilibrium in product and factor markets as well as in government finances. The policy instrument leads to changes in demand that, in general, must be met by reallocating scarce resources between competing activities. If all markets are perfectly competitive and the government has access to optimal lump-sum transfers, then *aggregate* indirect effects are zero because on the margin the benefits from reallocation equal the costs (i.e., marginal benefits are set equal to marginal costs throughout the economy and these also coincide with social costs and benefits). Where income distribution is sub-optimal, any indirect welfare effects arise solely from the redistribution of income. In the absence of perfect markets or where there are government-induced tax distortions, additional indirect welfare effects, due to the "reallocation" of resources and the "deadweight loss" from taxes, are also present. In general, such indirect effects can constitute a substantial proportion of the direct effects, even for marginal reforms.[2]

Consider an economy with three sets of agents: households, firms, and the government. Households are assumed to maximize utility that is a function of consumption levels, subject to a budget constraint that ensures that incomes equal

[2] See Coady and Harris (2000) for a more formal discussion and for calculations for Mexico.

expenditures.[3] In addition, households may face quantity constraints, e.g., subsidized rationing of some commodities. Household behavior can then be completely captured by an indirect utility function, $V(\boldsymbol{q},\boldsymbol{q_s},m,0)$, where $\boldsymbol{q}$ is a vector of prices faced by the consumer (including the price of labor), $\boldsymbol{q_s}$ is a vector of subsidized ration prices, $\boldsymbol{m}$ is household lump-sum income, and 0 is a vector of commodity rations.[4] The budget constraint for each household (denoted by h superscript) is then given by $\boldsymbol{q.x} = \boldsymbol{m}$, where $\boldsymbol{m}$ is lump-sum (nonlabor) incomes defined for each household as

$$m^h \equiv r^h + (\boldsymbol{q} - \boldsymbol{q_s}).0^h \ ,$$

where r^h is a cash transfer by the government to household h and 0^h is a vector of commodity ration levels facing the household that it receives at a subsidized price, $\boldsymbol{q_s} < \boldsymbol{q}$. Firms are assumed to operate under constant returns to scale so that supply is demand determined and profits are zero. The government's budget constraint is given by

$$R \equiv \boldsymbol{tx} - \textstyle\sum_h r^h - (\boldsymbol{q} - \boldsymbol{q_s}).0 \ ,$$

where $\boldsymbol{t}$ is a vector of taxes on commodities consumed and factors supplied by households, with $\boldsymbol{t} = \boldsymbol{q} - \boldsymbol{p}$ and $\boldsymbol{p}$ being a vector of producer prices. Since producer prices are assumed fixed, we have $d\boldsymbol{q} = d\boldsymbol{t}$.

The problem the "social planner" then faces is to redistribute resources using the most efficient policy instruments from among a set that includes commodity taxes or

[3] We are obviously treating the household as the relevant unit for welfare analysis. This formulation ignores a number of important policy issues related to the intrahousehold allocation of resources, e.g., the response of households to the transfer of resources to individual members (children, females).

[4] Throughout, bold type indicates a vector.

subsidies, ration levels and prices, and cast transfers. The constraints facing the planner are the market equilibrium constraints that demand must equal supply as well as the government budget constraint. As shown in DrPze and Stern (1987), using Walras' law, the planner's problem may be rewritten as

$$\langle (\boldsymbol{s};\mathrm{w}) \equiv W(\ldots,V^h(\boldsymbol{s};\mathrm{w}),\ldots) + \lambda R\,, \tag{1}$$

where ***s*** is a vector of policy instruments that are completely controlled by the planner and are chosen optimally, w is a vector of policy instruments that are outside the planner's complete control and which include the policy instruments highlighted above, and λ is the Lagrange multiplier on the government budget constraint (i.e., the marginal social—or shadow—value of government revenue). As before, $V^h(.)$ is the indirect utility function for *h*, and *W*(.) is a Bergson-Samuelson social welfare function. This formulation of the problem has the attraction of presenting the problem in terms of the standard trade-off between consumer welfare and government revenue. The impact of any "policy reform" on *W*(.) captures the direct welfare impact of the reform, while the impact on revenue captures the indirect welfare impacts.[5]

The policy reforms under consideration are assumed to include a change in the tax (subsidy) on commodity *i*, a change in the quantity or price of a rationed commodity, or an introduction of a cash-transfer program. All can be viewed as part of the exogenous

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[5] This implicitly assumes that the only distortions in the economy are government induced. Where other market imperfections exist, one needs to focus on "shadow revenue" that captures income effects accruing outside the government budget. See DrPze and Stern (1987) for detailed discussion.

policy parameters, w. The welfare impact of each policy reform can be seen by differentiating (1) w.r.t. each of the policy instruments (i.e., m^h, t_i, q_{si}, and 0_i) to get

$$\frac{\partial \leq}{\partial w}\,\mathrm{d}w \equiv \frac{\partial \mathrm{W}}{\partial w}\,\mathrm{d}w + l\,\frac{\partial \mathrm{R}}{\partial w}\,\mathrm{d}w \quad , \tag{2}$$

where the first term on the right-hand side captures the direct welfare effects and the second term, the indirect welfare effects.[6] Below we consider each policy reform in turn.

We first consider a (marginal) change in government transfers to households, $d\boldsymbol{m} \equiv \{dm^h\}$. Differentiating (1) w.r.t. $\boldsymbol{m}$ we get

$$\frac{\partial \leq}{\partial m}\,dm = \sum_h\, b^h\ dm^h \ - \ l \left(\sum_h dm^h - t.\frac{\partial x}{\partial m} \right) dm\,, \tag{3}$$

where $\beta^h \equiv (\partial W/\partial V^h)(\partial V^h/\partial m^h)$ is the marginal social valuation of income to h (or its "welfare weight"). This welfare weight is higher for the more "deserving," e.g., the poor, and so the social value depends on the distribution of the transfers across households. λ is the social cost of the revenue used to finance the transfer (i.e., the so-called *cost of public funds*), and the last term in brackets on the right-hand side captures the indirect revenue effects as demands change in response to the transfer. If households receiving the transfers have a high propensity to buy relatively highly taxed commodities, then this will reduce the net impact on the government budget and thus decrease the social cost of the transfer.

[6] This derivation makes use of the fact that the welfare impacts of changes in ***s*** in response to changes in w can, by the envelope theorem, be ignored.

Now consider a change in the tax of commodity *i*, e.g., food. If all households are net consumers of *i*, then redistributing income will usually involve reducing t_i (or increasing the subsidy, in which case t_i is negative). Using the standard properties of the indirect utility function, the welfare impact of a tax change is then

$$\frac{\partial \leq}{\partial t_i}\, dt_i = -\sum_h b^h\, x_i^h\, dt_i + l\left(x_i + t.\frac{\partial x}{\partial t_i} \right) dt_i\ . \qquad (4)$$

The first term indicates that households gain from the reform according to the level of their existing consumption; the existing level of demand gives a measure of this welfare effect in money terms. The direct impact on social welfare is greater the more poor households consume the good. Again, the social cost of the transfer using a commodity tax is lower if households respond to the price change by switching demand away from (toward) relatively highly subsidized (taxed) commodities.

The impact of a change in the subsidy on rationed commodities is got by differentiating (1) w.r.t. $\boldsymbol{q}_{is}$ to get

$$\frac{\partial \leq}{\partial q_{si}}\, dq_{is} = -\sum_h b^h\, 0_i^h\, dq_{is} + l\left(\sum_h 0_i^h - 0_i\, t.\frac{\partial x}{\partial m} \right) dq_{is}\ . \qquad (5)$$

The extent to which households lose depends on the level of the ration quantities they receive. Also, the government receives budget gains as the subsidy bill decreases, these gains being offset if households decrease their consumption of relatively heavily taxes commodities.

Changing the level of a ration involves differentiating w.r.t. 0_I giving

$$\frac{\partial \underline{<}}{\partial 0_i} d0_i \equiv \sum_h b^h (q_i - q_{is})\, d0_i - l\,(q_i - q_{is})(h^* - t.\frac{\partial x}{\partial m})\, d0_i\ , \qquad (6)$$

where h^* indicates the number of households who receive the extra rations. Households gain by the extent of the subsidy (i.e., they switch from more expensive market purchases when they get the extra ration) with the social value of the change increasing the more effectively the rations are targeted at poor households. This essentially assumes that rations are infra-marginal or that resale is possible. But the government has to finance the extra subsidized consumption (although it receives extra revenue to offset this if households increase their consumption of taxed commodities). Where the commodity cannot be purchased through a market, q_i must be replaced with the marginal willingness to pay, which can obviously vary across households.

The above equations can be interpreted as the marginal social value (MSV) of a change in each policy instrument, being positive/negative when the reform increases/decreases welfare. Alternatively, these can be interpreted as optimality conditions where we set the MSV to zero and solve for the optimal level of the relevant policy instrument. This simply highlights the fact that it is sometimes useful to interpret optimal policy as a special case of the theory of policy reform—the optimum is a situation from which no welfare-improving reform exists.[7] In the next section, we use the

[7] On this, and related issues, see Dixit (1975), Drèze and Stern (1987) and Coady and Drèze (2000).

above set of equations to provide a very useful framework for distributional policy analysis.

3. THE DISTRIBUTIONAL IMPACT OF POLICY INSTRUMENTS

The preceding section set out the ingredients for the evaluation of policy reform in the context of a simple general equilibrium model. This section focuses more specifically on the distributional impact of these reforms and ignores completely the general equilibrium consequences. This is not to say that these impacts are unimportant; on the contrary, they can be quite significant when the economy is characterized by large "distortions" and may differ substantially across instruments. Rather, the focus reflects that of much of the literature on the distributive efficiency of alternative policy instruments, which is our main concern here. The indirect effects identified above may be added onto the direct effects identified below to get the total effect.[8]

The direct distributional effect of the policy reforms (which by definition ignores the indirect general equilibrium welfare effects) can be derived from the above equations either by setting $\boldsymbol{t} = \mathbf{0}$ (i.e., by essentially assuming they are zero since no "distortions" exist) or by assuming no behavioral responses (i.e., price and income elasticities are zero). We can then solve out for the relevant λ, which can be interpreted as the marginal social benefit of transferring an extra unit of government revenue to households using

[8] See Coady and Harris (2000) for a more detailed discussion and an empirical example.

each policy instrument (Ahmad and Stern 1984, 1991; Skoufias and Coady 2000). For example, for a cash-transfer program this is calculated as

$$l_m = \frac{\sum_h b^h \, dm^h}{\sum_h dm^h}, \tag{7}$$

where the denominator can be interpreted as the poverty-alleviation transfer budget. This is essentially a benefit-cost ratio with the welfare-weighted sum of transfers across households constituting the benefit and the unweighted sum of transfers (i.e., the transfer budget) as the cost. A similar parameter can be derived for each policy instrument by replacing ***dm*** with $\boldsymbol{x}_i$ for tax instruments, by O_i for changes in the price of rationed commodities, and by ($\boldsymbol{q}_i$ - $\boldsymbol{q}_{is}$) for changes in the prices of rationed commodities (summed over h^*). At the optimum, the λs across instruments will be equalized.[9] Away from the optimum, for each instrument there will be a separate λ, and these can then be compared

[9] In this simple model, i.e., ignoring the general equilibrium (or, equivalently, second-best) effects, at the optimum λs will also be equal to the same social marginal utility of income to households (β), which will be constant across households, consistent with income distribution being optimal. In a second-best world, the optimum will not in general be characterized by equal incomes or a constant β (see Coady and Drèze 2000 for more detailed discussion).

across instruments. Social welfare can be increased by switching from instruments with low λs to those with high λs.[10]

For our purposes, it is useful to decompose λ by both adding and subtracting the *average* level of the transfer across all *beneficiaries* (i.e., across households with $dm^h > 0$) to get

$$\lambda = \frac{\sum_h \beta^h . d\overline{m}}{\sum_h dm^h} + \frac{\sum_h \beta^h (dm^h - d\overline{m})}{\sum_h dm^h} = \lambda_T + \lambda_R \,, \tag{8}$$

where λ_T is the *targeting efficiency* and λ_R is the *redistributive efficiency* of the transfer instrument. So λ_R captures the welfare impact, given those who are receiving transfers (i.e. the targeting rule), of deviating from uniform transfers. Alternatively, one can interpret λ_T as the welfare impact of a program that transfers the poverty alleviation budget to the same beneficiary households but in equal amounts, and λ_R as the adjustment that needs to be made to allow for the differentiation of transfers across households in a more progressive ($\lambda_R > 0$) or regressive ($\lambda_R < 0$) manner. The sense in which λ_R captures the redistributive efficiency of the policy instrument is made clearer by interpreting it as

[10] By letting β^h reflect the weights implicit in poverty evaluations (e.g., weights being zero above the poverty line but positive and nondecreasing in income below), we get standard results in the poverty literature (Besley and Kanbur 1988). Where the transfer takes the form of changing universal ration subsidies (or equivalently universal income transfers), using the poverty gap measure we get the result that the marginal social benefit (λ) is a function of the headcount index (Besley and Kanbur 1988, 704–706). The greater the proportion of the transfer budget received by poor households (or, equivalently, the greater the proportion of the total ration quantities consumed by the poor) the higher is λ. The result is easily extended to the case where the rations are geographically targeted. When we consider subsidies on market-purchased goods, the result is "that the net effect depends on how large total consumption of a commodity is relative to its consumption by the poor" (p. 708), which is another way of stating the budget allocation criterion as captured in λ.

the welfare impact of a self-financing program that transfers dm^h to households and finances this by a lump-sum poll tax on all households with $dm^h > 0$ (i.e., all beneficiary households).[11]

This decomposition of the welfare impact essentially defines progressivity (or regressivity) with respect to a distributionally Aneutral@ uniform transfer. Alternatively, one could define a neutral transfer program as one that is proportional with respect to household incomes.[12] This perspective can also be easily accommodated within the above decomposition by subtracting a proportional transfer from beneficiaries, as opposed to a uniform transfer, with the factor of proportionality being determined both by the total incomes of beneficiary households and the total budget. As before, λ_T is still independent of the size of the budget. One way of interpreting these alternative decompositions is in terms of their informational requirements. Given the budget and knowledge of which households receive transfers, the uniform transfer requires only extra information on the number receiving transfers, while the proportional requires additional information on incomes or at least the sum of incomes. Note also that a uniform transfer financed by a proportional tax is progressive ($\lambda_R > 0$), but a proportional transfer financed by a uniform

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[11] Strictly speaking, λ_R is a *conditional* redistributive index, since the program is assumed to be financed by a poll tax only on those receiving transfers. However, it is straightforward to construct a *generalized* or *unconditional* redistributive index by extending the poll tax across all households.

[12] See Lambert (1993, p. 164-7), Pfingsten (1986) and Besley and Preston (1988) for a more detailed discussion of the concept of progression and the distributional "neutrality"of transfer mechanisms. For a discussion on the analysis of the progressivity of tax schedules and the reform of these schedules see, for example, Keen, Papapaanagos, and Shorrocks 2000.

poll tax is regressive ($\lambda_r < 0$). Therefore, defining neutrality with reference to deviations from a uniform transfer implicitly reflects a stronger concern for redistribution.

Below we will use this decomposition to interpret the more conventional leakage and undercoverage measures of targeting efficiency within the above welfare theoretic framework. We will also use this decomposition for an empirical analysis of the relative welfare impact of alternative transfer instruments. For the sake of argument, consider some reference transfer scheme, *j*, e.g., the *status quo* or some optimal scheme. Then the welfare impact of moving to some alternative scheme, *i*, is

$$\frac{l_i - l_j}{l_j} = \frac{l_{Ti} - l_{Tj}}{l_j} + \frac{l_{Ri} - l_{Rj}}{l_j}, \qquad (9)$$

where the first term on the right-hand side captures the proportional change in welfare from moving from the reference scheme to the new scheme due to their different degrees of targeting efficiency, and the second term captures the proportional impact due to their different degrees of redistributive efficiency. Notice that a policy instrument that is poorly targeted may still have a relatively high welfare impact if the budget is allocated disproportionately to lower income households.

4. CONVENTIONAL ANALYSIS OF TARGETING

This section describes the more conventional approaches to analyzing the targeting effectiveness of transfer programs and interprets them within the standard welfare theoretic framework set out above.

LEAKAGE AND UNDERCOVERAGE

It is common for analyses of the targeting efficiency of programs and policies to focus on leakage (L) and undercoverage (U) rates, conventionally defined by Baker and Grosh (1994) as

> *Leakage*: The proportion of household reached by the program (i.e., are "in," denoted by i, as opposed to "out of," denoted by o, the program) who are classified as nonpoor (errors of inclusion), or
>
> $$L = \frac{N_{np,i}}{N_i},$$
>
> where $N_{np,i}$ is the number of nonpoor who are included in the program and N_i is the total number of households in the program.

Undercoverage: The proportion of poor households not included in the program (errors of exclusion), or

$$U = \frac{N_{p,o}}{N_p},$$

where $N_{p,o}$ is the number of poor households who are left out of the program and N_p is the total number of poor households.

By construction we have $N_i \equiv N_{np,i} + N_{p,i}$ and $N_o = N_{p,o} + N_{np,o}$, where the total number of households is $H = N_p + N_{np} = N_i + N_o$. Using these identities it is easy to see that $(1 - L) = N_{p,i} / N_i$ and $(1 - U) = N_{p,i} / N_p$. These latter indicators will be useful later.

An obvious criticism of these indicators is that they focus only on who gets the transfers and not on how much households get (i.e., the size of the transfer budget). Also, when comparing across programs, it is often the case that those that score well on undercoverage simultaneously score badly on leakage. For example, so-called universal programs would be expected to score relatively well on undercoverage but badly on leakage, but this approach does not address the issue of trade-off. Much of the problem lies in the fact that welfare weights are not made explicit, although it is obvious that all the poor and all the nonpoor are treated similarly—even if the issue of their relative weights is ignored.

We can try to give a possible interpretation to U and L within the standard welfare framework described above. Consider a program that has a budget of $1 for every poor household and that distributes $1 to N_i households using an imperfect targeting rule. If everyone below the poverty line is given a welfare weight of unity and everyone above the poverty line a welfare weight of zero, as is the case for the poverty gap indicator, then for this program we have, using equation (7),

$$l = \frac{N_{p,i}}{N_i},$$

which can also be interpreted as the proportion of the total budget (i.e., of N_i by construction) that reaches poor households. This is just (1 - L), a sort of measure of "coverage," so that L at least has some basis in welfare theory, even if only capturing a certain dimension of such programs. But it also equals (1 - U)N_p/N_i, so that some adjusted version of U also has a welfare interpretation. However, since N_i (and thus N_p/N_i) can vary across programs, each in general needs to be adjusted differently. Note also that when $N_p = N_i$, U and L coincide—this holds when the receipt of *some* income by a nonpoor household precludes the receipt of *any* income by a poor household, i.e., either the money goes to a poor or to a nonpoor household. It will apply, for example, when the number of (not necessarily poor) households given transfers is determined by the number of poor households.

To summarize, $(1 - L)$ is a valid measure of the welfare impact only for programs that transfer equal amounts to beneficiaries *and* only for a particular set of welfare weights (those consistent with the poverty gap indicator).[13] Using equation (8), it is clear that such a measure captures only the targeting efficiency (λ_T) of the program and ignores its redistributive efficiency (λ_R).

ROC CURVES

The welfare basis of the related concept of "relative operating characteristics" (ROC) curves can also be addressed using the above formula (Wodon 1997). This approach to poverty analysis uses the concepts of "sensitivity" (SE) and "specificity" (SP) defined as follows:

Sensitivity: The proportion of poor households who receive benefits (are "in").
Specificity: The proportion of nonpoor households not in the program.

Using the earlier notation, these are thus calculated as[14]

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[13] If all of the transfer to poor households contributed to reducing the poverty gap, then $(1 - L)$ equals the percentage reduction in the poverty gap. However, in practice, transfers to some poor households may be more than sufficient to bring the household up to the poverty line, so that $(1 - L)$ is an upper bound on the latter. The difference essentially arises from the fact that whereas our "marginal" analysis of transfers assumes welfare weights are fixed, the leakage measures encompass a discrete welfare-weighting scheme whereby the weight attached to a poor household goes from 1 to zero on crossing the poverty line. See also the discussion in Atkinson (1995, 30) of the concept of "horizontal efficiency" used by Weisbrod (1970). To get from λ to the poverty gap measure, just insert, in equation (8), $dm^h = (z - y^h)$ for those brought over the poverty line, z.

[14] Note that there appears to be a discrepancy in Table 1 of Wodon (1997, 2084) and its note regarding definitions. We use *SP* and *SE* definitions, which both reflect successes.

$$SE = \frac{N_{p,j}}{N_p} = l \, \frac{N_i}{N_p} = (1 - U)$$

and

$$SP = \frac{N_{np,o}}{N_{np}} = 1 - \frac{N_i}{N_{np}} + l \, \frac{N_i}{N_{np}} = 1 - L \frac{N_i}{N_{np}}).$$

Again, since, in general, N_i can differ across programs, both *SE* and *SP* need to be adjusted before they can be used for welfare comparisons across programs that transfer equal amounts to beneficiaries. With regard to ROC analysis where, for a given poverty line, one chooses the program (or instrument) that minimizes some weighted average of *SE* and *SP* (with, say, *a* and *b* as weights, respectively), it should be clear that these weights should be such that the program chosen should also maximize λ. It is straightforward to show that for this to hold it must be that $a = \alpha + b(n/p)$, where *a* and *b* are the weights on *SE* and *SP*, respectively, α is the number of poor households divided by the total number of households receiving transfers, *n* is the proportion of nonpoor who receive, and *p* the proportion of poor who receive.

E- AND F-MISTAKES

Others in the literature refer to E- and F-mistakes (Cornia and Stewart 1995). F-mistakes are equivalent to U above. E-mistakes are usually defined similarly to leakage using either the total number of nonpoor or the total population as the numerator. However, here we wish to focus on the definition of E-mistakes as

$$E = \frac{v\, N_{np}}{S},$$

where v is the average transfer received by all nonpoor households and S is the total budget. It is this easy to see that, for programs transferring equal amounts to beneficiaries, this just equals

$$E = \frac{\sum_{np} dm^h}{\sum_h dm^h} = 1 - l\,,$$

where the numerator is summed over all nonpoor and the denominator is summed over all households (i.e., poor and nonpoor). As Cornia and Stewart (1995, 353) recognized, "where the subsidy consists of a given sum, equal for each recipient…, this ratio is equivalent to the ratio of $N_{np,i}/N_i$" (our notation). From our perspective, choosing the program with the lowest E-mistakes is equivalent to choosing that with the highest λ, so the former is also the correct welfare measure, but again only for welfare weights consistent with the poverty gap measure.

5. ILLUSTRATION OF THE DECOMPOSITION USING DATA FROM MEXICO

This section shows how the decomposition presented above can be used to evaluate the relative targeting and redistributive efficiencies of alternative policy instruments. For the purposes of illustration, we focus on the recent shift in Mexico's poverty alleviation strategy toward better-targeted transfer schemes. The point of departure is one where universal food (i.e., cereals) subsidies constitute the main plank of the poverty alleviation strategy. However, these are perceived as being poorly targeted with much leakage of benefits to nonpoor households.

One can then consider a number of alternative targeting strategies. Here we consider two broad approaches: demographic and poverty targeting. Demographic targeting involves giving transfers only to households with children, similar to child benefit in many developed countries. Poverty targeting involves giving transfers only to households classified as poor according to some—usually welfare-based—criterion. The actual program implemented in Mexico is a combination of these two approaches, with an element of geographic targeting also involved. The targeted programs considered here are:

(i) *Demographic transfers*: where cash transfers are given to all households with children according to the structure set out in Table 1. Four alternatives are considered, namely, transfers to those children ages 0B4 years, transfers to those ages 5B10 years, transfers to those ages 0B10 years, transfers to those ages 5B19 years, or transfers given to those ages 0B19 years.[15]

(ii) *Poverty transfers*: where cash transfers, set at a uniform rate, are given to poor households. Also considered are a geographically targeted version where a uniform transfer is given to all households located in poor municipalities. Such uniform transfers can also be interpreted as capturing the welfare impacts arising from changes either in the levels of infra-marginal subsidized consumer rations or changes in the subsidy levels.

The actual program implemented was a combination of both (i) and (ii), since demographic transfers were given to poor households. This combined program is used to

Table 1—Structure of demographic transfers (pesos per month)

Childs age (years)	Male	Female
0-4	37.5	37.5
5-10	37.5	37.5
11-14	87.5	92.5
15-19	97.5	112.5

Notes: The program with cash transfers to 0-4-year-olds is denoted by "DemoC," to 5-10-year-olds by "DemoP," to 5-19-year-olds by "DemoPS," and to 0-19-year-olds by "DemoAll." When poverty targeting is combined with demographic targeting, programs are denoted by placing a "P" in front, e.g., "PDemoP" for a demographic program targeted at 5-10-year-olds. The "PDemoPS" program is used to determine the budget, which is then held fixed across all programs, e.g., by scaling the benefits structure up or down as appropriate.

[15] See Case and Deaton (1998) for an example of a cash transfer (pension) scheme targeted at older age groups in South Africa, which they find to be a good targeting mechanism given the high dependency ratios in these households.

determine the budget. Households are classified as poor if they fall into the bottom 30 percent of the distribution of consumption per adult equivalent (henceforth denoted as income, *y*).[16] With geographic targeting, the uniform transfer is given to the poorest municipalities until 30 percent of households are included.[17] Also considered is an alternative where the transfer amount is doubled and concentrated only on extremely poor municipalities. Table 2 defines the program acronyms used in the figures.

The data source is the Mexican household survey for 1996. Mean income is $455 per month and the poverty line is $200. The average poverty gap is 55 percent of the total

Table 2—Definition of program acronyms

Programs	Definition
Food Subsidies	Universal food subsidies on cereals
DemoC	Transfers to children ages 0-4 years in all households
DemoCP	Transfers to children ages 0-10 years in all households
DemoALL	Transfers to children ages 0-19 years in all households
DemoPS	Transfers to children age 5-19 years in all households
DemoP	Transfers to children ages 5-10 years in all households
GeogM	Uniform transfer to households in poor localities
Geog2M	Double GeogM transfers to poorest half of poor localities
Uniform	Uniform transfers to all poor households
PdemoC	Transfers to children ages 0-4 years in poor households
PdemoPS	Transfers to children ages 5-19 years in poor households
PdemoALL	Transfers to children ages 0-19 years in poor households
PdemoCP	Transfers to children ages 0-10 years in poor households
PdemoP	Transfers to children ages 5-10 years in poor households

[16] Note that this study does not address the issue of imperfect targeting information, i.e., where an imperfect indicator of income might have to be chosen. For an analysis that suggests that the welfare losses from having to choose income over *preferred* consumption are minimal, see Skoufias and Coady (2000).

[17] For the final municipality included, transfers are given to the poorest households until 30 percent of all households are included.

income of all poor households, i.e., the average incomes would have to be increased to eliminate poverty, and even then this would have to be distributed optimally (i.e., no leakage to the nonpoor and transfers being just sufficient to bring the household to the poverty line). The budget comes out at 47 percent of the poverty gap.

To calculate the various λs, one needs to specify a set of welfare weights, β^{h}. The conventional approach is to calculate these as

$$\beta^{h} = (y^{k}/y^{h})^{\varepsilon}, \tag{10}$$

where k is a reference household (e.g., the household on the poverty line) and $\varepsilon > 0$ is a parameter that captures our aversion to income inequality. The higher this parameter, the greater the relative weight attached to the income of poorer households. For example, for $\varepsilon = 1$ if $y^{k} = 2y^{h}$, then $\beta^{h} = 2\beta^{k}$. For $\varepsilon = 5$, our set of welfare weights puts most of the emphasis on income going to the poorest of the poor. In our empirical illustration, we concentrate on results for $\varepsilon = 2$, but also present results for $\varepsilon = 5$ for comparison.

The λs for the alternative programs are presented in Figure 1a and Figure 1b for $\varepsilon = 2$ and $\varepsilon = 5$, respectively. All alternative programs perform substantially better than food subsidies. There is a clear pattern across targeting alternatives. Demographically targeted programs are dominated by poverty-targeted programs (including geographic targeting), which in turn are dominated by the combination of demographic and poverty targeting.

Figure 1a: Lambda(e=2) Across Alternative Programs

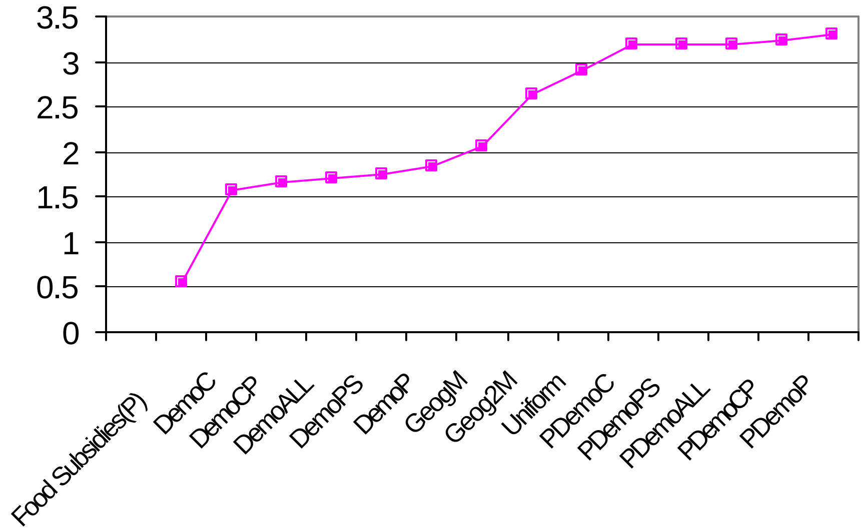
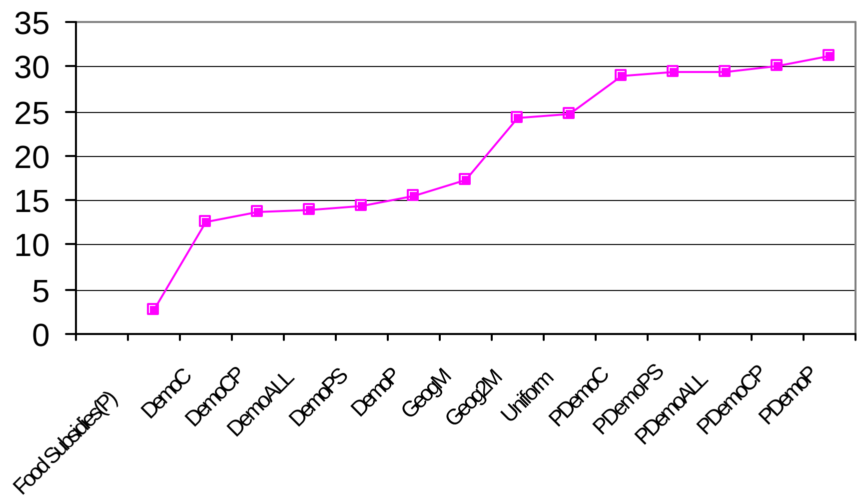


Figure 1b: Lambda (e=5) Across Alternative Programs



The magnitude of the welfare gain in moving from food subsidies to demographically targeted programs is similar to the gain in moving from these latter programs to the combination of poverty and demographic targeting.

Figures 2a and 2b present the proportional welfare gains in moving from food subsidies, and decomposes this gain into that due to improved targeting efficiency and that due to improved redistributive efficiency using equation (9). The contrast between demographic and poverty targeting is clear. As expected, most of the welfare gain from demographic targeting is due to improved redistributive efficiency, whereas most of the welfare gain from poverty targeting is due to improved targeting efficiency. Thus, there is a very high return from improving targeting efficiency, i.e., the additional redistributive gains from combining poverty with demographic targeting are relatively small. Similar results follow when we use proportional—as opposed to uniform—transfers as our reference for neutrality (Figure 3a, 3b).

In summary, then, the important gains achieved by moving away from universal food subsidies to the combined demographic- and poverty-targeted program implemented in Mexico arise mainly from the greater targeting (as opposed to redistributive) efficiency of the approach. The returns to efforts devoted to identifying which households are most deserving (i.e., the poor) appear to be quite substantial.

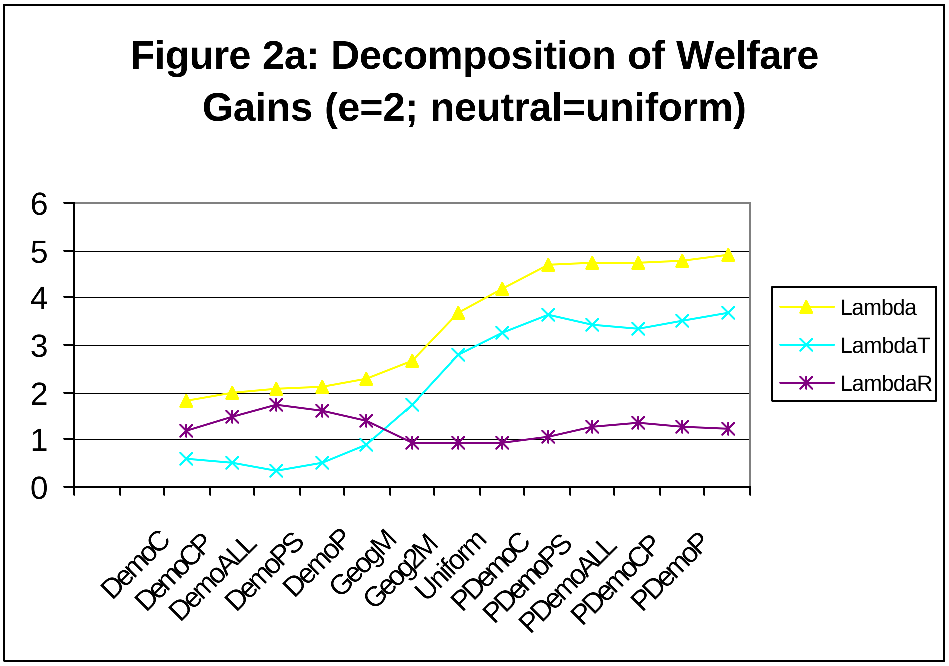


Figure 2a: Decomposition of Welfare Gains (e=2; neutral=uniform)
6
5
4
3
2
1
0
Lambda
LambdaT
LambdaR
DemoC
DemoCP
DemoALL
DemoPS
DemoP
GeogM
Geog2M
Uniform
PDemoC
PDemoPS
PDemoALL
PDemoCP
PDemoP

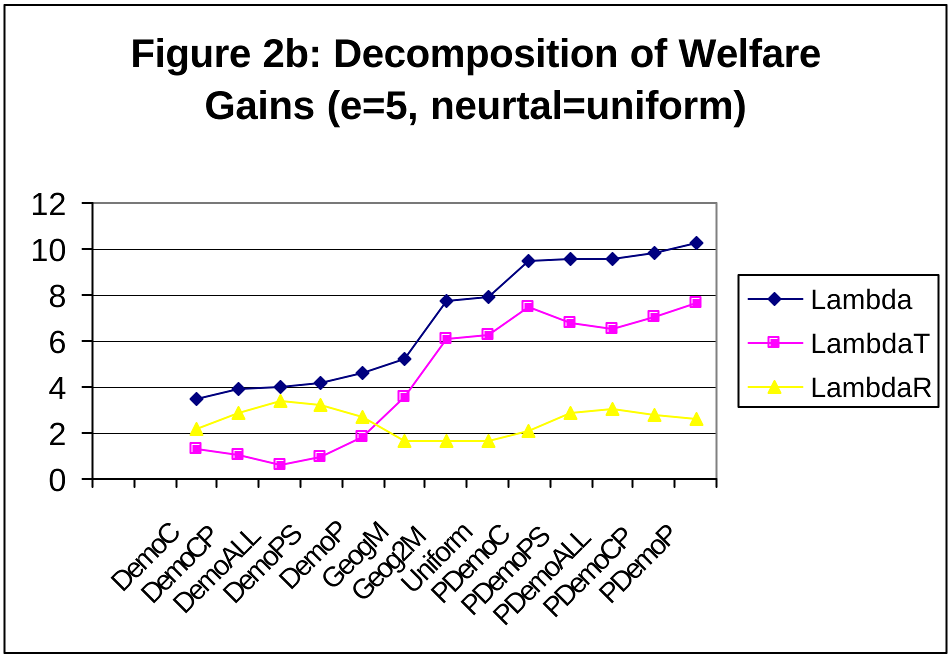


Figure 2b: Decomposition of Welfare Gains (e=5, neurtal=uniform)
12
10
8
6
4
2
0
Lambda
LambdaT
LambdaR
DemoC
DemoCP
DemoALL
DemoPS
DemoP
GeogM
Geog2M
Uniform
PDemoC
PDemoPS
PDemoALL
PDemoCP
PDemoP

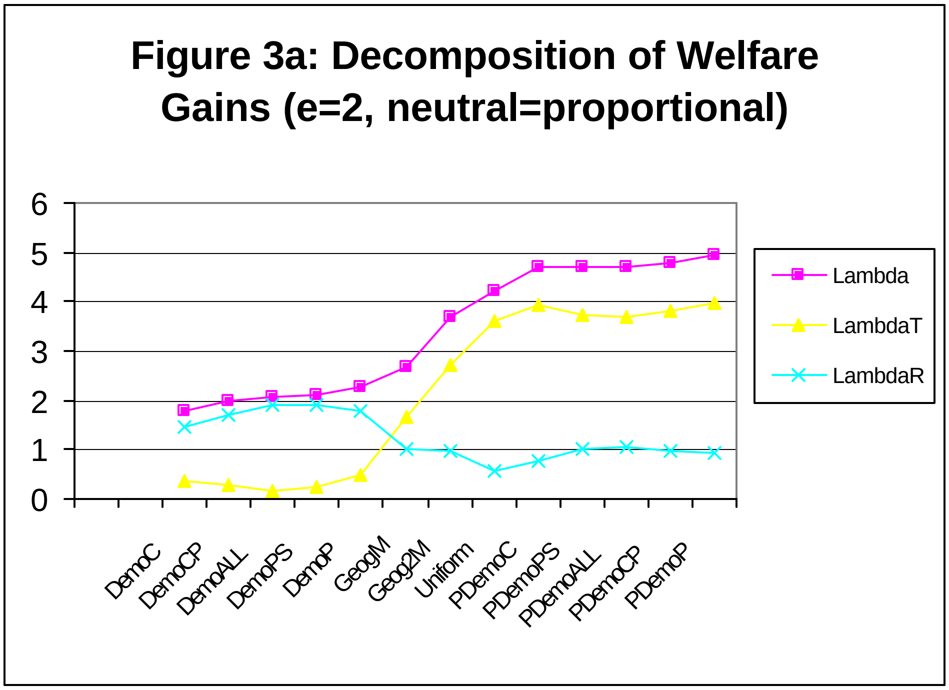


Figure 3a: Decomposition of Welfare Gains (e=2, neutral=proportional)
6
5
4
3
2
1
0
DemoC
DemoCP
DemoALL
DemoPS
DemoP
GeogM
Geog2M
Uniform
PDemoC
PDemoPS
PDemoALL
PDemoCP
PDemoP
Lambda
LambdaT
LambdaR

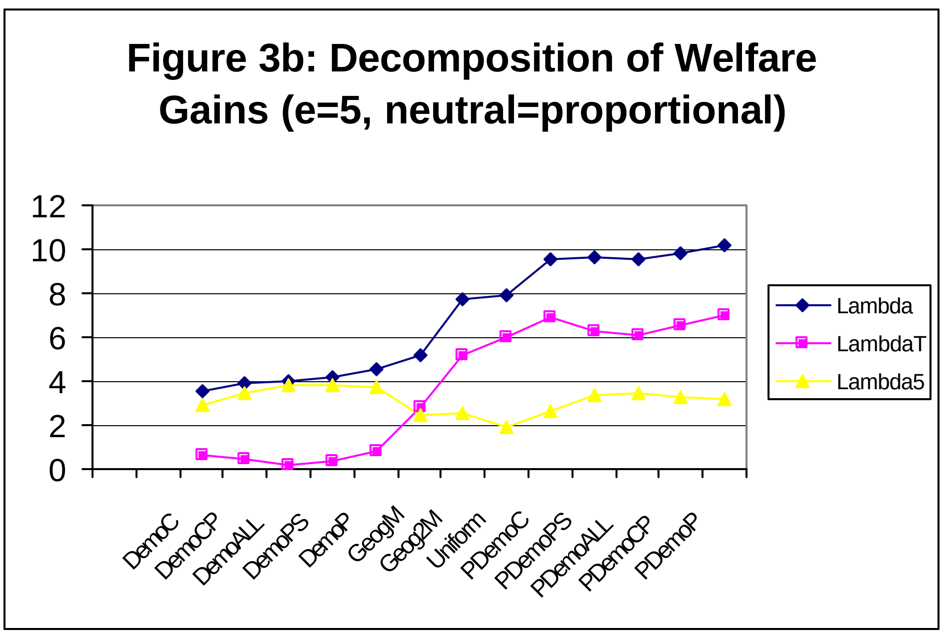


Figure 3b: Decomposition of Welfare Gains (e=5, neutral=proportional)
12
10
8
6
4
2
0
DemoC
DemoCP
DemoALL
DemoPS
DemoP
GeogM
Geog2M
Uniform
PDemoC
PDemoPS
PDemoALL
PDemoCP
PDemoP
Lambda
LambdaT
Lambda5

6. SUMMARY AND CONCLUSIONS

This paper sets out a simple general equilibrium model for the welfare evaluation of alternative poverty-alleviation programs or policy instruments. The total welfare impact of a program is derived as the sum of the direct impact on welfare plus an indirect welfare impact that arises from the need to restore equilibrium to product and factor markets as well as to public finances. Focusing on the direct welfare impact, we decompose the welfare impact of programs into their targeting and redistributive efficiencies. Using this decomposition, we are able to give a welfare interpretation to the more conventional measures of program effectiveness, namely leakage and undercoverage. We show that such measures ignore the relative redistributive efficiencies of programs and, even then, are a valid index of their relative targeting efficiencies only for a set of welfare weights consistent with the poverty-gap measure. Using, as an illustration, the recent policy switch in Mexico toward a more targeted poverty-alleviation program, we show that the biggest welfare gain in moving away from universal subsidies is due to improved targeting, as opposed to redistributive, efficiency.

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