Evaluating Targeted Cash Transfer Programs

A General Equilibrium Framework with an Application to Mexico

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Foreword

It is now widely accepted that social safety nets play a crucial role in any comprehensive poverty alleviation strategy. However, many people perceive that existing social safety nets are not cost effective because they are both badly targeted to poor households and often involve inefficient financing policies. Consequently, many developing-country governments and international development institutions have come to favor direct transfer instruments such as cash transfers or subsidized food rations. But most evaluations of such programs focus solely on the partial equilibrium impacts of program targeting outcomes, and those that focus on the general equilibrium impacts tend to concentrate on their efficiency implications with very limited analysis of income distribution outcomes and little attempt to combine both the equity and efficiency dimensions.

In this report, Coady and Harris study the general equilibrium effects of transfer programs, focusing on the recent switch by the government of Mexico toward targeted transfer programs and away from universal food subsidies. They show how the results from a computable general equilibrium model can be combined with the information available in standard household surveys to provide an integrated analysis of both the direct distributional impact of such programs and the indirect distributional and efficiency impacts arising from the nature of its domestic financing. The focus on the domestic financing aspect of these programs reflects the view that any credible poverty alleviation strategy must have a credible underlying financing strategy, and this need for domestic financing can have important consequences for both the level and the distribution of household incomes. It is often argued, for example, that the major constraints for developing countries in establishing a comprehensive social safety net are the undue strain put on domestic finances and the economic inefficiencies generated by the policy instruments used.

The results presented in the report clearly show that the general equilibrium welfare impacts associated with domestic financing can be quite substantial. When initial redistribution mechanisms are inefficient, the welfare gains from switching to a better-targeted direct transfer scheme are reinforced by efficiency gains associated with the removal of relatively distortionary financing instruments. More generally, the indirect welfare costs associated with domestic financing can be reduced by taking the opportunity to reform the existing tax system to reduce any existing trade-off between efficiency and equity objectives. The analysis of the spatial distribution of these welfare impacts helps to highlight the importance of recognizing the shortcomings of crude geographic targeting. Not only did the urban poor not benefit from the transfer program but they were also adversely affected by its general equilibrium impacts. The analysis also found, however, that combining the transfer program with efficient tax reforms reduced this adverse impact and ultimately benefited the urban poor through the general equilibrium changes in incomes and prices.

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At the time this research was undertaken, both authors were employed by the International Food Policy Research Institute, in the Food Consumption Nutrition Division and the Trade and Macroeconomic Division, respectively. Rebecca Lee Harris is now research director, Globalization Research Center, University of South Florida. Both would like to thank Sherman Robinson for numerous insightful discussions and suggestions. We would also like to thank participants at seminars at PROGRESA, the Mexican Ministry of Finance, IFPRI, the Inter-American Development Bank, the International Monetary Fund, and the World Bank. The study also benefitted substantially from comments from two anonymous referees of this report as well as from comments from three referees of related journal submissions. We also thank Lourdes Hinayon for excellent administrative support. We, the authors of this report, and not IFPRI or PROGRESA, are responsible for all the contents of this report.

Summary

It is now widely accepted that social safety nets play a crucial role in any comprehensive poverty alleviation strategy. Existing social safety nets, however, are perceived by many as not very cost effective because they are very badly targeted to poor households and in addition often involve inefficient pricing policies. For example, a recent review of social safety net programs found that a staggering one quarter of the programs for which there was empirical evidence had regressive benefit incidence, that is, the poor received less than their population share. Among the most poorly targeted transfer programs were universal food subsidies, which have also been found to generate substantial economic inefficiency in both production and consumption patterns. This has led both developing country governments and international development institutions to put more emphasis on developing well-targeted direct transfer instruments, either in the form of cash transfers (e.g., in Latin America) or subsidized food rations (e.g., in South Asia).

When evaluating the economic impact of such transfers, it is useful to separate these into direct and indirect income (or welfare) effects. The direct income effects reflect the design of the program (i.e., the rules for targeting transfers); these are often referred to as first-round effects and are captured by partial equilibrium approaches to policy evaluation. The indirect effects capture the second-round income changes brought about by the impact of cash transfers, and their financing, on the level and composition of demand and supply. Most evaluations of social safety net programs focus on the partial equilibrium evaluation of program targeting outcomes. Even those that focus on the indirect impacts tend to concentrate on their efficiency implications, with only a very limited analysis of income distribution outcomes and little attempt to combine both the equity and efficiency dimensions. This, of course, is all the more limiting given that the central objective of these programs is to improve income distribution.

It is often argued, for example, that one of the major constraints facing developing countries wishing to develop a comprehensive social safety net is the fact that they put undue strain on domestic finances and are often financed using policy instruments that generate substantial economic inefficiencies. In such circumstances the gains from developing more direct transfer mechanisms are twofold. First, better targeted transfer programs can generate a larger impact on poverty alleviation for the same budget cost (or, equivalently, the same impact at lower cost). Second, substantial welfare gains may be achieved by replacing existing inefficient transfer instruments with more efficient direct transfer schemes. The central objective of this report then is to clarify such issues and show how they can be evaluated in an integrated framework.

In this report we contribute to filling this research gap by focusing primarily on the indirect general equilibrium impacts of the shift to better targeted direct transfer programs. In particular, we show how the results from a computable general equilibrium model can be combined with the information available in standard household surveys to provide an integrated analysis of both the direct distributional impact of such programs and the indirect distributional and efficiency impacts arising from the alternative forms of domestic financing. Our focus on the domestic financing aspect of these programs reflects our view that any credible poverty al-

leviation strategy must have an underlying credible financing strategy, and this need for domestic financing can have important consequences for both the level and the distribution of household incomes. For the purpose of illustration we focused on the recent introduction in Mexico of an innovative poverty alleviation transfer program called PROGRESA, which has been used as a prototype for similar programs that have recently been implemented in other developing countries.

In Chapter 2 we set out a very general theoretical model that identifies the different sources of the indirect welfare impacts of different financing strategies for a targeted cash-transfer program. The analytical equations derived using the model show clearly the three sources of welfare impacts. First, a *redistribution effect* arises from the fact that someone must be taxed in order to pay for the cost of the transfer program. For example, if high-income households bore the brunt of this taxation, and if we attributed a social value to a more equal distribution of income, then the resulting welfare cost would be less than the direct welfare gain from the transfers. Second, a *reallocation effect* results from the fact that the pattern of demand will change if those who finance the program have income elasticities of demand different from those who receive the transfers. The resulting demand changes can have important consequences for government revenues when taxes vary substantially across commodities. The welfare effects arise essentially because demand shifts away from (or toward) commodities for which demand was previously too low owing to their inefficiently high tax rates. Third, a *distortionary effect* arises because of the need to raise the revenue to finance the program through manipulating distortionary commodity taxes and subsidies. For example, if the program is financed by reducing distortionary subsidies, then this effect is positive, but if financed by increasing distortionary taxes then it may be negative.

Knowledge of the aforementioned dimensions of the welfare impact of the program also helps us to interpret the results from our empirical analysis in the subsequent chapters. With this in mind, we therefore also show how the preceding model can be adapted to provide a useful framework for integrating the simulation results from a computable general equilibrium model with the more disaggregated information available in a household data set. We further show how the three components can be usefully subsumed within one parameter, namely, the *cost of public funds.* Because concerns for equity are the major motivating factor for such programs, we make explicit how these concerns are captured by this parameter.

In Chapter 3 we describe how we have applied the theoretical framework developed in the previous chapter to data for Mexico to evaluate the welfare impact of introducing a targeted direct cash-transfer program in rural areas of the country. We started by describing the construction and structure of the computable general equilibrium model used to simulate the indirect welfare impacts of alternative financing strategies. Our results help to bring out clearly that the actual program, which finances the direct transfers by eliminating existing food subsidies, has two sources of benefit: (1) the introduction of a more distributionally powerful transfer policy instrument and (2) the fact that this reduces the need to trade off equity objectives against efficiency objectives when designing the tax system. These factors combined result in a very large welfare increase from such a policy reform; for moderate concerns for income inequality, the benefit–cost ratio for the program was around 4, which is a very high social return by any standards.

To broaden the relevance of the analysis to a wider set of countries with differing possibilities for financing such transfer programs, we also considered alternative financing strategies. These involved different manipulations of the existing value-added tax system. Although the welfare gains from these alternative financing regimes were not as high, they were still substantial. They were also higher when the reforms involved changes in the tax system that made it more efficient (e.g., redirecting tax rates toward commodities with relatively low price elasticities away from those with relatively high elasticities). More generally, then, the indirect welfare cost of funding such programs can be substantially lowered when the programs are accompanied by efficient reforms of the tax system.

Finally, because the construction of our computable general equilibrium model requires using behavioral parameters for which there is scant empirical evidence, we thought it important to evaluate the robustness of our conclusions to alternative assumptions. We therefore undertook sensitivity analysis using a range of consumption, production, and international trade behavioral responses. In all cases we found that our results were extremely robust to alternative values for the more important parameter values.

One of the attractive features of the computable general equilibrium model used for our analysis is the degree of spatial disaggregation it contains with separate sub-models for four rural regions and an urban region. Information on the differential regional welfare impacts is important for a number of reasons. For example, the regional distribution of welfare impacts can be important from a political economy perspective concerned with generating political support for the program. Similarly, because of differential regional impacts, the distribution of poverty after the program may differ from that before the program, and such information can be extremely important for the design of other components of a poverty alleviation strategy. For example, the exclusion of urban areas in the first phase of the program will obviously affect the urban–rural proportions of poverty and the indirect effects can either mitigate or exacerbate these outcomes.

Therefore, in Chapter 4 we analyze the regional pattern of welfare changes in more detail using a related but somewhat different methodology, which is becoming increasingly popular in the literature, to evaluate the welfare impact of the transfer program. This approach focuses separately on the impacts on both mean income and the inequality of its distribution and views total welfare as the product of the two. We find this approach particularly useful for examining the regional variations in the welfare impact of the program and its application here provides a useful example of its application and its relationship to the approach used in earlier chapters. In Chapter 4 we analyze the differential regional impacts that targeted transfer programs can generate, and how this spatial distribution of welfare changes differs across alternative domestic financing arrangements. Our analysis makes use of the regional disaggregation of the underlying social accounting matrix and computable general equilibrium model. We identify four rural regions (i.e., North, Central, Southwest, and Southeast) and one urban region, which differ according to production and consumption patterns as well as inter-regional flows.

Our analysis highlights the following features of the results. First, the direct impact of the transfers (i.e., before their financing is accounted for) differs regionally owing to the initial distribution of poverty varying across regions. The poorest regions experience both the largest increases in mean incomes and the largest decreases in inequality. The large decreases in inequality reflect (by construction) the high distributional power of the targeted program. Second, the incidence of the taxation introduced to finance the program differs substantially across regions and is regressive overall. The progressive effect of program financing in terms of decreasing inter-regional inequality is more than offset by the regressive effect in terms of increasing intra-regional inequality. Thus, the overall effect on inequality is lower than that under the direct effect alone. The high distributional power inherent in the targeted nature of the program means that inequality decreases in all rural regions.

Third, the aggregate effect of taxation is very sensitive to the program financing strategy. The move to a more efficient tax system (e.g., removing agriculture subsidies or increasing VAT on necessities) both increases aggregate income and is less regressive than moves toward the more inefficient alternatives (e.g., involving increasing taxes on luxuries). Fourth, the regional effects of taxation are also very sensitive to the program financing strategy. The more efficient tax systems have a clear bias in favor of urban areas, resulting in a lower negative impact on urban mean income and also a less regressive tax incidence. The less efficient tax systems lead to higher mean incomes in all rural areas, but especially in North and Central. But the latter come at a cost in terms of a more regressive tax incidence. The relatively smaller positive effect on mean incomes in Southeast and Southwest (compared to North and Central) under the inefficient tax systems reflects the relatively stronger negative impact of lower mean income in urban areas. Fifth, although the program leads to a substantial decrease in poverty at the national level, the exclusion of urban areas means that urban poverty increases and, after the program, accounts for a substantially higher proportion of total national poverty (i.e., an increase from 18 percent before the program to 30 percent after the program). The increase in urban poverty is also sensitive to the financing strategy used, with the less (more) efficient tax system leading to a 10 percent (5 percent) increase in urban poverty. This highlights the shortcomings inherent in rural targeting and raises concerns associated with horizontal equity.

To summarize, one of the main purposes of this report is to bring out clearly the need to consider the general equilibrium consequences of redesigning social safety nets with the objective of making them more cost effective. To this end we have presented a framework that facilitates such an analysis by showing how the results from an applied computable general equilibrium model can be integrated with the information available in household surveys to provide a more comprehensive evaluation of the welfare implications of domestically financed targeted transfer programs. In the context of a cash-transfer program in Mexico, our results indicate that the general equilibrium welfare impacts associated with domestic financing can be quite substantial. When initial redistribution mechanisms are inefficient, the welfare gains from switching to a better targeted direct transfer scheme are reinforced by efficiency gains associated with the removal of relatively distortionary financing instruments. More generally, the indirect welfare costs associated with domestic financing can be reduced by taking the opportunity to reform the existing tax system to reduce any existing trade-off that exists between efficiency and equity objectives. Our analysis of the spatial distribution of these welfare impacts helps to highlight the importance of recognizing the shortcomings of crude geographic targeting. Not only did the urban poor not benefit from the transfer program but they were also adversely affected by the general equilibrium impacts of the program. However, we also found that accompanying the transfer program with efficient reforms of the tax system can not only minimize this adverse impact but may actually lead to the urban poor benefiting through the general equilibrium changes in incomes and prices.

CHAPTER 1

Introduction

It is now widely accepted that social safety nets play a crucial role in any comprehensive poverty alleviation strategy (World Bank 1997). Existing social safety nets, however, are perceived by many as not very cost effective because they are very badly targeted to poor households and often involve inefficient pricing policies. For example, a recent review of social safety net programs found that a staggering 25 percent of the programs for which empirical evidence was available had regressive benefit incidence, that is, the poor received less than their population share (Coady, Grosh, and Hoddinott 2004). Among the most poorly targeted transfer programs were universal food subsidies, which have also been found to generate substantial economic inefficiency in both production and consumption patterns (Mellor and Ahmed 1988; Coady 1997; Newbery and Stern 1987). This has led both developing-country governments and international development institutions to put more emphasis on developing well-targeted direct transfer instruments, either in the form of cash transfers (e.g., Latin America) or subsidized food rations (e.g., South Asia).

When evaluating the economic impact of such transfers, it is useful to separate these into direct and indirect income (or welfare) effects. The direct income effects reflect the design of the program (i.e., the rules for targeting transfers); these are often referred to as first-round effects and are captured by partial equilibrium approaches to policy evaluation. The indirect effects capture the second-round income changes brought about by the impact of cash transfers, and their financing, on the level and composition of demand and supply. Most evaluations of social safety net programs focus on the partial equilibrium evaluation of program targeting outcomes. Even those that focus on the indirect impacts tend to concentrate on their efficiency implications, with only a very limited analysis of income distribution outcomes and little attempt to combine both the equity and efficiency dimensions. This, of course, is all the more limiting given that the central objective of these programs is to improve income distribution.

In this report, we focus primarily on the indirect effects of transfer programs. In particular we show how the results from a computable general equilibrium model can be combined with the information available in standard household surveys to provide an integrated analysis of both the direct distributional impact of such programs and the indirect distributional and efficiency impacts arising from the nature of its domestic financing. Our focus on the domestic financing aspect of these programs reflects our view that any credible poverty alleviation strategy must have an underlying credible financing strategy, and this need for domestic financing can have important consequences for both the level and the distribution of household incomes.

It is often argued, for example, that one of the major constraints facing developing countries wishing to develop comprehensive social safety nets is the fact that such systems put undue strain on domestic finances and are often financed using policy instruments that generate substantial economic inefficiencies. In such circumstances the gains from developing more direct transfer mechanisms are twofold. First, better targeted transfer programs can generate a larger impact on poverty alleviation for the same budget cost (or, equivalently, the same impact at lower cost). Second, substantial welfare gains may be achieved by replacing existing inefficient transfer instruments with more efficient direct transfer schemes. The central objective of this report then is to clarify such issues and show how they can be evaluated in an integrated framework.

For the purpose of illustration we focus on the recent introduction in Mexico of an innovative poverty alleviation transfer program called PROGRESA. This program has two defining features. First, using a combination of targeting methods, it targets transfers at poor rural households in some of the remotest parts of the country. Second, continued eligibility for these transfers is conditioned on beneficiaries investing in the human capital status of their children through increased attendance at school and health clinics. Although the latter condition is a crucial component of the program, it is the former that we are concerned with in this report.[1] This program has provided a prototype for similar programs that have recently been implemented in other developing countries.[2]

The cash transfers in PROGRESA are substantial and constitute, on average, about a 30 percent increase in total income for beneficiary households. The first phase of the program focused only on rural households and thus excluded poor households in urban areas. The program was introduced in August 1997, and by the end of 1999 had covered 2.6 million rural households, equivalent to about 40 percent of all rural households and one ninth of all Mexican households. Its budget in that year was US$777 million, equivalent to about 0.2 percent of Mexican gross domestic product (GDP) and 20 percent of the total federal poverty alleviation budget.

This report is organized as follows. To facilitate understanding of the sources of the indirect welfare effects from a domestically financed cash-transfer program, in Chapter 2 we set out a simple general equilibrium model that shows how one can separate these effects into three components. First, a *redistribution effect* arises from the fact that someone must be taxed in order to pay for the cost of the transfer program. If high-income households bear the brunt of this taxation, and if we attribute a social value to a more equal distribution of income, then the resulting welfare cost will be less than the direct welfare gain from the transfers. Second, a *reallocation effect* results from the fact that the pattern of demand will change if those who finance the program have income elasticities of demand different from those who receive the transfers. The resulting demand changes can have important consequences for government revenues when taxes vary substantially across commodities. The welfare effects arise essentially because demand shifts away from (or toward) commodities for which demand was previously already too low (high) because of their inefficiently high (low) tax rates. Third, a *distortionary effect* arises because of the need to raise the revenue to finance the program through manipulating distortionary commodity taxes and subsidies. For example, if the program is financed by reducing distortionary subsidies, then this effect is positive, but if financed by increasing distortionary taxes then it may be negative.

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[1]See Skoufias (2001), Coady (2003), and Morley and Coady (2003) for more details on the program design and impact as well as the numerous reports generated as part of the evaluation. These are all available on <http://www.ifpri.org/themes/progresa.htm>.

[2]For example, programs now exist or are in the planning stages in Argentina, Brazil, Colombia, Honduras, Jamaica, Nicaragua, Panama, and Turkey.

Knowledge of the aforementioned dimensions of the welfare impact of the program will also help us to interpret the results from our analysis. In Chapter 2 we also show how the above model can be adapted to provide a useful framework for integrating the simulation results from a computable general equilibrium model with the more disaggregated information available in a household data set. We further show how the three components can be usefully subsumed within one parameter, namely, the *cost of public funds*. Because concerns for equity are the major motivating factor for such programs, we make explicit how these concerns are captured by this parameter.

In Chapter 3 we present an illustration of the approach using data for Mexico to evaluate the recent redirection of the government's poverty alleviation strategy away from universal food subsidies toward targeted cash transfers. We start by setting out the details of the computable general equilibrium model used to trace through the general equilibrium responses to the initial increase in demand generated by the transfers. We describe the data and assumptions used to construct the model and the nature of the policy simulations carried out. We also simulate alternative financing scenarios involving various reforms of the existing value-added tax system. Both these sets of simulations help to broaden the relevance of our analysis to a larger set of countries with differing financing constraints. We conclude this chapter with a detailed discussion of the results of the simulations.

One of the attractive features of the computable general equilibrium model used for our analysis is the degree of spatial disaggregation it contains with separate submodels for four rural regions and an urban region. Information on the differential regional welfare impacts is important for a number of reasons. For example, the regional distribution of welfare impacts can be important from a political economy perspective concerned with generating political support for the program. Similarly, because of differential regional impacts, the spatial distribution of poverty after the program may differ from that before the program, and such information can be extremely important for the design of other components of a poverty alleviation strategy. For example, the exclusion of urban areas in the first phase of the program will obviously affect the urban–rural shares of poverty, and the indirect effects can either mitigate or exacerbate these outcomes. Therefore, in Chapter 4 we look at the regional pattern of welfare changes in more detail. In this chapter we use a related but somewhat different methodology, which is becoming increasingly popular in the literature, to evaluate the welfare impact of the transfer program. This approach focuses separately on the impacts on both mean income and the inequality of its distribution and views total welfare as the product of the two. We find this approach particularly useful for examining the regional variations in the welfare impact of the program and its application here provides a useful example of its application and its relationship to the approach used in earlier chapters. Finally, Chapter 5 provides a summary and conclusion.

CHAPTER 2

Analytical Framework

We start this chapter by presenting a general equilibrium theoretical model of the economy that identifies the different sources of the welfare impacts of domestically financed cash-transfer programs. We then show how this model can be adapted to provide a useful framework for integrating the results from policy simulations within an applied computable general equilibrium model with the more disaggregated data available from household data sets. The analytical equations derived from the model make explicit how the separate distributional and efficiency implications of these policies enter into the analysis. We also clarify the role of the cost of public funds in the analysis and how it needs to be adjusted in order to arrive at the indirect welfare cost arising from the need to finance the transfers domestically. We derive a benefit–cost ratio, defined as the direct welfare benefit from the transfers divided by the indirect cost from domestic financing, which serves as a sufficient statistic for evaluating alternative financing strategies and provides a useful approach for presenting the results from the simulations. For presentational purposes, the model shown is, of course, much more simple than the applied computable general equilibrium model used to evaluate policy regimes but it does suffice for our purpose of structuring and interpreting the results from our analysis.

A Theoretical Model

The purpose of this section is to use a simple model to bring out the source of welfare changes arising from transfer programs and their domestic financing, particularly financing packages involving reforms in commodity taxes and subsidies. Consider an economy made up of households, firms, and the government.[3] Firms are assumed to maximize profits subject to constant returns to scale production functions so that supply is demand determined, profits are zero, and producer prices are fixed. The welfare of household h is captured by a standard indirect utility function, $V^h(\mathbf{q}, m^h)$, where $\mathbf{q}$ is a vector of consumer commodity and (negative) factor prices, and m^h is household lump-sum income (which here is synonymous with gov-

[3]To bring out the main sources of welfare changes, the model presented is simpler than the CGE model used in our illustration of the methodology that follows. More complex market structures, however, can be easily incorporated by replacing producer prices with shadow prices and actual government revenue with shadow government revenue (see Drèze and Stern 1987). However, the analysis as presented here will still go through with only minor changes (Coady and Drèze 2002).

ernment transfers, r^h, i.e., $m^h \equiv r^h$).[4] The budget constraint for each household is then given by:

$$\mathbf{q}\,\mathbf{x}^h = m^h \equiv r^h$$

where $\mathbf{x}$ is the demand for final goods and the supply of factors. The government's budget constraint is given by:

$$R \equiv \mathbf{t}\,\mathbf{x} - \sum_h r^h$$

where $\mathbf{t}$ is a vector of taxes on commodities consumed and factors supplied by households respectively, and $\mathbf{t} \equiv \mathbf{q} - \mathbf{p}$ with $\mathbf{p}$ being a vector of producer prices. Because producer prices are assumed fixed we have $d\mathbf{q} = d\mathbf{t}$.[5]

The planner's problem in this economy is to maximize social welfare, $W(\cdot)$, subject to the government's budget constraint. Social welfare is typically captured by a Bergson–Samuelson social welfare function of the form:

$$W(V^1(\mathbf{q}, m^1), \ldots, V^h(\mathbf{q}, m^h), \ldots, V^H(\mathbf{q}, m^H))$$

defined over H households.[6] The corresponding Lagrangean can be written as:

$$\mathscr{L} \equiv \mathrm{W}(V^1(\mathbf{p}, \mathrm{t}, r^1), \ldots, V^h(\mathbf{p}, \mathbf{t}, r^h), \ldots, V^H(\mathbf{p}, \mathbf{t}, r^H)) + \lambda\left(\mathbf{t}\,\mathbf{x}(\mathbf{p}, \mathbf{t}, r^h) - \sum_h r^h\right) \qquad (1)$$

where $\{\mathbf{t}, r^h\}$ are the policy parameters whose reform is under consideration and λ can be interpreted as the marginal social value of government revenue and is often referred to as the "cost of public funds." If V^* is the maximum value function for the above Lagrangean then, from the envelope theorem, we know that the gradient of V^* is the same as the gradient of the Lagrangean. Therefore, the welfare impact of changes in $\{\mathbf{t}, r^h\}$ is given by the derivative of the Lagrangean with respect to the relevant policy parameter. The impact of any "policy reform" on social welfare is thus captured by the direct welfare impact of the reform through $W(\cdot)$ plus the indirect welfare impact attributable to changing government revenue.

The preceding formulation of the problem has the attraction of presenting the problem in terms of the standard trade-off between consumer welfare and government revenue. However, it has a clear general equilibrium interpretation. This can be seen by substituting the household budget constraint into the government revenue constraint and allowing for the fact that under constant returns to scale profits are zero, that is, $\mathbf{p}\,\mathbf{y} = 0$, where $\mathbf{y}$ is a vector of domestic commodity and factor supplies. This gives:

$$R \equiv (\mathbf{q} - \mathbf{p})\mathbf{x} - \sum_h r^h = \mathbf{p}\cdot(\mathbf{y} - \mathbf{x})$$

[4]Throughout we use boldface type to denote vectors (lowercase) and matrices (uppercase).

[5]Although the analytical equations derived in the following are based on differentiating the Lagrangean with respect to policy parameters *as if* producer prices (including factor prices) are fixed, this does not require the assumption that producer prices are actually fixed. The device of holding producer prices constant is much more general than it appears at first sight. For example, the derivation is valid if any of the following holds: (1) producer prices are actually fixed (as in Diamond and Mirrlees 1975); (2) producer prices adjust endogenously to clear the scarcity constraints; and (3) producer prices are directly controlled and set optimally by the planner. See Drèze and Stern (1987, 1990) for a more detailed discussion.

[6]This specification has important implications for the way in which we model the program later. In particular, the absence of public goods from the utility functions and the static nature of the specification mean that to ensure consistency we must keep both real government consumption (i.e., public consumption) and investment constant in our CGE model.

Therefore, when commodity and factor markets are balanced (i.e., supply equal demand) then so too is the government budget and vice versa. Similarly, policy reforms that balance the budget will also leave commodity and factor markets balanced.[7]

The policy reforms under consideration are a cash-transfer program, $d\mathbf{r} \equiv \{dr^h\}$, to be financed by a revenue neutral change in commodity taxes or subsidies, $d\mathbf{t}$. The welfare impact of the cash-transfer program in isolation can be seen by differentiating (1) w.r.t. $\mathbf{r}$ to get:

$$dW = \frac{\partial \mathcal{L}}{\partial \mathbf{r}} = \sum_h \beta^h dr^h - \lambda\Big(\sum_h dr^h - \mathbf{t}\cdot\mathbf{X}_m \cdot d\mathbf{r}\Big) \quad (2)$$

where $\beta^h \equiv (\partial W/\partial m^h)$ is the social valuation of extra income accruing to h (or "welfare weight") and $\mathbf{X}_m$ is a matrix with each household's marginal budget shares across commodities as column entries. The first term captures the direct welfare impact of the cash-transfer program as depicted by typical evaluations of such programs. The term in brackets is the net revenue cost of the program calculated as the program budget adjusted for any changes in revenue due to changing demands by these households for taxed or subsidized commodities. The cost of public funds, λ, is the social cost of raising a unit of revenue and will obviously depend on the set of instruments used to balance the budget and the incidence of this financing.

Note that equation (2) can be rewritten as (Coady and Drèze 2002):

$$dW = \sum_h (\beta^h - \lambda) dr^h + \lambda(\mathbf{t}\cdot\mathbf{X}_m \cdot d\mathbf{r}) \quad (3)$$

The first term captures the pure *redistribution* impact and can be expected to be positive if those receiving transfers are on average more deserving (i.e., have higher welfare weights) than those who will finance the program. The second term can be thought of as a *reallocation* impact and captures the deadweight loss from lump-sum transfers in the presence of tax distortions. This reallocation effect arises from the fact that the initial pattern of consumption was distorted owing to consumer prices being different from producer prices, the latter capturing the true social cost of production in this model (i.e., producer prices coincide with shadow prices). Reforms that switch demand toward commodities with consumer prices being too high (e.g., because of relatively high taxes) will thus increase welfare, and this is reflected through an increase in government revenue.

Now consider the transfer program being financed by a change in indirect taxes, $d\mathbf{t}$. Using the standard properties of the indirect utility function, the welfare impact of a tax change is then:

$$dW = \frac{\partial \mathcal{L}}{\partial \boldsymbol{t}} d\boldsymbol{t} = -\beta\cdot\boldsymbol{x}\cdot d\boldsymbol{t} + \lambda\left(\boldsymbol{x} + \boldsymbol{t}\cdot\frac{\partial \boldsymbol{x}}{\partial \boldsymbol{t}}\right)d\boldsymbol{t} \quad (4)$$

The first term indicates that households gain (or lose) from the tax change according to the level of their existing consumption, that is, 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 lower-income households (i.e., with high βs) consume the commodities with the highest tax increases. Again, the social cost of raising revenue using a commodity tax is lower if households respond to the price change by switching demand away from (toward) relatively highly subsidized (taxed) commodities. Rearranging equation (4) and using the Slutsky decomposition, this can be rewritten as:

$$\mathrm{d}W = \sum_h (\beta^h - \lambda)\, \boldsymbol{x}^h \mathrm{d}\boldsymbol{t} - \lambda\, \boldsymbol{t}\boldsymbol{X}_m \boldsymbol{x}\,\mathrm{d}\boldsymbol{t} + \lambda\boldsymbol{t}\,\frac{\partial \boldsymbol{x}^c}{\partial \boldsymbol{q}}\,\mathrm{d}\boldsymbol{t} \quad (5)$$

[7]For more details see Drèze and Stern (1987, pp. 930–932).

where $\mathbf{x}^c$ is the compensated demand function. Again the first term is the redistribution effect comparing the distribution of the tax burden across households to the incidence of the policy instruments used to balance the budget. The second term is the reallocation effect arising from the income effects of the tax change. The third is the *distortion* effect of using distortionary taxes to finance the transfers.[8] The final two terms thus capture the efficiency implications of taxes.

Later, in our discussion of the results from various policy simulations, we will use the preceding discussion of the sources of the welfare changes arising from a domestically financed transfer program to interpret our findings. These simulations choose d$\mathbf{t}$ to balance the budget, that is, so that the revenue from these taxes exactly covers the net revenue effect of the transfers. In other words, the welfare changes are all passed on to households by adjusting d$\mathbf{t}$ to balance the budget. If efficiency effects are negative (e.g., through transfers resulting in a switch in consumption toward subsidized commodities and/or the government introducing distortionary taxes to balance the budget) then taxes will have to be higher than in the absence of this negative effect.

For presentational purposes, the model presented in the foregoing discussion assumes that producer prices are constant and that the only "distortions" in the economy are attributable to the presence of domestic indirect taxes. However, the preceding results can be easily extended with minor modifications to a wider set of second-best structures discussed in the literature, for example, to allow for changing producer prices and the presence of consumer and producer rationing and trade taxes.[9] Essentially one simply replaces domestic taxes, $\mathbf{t}$, with "shadow taxes," $\mathbf{t^*}$, defined as the difference between consumer prices and "shadow prices," that is:

$$\mathbf{t}^* \equiv (\mathbf{q} - \mathbf{v}) = (\mathbf{q} - \mathbf{p}) - (\mathbf{p} - \mathbf{v})$$

where $\mathbf{v}$ is a vector of "shadow prices," $\mathbf{p}$ a vector of producer prices, $(\mathbf{q} - \mathbf{p})$ is a vector of domestic taxes, and $(\mathbf{p} - \mathbf{v})$ a vector of "shadow producer taxes." For example, the shadow price for a traded commodity is usually taken as its world price, and import tariffs and export taxes create a wedge between this price and domestic consumer and producer prices. More generally, shadow prices will depend on the structure of the economy (e.g., whether a good is traded or nontraded or whether markets are perfectly competitive or not) as well as the set of policy instruments available to the government (e.g., instruments for distributing income or taxing profits). Such issues therefore enter the preceding welfare analysis through the specification of shadow prices.

Application of the Model

A Two-Step Approach

To identify the general equilibrium effects identified in the preceding, we use a computable general equilibrium (CGE) model of the economy and apply the following *two-step* approach. First, the transfers are fed into the CGE model and we consider alternative budget-closure rules. Then, together with the direct transfers, the resulting indirect

[8]See Allgood and Snow (1998), and references therein, for analyses that focus solely on the final two "efficiency" effects in the context of a redistribution program financed by a reform of a progressive income tax structure in the United States. Our first term captures the additional impact on social welfare resulting from the redistribution of income from a socially suboptimal position, as discussed in Ballard (1988). We later further clarify how redistribution concerns enter the analysis of the indirect welfare impacts. See also Coady and Drèze (2002) for a more detailed discussion of commodity tax reform.

[9]See Drèze and Stern (1987) and Coady and Drèze (2002) for a more detailed discussion.

effects simulated in the CGE model (i.e., proportional income changes attributable to factor price changes as well as the commodity price changes) are superimposed on the disaggregated household data, where households are mapped to one of the representative households in the CGE. These are then aggregated to calculate the total impact on social welfare.

To get a more detailed understanding of this two-step procedure, consider the following. For all revenue neutral reforms, all indirect welfare effects operate through changes in commodity and factor prices. Fully differentiating the social welfare function above after separating out factor (w) and commodity prices (q), the welfare effects brought about by the domestically financed transfer program are:

$$\mathrm{d}W = \sum_h \frac{\partial W}{\partial V^h} \frac{\partial V^h}{\partial m^h} \mathrm{d}m^h + \sum_h \frac{\partial W}{\partial V^h} \frac{\partial V^h}{\partial \boldsymbol{q}} \mathrm{d}\boldsymbol{q} + \sum_h \frac{\partial W}{\partial V^h} \frac{\partial V^h}{\partial \boldsymbol{w}} \mathrm{d}\boldsymbol{w}$$

where the first term captures the direct welfare effect from income transfers and the final two terms capture the indirect welfare effects coming through the resulting general equilibrium changes in commodity and factor prices, respectively.

In Appendix A we show that defining $\beta^h \equiv (\partial W/\partial m^h)$ and using Roy's identity, this can be rewritten as:

$$\mathrm{d}W = \sum_h \beta^h dm^h + \sum_h \beta^h \mathrm{d}e^h - \sum_h \sum_i \beta^h x_i^h \mathrm{d}q_i \quad (6)$$

where $\mathrm{d}e^h$ is the change in factor incomes, x_i^h is the quantity of commodity i consumed by household h, and $\mathrm{d}q_i$ the corresponding price change. Multiplying and dividing all terms by total income y^h and the last term also by q_i, and using the household budget constraint, this can be rewritten as:

$$\mathrm{d}W = \sum_h \beta^h y^h \left[\phi^h + \gamma^h - \sum_i \theta_i^h \rho_i\right]$$

where ϕ^h and γ^h are the proportionate changes in household income due to the direct transfers and indirect (factor) income effects respectively, ρ_i the proportionate change in the price of commodity i, and θ_i^h is the share of expenditure on commodity i in the total expenditure of the household. The term in brackets can be interpreted as the proportionate change in real incomes (i.e., nominal incomes minus a cost-of-living index). These proportionate changes are outputs from the CGE model and are then applied to household-level data.

To apply the above approach, one needs to specify the welfare weights β^h. These can be calculated as:

$$\beta^h = (y^k/y^h)^\varepsilon$$

where y^k is the income of a reference household (for which $\beta^k = 1$) and ε can be interpreted as an "inequality aversion" parameter with concern for inequality increasing with ε. For example, with $\varepsilon = 0$ all welfare weights take the value unity so that extra income to all households is considered equally socially valuable. With $\varepsilon = 1$, the social value of extra income to a household with twice the initial income of k is considered only as half as socially valuable as extra income to k. This welfare weight decreases to a quarter when $\varepsilon = 2$ and so on.[10]

The Cost of Public Funds

We now present a very simple manipulation of the model that suggests a very useful way of presenting the results of such an analysis. One can manipulate equation (2), recognizing that $\mathrm{d}m^h = \mathrm{d}r^h$, to get:

$$\mathrm{d}W = \sum_h \beta^h \mathrm{d}m^h - \lambda\eta \sum_h \mathrm{d}m^h \quad (7)$$

[10]See Atkinson (1970) and Myles (1995, pp. 114–115) for further discussion.

where

$$\eta = \frac{\sum_h \mathrm{d}m^h - \boldsymbol{tX_m}\mathrm{d}\boldsymbol{m}}{\sum_h \mathrm{d}m^h}$$

and η is a tax propensity used to adjust the direct effect of the transfers on government revenue for the fact that households spend this extra income on taxed (or subsidized) commodities, thus decreasing (increasing) the amount of revenue that needs to be raised to balance the budget. As earlier, $\mathrm{d}m^h$ ($= \mathrm{d}r^h$) is the direct cash transfer to household h, $\sum_h \mathrm{d}m^h$ is the program budget, and β^h is the social valuation of this transfer.

From equation (7), the total welfare impact of a domestically financed transfer program will thus depend on how this program is financed and the government budget balanced. The term $\eta\sum_h \mathrm{d}m^h$ tells us how much revenue has to be raised to balance the budget and λ is the social welfare cost of raising one unit of this revenue. The welfare impacts of any given financing strategy operate through changes in commodity and factor prices, and these are captured by the indirect welfare impacts in equation (6). Subsuming both these indirect welfare effects in equation (6) into one variable, dz, and equating this term with the second term in equation (7), we get:

$$-\eta\lambda\sum_h \mathrm{d}m^h = \sum_h \beta^h \mathrm{d}z^h$$

Rearranging, we derive an expression for λ^*, the *adjusted cost of public funds,* as:

$$\lambda^* \equiv \eta\lambda = \frac{\sum_h \beta^h \mathrm{d}z^h}{\sum_h \mathrm{d}m^h}$$

$$= \frac{\sum_h \beta^h \mathrm{d}z^h}{\sum_h \mathrm{d}z^h} \frac{\sum_h \mathrm{d}z^h}{\sum_h \mathrm{d}m^h} \equiv \lambda_I \rho \qquad (8)$$

The term λ_I captures the distributional pattern of the indirect income effects and is essentially a weighted average of the share of each household in the indirect income changes with welfare weights as weighting factors. The more progressive the distributional incidence of the indirect income effects, the lower this term and thus the social welfare cost of financing the program. The term ρ is a scale factor capturing the efficiency implications (i.e., the combined reallocation and distortionary effects discussed earlier) of domestic financing. This efficiency ratio, ρ, is greater (less) than unity if the domestic financing strategy results in less (more) efficient patterns of production and consumption, thus increasing (decreasing) the social cost of financing the program. Note also that λ is independent of how the budget is spent and depends only on how the budget is raised, whereas the opposite holds for η.[11]

Combining equations (7) and (8), the total welfare impact of introducing the cash-transfer programs is given by:

$$\mathrm{d}W = (\lambda_D - \lambda_I \rho)\sum_h \mathrm{d}m^h \qquad (7)'$$

where

$$\lambda_D = \frac{\sum_h \beta^h \mathrm{d}m^h}{\sum_h \mathrm{d}m^h} = \sum_h \beta^h \alpha^h$$

and α^h is the transfer received by household h as a proportion of the transfer budget. Thus λ_D (as with λ_I earlier) is a weighted average of household βs since $\sum_h \alpha = 1$ and

[11]As highlighted by Ballard et al. (1985), "differential incidence" studies focus on λ^* whereas "balanced budget incidence" studies focus on λ. In such studies, the use of "exhaustive expenditures" that do not enter into either the utility function or production function can give misleading estimates of the efficiency cost of transfer programs, this bias depending on the magnitude of η.

is higher the more progressive is the pattern of program transfers.[12]

The total welfare of the cash-transfer program can then be seen as depending directly on the difference between distributional incidence of the transfers minus the product of the distributional incidence of the tax burden associated with financing these transfers times a factor capturing the degree of inefficiency in the tax system. For example, if the government is unconcerned about income distribution (e.g., either because incomes are already equalized or $\varepsilon = 0$) then $\beta^h = 1 (= \beta)$ for all households and $\lambda_D = \lambda_I = 1$. If, in addition, the government can finance all its revenue requirements with lump-sum transfers (i.e., using nondistortionary tax instruments) then we have $\rho = 1$. The program then results in no overall change in welfare. However, if instead the transfers have to be financed by introducing distortionary taxes then we have $\rho > 1$ so that the net welfare impact is negative owing to an indirect distortionary effect capturing the so-called "deadweight losses" associated with taxes. If distortionary taxes already existed then the size of ρ will depend on whether these were optimally set or not and which taxes (subsidies) are increased (decreased) to finance the program. If initially taxes were set optimally then $\rho > 1$ and welfare decreases.[13] If instead the program is financed by the removal of distortionary subsidies then $\rho < 1$ and welfare increases. If initially taxes were not set optimally then $\rho > 1$ ($\rho < 1$) if the program is financed by raising taxes that were initially too high (low). In the presence of an inefficient tax structure one also gets reallocation effects if income elasticities differ across those receiving and financing the budget. For example, if the poor (who receive transfers) have a relatively high propensity to consume highly subsidized commodities from extra income then this will increase ρ since the net revenue costs of financing the program will be greater. Finally, if $\rho = 1$ for any of the above reasons, then the welfare impact of the program will depend on the relative progressive incidence of the direct and indirect income effects.

We are interested in determining the overall welfare impact of the actual transfer program but also in comparing across alternatives. For example, in our illustration below the actual program is the transfer program financed by a reduction in food subsidies and the alternatives reflect alternative financing scenarios, namely, alternative reforms of the VAT system. To motivate the manner in which we present our results, it is useful to rearrange equation (7)′. Because the transfer budget and the direct welfare impact are common across all (i.e., the actual and alternative) programs, one can equivalently compare the welfare impacts by comparing the benefit–cost ratios of programs defined as:

$$\theta_j \equiv \frac{\lambda_D}{\lambda_I \rho} = \frac{\lambda_D}{\lambda_j^*} \qquad (9)$$

where λ_j^* is the welfare cost of raising revenue to finance the program (i.e., one parameter for each of the actual and alternative financing strategies, j) and λ_D is the welfare benefit of that unit of revenue transferred to households through program j. In principle

[12]This term is analogous to what is commonly referred to as the "distributional characteristic" of policy instruments (Feldstein 1974). See Coady and Skoufias (2004) for a detailed discussion of this partial equilibrium statistic and its relationship to other measures used in the literature.

[13]Optimal taxation requires that, for all taxes under the control of the policy maker, the deadweight loss from raising extra revenue (i.e., λ) is equalized across all tax instruments (see Myles 1995, Chapter 4; Coady and Drèze 2002).

one should choose the program with the highest $\theta_j > 1$; that is, conditional on benefits exceeding costs, one chooses the program that exhibits the lowest welfare cost of financing these benefits. In other words, θ_j is the social return to every dollar raised to finance the program. In the next chapter we present results for λ_D, λ_j^*, and θ_j across alternative financing scenarios and different degrees of aversion to inequality (i.e., values of ε).

CHAPTER 3

The Computable General Equilibrium Model and Policy Simulations

In this chapter we provide an illustration of the preceding approach by way of an evaluation of the recent shift in policy emphasis in Mexico's poverty alleviation strategy away from universal food subsidies toward targeted cash transfers. To recap, the social accounting matrix (SAM) underlying the computable general equilibrium (CGE) model of the Mexican economy is constructed using both Mexican household-level survey data as well as sectoral and macro-aggregate data. The basic approach is to feed the transfers, equivalent to a 30 percent increase in the incomes of poor rural households, into the CGE model. This leads to general equilibrium changes in commodity and factor prices. The resulting proportionate changes in household incomes (γ^h) and commodity prices (ρ_i) are then superimposed on household-level survey data to calculate the indirect changes in real incomes of each household (dz^h). The direct transfers ($dr^h = dm^h$) and these indirect income effects are then aggregated using welfare weights to calculate λ_D, λ_I, and μ. Using equation (9), these three parameters are combined into a benefit–cost ratio (θ_j), one for each program characterized by different domestic financing arrangements (i.e., removing food subsidies and different VAT reform programs). This benefit–cost ratio acts as a sufficient statistic for comparing the relative welfare impacts across alternative transfer programs. Given that the structure and size of the direct transfers, and thus the overall program budget, are the same across all alternatives, one can equivalently use λ^* to compare across programs.

The general equilibrium impact of a transfer program on factor and commodity prices will depend on the structure of the CGE model, the behavioral parameters that determine how economic agents respond to these price changes, and the way in which the program is financed. Below we present more detail on the structure of the CGE model and the SAM underlying its construction as well as the different domestic financing arrangements considered. One can think of three sets of parameters that determine how economic agents respond and how markets clear through price changes: consumption, production, and trade parameters. Below we discuss these parameters in more detail. Because estimates of the large number of parameters required are never available for any one country, these are taken from other studies and thus should be treated as "guesstimates."[14] As a result, to check the robustness of our conclusions, we undertake sensitivity analysis over a range of consumption, production, and trade parameters. The base parameters are presented in the following section, as is the strategy for sensi-

[14]The sectoral parameters used are adapted from those used in a similar CGE model constructed by Bautista et al. (2002).

tivity analysis. The final section presents the results from the policy simulations and sensitivity analyses.

The Database and SAM

The CGE model used in this analysis relies on a social accounting matrix (SAM) of Mexico, based on 1996 data (see Harris 1999 for more details). The SAM accounts for all income and expenditure transactions of all sectors and institutions in the national economy, and thus serves as the underlying data framework for the CGE model.[15] The data were first collected as a national SAM, which was then divided into five regions. The model is able to capture differences among the regions in terms of production and consumption patterns, in a "top-down" approach: rather than having complete regional SAMs, the model regionally disaggregates the national SAM only by production and factor markets as well as households.

The model includes four rural regions—North, Central, Southwest, and Southeast—which produce only primary agricultural products.[16] There is one "national" urban region, which comprises all of the urban areas of Mexico, regardless of geographic location. The urban area produces processed agricultural goods and other goods and services. Appendix Table E.1 shows which states are in each rural region. Generally, the North region produces more high-valued agriculture, in particular fruits and vegetables, much of which is exported. Agriculture production relies on more irrigated land use, and households are wealthier. The Southeast region is poorest, more of the land used is non-irrigated, and there is less commercial farming. The Central and Southwest regions are a mixture of the first two, with a range of subsistence and commercial farming and agricultural technology. These two areas also produce the largest amounts of basic grains and beans.

The SAM and CGE model permit the regionalization of agriculture. Each rural region produces six agricultural activities: maize, wheat, other grains, beans, fruits and vegetables, and other crops. The model allows for multiple production activities to produce one national commodity. For example, all four rural regions produce the maize activity, which is supplied to a single national maize commodity market. Thus there are 24 agricultural *activities* but six agricultural *commodities.* A given sector's production is differentiated among the regions according to output levels and technology (in terms of factor and input usage). The livestock/forestry/fishery sector is not regionalized, owing to data limitations. The urban region produces all other goods, including processed agricultural goods. Appendix Table E.2 lists the sectors used in the model.

There are four types of non-agricultural labor: professional, white-collar, blue-collar, and unskilled/informal (referred to in this report as unskilled), and four agricultural labor categories, differentiated by region. The agricultural activities employ only agricultural labor and non-agricultural activities do not use any agricultural labor. Each rural region uses two types of land, irrigated and non-irrigated, for a total of eight land types. There is one capital category, used by all sectors. The model may be thought of as medium-term in nature, as labor is mobile across sectors, but capital and land are not.

Each region has three households, defined as poor, medium, or rich according to the income tercile into which they fall. The delineation among the categories comes from national data. In this way, distributional

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15For a detailed discussion of SAMs, see Pyatt and Round (1985).

16The definition of "rural" used in this model is somewhat different from the standard. Here we use an urban–rural cutoff set at 15,000 individuals.

impacts of different scenarios can be observed among income groups as well as among the regions. The rural regions get labor income from all labor types, distributed according to national survey data. Poor rural households receive 45 percent of the agricultural returns to dry land in their region, while medium rural households receive 55 percent of dry land income. All of the irrigated land payments go to the rich households. The land returns (to dry land) for the livestock/forestry/fishery sector are split among the medium and rich rural households. Rural households also receive capital income indirectly through enterprises. This income is calculated as the residual between income and expenditure. Urban households do not receive any income from agricultural labor; the other labor categories distribute payments to the households according to shares given in the national survey. Urban households do not receive any land income and, like their rural counterparts, receive capital payments via the enterprise account. Household consumption patterns also come from the survey data. Rural households have home consumption of the agricultural goods produced in their respective regions; all other goods are bought on the national market. All households save according to parameters estimated from household survey data.

There is a clear trade-off between the income and spatial disaggregations in the model. *Ceteris paribus,* expanding either dimension results in much smaller data cells and less reliable data on, for example, the shares of different income sources or the patterns of expenditures. This suggests two possible strategies: (1) use more regional categories (say, five) and fewer income groups (say, three), or (2) use fewer regional categories (say, two) and more income groups (say, five). In our model we used the former approach in order to capture important regional diversity in terms of income shares and expenditure patterns. However, this simple description gives a misleadingly pessimistic view of the trade-off in terms of disaggregation across income groups. In reality we have substantially more disaggregation because, from the perspective of the potential for differential income effects, we have 15 household groups (i.e., three income groups times five regions), each of which can experience different income effects arising from some given policy change because of their varying income sources and expenditure patterns. When combined with a greater disaggregation across income groups in the households data, the effective degree of disaggregation is much higher than three groups. Appendix Table E.3 shows the regional distribution of households across national income deciles.

The government and the enterprise account already alluded to are the other domestic institutions in the SAM. The government, which is national, collects seven types of taxes: a value-added tax, a producer tax, an export tax, a sales tax, an import tariff, a payroll tax, and an income tax. It receives transfers from the rest of the world and provides transfers to households and enterprises. The rest of the world account provides transfers to households, buys Mexico's exports, and sells its imports.

With the data for the SAM coming from so many disparate sources, it is not surprising that its initial construction was neither balanced nor consistent. The SAM was therefore balanced using maximum entropy techniques to incorporate prior knowledge in a consistent way.[17] In Appendix Table E.4 we present some useful summary statistics of the data used in the analysis; the tax rates are important because all the indirect welfare and revenue effects result from the existence of these tax distortions and the trade statistics show the importance of international trade in equilibrating demand and supply.

[17]For discussion on this technique, see Robinson et al. (1998).

Description of the CGE Model

The computable general equilibrium model used in this study follows the sectoral and socioeconomic structure of the SAM described in the preceding section. The CGE model is neoclassical in spirit, with agents responding to price changes. The model is Walrasian, determining only relative prices. Product prices, factor prices, and the equilibrium exchange rate are defined relative to the consumer price index, which serves as the price numeraire. The country is "small" in the sense that it takes world prices as given.

Households receive income from factor payments (land, labor, and capital payments) net of factor taxes, government transfers, and transfers from the rest of the world. They consume goods according to a linear expenditure function (LES), purchasing goods from the market as well as from home production (in rural areas only). Household consumption demand is modeled as a modified linear-expenditure system based on the following utility function:

$$U = \prod_i (C_i - \gamma_i)^{\phi_i}$$

where the subscript i refers to commodities, C is total household consumption, γ is subsistence consumption, and ϕ is the marginal propensity to consume each commodity. Total consumption is taken from the SAM database and marginal budget shares are taken from estimates in the literature. Subsistence consumption levels are used to calibrate the model. We also test the sensitivity of our results to alternative values for ϕ.

Households also pay taxes on their monetary income and save a share of their total income. Enterprises serve as the conduit between the capital factor account and the other institutions (households, government, and the rest of the world). They receive capital income minus capital payments to the rest of the world, as well as government transfers. Enterprises transfer that payment, net of depreciation and taxes, to households. Government income is the sum of all taxes: direct taxes on households and enterprises, value-added taxes, producer taxes, import tariffs, export taxes, social security taxes, and sales taxes. The government consumes commodities according to fixed shares (given in the SAM) and also spends money on producer subsidies, transfers to domestic institutions, and transfers to the rest of the world.

The production technology is a nested function of a constant elasticity of substitution (for factors within value added) and Leontief functions (for intermediate inputs and total value added).[18] At the top level, domestic output is a linear combination of value-added and intermediate inputs. The value-added function for each commodity is modeled as a CES function of the primary factors of production (the land types, labor types, and capital mentioned earlier):

$$V = \alpha^v \left[\sum_f \delta_f F_f^{-\rho_f}\right]^{-\frac{1}{\rho_f}}$$

where the superscript v refers to value added, the subscript f denotes factors, V is total value added, α^v is an efficiency parameter, δ_f is a value-added share parameter for each factor, F is the quantity demanded of each factor, and ρ_f is a transformation of the elasticity of factor substitution (i.e., the smaller ρ_f the higher this elasticity and the larger the optimal change in the ratios between different factor quantities in response to changes in factor prices). Intermediate input demand is determined according to fixed input–output coefficients. The commodity output is a composite of different activities, which are imperfectly substitutable: thus this framework allows multiple activities to produce one commodity, as

[18]In the equations that follow we drop commodity subscripts for convenience.

discussed in the SAM description. We test the sensitivity of our results to alternative values for factor elasticities.

Producers of exportables decide to supply their output to either the export or domestic market according to a constant elasticity of transformation (CET) function, which permits some degree of independence from international prices:

$$Y = \alpha^e[\delta^e E^{\rho_e} + (1 - \delta^e)D^{\rho_e}]^{\frac{1}{\rho_e}}$$

where the superscript e refers to exportables, Y is domestic production of the commodity, α^e is a CET shift parameter, δ^e is a share parameter, E is the quantity of exports, and D is the quantity sold in the domestic market. The elasticity of transformation is calculated as $\Omega_e = (1/1 - \rho_e)$, varying from zero to infinity as the value of ρ_e varies from infinity to unity. Similarly, importables (m) are modeled as a constant elasticity of substitution function of imported and domestically produced commodities. This aggregation, known as the Armington function, permits imperfect substitutability between imported and domestically produced goods, and, therefore, two-way trade. We test the sensitivity of our results to alternative value of Ω_e and Ω_m.

Macroclosure refers to the four macroeconomic accounts that must be balanced in the CGE model: the current account with the rest of the world, the government account, the savings–investment account, and the factor markets. In each condition, there are variables that serve to equilibrate the equation. The current account can be balanced by either the foreign savings variable or the exchange rate. This study chooses the latter, so that the welfare changes are not influenced by changes in foreign inflows. The choice of government budget closure will depend on the simulation being performed; in all cases, government savings (or dissavings, as the case may be), will be held fixed, as will real government spending. One of the tax instruments will be free to adjust to keep government savings at its baseline level. This will allow us to perform government budget-neutral experiments without having government purchases of goods and services affect the welfare analysis. Similarly, in the savings–investment balance, real investment will be held fixed, and the marginal propensities to save are adjusted proportionally to equilibrate the account. In the factor markets, labor and land are mobile across sectors (within a region) and capital is fixed, giving the model a medium-term time frame.

The preceding gives a general description of the model structure. In Appendix B we present a more detailed discussion of a number of important features of the model, namely, the Armington treatment of imports, the price equations, and the LES consumption behavior. Appendix C presents a list of the variables included in the model and Appendix D contains a complete listing of the CGE equations.

General Equilibrium Simulations

In this section we briefly discuss the impact of each of the policy simulations on macroeconomic, sectoral, and regional flows. Two different types of simulations are performed with the CGE model to experiment with different ways of raising the money needed to pay for the cash-transfer program. In the first, consumer subsidies are removed to finance the transfer. The second set of simulations experiments with different types of value-added tax (VAT) reforms.

In the base run, the government deficit is 12 billion pesos.[19] The CGE model is programmed to keep this number constant. In each simulation, the method of "closing"

[19]The exchange rate in 1996 was around US$1 = 10 pesos.

Table 3.1 CGE changes in nominal income (percentage from base)

			VAT adjustments[b]				
Households	**Transfer[a]**	**Subsidy**	**PVAT**	**TVAT**	**SVAT**	**HVAT**	**BVAT**
North							
Poor	30	26.20	24.61	23.97	23.65	24.93	23.91
Medium		–4.61	–2.58	–3.08	–4.81	–2.24	–4.43
Rich		–8.62	–0.46	–1.72	–9.22	0.17	–7.79
Central							
Poor	30	28.15	25.64	24.7	24.24	26.08	24.65
Medium		–3.07	–2.55	–3.16	–4.64	–2.19	–4.25
Rich		–8.64	1.16	0.46	–7.04	1.50	–5.81
Southwest							
Poor	30	26.62	26.16	24.98	23.03	26.66	23.73
Medium		–3.34	–2.87	–3.70	–5.50	–2.49	–4.96
Rich		–3.90	–3.79	–4.41	–6.50	–3.55	–5.99
Southeast							
Poor	30	27.14	26.19	25.14	23.89	26.73	24.43
Medium		–2.93	–3.31	–3.96	–4.46	–2.89	–4.20
Rich		–1.91	–3.10	–3.97	–3.80	–2.62	–3.52
Urban							
Poor		–1.85	–4.31	–4.73	–3.52	–4.04	–3.55
Medium		–1.62	–3.76	–4.10	–3.08	–3.59	–3.10
Rich		–1.47	–3.27	–3.55	–2.55	–3.20	–2.58

[a] The program gives a direct cash transfer to poor households in rural areas, equivalent to a 30 percent increase in nominal incomes. Poor, medium, and rich correspond to income terciles. The final six columns present the *net* income effects under each of the six alternative financing strategies.

[b] See Table 3.3 for an explanation of VAT experiments. The subsidy and tax simulations are discussed in detail in the text in the third section of this chapter.

the budget must take into account the general equilibrium consequences of the transfer. For example, although the direct cost of the program is 57 billion pesos, it may be that increased (or decreased) tax revenues from the second-round effects of the transfer decrease (or increase) the amount of revenue the government needs in order to keep its budget constant. The model adjusts for this through one of the equilibrating tax variables, specified later. The results (i.e., proportional income and price changes) used for our following discussion of the channels through which general equilibrium effects flow under the various scenarios, are presented in Table 3.1. Table 3.2 gives the resulting changes in factor prices and the exchange rate.

Subsidies

In the base run of the model, subsidies on *Manufactured Maize, Manufactured Wheat,* and *Dairy Manufacturing* imply a consumer subsidy on these goods of 25 percent, 20 percent and 20 percent, respectively.[20] These subsidies cost about 58 billion pesos, so their removal can be used to finance the PROGRESA transfer. In the experiment, the

[20]In 1996, the base year of the model, most consumer subsidies had already been abolished. This model augments the subsidies on these three goods in an attempt to re-create the pre-reform environment and show the effects of removing those subsidies to pay for the transfers, as did occur in reality.

Table 3.2 CGE changes in factor prices (percentage from base)

		VAT adjustments[a]				
Factors	**Subsidy**	**PVAT**	**TVAT**	**SVAT**	**HVAT**	**BVAT**
Labor						
Agr–North	–8.43	2.66	2.14	–8.93	2.94	–7.30
Agr–Central	6.64	1.16	0.68	–7.57	1.40	–6.32
Agr–Southwest	–5.54	2.25	1.73	–8.82	2.2	–7.25
Agr–Southeast	–3.53	1.97	1.42	–8.77	2.26	–7.24
Professional	–1.16	–3.13	–3.77	–3.46	–2.90	–3.24
White collar	–1.00	–3.19	–3.36	–2.52	–3.20	–2.55
Blue collar	–1.44	–2.93	–2.98	–2.62	–3.02	–2.64
Unskilled	–1.38	–2.78	–2.90	–3.28	–2.82	–3.16
Land						
Dry–North	–12.11	4.09	3.67	–8.18	4.29	–6.46
Dry–Central	–9.70	3.37	2.86	–8.93	3.63	–7.19
Dry–Southwest	–14.43	4.47	3.97	–8.38	4.73	–6.58
Dry–Southeast	–7.46	2.64	2.09	–8.73	2.94	–7.12
Irrig–North	–12.87	3.10	2.53	–9.47	3.41	–7.70
Irrig–Central	–15.06	2.48	1.88	–10.32	2.82	–8.53
Irrig–Southwest	–18.21	2.93	2.33	–10.55	3.27	–8.67
Irrig–Southeast	2.54	–0.40	–1.00	–9.64	–0.08	–8.31
Capital	–1.67	–2.96	–3.40	–2.71	–2.86	–2.60
Exchange rate[b]	–1.00	+1.00	0.00	0.00	+1.00	0.00

[a] See Table 3.3 for explanation of VAT experiments.
[b] An increase in the exchange rate is a depreciation.

income tax, which is modeled as a lump sum tax, serves as the equilibrating variable for the government budget and it falls very slightly. Removing the distorting subsidies causes an improvement in the macroeconomic accounts, with consumption increasing three quarters of a percent and GDP and absorption rising by one half of one percent.

At the micro level, the decreased subsidies directly lead to decreases in production of the formerly subsidized goods, and as a consequence, the output of their intermediate goods (raw *Maize, Wheat,* and *Livestock,* in particular) also falls. This causes resources to shift to the other agricultural goods, and in fact, overall agricultural output increases because resources are now allocated more efficiently. As a result, there is downward pressure on the wage and rental returns of most agricultural factors of production—the exceptions are agricultural labor in the Central region, where the labor-intensive *Beans* production experiences a large increase in output, and irrigated land in the Southeast region, where *Other Crops* has a relatively larger increase in output. The fact that most rural factors now receive lower payments explains in large part the decline in nonbeneficiary rural household income as well as why beneficiary households end up receiving less than the full amount of the income transfer.

The urban area's production contracts by one half of a percentage point as a result of the policy. This is attributable mainly to the decrease in production of the processed foods which were formerly protected. Thus, all urban factors of production receive lower payments, which leads to a decline in urban household incomes. This also negatively impacts rural households owing to their reliance on urban factor income.

Table 3.3 Description of VAT experiments

VAT experiment	Description[a]	Low rate[b]	Middle rate[c] (percentages)	High rate[d]
Base	—	0	5.0	10
PVAT	Proportional increase in base VAT rates	0	7.3	14.6
HVAT	Increase in high rate only	0	5.0	16.1
TVAT	Uniform top rate	0	11.4	11.4
BVAT	Uniform bottom rate	7.2	7.2	10
SVAT	Single rate	8.3	8.3	8.3

[a] The subsidy reforms are discussed in the text in the third section and involve removing the subsidies on manufactured maize flour (25 percent), manufactured wheat flour (20 percent), and dairy manufactures (20 percent).
[b] Low rate is applied to all raw agricultural, processed agricultural, and other food activities.
[c] Middle rate is applied to *Light Manufacturing, Intermediate Goods,* and *Professional Services* activities.
[d] High rate is applied to *Capital Goods, Consumer Durables, Construction,* and *Commerce, Trade, and Transportation* activities.

Value-Added Taxes

The base data have three levels of the value-added tax (VAT):[21] all raw agricultural goods, processed agricultural goods, and food have a VAT rate of zero; the "middle" VAT rate is imposed on *Light Manufacturing, Intermediate Goods,* and *Professional Services* at 5 percent; and the "high" VAT rate is on *Capital Goods, Consumer Durables, Construction,* and *Commerce, Trade, and Transportation,* equaling 10 percent. The VAT is adjusted in five ways to raise the revenue needed to fund the PROGRESA transfer. In the first experiment (PVAT), the VAT is raised proportionally on all goods, which causes the middle VAT rate to increase to 7.3 percent and the higher rate to increase to 14.6 percent. Next, the VAT is increased only for those goods with the upper rate, rising to 16.1 percent (HVAT). Third, the VAT is increased and made uniform for the goods which initially had a VAT imposed on them, with the resulting new rate equal to 11.4 percent (TVAT). Then, the VAT is increased and made uniform for the goods that initially had either zero VAT or the middle rate, so that these goods are now subject to a 7.2 percent VAT, while the high VAT rate remains at 10 percent (BVAT). Finally, the VAT is adjusted so that it is uniform for *all* goods, including the ones that were previously exempt, for a single VAT rate of 8.3 percent (SVAT). See Table 3.3 for a summary of these experiments.

Two of the VAT experiments slightly improve the macroeconomic indicators, namely, the uniform increase of the zero and low-VAT goods (i.e., BVAT), and the uniform increase of all goods (i.e., SVAT). The resulting VAT structures from these experiments are less distorting than from the other experiments. On the other hand, because these two VAT changes increase the VAT rate on agricultural products, agricultural factors of production suffer from lower returns. For example, when the VAT is made uniform for all activities, agricultural wages fall by between 7.6 percent and 8.9 percent, and land returns fall by between 8.2 percent and 10.6 percent. This then dampens the

[21]These data do not reflect actual VAT rates because they are imposed on composite production goods, the individual components of which may have different rates and may include exports (which are zero-rated). Thus the rates must be interpreted as *average* VAT rates for these aggregated sectors.

income gains to recipient households, by about 5.5 percent to 6.5 percent in either experiment. The increase in the VAT for the sectors that originally had a low VAT decreases payments to the urban factors, which hurts both urban and rural household income.

The other three VAT experiments are more inefficient, as evidenced by the slight decline in macroeconomic indicators. However, because raw agricultural production and processed agriculture is not taxed, the increased demand for these products raises the agricultural wages in all three experiments. This does not imply that beneficiary household incomes increase beyond the transfer payment, because of their reliance on urban factor income. The VAT lowers urban wages by more in these scenarios, because urban sector production is harder hit, and this negatively impacts all rural households, including the beneficiaries. However, their income changes are still higher than in the two VAT simulations mentioned earlier. Also, as expected, urban households see even greater decreases in their income with the more distorting VAT systems, as the VAT rates are now higher for the goods from which they receive factor income.

Welfare Evaluation of Policy Simulations

In this section we very briefly summarize our policy simulations and then evaluate their impacts on welfare. To recap, our approach involves taking the indirect welfare impacts from the CGE analysis and superimposing them on the household-level data. The program is modeled as a poverty alleviation program that transfers income to "poor" households in rural areas, equivalent to a 30 percent increase in their nominal incomes and 2 percent of aggregate consumption. The total welfare impact of such a program will depend on how it is financed, and we consider a number of alternatives. The basic approach is to compare the social costs of raising the necessary revenue to finance the program (the adjusted "cost of public funds," λ_j^*) with those of the actual financing instrument, that is, the elimination of food subsidies, as well as with the program benefit (i.e., λ_D).

The results of our simulations are presented in Table 3.4, for the range of welfare weights used throughout the analysis (i.e., $\varepsilon = 0, 0.5, 1.0, 2.0, 5.0$). We start by comparing the cost of public funds across alternative financing packages for $\varepsilon = 0$, that is,

Table 3.4 Social cost of public funds

		Cost of raising a unit of revenue (λ_j^*)[a]					
Inequality aversion[b]	**Benefit (λ_D)**	**Food subsidies**	**PVAT (0, 7.5, 15)**	**HVAT (0, 5, 16)**	**TVAT (0, 11)**	**BVAT (7, 10)**	**SVAT (8.3)**
$\varepsilon = 0$	1	0.625	1.061	1.071	1.051	0.969	0.955
$\varepsilon = 0.5$	1.242	0.468	0.732	0.751	0.718	0.668	0.685
$\varepsilon = 1$	1.584	0.397	0.611	0.633	0.602	0.560	0.599
$\varepsilon = 2$	2.792	0.395	0.658	0.679	0.664	0.612	0.69
$\varepsilon = 3$	5.448	0.557	1.023	1.045	1.054	0.970	1.109
$\varepsilon = 4$	11.549	0.996	1.962	1.988	2.042	1.882	2.155
$\varepsilon = 5$	26.011	2.060	4.227	4.263	4.425	4.082	4.671

[a] See Table 3.3 for details of VAT structures before and after the program. The numbers in parentheses indicate the rates after financing the program. The program involves transfers to "poor" households (i.e., those in the bottom third of the national income distribution) equivalent to a 30 percent increase in their nominal incomes.

[b] The value $\varepsilon = 0$ indicates no distributional concerns with aversion for inequality captured by $\varepsilon > 0$, with $\varepsilon = 5$ incorporating the greatest concern for poorest households. The same values are used throughout the analysis.

where we are concerned only with the efficiency aspects of the program and not with its impact on the distribution of income or poverty. It is clear that, from an efficiency perspective, financing the program by reducing subsidies dominates, with the cost of raising 100 pesos being only 62 pesos. In other words, every 100 pesos raised to finance the program increases welfare (and GDP) by 38 pesos. These substantial welfare gains result from the elimination of a highly distortionary subsidy. This compares extremely favorably with the alternative forms of VAT financing.

Two of the VAT alternatives, that is, SVAT and BVAT, also result in welfare gains, with the cost of raising 100 pesos being 95 pesos if financed by a move to a single uniform VAT rate or 97 pesos if financed by a move toward a uniform VAT rate in the place of the bottom two rates. These efficiency gains arise from the reform in the VAT structure. In general, the inefficiency associated with a tax system is minimized by having relatively higher rates on commodities with relatively low own-price elasticities of demand.[22] Because basic food items tend to have low price elasticities, shifting taxes toward these commodities will tend to increase welfare and this is what happens in both the case of SVAT and BVAT. Our results tell us that the gains resulting from thus reforming the VAT structure outweigh the welfare losses from the higher average rate required to finance the program.

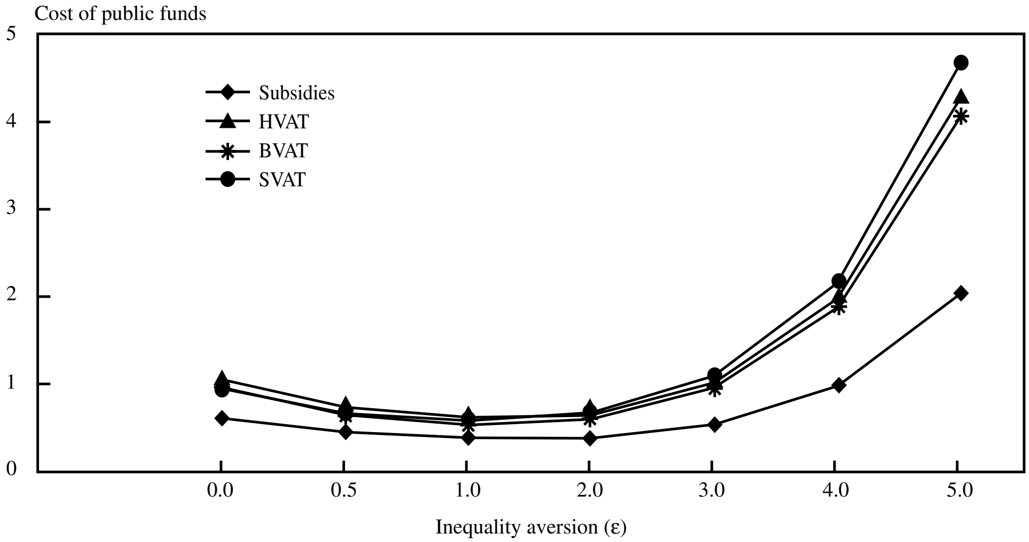
The other VAT alternatives considered all have a cost of public funds greater than unity, ranging between 105 and 107 pesos per 100 pesos of revenue raised. All of these involve an increase in the VAT rates of one or both of the top two VAT rates and the commodities falling within these rates tend to be the most price elastic. These welfare losses mean that, in the absence of any social value being attached to any improvement in the income distribution, such a program would be welfare decreasing. However, not only are distributional concerns the motivating force for the program in the first place, but they also tend to be the motivation behind tax structures that exhibit high tax rates on low price-elastic luxuries typically consumed disproportionately by higher-income households. Therefore, any evaluation of the program should explicitly address this issue.

Introducing distributional concerns involves analyzing the results for values of $\varepsilon > 0$. The cost of public funds for a number of financing instruments is presented in Figure 3.1: in order to avoid clutter we focus on only three of the VAT alternatives, that is, the most inefficient system (HVAT) and the two most efficient systems (BVAT and SVAT), along with subsidy financing. The first thing to notice is that even for low aversions to inequality (e.g., $\varepsilon = 0.5$) the cost of raising a peso becomes substantially less than one peso for all financing instruments.[23] This reflects the fact that the indirect income effects are distributed in favor of the poor at the expense of the nonpoor. The second thing to notice is that the relationship between the cost of public funds and ε is U-shaped, with the former beginning to rise after $\varepsilon = 1$. Eventually, at around $\varepsilon = 3$, the cost of public funds goes above unity. This pattern indicates that although the tax incidence is lowest for the poor as a whole, it is relatively high for the poorest of the poor, and the greater the weight we place on the income of the poorest the higher the social cost of raising revenue through the alternative VAT instruments.

[22]We are implicitly assuming that cross-price elasticities are zero or sufficiently small as to make this general rule of thumb valid. See, for example, Coady and Drèze (2002) and Myles (1995) for more detailed discussion.

[23]A similar result was found by Ballard (1988) for the United States. Note that an adjusted cost of public funds greater (less) than unity means that the total welfare impact per unit program expenditure is less (greater) than that suggested by focusing exclusively on the direct impact on welfare.

Figure 3.1 Cost of public funds

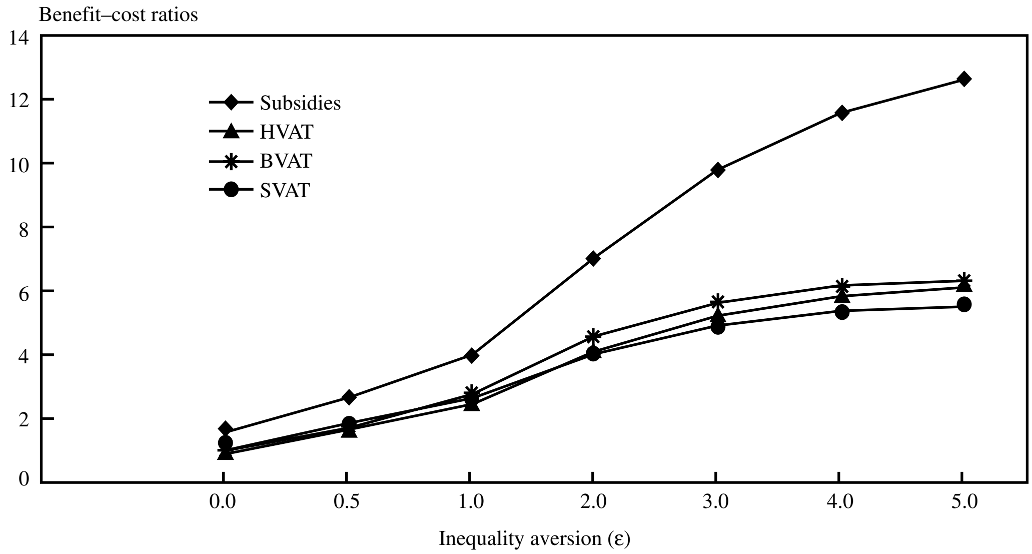


Although the cost of financing the program through reducing subsidies follows the same U-shaped pattern, it remains the most attractive form of finance throughout. In fact, for higher values of ε, it also appears to be the least regressive form of financing. This is brought out clearly in Figure 3.2 which shows the benefit–cost ratios (BCRs) across the instruments discussed in the preceding. The higher the value of ε the more attractive subsidy reductions look relative to VAT financing. For example, at only moderate levels of aversion to income inequality, the BCR with subsidy financing is about four, that is, every 100 pesos raised to finance the program increases welfare by 400 pesos, a very high social return by any standard. But even the BCRs for VAT financing increase monotonically with ε reflecting the very high targeting performance of the transfers at poor households.[24] This brings out one of the main attractions of the program, that is, the fact that it is very efficiently targeted. More generally, it indicates the potential return in welfare terms from introducing a more efficiently targeted transfer program. The presence of such a program enables one to design a more efficient tax system by lessening the need to trade off efficiency goals against equity objectives, for example, by reducing the need for high subsidies on necessities or high taxes on price-elastic luxuries that exist for equity reasons. More generally, it is also clear that the indirect cost of the transfer program can be substantially reduced if the program can be combined with reform of an initially inefficient tax system.

We finish by discussing the sensitivity of our results to alternative values for the more important underlying parameters in the model. We focus on three sets of parameters: (1) the marginal budget shares, ϕ; (2) the elasticity of factor substitution, $\sigma_f = (1/1 - \rho_f)$; and (3d) the elasticity of transformation between domestically produced tradables and their traded alternatives, $\Omega_e = (1/1 - \rho^e)$ and $\Omega_m = (1/1 - \rho^m)$. In the case

[24]The very good targeting performance reflects, of course, the fact that by construction only poor rural households receive transfers. However, note also that some very poor urban households are left out of the program. We look at this spatial pattern of welfare impacts in the next chapter.

Figure 3.2 Benefit–cost ratios



of the marginal budget shares, we both increase and decrease the ϕ for foods by 10 percent, allowing those for other goods to adjust accordingly to meet the additivity constraint that all ϕs sum to unity. In the case of factor and trade elasticities, we both increase and decrease these by 20 percent from the base run. Each of these three sets of sensitivity analyses are undertaken separately. For clarity, we also focus solely on the actual financing strategy, that is, the removal of food subsidies.

In Figure 3.3a–c, for each of the above we compare the (adjusted) cost of public funds for different values of ε (i.e., inequality aversion). In all cases we observe an almost identical pattern across various values of ε: the cost of public funds starts off below unity, then falls as ε increases and eventually rises for higher values of ε above unity. Given that our sensitivity analyses cover a wide range for the model parameters, these results suggest that our main policy conclusions are very robust.

Figure 3.3a Sensitivity to marginal budget shares for food (subsidy removal simulation)

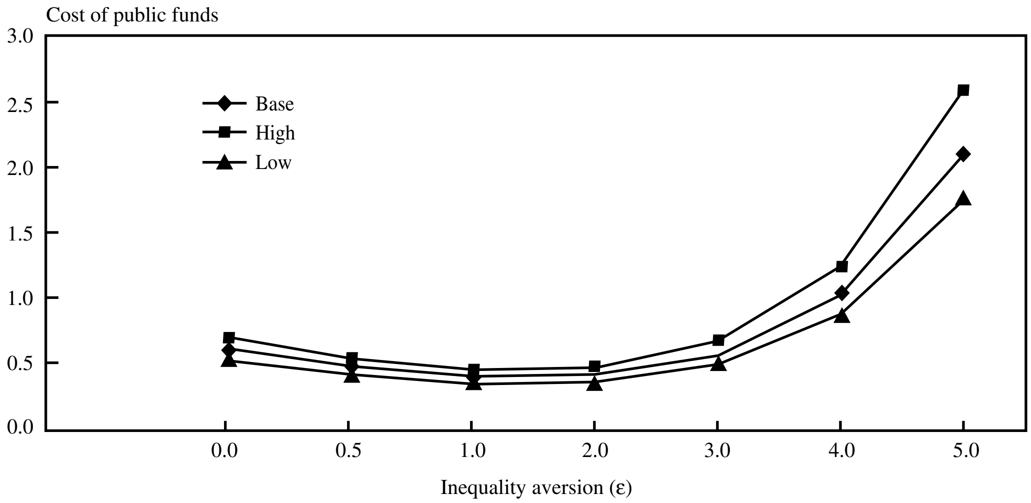


Figure 3.3b Sensitivity to factor elasticities (subsidy removal simulation)

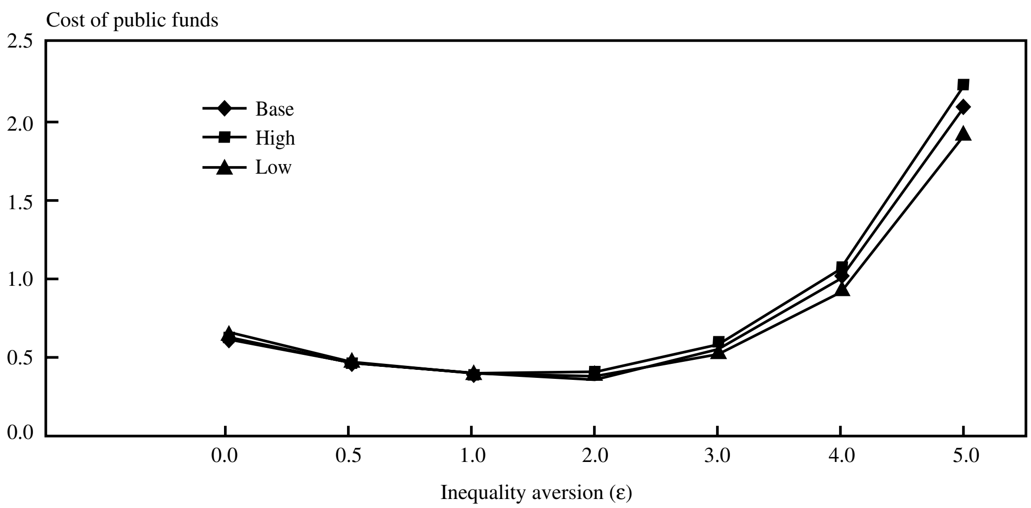
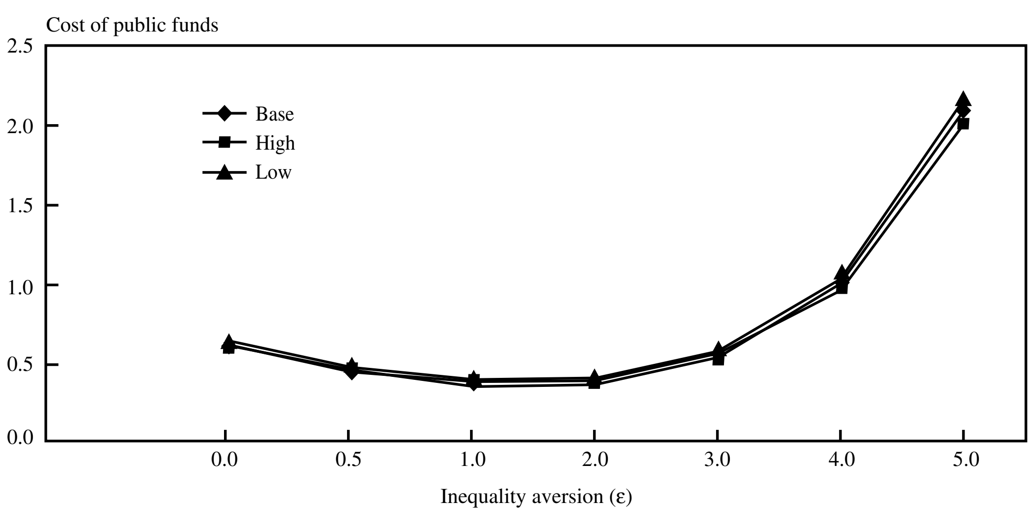


Figure 3.3c Sensitivity to trade elasticities (subsidy removal simulation)



CHAPTER 4

The Spatial Distribution of Welfare Impacts

In this chapter we make use of the spatial disaggregation within the CGE model to evaluate how the transfer program differentially impacts different regions of the country. The welfare impact of such transfers can be expected to vary substantially across regions both because poverty (and thus the level of cash transfers) varies spatially but also because the indirect general equilibrium welfare effects can vary spatially. The former reflects program design features, whereas the nature of the latter depends on such things as nature of consumption and production patterns across households and regions, the regional structure of factor and commodity markets and the mechanisms through which equilibrium is restored in these markets, and the ways in which the program is financed.

Information on the likely differential regional welfare impacts is important for a number of reasons. For example, the regional distribution of the welfare impacts is potentially important from a political economy perspective in determining political support for the program. Similarly, because of differential regional impacts, the distribution of poverty after the program may differ from that before the program and such information can be extremely important for the design of other components of the poverty alleviation strategy.

The chapter is structured as follows. In the first section we briefly discuss the methodology used for evaluating the differential regional welfare (and poverty) impacts of the transfers and also present a brief picture of the situation prior to the introduction of cash transfers. In the second section we present our results on the regional distribution of the welfare impact of the transfers. The final section presents a summary and conclusion.

The Level and Distribution of Welfare before the Program

In this section we present a very brief description of the spatial distribution of social welfare in Mexico prior to the reforms under consideration. This will provide a reference point from which to evaluate the spatial impact of the reforms on social welfare. Our analysis uses the 1996 nationally representative household survey data and our indicator of welfare is adult-equivalent household per capita expenditure (henceforth referred to as consumption or income) denoted by *y*.

The methodology we apply is to think of welfare (W) as being the product of the mean level of consumption, μ, and some measure of inequality, I, as follows (Deaton 1997, Chapter 3):

$$W = \mu(1 - I)$$

where W is increasing in mean consumption but decreasing in the index of inequality. This formulation captures the standard notion of a trade-off between efficiency and inequality, that is, we are willing to trade off a lower mean for a more equal distribution or vice versa. Proportional changes (or differences) in welfare can then be decomposed additively into the proportional change (difference) in mean income minus the proportional change (difference) in an index of inequality. This, of course, is directly analogous to our comparisons of benefit–cost ratios for the alternative programs in the previous chapter since, in equation (9), these are derived as the product of the relative progressiveness of the direct and indirect income changes from the program times an efficiency parameter that captures the change in aggregate income.

To be consistent with the welfare analysis in Chapter 3, for our measure of inequality we use the Atkinson index, which has a basis in standard welfare theory. This index can be derived from an additive social welfare function as:

$$I = 1 - \left[\frac{1}{N}\sum_{i=1}^{N}\left(\frac{y_i}{\mu}\right)^{1-\varepsilon}\right]^{\frac{1}{1-\varepsilon}}$$

for $\varepsilon \neq 1$. For $\varepsilon = 1$ one can use the multiplicative form:

$$I = 1 - \prod_{i=1}^{N}(y_i/\mu)^{1/N}$$

where μ is mean income and, as in Chapter 2, $\varepsilon \geq 0$ captures ones degree of aversion to inequality in the income distribution, that is, our willingness to make a trade-off between mean income and inequality. The welfare weights underlying this social welfare function are exactly those used in the previous chapters.[25]

To be comparable and consistent with our CGE analysis, in the household data set we group households into five regions: (1) North, (2) Central, (3) Southwest, (4) Southeast, and (5) Urban. The distribution of all households across regions is presented in Table 4.1. One can see that more than one half of the population live in the urban areas and Urban's even higher share of total income is consistent with a higher productivity of labor. Urban and North have the highest mean income and Southeast has the lowest. However, these two wealthier regions also have the most unequal distribution of income. Notice also that their inequality ranking switches as we go from $I(\varepsilon = 0.5)$ to $I(\varepsilon = 1)$, consistent with income in North being especially unequally distributed at the lower end of the distribution. Decomposing by region, we found that differences in mean incomes across states account for only around 15 percent to 20 percent of total income inequality (with this proportion increasing in ε), indicating a substantial inequality of income within regions.[26]

The above pattern of mean income and inequality has the implication that our spatial ranking by welfare can in principle depend on our aversion to inequality. However, in the present case, it is fairly obvious that the differences in means will dominate the

[25] See Atkinson (1970) for details, and also Deaton (1997) for a useful discussion on this approach. This Atkinson index can be written as $I = 1 - (y_e / \mu)$, where y_e is the "equally distributed equivalent income," that is, the amount of income that if distributed equally would result in the same level of social welfare as the existing distribution of income. Because social welfare is decreasing in inequality we have $y_e < \mu$, with their ratio decreasing the greater our aversion to inequality (i.e., the higher ε). So y_e already encapsulates the concern for unequal distribution. For this reason, I is often referred to as an "index of waste" because it captures the amount of social welfare lost through not having an equal distribution of income. The index takes the value zero either when income is equally distributed (with everyone having mean income so that $y_e = \mu$) or when we are unconcerned about the distribution of income (i.e., $\varepsilon = 0$), in which case social welfare is adequately captured by focusing only on mean income.

[26] The Atkinson index is not additively decomposable. However, the same pattern is displayed by other decomposable inequality measures such as the Theil index and other members of the general entropy family of inequality indices. See Cowell (1995) and Kakwani (1980) for detailed discussion of alternative indices of inequality.

Table 4.1 Inequality profile using ENIGH96

Region	Atkinson inequality indices			Population share	Mean income	Income share	Welfare index (ε = 2)
	ε = 0.5	ε = 1.0	ε = 2.0				
North	0.182	0.291	0.437	0.060	1,349	0.057	759
Central	0.141	0.251	0.411	0.152	878	0.093	517
Southwest	0.137	0.248	0.417	0.086	975	0.059	568
Southeast	0.14	0.25	0.411	0.166	782	0.091	460
Urban	0.169	0.293	0.462	0.536	1,868	0.7	1,005
All regions	0.187	0.323	0.506	1	1,429	1	706

Note: The welfare index is calculated by multiplying mean income by 1 minus the relevant inequality index.

differences in inequality levels (over plausible value for ε) with the result that the ranking by mean income gives simultaneously the welfare rankings. This is indeed borne out by our welfare index.

For completeness, we also present a brief "poverty profile" for Mexico. Although we expect this profile to mimic the preceding welfare discussion, it is useful also to have a picture of the distribution of poverty because we are essentially using the poverty criterion as our "targeting rule" for determining who gets transfers and who does not. In this sense, we are using the poverty analysis in a "positive" as opposed to a "normative" manner. Assuming that one third of Mexicans are "poor," we identify poor households as those in the bottom tercile of the income distribution. As this may be viewed as a relatively generous poverty line, we describe poverty using a range of indices that capture varying degrees of aversion to the "severity of poverty." By construction, the national headcount index (i.e., the percentage of households falling below the poverty line) is 33.3 percent, although this can vary by region, and by design will be affected by the reforms to be analyzed later. We also present the "poverty gap," which (unlike the headcount index) measures the depth of poverty and, if multiplied by the poverty line, gives the increase in the mean income of poor households required to eliminate poverty completely. This should of course be interpreted as the minimum required, as the elimination of poverty with this "budget" would also require it to be "optimally" allocated (e.g., with zero "leakage" or "under-coverage") and, even then, it ignores any deadweight losses (or incentive effects) associated with the policy instruments used to transfer income and to finance these transfers. Finally, we also present the "severity index," which attaches a greater weight to households the further they are below the poverty line.[27]

Using this relative poverty line (which comes out at just below 657 pesos in terms of household per capita adult equivalent consumption), we categorize households as poor and nonpoor. The distribution of poor households across regions is presented in Table 4.2. Using the headcount ratio (i.e., the proportion of households classified as poor) we find that within rural areas more than one half of households in both Central and Southeast are classified as poor and just over 53 percent of the poor are found in these two regions. Whereas only 18 percent of urban households are classified as poor, nearly 29 percent of the poor are found in urban areas. So although a relatively high percentage of rural households are poor,

[27]See Ravallion (1993) and Deaton (1997) for a more detailed discussion of these indices.

Table 4.2 Poverty profile using household survey data (ENIGH96)

		Poverty indices		Regional distribution of poor	
Region	Headcount	Gap	Severity	Headcount	Severity
North	0.332	0.091	0.036	0.060	0.040
Central	0.529	0.199	0.098	0.240	0.272
Southwest	0.451	0.164	0.080	0.117	0.128
Southeast	0.589	0.239	0.122	0.293	0.373
Urban	0.18	0.049	0.019	0.29	0.186
All regions	0.333	0.116	0.054	1	1

Note: Poverty line is approximately 657 pesos. N = 13,208 households.

there is still a substantial number of poor located in urban areas. This is important because, in the reforms to be evaluated later, the poverty alleviation budget is targeted only to rural areas.

The total poverty gap (i.e., the sum of household poverty gaps) comes out at 76 pesos per household (or 5.3 percent of aggregate income) so that a 5.3 percent increase in mean incomes, with the proceeds allocated optimally over only poor households, would be required to eliminate poverty completely.[28] In comparison, the poverty alleviation budget constitutes around 2 percent of total income. Alternatively, the alleviation of poverty would require an optimal lump-sum transfer from the nonpoor (who account for 90 percent of total income) equivalent to 5.9 percent of their income.[29] More than 81 percent of this gap is concentrated in rural areas, especially in the Central and Southeast regions. The "poverty shares" of these two regions (and of Southwest) increase in moving from the poverty gap to using the severity index, suggesting that the poorest households are also located in these rural areas.

The Spatial Distribution of Welfare after the Program

We now decompose the total welfare impact of the program in terms of its spatial pattern. The results are presented in Table 4.3, but also in diagrammatic form in Figures 4.1a,b and 4.2a,b for convenience. The first panel of results in the table shows the regional income, inequality, and welfare situation before the transfers take place. As discussed earlier, before the transfers take place, regional mean incomes vary directly with regional inequality. The second panel of results presents the situation after we account for the direct impact of the transfers. There we see that mean incomes increase on average by 2 percent but that this growth is distributed strongly in favor of the poorest regions. For example, the poorest region, Southeast, exhibits an 8.8 percent increase in mean income. This is as expected because the transfers are targeted at the poor and these regions have higher poverty rates. The lack of any direct impact in urban areas is due to the concentration of the program exclusively on the rural poor. Because the transfers were concentrated in the lowest income

[28]These are crude measures in that household size may vary by income level. For example, if the poor have larger families then these numbers would be an underestimate of the percentage poverty gap.

[29]Obviously this tax should not be collected from those sufficiently near the poverty line that payment of the tax would push them into poverty. Also, in practice governments have to resort to "distortionary" tax instruments which would tend to require a higher tax rate (reflecting the substitution of households away from taxed activities). These, and other such issues, are addressed by our analysis that follows.

Table 4.3 Distribution of welfare after rural program impact

	Initial			Direct effect			Total effect from subsidy			Total effect from SVAT		
Mean	**Mean income**	**Inequality**	**Welfare**	**Mean income**	**Inequality**	**Welfare**	**Mean income**	**Inequality**	**Welfare**	**Mean income**	**Inequality**	**Welfare**
North	1,349	0.437	759	1,396	0.373	875	1,317	0.360	843	1,323	0.362	844
				(0.035)	–(0.172)	(0.152)	–(0.024)	–(0.176)	(0.11)	–(0.019)	–(0.172)	(0.111)
Central	1,878	0.411	517	943	0.332	630	904	0,316	618	909	0.328	611
				(0.074)	–(0.238)	(0.218)	(0.03)	–(0.231)	(0.196)	(0.035)	–(0.202)	(0.181)
Southwest	975	0.417	568	1032	0.339	682	1,001	0.337	664	990	0.336	657
				(0.058)	–(0.23)	(0.2)	(0.027)	–(0.192)	(0.168)	(0.015)	–(0.194)	(0.156)
Southeast	782	0.411	461	851	0.332	568	843	0.331	564	828	0.334	551
				(0.088)	–(0.238)	(0.234)	(0.078)	–(0.195)	(0.224)	(0.059)	–(0.187)	(0.197)
Urban	1,868	0.462	1,005	1,868	0.462	1,005	1,861	0.469	988	1,847	0.464	990
				(0.)	(0.)	(0.)	–(0.004)	(0.015)	–(0.017)	–(0.011)	(0.004)	–(0.015)
All	1,429	0.506	706	1,458	0.456	793	1,440	0.459	779	1,430	0.459	774
				(0.02)	–(0.11)	(0.124)	(0,008)	–(0.093)	(0.104)	(0.001)	–(0.093)	(0.096)

	Total effect from BVAT			Total effect from PVAT			Total effect from TVAT			Total effect from HVAT		
Mean	**Mean income**	**Inequality**	**Welfare**	**Mean income**	**Inequality**	**Welfare**	**Mean income**	**Inequality**	**Welfare**	**Mean income**	**Inequality**	**Welfare**
North	1,315	0.356	847	1,390	0.386	853	1,386	0.384	854	1,391	0.387	853
	–(0.025)	–(0.185)	(0.115)	(0.03)	–(0.117)	(0.124)	(0.027)	–(0.121)	(0.124)	(0.031)	(0.114)	(0.123)
Central	905	0.326	610	929	0.340	613	937	0.346	613	937	0.346	613
	(0.031)	–(0.207)	(0.18)	(0.058)	–(0.173)	(0.186)	(0.067)	–(0.158)	(0.185)	(0.067)	–(0.158)	(0.185)
Southwest	986	0.336	655	1,006	0.339	665	1,005	0.34	663	1,005	0.339	664
	(0.011)	–(0.194)	(0.152)	(0.032)	(0.187)	(0.17)	(0.031)	–(0.185)	(0.167)	(0.031)	–(0.187)	(0.169)
Southeast	828	0.334	551	831	0.334	553	830	0.335	552	830	0.334	553
	(0.059)	–(0.187)	(0.197)	(0.063)	(0.187)	(0.202)	(0.061)	–(0.185)	(0.198)	(0.061)	–(0.187)	(0.2)
Urban	1,850	0.464	992	1,825	0.466	975	1,824	0.465	976	1,823	0.467	972
	–(0.01)	(0.004)	–(0.013)	–(0.023)	(0.009)	–(0.03)	–(0.024)	(0.006)	–(0.029)	–(0.024)	(0.011)	–(0.033)
All	1,431	0.459	774	1,428	0.460	771	1,428	0.46	771	1,427	0.461	769
	(0.001)	–(0.093)	(0.097)	–(0.001)	–(0.091)	(0.092)	–(0.001)	–(0.091)	(0.092)	–(0.001)	–(0.089)	(0.09)

Note: Numbers in parentheses represent change from the initial situation.

Figure 4.1a Regional distribution of income effect

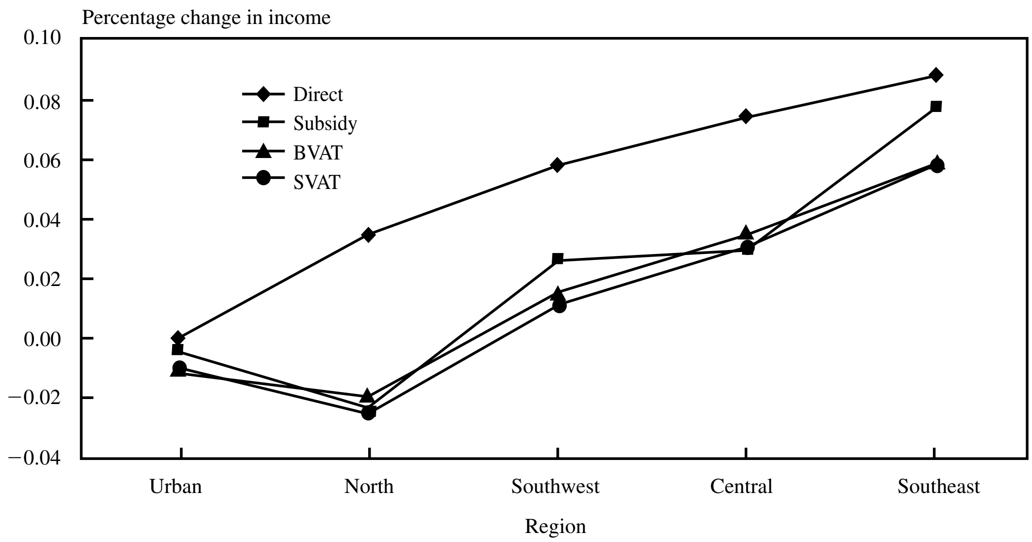
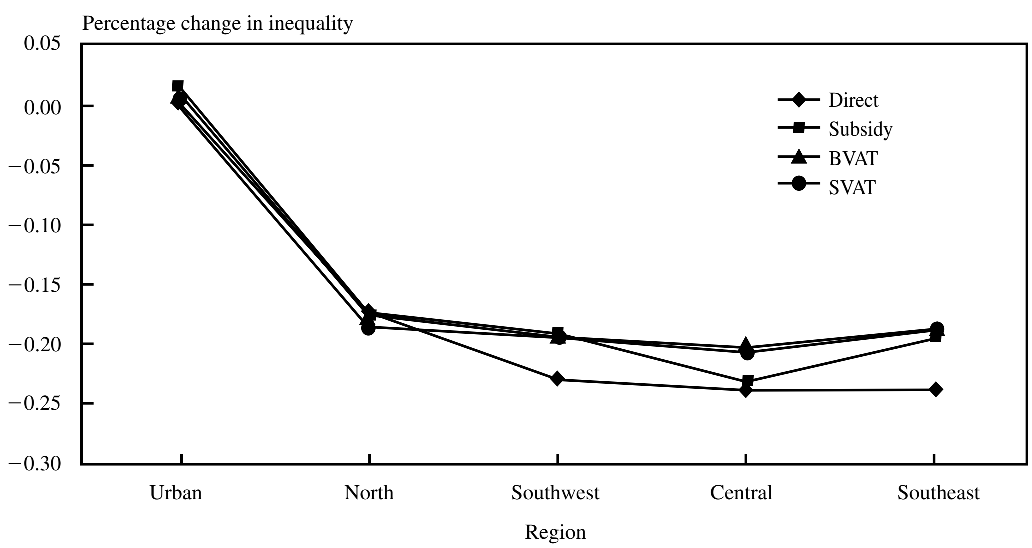


Figure 4.1b Regional distribution of inequality impact



tercile, inequality also falls substantially, on average by 11 percent of the previous level. But this fall varies inversely with mean income, being strongest in the three poorest regions (at around 23 percent). Both of these combine to produce an average increase in welfare of 12.4 percent, which is similarly biased toward the poorest regions.

Focusing on the direct effect ignores the fact that the program has to be financed, in this case domestically. Earlier we showed that the indirect welfare effects associated with domestic financing arise from three sources: (1) a *redistribution effect* reflecting the fact that someone has to pay for the transfers through taxation; (2) a *reallocation effect* reflecting the fact that those on whom the tax burden falls may have different propensities for spending income on taxed commodities than do those who receive transfers; and (3) a *distortionary effect* reflecting the "deadweight loss" that arises

Figure 4.2a Regional distribution of income effect

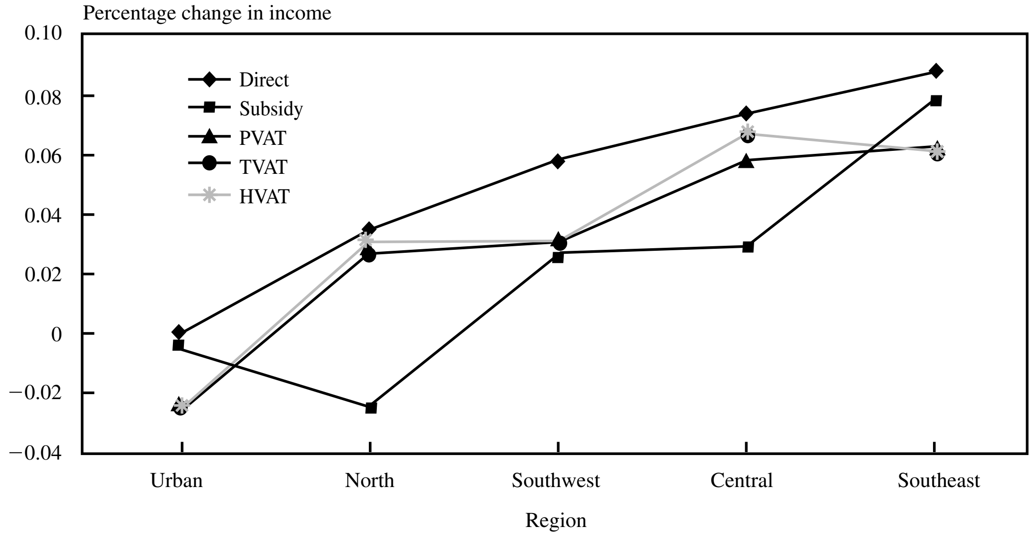
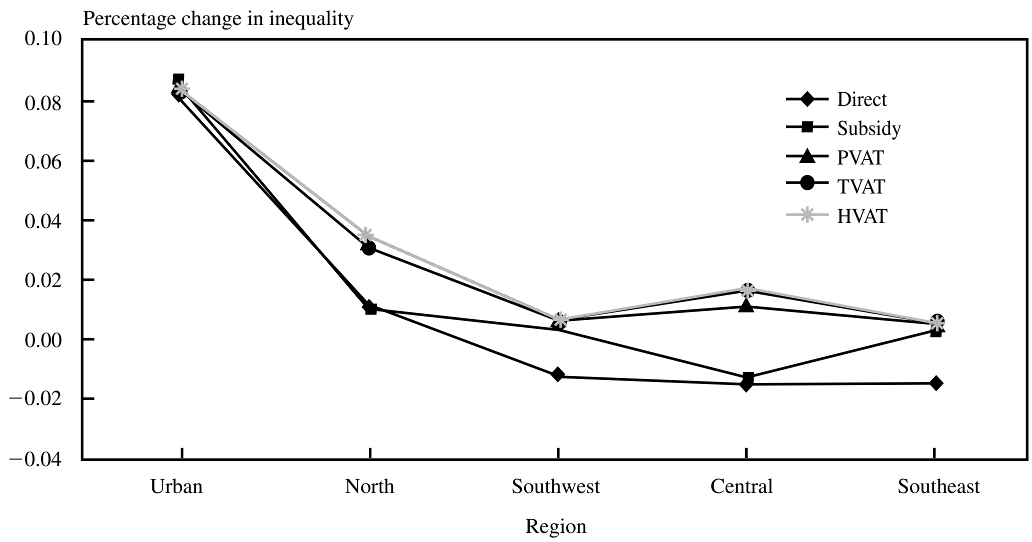


Figure 4.2b Regional distribution of inequality impact



when distortionary (as opposed to lump-sum) taxation is used to finance the program. The first effect captures the implication of the program for equity, whereas the latter two capture the implications for efficiency. The remaining panels incorporate these indirect general equilibrium effects for alternative financing packages. The third panel simulates the situation when the program is financed by the elimination of agriculture subsidies and represents the actual situation. The remaining panels simulate hypothetical financing alternatives involving different reforms of the structure of value-added taxes (VATs).

As indicated in Table 3.3 in the previous chapter, the existing VAT structure involves a "low" zero VAT on agriculture and processed foods, a "middle" 5 percent rate on light and intermediate manufacturing, and a "high" 10 percent rate on consumer durables and capital goods. The famous Ramsey tax rule provides the following rule of thumb for characterizing efficient tax systems: commodity taxes should be inversely related to own-price elasticities.[30] Typically, necessities such as food have low price elasticities and luxuries such as consumer durables have high elasticities, suggesting that an efficient VAT system would have high taxes for food and low taxes for consumer durables. This, of course, is undesirable from an equity perspective because necessities are more important in the budgets of the poor, thus introducing an inevitable trade-off between equity and efficiency. Therefore, in practice one often observes low taxes (or even subsidies) on food and high taxes on consumer durables. However, in subsistence economies with substantial consumption from home production (as opposed to from purchases through the market) the relevant net market trade elasticities can be quite high so that taxes (or subsidies) on such trade can be highly distortionary.

From the preceding one can characterize the removal of agricultural subsidies as the removal of highly distortionary price wedges. Likewise, the increase in VAT rates on food (BVAT and SVAT) results in a more efficient tax system. A proportional increase in VAT rates (PVAT) just exacerbates the inefficiency inherent in the existing VAT structure, while this is further exacerbated by having either a higher uniform top rate (TVAT) or by increasing the high rate (HVAT).

The third panel looks at the total effect on real incomes when the transfers are financed by the elimination of agricultural subsidies. Here, average mean incomes increase by 0.8 percent compared to the pre-transfer situation, capturing the efficiency gains from eliminating distortionary agricultural subsidies. However, one observes very different effects across regions. The mean incomes of the three poorest regions increase, while the mean incomes for the two richest regions decrease. In aggregate, then, the three poorest regions receive positive net transfers while the two richest experience negative net transfers. The latter is particularly pronounced in North where, although the direct transfers increase mean incomes by 3.5 percent, when the incidence of taxation is accounted for it leads to a 2.4 percent fall in mean income. Thus the tax incidence inherent in the elimination of food subsidies falls disproportionately on this region. It is also the case that allowing for program financing leads to a relatively greater decrease in the mean incomes in the richer regions relative to the situation without financing and thus contributes to a reduction in inter-regional inequalities in rural areas. For example, the effect of program financing is to reduce the effect of the transfers on mean incomes by 5.9 percent points in North but by only 1 percent point in Southeast.

Inequality also falls within the poorest regions (i.e., Southeast, Central, and Southwest) so that one observes a substantial increase in welfare in these regions of between 16.8 percent and 22.4 percent. The fact that the fall in inequality within these regions is lower than that observed for the direct effect in isolation indicates that the overall incidence of taxation is regressive in spite of the decrease in inter-regional inequality. Although mean income falls by 2.4 percent in North, inequality also decreases by 17.6 percent, resulting in an overall increase in welfare of 11 percent. The fact that inequality increases within Urban also implies that the incidence of taxation here is also regressive and, when combined with a fall in mean income, this leads to a 1.7 percent fall in welfare. The smaller decreases in inequality (relative to the situation ignoring taxation) in the remaining rural regions indicates that the incidence of taxa-

[30]See Ramsey (1927), Diamond and Mirrlees (1971), Newbery and Stern (1987), Coady (1997), and Coady and Drèze (2002) for more detailed discussion.

tion is regressive and, because all these regions also experience increases in mean incomes, welfare also increases from between 16.8 percent and 22.4 percent compared to the pre-program situation. In aggregate, we observe a smaller decrease in inequality of 9.3 percent (compared to 11 percent before taxation), indicating that nationally the incidence of taxation is regressive. When combined with the 0.8 percent increase in mean income, this results in a 10.4 percent increase in welfare.

The fourth and fifth panels present, respectively, the results when the program is financed by (1) a movement to a single uniform rate (SVAT) and (2) a uniform rate in place of the low and middle rates (BVAT). Both these now involve a higher tax on processed foods and light and intermediate manufactures, sectors located in urban areas. But the uniform single rate also involves a lower rate for consumer durables and capital goods and these sectors are also located in urban areas. The impacts on regional mean incomes are presented in Figure 4.1a, comparing these to the results that ignore program financing and to financing through eliminating agricultural subsidies. The overall increase in mean income, although positive because of the move to a more efficient tax system, is much smaller than under the elimination of agricultural subsidies (i.e., 0.1 percent compared to 0.8 percent). The effect on overall inequality remains the same so that tax incidence is still regressive, but welfare still increases by 9.6 percent and 9.7 percent under both programs, respectively.

Although mean income in Urban experiences a larger fall, this is more than offset by a much less regressive tax incidence (i.e., a lower increase in inequality in Figure 4.1b), leading to a somewhat smaller decrease in welfare than under subsidy removal. We also observe smaller increases in mean incomes in Southwest and Southeast, consistent with these regions being more reliant on transfers from urban areas. When combined with little differences in inequality reductions, this leads to a smaller increase in welfare than under subsidy financing. The decrease in mean income in North is substantially smaller than that under subsidy reduction, but North still experiences negative net transfers. With North experiencing a slight decrease in the regressivity of the tax system, which is now neutral relative to the without-taxation scenario, welfare increases only by slightly more than it did under subsidy reduction (11.1 percent compared to 11 percent). Although Central experiences a slightly higher increase in mean income this is offset by a substantially smaller decrease in inequality capturing a more regressive tax incidence so that the welfare increase is smaller than that under subsidy reductions.

The final three panels of Table 4.3 present the impacts when the program is instead financed by VAT reforms that involve increases in the middle and high rates: (1) a proportional increase where food retains a zero rate (PVAT), (2) a uniform top rate that involves an increase in the middle rate but a fall in the high rate (TVAT), and (3) an increase in the top rate only (HVAT). In all cases, the overall impact on mean income is negative, capturing the greater inefficiency in the tax structure. This is exacerbated by a slightly smaller decrease in inequality (i.e., the incidence of these tax changes is more regressive than those discussed earlier), thus leading to a lower increase in welfare. The regional impacts are described in Figures 4.2a,b and are compared to the impact ignoring taxation and under subsidy reduction.

The first thing to notice is that mean income in Urban exhibits a larger decrease at 2.4 percent compared to 0.1 percent for the other (more efficient) VAT reforms. This is exacerbated by a relatively large increase in inequality (i.e., 0.6 percent to 1.1 percent compared to 0.4 percent) so that welfare falls by about 3 percent (compared to around 1.4 percent). In spite of this, we observe higher increases in mean income in Southwest and Southeast due to the shift away from the VAT on food that had adverse effects on agriculture and thus rural areas. Whereas the new tax regimes are equally regressive in Southeast, they are slightly more regressive in Southwest. But their resulting increase in welfare is still higher than that under the VAT alternatives considered earlier. There is a substantially higher increase in mean income in North, which now shifts from being a net contributor to the program to being a net beneficiary, reverting from around a 2 percent drop in mean income to around a 3 percent gain. Not only does North now benefit from the shift away from food taxes (or the removal of agricultural subsidies), but it is less affected by the negative effects on the urban nonfood sectors. But inequality now falls by only around 12 percent as against around 17 percent under the alternative VAT structures, so that it exhibits only a slightly higher increase in welfare (i.e., 12 percent as against 11 percent). For similar reasons, Central also experiences a substantially higher increase in mean income. But this again is offset by a smaller decrease in inequality reflecting a more regressive tax incidence, so that the increase in welfare is similar to those observed under the other financing regimes. So the overall bias in favor of rural mean incomes is offset by a more regressive tax system, thus leading to a relatively small difference in relative welfare impacts.

We conclude by describing the distribution of poverty after the program under the subsidy removal. In Table 4.4, we present the impact on regional changes in poverty rates and the distribution of poverty across regions. Focusing on the direct impact and the headcount index, we see that the percentage of people who are poor decreased by 19 percent. This decrease is biased toward the better-off rural regions, reflecting the fact that although poverty (by all measures) is lowest in these regions, the higher incomes mean that most of the poor are concentrated just below the poverty line. Thus, the transfers are able to bring a greater proportion of the poor in these regions above this line.

Our other measures of poverty—the poverty gap and the severity index—show a similar result but less pronounced (Figures 4.3 and 4.4). The fact that the decrease is less biased toward the richer rural regions reflects the smaller degree of inefficiency in the transfers in poorer regions. In the richer regions a lot of income is wasted (from the perspective of poverty alleviation) in that it is more than sufficient to raise people out of poverty and we are now also attaching a value to pushing the poor "nearer" the

Table 4.4 Impact of rural transfers on regional poverty

	Headcount			Gap			Severity		
Location	Before	Direct	Subsidy	Before	Direct	Subsidy	Before	Direct	Subsidy
North	0.332	0.184	0.231	0.091	0.043	0.048	0.036	0.015	0.017
		–(0.446)	–(0.304)		–(0.527)	–(0.473)		–(0.583)	–(0.528)
Central	0.529	0.385	0.407	0.199	0.121	0.124	0.098	0.053	0.057
		–(0.272)	–(0.231)		–(0.392)	–(0.377)		–(0.459)	–(0.439)
Southwest	0.451	0.311	0.343	0.154	0.099	0.105	0.080	0.044	0.047
		–(0.31)	–(0.239)		–(0.395)	–(0.360)		–(0.450)	–(0.413)
Southeast	0.589	0.460	0.472	0.239	0.152	0.155	0.122	0.069	0.070
		–(0.219)	–(0.199)		–(0.364)	–(0.351)		–(0.434)	–(0.426)
Urban	0.180	0.180	0.188	0.049	0.049	0.052	0.019	0.019	0.021
		(0.00)	(0.044)		(0.000)	(0.061)		(0.000)	(0.105)
All	0.333	0.269	0.284	0.116	0.081	0.084	0.054	0.034	0.036
		–(0.192)	–(0.147)		–(0.302)	–(0.276)		–(0.37)	–(0.333)

Note: Numbers in parentheses represent change from initial situation.

Figure 4.3 Impact on severity of poverty index (percentage reduction)

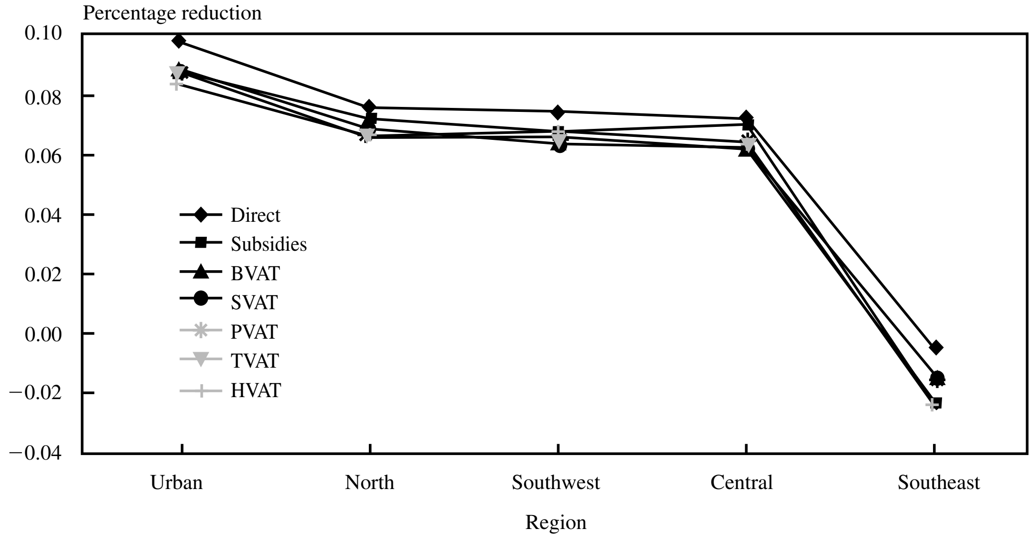
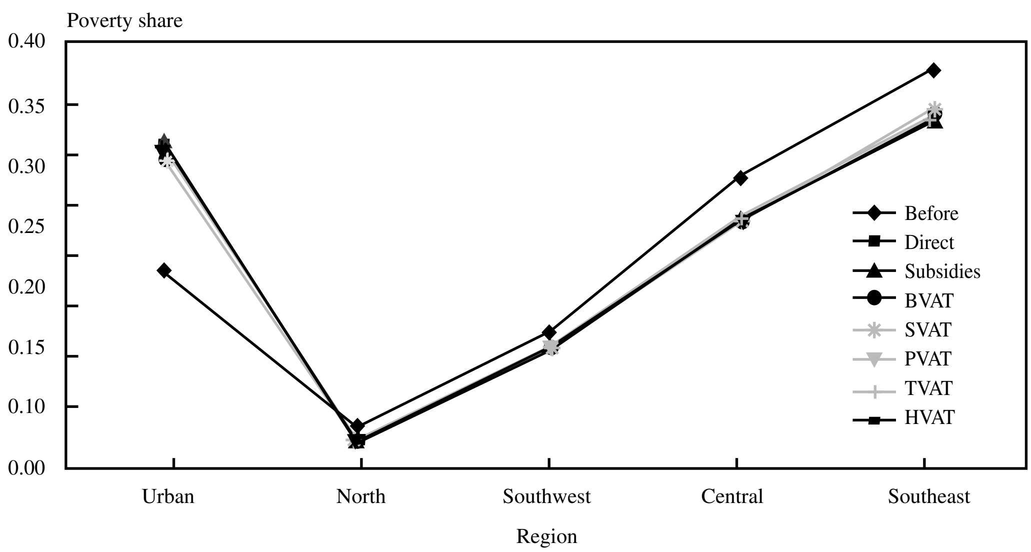


Figure 4.4 Regional shares of poverty based on severity index



poverty line rather than to above the poverty line, with the value increasing the greater the initial distance from the poverty line. However, this inefficiency is offset by the lower initial poverty levels in richer areas so that we still observe a bias in poverty reduction toward those areas in terms of percentage reduction. As expected, with these poverty measures we also observe a more substantial percentage reduction in poverty, especially in the poorest rural regions.

As anticipated, when the fact that the program must be financed domestically is taken into account, the impacts on poverty will decrease. Overall poverty decreases by 14.7 percent and 33.3 percent according to the headcount and severity indices respectively, compared to 19.2 percent and 37 percent previously. But the biggest changes are in North, which experiences a 30.4 percent reduction in headcount poverty compared to 44.6 percent previously. The fact that this difference is not as pronounced using the severity index (52.8 percent compared to 58.3 percent previously) suggests that those who lose from the indirect effects are concentrated around the poverty line. In addition, the headcount poverty increases in Urban by 4.4 percent because these households do not receive benefits but must help to finance the program. The increase in urban poverty is greater using the severity index suggesting that the poorest of the poor are worst hit. This highlights the problems associated with geographically targeting rural areas and raises the important issue of horizontal equity. It is clear that any comprehensive poverty alleviation strategy must incorporate urban areas.

CHAPTER 5

Summary and Conclusions

Over the last decade there has been a growing recognition of the important role that social safety nets can play in any comprehensive poverty alleviation strategy. However, these are often perceived not to be very cost effective, reflecting both inequitable targeting to poor households and also the fact that they have often involved substantial economic inefficiency. For example, food subsidy schemes have been found to be very poorly targeted and also financed by highly distortionary price controls. As a result, both developing country governments and the international development institutions have put a greater emphasis on developing well-targeted direct transfer instruments. This has in turn led to an increasing literature evaluating the welfare gains from introducing such programs. However, for the most part, this literature has focused on the transfers themselves, while ignoring their general equilibrium welfare impacts. Even studies that address the issue of general equilibrium impacts tend to focus more on the efficiency implications with little attempt to integrate both the equity and efficiency implications. This, of course, is all the more limiting given that improving income distribution is the central objective of these programs.

In this report we contribute to filling this research gap by focusing primarily on the indirect general equilibrium impacts of the shift to better-targeted direct transfer programs. In particular, we show how the results from a computable general equilibrium model can be combined with the information available in standard household surveys to provide an integrated analysis of both the direct distributional impact of such programs and the indirect distributional and efficiency impacts arising from the alternative forms of domestic financing. Our focus on the domestic financing aspect of these programs reflects our view that any credible poverty alleviation strategy must have an underlying credible financing strategy, and this need for domestic financing can have important consequences for both the level and the distribution of household incomes. For the purpose of illustration we focused on the recent introduction in Mexico of an innovative poverty alleviation transfer program called PROGRESA, which has been used as a prototype for similar programs that have recently been implemented in other developing countries.

In Chapter 2 we set out a very general theoretical model that identified the different sources of the indirect welfare impacts of different financing strategies for a targeted cash-transfer program. The analytical equations derived using the model show clearly the three sources of welfare impacts. First, a *redistribution effect* arises from the fact that someone must be taxed in order to pay for the cost of the transfer program. If high-income households bear the brunt of this taxation, and if we attribute a social value to a more equal distribution of income, then the resulting welfare cost will be less than the direct welfare gain from the transfers. Second, a *reallocation effect* results from the fact that the pattern of demand will change if those who finance the program have income elasticities of demand different from those who receive the transfers. The resulting demand changes can have important consequences for government revenues when taxes vary substantially across commodities. The welfare effects arise essentially because demand shifts away from (or toward) commodities for which demand was previously too low owing to their inefficiently high tax rates. Third, a *distortionary effect* arises because of the need to raise the revenue to finance the program through manipulating distortionary commodity taxes and subsidies. For example, if the program is financed by reducing distortionary subsidies, then this effect is positive, but if financed by increasing distortionary taxes then it may be negative.

Knowledge of the above dimensions of the welfare impact of the program also helps us to interpret the results from our empirical analysis in the subsequent chapters. With this in mind, we therefore also show how the above model can be adapted to provide a useful framework for integrating the simulation results from a computable general equilibrium model with the more disaggregated information available in a household data set. We further show how the three components can be usefully subsumed within one parameter, namely, the *cost of public funds.* Because concerns for equity are the major motivating factor for such programs, we make explicit how these concerns are captured by this parameter.

In Chapter 3 we described how we have applied the theoretical framework developed in the previous chapter to data for Mexico to evaluate the welfare impact of introducing a targeted direct cash-transfer program in rural areas of the country. We started by describing the construction and structure of the computable general equilibrium model used to simulate the indirect welfare impacts of alternative financing strategies. Our results help to bring out clearly that the actual program, which finances the direct transfers by eliminating existing food subsidies, has two sources of benefit: (1) the introduction of a more distributionally powerful transfer policy instrument, and (2) the fact that this reduces the need to trade off equity objectives against efficiency objectives when designing the tax system. Both these factors combined result in a very large welfare increase from such a policy reform; for moderate concerns for income inequality, the benefit–cost ratio for the program was around 4, which is a very high social return by any standards.

To broaden the relevance of the analysis to a wider set of countries with differing possibilities for financing such transfer programs, we also considered alternative financing strategies. These involved different manipulations of the existing value-added tax system. Although the welfare gains from these alternative financing regimes were not as high, they were still substantial. They were also higher when the reforms involved changes in the tax system that made it more efficient (e.g., redirecting tax rates toward commodities with relatively low price elasticities away from those with relatively low elasticities). More generally, then, the indirect welfare cost of funding such programs can be substantially lowered when they are accompanied by efficient reforms of the tax system.

Finally, because the construction of our computable general equilibrium model requires using behavioral parameters for which there is scant empirical evidence we thought it important to evaluate the robustness of our conclusions to alternative assumptions. We therefore undertook sensitivity analysis using a range of consumption, production, and international trade behavioral responses. In all cases we found that our results were extremely robust to alternative values for the more important parameter values.

One of the attractive features of the computable general equilibrium model used for our analysis is the degree of spatial disaggregation it contains with separate submodels for four rural regions and an urban region. Information on the differential regional welfare impacts is important for a number of reasons. For example, the regional distribution of welfare impacts can be important from a political economy perspective concerned with generating political support for the program. Similarly, because of differential regional impacts, the distribution of poverty after the program may differ from that before the program and such information can be extremely important for the design of other components of a poverty alleviation strategy. For example, the exclusion of urban areas in the first phase of the program will obviously affect the urban–rural shares of poverty and the indirect effects can either mitigate or exacerbate these outcomes.

Therefore, in Chapter 4 we analyzed the regional pattern of welfare changes in more detail using a related but somewhat different methodology, which is becoming increasingly popular in the literature, to evaluate the welfare impact of the transfer program. This approach focuses separately on the impacts on both mean income and the inequality of its distribution and views total welfare as the product of the two. We find this approach particularly useful for examining the regional variations in the welfare impact of the program and its application here provides a useful example of its application and its relationship to the approach used in earlier chapters. In that chapter we analyze the differential regional impacts that targeted transfer programs can generate, and how this spatial distribution of welfare changes differs across alternative domestic financing arrangements. Our analysis makes use of the regional disaggregation of the underlying social accounting matrix and computable general equilibrium model. We identify four rural regions (i.e., North, Central, Southwest, and Southeast) and one Urban region, which differ according to production and consumption patterns as well as interregional flows.

Our analysis highlights the following features of the results. First, the direct impact of the transfers (i.e., before their financing is accounted for) differs regionally owing to the initial distribution of poverty varying across regions. The poorest regions experience both the largest increases in mean incomes and the largest decreases in inequality. The large decreases in inequality reflect (by construction) the high distributional power of the targeted program. Second, the incidence of the taxation introduced to finance the program differs substantially across regions and is regressive overall. The progressive effect of program financing in terms of decreasing inter-regional inequality is more than offset by the regressive effect in terms of increasing intraregional inequality. Thus, the overall effect on inequality is lower than that under the direct effect alone. The high distributional power inherent in the targeted nature of the program means that inequality decreases in all rural regions.

Third, the aggregate effect of taxation is very sensitive to the program financing strategy. The move to a more efficient tax system (e.g., removing agriculture subsidies or increasing VAT on necessities) both increases aggregate income and is less regressive than moves toward the more inefficient alternatives (e.g., involving increasing taxes on luxuries). Fourth, the regional effects of taxation are also very sensitive to the program financing strategy. The more efficient tax systems have a clear bias in favor of urban areas, resulting in a lower negative impact on urban mean income and also a less regressive tax incidence. The less efficient tax systems lead to higher mean incomes in all rural areas, but especially in North and Central. But the latter come at a cost in terms of a more regressive tax incidence. The relatively smaller positive effect on mean incomes in Southeast and Southwest (compared to North and Central) under the inefficient tax systems reflects the relatively stronger negative impact of lower mean income in urban areas. Fifth, although the program leads to a substantial decrease in poverty at the national level, the exclusion of urban areas means that urban poverty increases and, after the program, accounts for a substantially higher proportion of total national poverty (i.e., an increase from

18 percent before the program to 30 percent after the program). The increase in urban poverty is also sensitive to the financing strategy used, with the less (more) efficient tax system leading to a 10 percent (5 percent) increase in urban poverty. This highlights the shortcomings inherent in rural targeting and raises concerns associated with horizontal equity.

To summarize, one of the main purposes of this report is to bring out clearly the need to consider the general equilibrium consequences of redesigning social safety nets with the objective of making them more cost effective. To this end we have presented a framework that facilitates such an analysis by showing how the results from an applied computable general equilibrium model can be integrated with the information available in household surveys to provide a more comprehensive evaluation of the welfare implications of domestically financed targeted transfer programs. In the context of a cash-transfer program in Mexico, our results indicate that the general equilibrium welfare impacts associated with domestic financing can be quite substantial. When initial redistribution mechanisms are inefficient, the welfare gains from switching to a better targeted direct transfer scheme are reinforced by efficiency gains associated with the removal of relatively distortionary financing instruments. More generally, the indirect welfare costs associated with domestic financing can be reduced by taking the opportunity to reform the existing tax system to reduce any existing trade-off that exists between efficiency and equity objectives. Our analysis of the spatial distribution of these welfare impacts helps to highlight the importance of recognizing the shortcomings of crude geographic targeting. Not only did the urban poor not benefit from the transfer program but they were also adversely affected by the general equilibrium impacts of the program. However, we also found that accompanying the transfer program with efficient reforms of the tax system can not only minimize this adverse impact but may actually lead to the urban poor benefiting through the general equilibrium changes in incomes and prices.

APPENDIX A

Description of Two-Step Procedure for Integrating the Results of the CGE Model with the Disaggregated Household Data

The social welfare function is assumed to take the typical Bergson–Samuelson form, defined over $h = 1, H$ households:

$$W(V^1(\mathbf{q}, \mathbf{w}, m^1), \ldots, V^h(\mathbf{q}, \mathbf{w}, m^h), \ldots, V^H(\mathbf{q}, \mathbf{w}, m^H))$$

where $V^h(\mathbf{q}, \mathbf{w}, m^h)$ is the indirect utility function for household h, $\mathbf{q}$ is a vector of consumer commodity prices, $\mathbf{w}$ is a vector of factor prices (say, the wage rate for labor), and m^h is household lump-sum income (i.e., from government transfers). This is the same function as that in the text, with commodity and factor prices separated out for convenience. For a revenue neutral domestically financed transfer program, all changes in welfare come through changes in these three vectors (i.e., changes in lump-sum incomes, consumer commodity prices, and factor prices). Fully differentiating the social welfare function in the preceding, the welfare effects brought about by the domestically financed transfer program are:

$$\mathrm{d}W = \sum_h \frac{\partial W}{\partial V^h}\frac{\partial V^h}{\partial m^h}\,\mathrm{d}m^h + \sum_h \frac{\partial W}{\partial V^h}\frac{\partial V^h}{\partial \mathbf{q}}\,\mathrm{d}\mathbf{q} + \sum_h \frac{\partial W}{\partial V^h}\frac{\partial V^h}{\partial \mathbf{w}}\,\mathrm{d}\mathbf{w}$$

where the first term captures the direct welfare effect from income transfers and the final two terms capture the indirect welfare effects coming through the resulting general equilibrium changes in commodity and factor prices, respectively.

From Roy's identity, the partial derivatives of the indirect utility function with respect to consumer commodity prices (subscripted i) and factor prices (subscripted j) are:

$$\frac{\partial V^h}{\partial q_i} = -x_i^h \frac{\partial V^h}{\partial m^h}$$

and

$$\frac{\partial V^h}{\partial w_j} = l_j^h \frac{\partial V^h}{\partial m^h}$$

where x_i^h and l_j^h are the consumption of commodity i and the supply of factor j by each household, respectively. Defining $\beta^h \equiv \partial W/\partial m^h$, as before, and using substituting these into the above equation we get:

$$\mathrm{d}W = \sum_h \beta^h \mathrm{d}m^h + \sum_h \sum_j \beta^h l_j^h \mathrm{d}w_j - \sum_h \sum_i \beta^h x_i^h \mathrm{d}q_i \quad (10)$$

From the household budget constraint we also have:

$$y^h \equiv \sum_i q_i x_i^h = m^h + \sum_j w_j l_j^h$$

Rearranging equation (10) and multiplying and dividing all terms by total income y^h we get:

$$\mathrm{d}W = \sum_h \beta^h y \left[\frac{\mathrm{d}m^h}{y^h} - \sum_j \frac{l_j^h \mathrm{d}w_j}{y^h} - \sum_i \frac{x_i^h}{y^h} \mathrm{d}q_i \right]$$

Multiplying and dividing the last term in brackets by q, and using the household budget constraint, this can be rewritten as:

$$\mathrm{d}W = \sum_h \beta^h y^h \left[\phi^h + \gamma^h - \sum_i \theta_i^h \rho_i \right] \quad (11)$$

where ϕ^h and γ^h are the proportionate changes in household income attributable to the direct transfers and indirect (factor) income effects respectively, ρ_i is the proportionate change in the price of commodity i, and θ_i^h is the share of expenditure on commodity i in the total expenditure of the household. The term in brackets can be interpreted as the proportionate change in real incomes (i.e., nominal incomes minus a cost-of-living index). These proportionate changes are outputs from the CGE model and are then applied to household-level data.

APPENDIX B

Details of the CGE Model Structure

In this appendix we present a more detailed discussion than that in the text of important features of the model structure. We discuss, in turn, the Armington treatment of imports, the system of price equations, and the LES consumption behavior.

The Armington Function

The use of the Armington function in trade differs from the standard neoclassical trade model in which all goods are tradable and all domestically produced goods are perfectly substitutable with imports. The standard treatment has several drawbacks. It leads to the conclusion that the domestic relative price of tradeables is fully determined by world prices, which is not the case empirically. These models result in the full transmission of world price changes and in extreme specialization in production. In the Armington framework, the economy is less responsive to world price changes, thus dampening the move toward specialization. Also, this setup accounts for two-way trade in a given sector, which occurs regularly even in very disaggregated sectors.

De Melo and Robinson (1989) show the importance of the elasticity of substitution in their discussion of how a term of trade deterioration affects the exchange rate. For a low elasticity, say 0, the exchange rate must depreciate so that the country can export more to earn the foreign exchange needed for the nonsubstitutable import. For a higher elasticity, the economy switches its production from the export sector into the domestic substitute for the import. To encourage this contraction of exports, the exchange rate must appreciate.

The parameters for this CGE model are given in Appendix Table E.5. The trade parameters were not available empirically, and thus may be considered "guestimates."

Price Determination and Role of Taxes

The price equations in the model (see Appendix D) highlight the imperfect substitutability in trade and show where the taxes fit into this model. Equations (12) and (13) describe the import price (PM_c) and export price (PE_c), respectively. These prices depend on the world price, valued in domestic currency, along with the import tariff or export tax. With the world prices set exogenously, the country is assumed to be "small."

PQ_c, the domestic composite price [equation (14)], is the average of the price of the commodity produced and sold domestically and the price of the imported commodity, weighted by their respective quantities, plus the sales tax. Thus, the sales tax is imposed on both domestically produced goods as well as imports (which are already tariff-ridden). Implicit in equation (14) is the Armington assumption (described previously), as the price that the consumer faces is not totally determined by world prices.

Equation (15) gives the average output price of the commodity output, PX_c. It is the weighted average of the price of domestically produced goods sold domestically and domestically produced goods that are exported. This equation reflects the use of the CET function described in the second section of Chapter 3, which implies that the world price is not completely transmitted to the output price that domestic producers receive.

In equation (18), the value-added price, PVA_a, is described as the activity price minus any tax on (or subsidy to) producers, as well as the cost of intermediate goods. Equations (19) and (20) give the definitions of the consumer price index and the producer price index, respectively. As is standard in CGE models, this model solves for *relative* prices. Thus one price, in this case, the consumer price index, is chosen as the *numeraire,* around which the other prices, including the exchange rate, are based.

Equation (22) describes factor demands that are derived from the first-order conditions of the CES function for the primary factors. In the model it is assumed that the primary factors are paid the same economy-wide rental or wage rate (WF_f), regardless of sector. To adjust for distortions in factor markets, a sector specific variable ($WFDIST_{f,a}$) is included. If there are no distortions in a particular factor market, this variable is equal to 1 for all sectors. This equation shows that marginal cost must equal marginal revenue; because *PVA* is multiplied by the value-added tax, tva_a, it can be seen that an increase in the value-added tax lowers the marginal revenue product and, *ceteris paribus,* lowers factor demand.

The income tax, *TTINS,* appears in the equations for institutional behavior in Appendix D [equations (37)–(39)]. It is imposed as a lump-sum tax (i.e., it does not affect the agent's decisions with respect to earning income) on households and the enterprise. For both types of institutions, the income tax affects the amount of inter-institutional transfers, as taxes must be netted out of income before any transfers can be made. Similarly, savings is based on net income. Households do not pay income tax on home consumption.

Consumption Behavior

Consumption is determined by LES demand functions, with separate equations written for marketed consumption and home consumption.[31] The LES equation comes from the maximization of the Stone–Geary utility function:

$$U = \prod_i (C_i - \gamma_i)^{\phi_i}$$

where the subscript *i* refers to commodities, *C* is total household consumption, γ is subsistence consumption, and ϕ is the marginal propensity to consume each commodity. The resulting demand functions, in equations 40 and 41 of Appendix D show that the amount of expenditure on a good will consist of the subsistence expenditure plus the marginal budget share of the "supernumerary income" —that is, the income that is left over after accounting for the subsistence expenditures of all other goods. The parameters for the system were not available for Mexico; instead, they come from the adaptation of parameters used in a study of Zimbabwe (Bautista et al. 1999). These parameters are presented in Appendix Table E.6.

[31]Note that the use of two interdependent functions is necessitated by the differentiation between *activities* (whose purchase by households designates home consumption) and *commodities* (whose purchase by households signifies marketed consumption).

APPENDIX C

CGE Model Sets, Variables, and Parameters of the CGE Model

Sets

AAC	global set

Subsets of AAC

a	activities
c	commodities
ce(c)	exported commodities
cm(c)	imported commodities
cne(c)	nonexported commodities
cnm(c)	nonimported commodities
en(ins)	enterprises
f	factors
h(ins)	households
id	domestic institutions
ins	institutions (domestic and rest of world)
lab(f)	labor factors
ld(f)	land factors

Parameters

α^{a}_{a}	shift parameter for CES activity production function
α^{ac}_{a}	shift parameter for domestic commodity aggregation function
α^{q}_{c}	shift parameter for Armington function
α^{t}_{c}	shift parameter for CET function
$\beta^{h}_{a,h}$	LES marginal budget shares for home consumed goods (activities)
$\beta^{m}_{c,h}$	LES marginal budget shares for marketed goods (commodities)
$cwts_{c}$	consumer price index weights
$\delta^{a}_{f,a}$	share parameter for CES activity production function
$\delta^{ac}_{a,c}$	share parameter for domestic commodity aggregation function
δ^{q}_{c}	share parameter for Armington function
δ^{t}_{c}	share parameter for CET function
$dwts_{c}$	domestic sales price weights
$\gamma^{h}_{a,h}$	LES subsistence minima for home consumed goods (activities)
$\gamma^{m}_{c,h}$	LES subsistence minima for marketed goods (commodities)

$ica_{c,a}$	intermediate input *c* per unit of activity *a*
$insub_a$	input subsidy for activity *a*
mps_{ins}	marginal propensity to save for domestic institution
$p01_{ins}$	0–1 parameter (1 for institution with variable income tax rate, 0 for others)
$p04_a$	0–1 parameter (1 for activity with variable VAT rate, 0 for others)
$qbardst_c$	inventory investment by sector of origin
$qbarg_c$	exogenous (unscaled) government demand
$qbarinv_c$	exogenous (unscaled) investment demand
ρ_c^{ac}	domestic commodity aggregation function exponent
ρ_c^q	Armington function exponent
ρ_a^a	CES activity production function exponent
ρ_c^t	CET function exponent
$shif_{id,f}$	share of domestic institution *id* in income of factor *f*
$shii_{id,idp}$	share of domestic institution *id* in post-tax post-savings income of institution *idp*
$supernum_h$	LES supernumerary income
ta_a	producer tax rate
te_{ce}	export tax rate
tf_f	tax per physical unit of factor *f*
$\theta_{a,c}$	yield of commodity *c* per unit of activity *a*
$tins_{ins}$	direct tax rate on institution *ins*
tm_c	tariff rates on imports of *c*
tq_c	sales tax
$tr_{i,aac}$	transfers from institution or factor ACC to institution *i*
tva_a	value-added tax for activity *a*

Variables

CPI	consumer price index (*PQ*-based)
DPI	index for domestic-sales producer prices (*PDS*-based)
DTAXADJ	direct tax scaling factor
DTINS	change in domestic institution tax share
DVATADJ	VAT scaling factor
EG	government expenditure
EXR	exchange rate
FSAV	foreign savings
GADJ	government demand scaling factor
GSAV	government savings
IADJ	investment scaling factor (for fixed capital formation)
INVEST	total investment value
PA_a	output price of activity *a*
PDD_c	demand price for commodity *c* produced and sold domestically
PDS_c	supply price for commodity *c* produced and sold domestically
PE_c	price of exports
PM_c	price of imports
PQ_c	price of composite good *c*
PVA_a	value added price
PWE_{ce}	world price of exports
PWM_{cm}	world price of imports
PX_c	average output price

$PXAC_{a,c}$	price of commodity *c* from activity *a*
QA_a	domestic activity output
QD_c	domestic sales
QE_{cm}	exports
$QF_{f,a}$	demand for factor *f* from activity *a*
QFS_f	factor supply
QG_c	government consumption
$QH_{c,h}$	household consumption demand
$QINT_c$	intermediate demand for *c*
$QINV_c$	fixed investment demand
QM_{cm}	imports
QQ_c	composite goods supply
QX_c	commodity output
$QXAC_{a,c}$	ouput of commodity *c* from activity *a*
$SADJ$	savings adjustment variable for domestic institutions
$SAVINGS$	total savings value
$TRII_{i,ip}$	transfers to domestic institution *i* from domestic institution *ip*
$TTINS_{ins}$	total direct tax on institution *ins*
$TVAADJ$	change in activity's VAT share
$WALRAS$	savings-investment imbalance (should be zero)
WF_f	average factor price (rent)
$WFDIST_{f,a}$	factor market distortion variable
YD_{id}	expendable income
YF_f	factor income
YG	government income
YHA_h	own household consumption/income
YHM_h	marketed income
YI_{ins}	income of (domestic nongovernmental) institution *i*
$YIF_{ins,f}$	income of institution *i* from factor *f*

APPENDIX D

Model Equations

Price Block

$$PM_{cm} = \overline{PWM_{cm}} \cdot (1 + tm_{cm}) \cdot EXR \tag{12}$$ [32]

$$PE_{cd} = \overline{PWE_{ce}} \cdot (1 - te_{ce}) \cdot EXR \tag{13}$$

$$PQ_c \cdot (1 - tq_c) \cdot QQ_c = PDD_c \cdot QD_c + PM_{cm} \cdot QM_{cm} \tag{14}$$

$$PX_c \cdot \mathrm{QX_c} = PDS_c \cdot QD_c + PE_{ce} \cdot QE_{ce} \tag{15}$$

$$PDD_c = PDS_c \tag{16}$$

$$PA_a = \sum_c \theta_{a,c} \cdot PXAC_{a,c} \tag{17}$$

$$PVA_a = PA_a \cdot (1 - ta_a + insub^a) - \sum_c ica_{c,a} \cdot PQ_c \tag{18}$$

$$\overline{CPI} = \sum_c cwts_c \cdot PQ_c \tag{19}$$

$$\overline{DPI} = \sum_c dwts_c \cdot PDS_c \tag{20}$$

Supply and Trade Block

$$QA_a = \alpha_a^a \cdot \left(\sum_f \delta_{f,a}^a \cdot QF_{f,a}^{-\rho_a^a}\right)^{-\frac{1}{\rho_a^a}} \tag{21}$$

$$WF_f \cdot \overline{WFDIST_{f,a}} = PVA_a \cdot (1 - DVATADJ \cdot tva_a \cdot (1 + tvaadj \cdot P04_a)) \cdot \alpha_a^a \cdot \left(\sum_{fp} \delta_{fp,a}^a \cdot QF_{fp,a}^{-\rho_a^a}\right)^{-\frac{1}{\rho_a^a}-1} \cdot \delta_{f,a}^a \cdot QF_{f,a}^{-\rho_a^a-1} \tag{22}$$

$$QINT_c = \sum_a ica_{c,a} \cdot QA_a \tag{23}$$

$$QXAC_{a,c} = \theta_{a,c} \cdot \left(QA_a - \sum_h QAH_{a,h}\right) \tag{24}$$

$$QX_c = \alpha_c^{ac} \cdot \sum_a (\delta_{a,c}^{ac} \cdot QXAC_{a,c}^{-\rho_a^{ac}})^{-\frac{1}{\rho_a^{ac}}} \tag{25}$$

[32]A bar over a variable indicates that the variable is exogenously fixed.

$$PXAC_{a,c} = PX_c \cdot \alpha_c^{ac} \cdot \left(\sum_{ap} \delta_{ap,c}^{ad} \cdot QXAC_{ap,c}^{-\rho_a^{ac}}\right)^{-\frac{1}{\rho_c^{ac}}-1} \cdot \delta_{a,c}^{ac} \cdot QXAC_{a,c}^{-\rho_c^{ac}-1} \quad (26)$$

$$QX_{ce} = \alpha_{ce}^t \cdot (\delta_{ce}^t \cdot QE_{ce}^{\rho_{ce}^t} + (1 - \delta_{ce}^t) \cdot QD_{ce}^{\rho_{ce}^t})^{\frac{1}{\rho_{ce}^t}} \quad (27)$$

$$QX_{cne} = QD_{cne} \quad (28)$$

$$QE_{ce} = QD_{ce} \cdot \left(\frac{PE_{ce}}{PDS_{ce}}\right) \cdot \left(\frac{1 - \delta_{ce}^t}{\delta_{ce}^t}\right)^{\frac{1}{\rho_{ce}-1^t}} \quad (29)$$

$$QQ_{cm} = alphaq_{cm} \cdot (deltaq_{cm} \cdot QM_{cm}^{-rhoq_{cm}} + (1 - deltaq_{cm}) \cdot QD_{cm}^{-rhoq_{cm}})^{-\frac{1}{rhoq_{cm}}} \quad (30)$$

$$QQ_{cnm} = QD_{cnm} \quad (31)$$

$$QM_{cm} = QD_{cm} \cdot \left(\frac{PDD_{cm}}{PM_{cm}}\right) \cdot \left(\frac{\delta_{cm}^q}{1 - \delta_{cm}^q}\right)^{\frac{1}{1=\rho_{cm}^q}} \quad (32)$$

Institution Block

$$YF_f = \sum \overline{WF_f} \cdot \overline{WFDIST_{f,a}} \cdot QF_{f,a} \quad (33)$$

$$YIF_{id,f} = shif_{id,f} \cdot (YF_f - tr_{row,f} \cdot EXR) \cdot (1 - tf_f) \quad (34)$$

$$YI_{id} = \sum_f YIF_{id,f} + \sum_{idp} TRII_{id,idp} + tr_{id,gov} + tr_{id,row} \cdot EXR \quad (35)$$

$$TTINS_{idp} = (\overline{DTAXADJ} \cdot tins_{idp} - \overline{DTINS} \cdot p01_{idp}) \quad (36)$$

$$TRII_{id,en} = shii_{id,en} \cdot (1 - \overline{SADJ} \cdot mps_{en}) \cdot (1 - TTINS_{en}) \cdot YI_{en} \quad (37)$$

$$TRII_{id,h} = shii_{id,h} \cdot ((1 - \overline{SADJ} \cdot mps_h) \cdot (1 - TTINS_h) \cdot YHM_h + YHA_h) \quad (38)$$

$$YD_h = (1 - SADJ \cdot mps_h) \cdot \left(\left(1 - \sum_{ins} shii_{ins,h}\right) \cdot (1 - TTINS_h) \cdot YHM_h + YHA_h\right) \quad (39)$$

$$PQ_c \cdot QH_{ch,h} = PQ_c \cdot \gamma_{c,h}^m + \beta_{c,h}^m \cdot \left(YD_h - \sum_{cp} PQ_{cp} \cdot \gamma_{cp,h}^m - \sum_a PA_a \cdot \gamma_{a,h}^h\right) \quad (40)$$

$$PA_a \cdot QAH_{a,h} = PA_a \cdot \gamma_{a,h}^h + \beta_{a,h}^h \cdot \left(YD_h - \sum PQ_c \cdot \gamma_{c,h}^m - \sum PA_{ap} \cdot \gamma_{ap,h}^h\right) \quad (41)$$

$$YHA_h = \sum PA_a \cdot QAH_{a,h} \quad (42)$$

$$YHM_h = YI_h - YHA_h \quad (43)$$

$$YG = \sum_{id} (TTINS_{id}) \cdot YI_{id} + \sum_a DVATADJ \cdot tva_a \cdot (1 + tvaadj \cdot P04_a) \cdot PVA_a \cdot QA_a + \sum_a ta_a \cdot PA_a \cdot QA_a + \sum_{cm} tm_{cm} \cdot QM_{cm} \cdot PWM_{cm} \cdot EXR + \sum_{ce} te_{ce} \cdot QE_{ce} \cdot PWE_{ce} \cdot EXR + \sum_c tq_c \cdot PQ_c \cdot QQ_c + \sum_f tf_f \cdot YF_{ff} + tr_{gov,row} \cdot EXR \quad (44)$$

$$EG = \sum_c PQ_c \cdot QG_c + \sum_{id} tr_{id,gov} + \sum_a insub_a \cdot QA_a \quad (45)$$

$$QG_c = \overline{GADJ} \cdot qbarg_c \quad (46)$$

$$GSAV = YG - EG \quad (47)$$

$$QINV_c = IADJ \cdot qbarinv_c \quad (48)$$

$$INVEST = \sum_c PQ_c \cdot (QINV_c + qbardst_c) \quad (49)$$

$$SAVINGS = \sum_{en} \overline{SADJ} \cdot mps_{en} \cdot (1 - TTINS_{en}) \cdot YI_{en} + \sum_h sadj \cdot mps_h \cdot (1 - TTINS_h) \cdot YHM_h + YHA_h) + GSAV + \overline{FSAV} \cdot EXR \quad (50)$$

System Constraint Block

$$QQ_c = QINT_c + \sum_h QH_{c,h} + QG_c + QINV_c + qbardst_c \qquad (51)$$

$$\overline{QFS_f} = \sum_a QF_{f,a} \qquad (52)$$

$$\sum_{cm} \overline{PWM_{cm}} \cdot QM_{cm} + \sum_f tr_{row,f} = \sum_c \overline{PWE_c} \cdot QE_c + \sum_{id} tr_{id,row} + \overline{FSAV} \qquad (53)$$

$$SAVINGS = INVEST + WALRAS \qquad (54)$$

APPENDIX E

Supplementary Tables

Table E.1 Rural regions

Regions	States
North	Baja California Norte, Baja California Sur, Sonora, Sinaloa, Chihuahua, Coahuila, Nuevo Leon
Central	Durango, Zacatecas, Aguascalientes, San Luis Potosi, Guanajuato, Queretaro, Hidalgo, Tlaxcala, Puebla, Tamaulipas
Southwest	Nayarit, Jalisco, Colima, Michoacan, Estado de Mexico, Distrito Federal, Guerrero, Morelos
Southeast	Veracruz, Oaxaca, Chiapas, Tabasco, Campeche, Yucatan, Quintana Roo

Table E.2 National sectors in model[a]

1. Maize
2. Wheat
3. Beans
4. Other grains (sorghum, barley)
5. Fruits and vegetables
6. Other crops (tobacco, hemp, cotton, cocoa, sugar, coffee, soy, safflower, sesame, and others)
7. Livestock/forestry/fisheries (bovines, goats, sheep, bees, poultry and others, forestry and fisheries)
8. Dairy
9. Prepared fruits and vegetables
10. Wheat manufacturing
11. Corn manufacturing
12. Sugar manufacturing
13. Other processed foods (coffee manufacturing, processed meats, oils and fats, feeds, alcohol, beverages, and others)
14. Light manufacturing (lumber, wood, paper, print, and cigar manufacturing, soft fiber textiles, hard fiber textiles, other textiles, leather, apparel)
15. Intermediates (chemicals, synthetics, rubber, glass, cement, fertilizers, other chemicals, oil refining, oil and gasoline, petrochemicals, coal, iron, nonferrous metal, sand/gravel, minerals)
16. Consumer items (pharmaceuticals, soaps, plastic, metal furnishings, household appliances, electronic equipment, automobiles and parts)
17. Capital goods (metal products, metal manufacturing, nonelectronic machines, electronic machines, other electric goods, transportation materials, mineral manufacturing, iron manufacturing, nonferrous metal manufacturing, others)
18. Professional services (professional services, education, medical, finance/real estate, public administration and defense, electricity, gas and water)
19. Other services (other services, restaurants)
20. Construction
21. Commerce, trade, and transportation

[a] Note that there are four activities for each of the agricultural crop sectors (sectors 1–6): one for each region. Otherwise, the activities are the same as these sectors. The commodities are the same as these sectors.

Table E.3 Disaggregation across income groups and regions (distribution of households across national income deciles by region)

	Regions				
Decile group	**North**	**Central**	**Southwest**	**Southeast**	**Urban**
First decile (bottom)	0.06	0.18	0.15	0.23	0.03
Second decile	0.09	0.17	0.12	0.19	0.05
Third decile	0.11	0.14	0.13	0.14	0.07
Fourth decile	0.15	0.11	0.12	0.11	0.09
Fifth decile	0.11	0.10	0.12	0.09	0.10
Sixth decile	0.10	0.09	0.11	0.07	0.11
Seventh decile	0.09	0.07	0.07	0.06	0.13
Eighth decile	0.11	0.06	0.08	0.05	0.13
Ninth decile	0.09	0.05	0.06	0.04	0.14
Tenth decile (top)	0.08	0.03	0.04	0.02	0.15
Share of bottom decile in bottom three deciles	0.23	0.37	0.37	0.41	0.20

Note: Numbers are the proportion of households in the region falling into each decile.
Source: Authors' calculations based on 1996 national household income and expenditure survey.

Table E.4 Summary statistics

	Producer tax	VAT	Sales tax	Tariff	Export tax	Output	Sectoral composition (percentage): Domestic supply	Sectoral composition (percentage): Imports	Sectoral composition (percentage): Exports	Exports/ output	Imports/ domestic supply
Maize	0	—	0.006	0.012	0.007	0.62	0.83	1.17	0.03	0.85	24.19
Wheat	–0.571	—	0.000	0.007	0.032	0.12	0.12	0.00	0.01	1.44	0.07
Beans	–0.003	—	0.008	0.009	0.006	0.11	0.10	0.14	0.17	29.03	24.37
Other grain	–0.449	—	0.000	0.000	0.008	0.16	0.16	0.00	0.15		
Fruits and vegetables	–0.001	—	0.006	0.000	0.018	0.75	0.64	0.32	0.95	23.43	8.55
Other crops	–0.002	—	0.007	0.016	0.006	0.84	0.77	1.55	1.89	41.72	34.75
Livestock	0.001	—	0.008	0.014	0.033	2.20	2.21	0.39	0.42	3.53	3.00
Dairy	–0.308	—	0.008	0.005	0.007	1.81	1.89	0.56	0.12	1.18	5.04
Maize manufacturing	–0.308	—	0.008	0.018	0.007	1.47	1.47	0.02	0.10	1.28	0.28
Wheat manufacturing	–0.308	—	0.008	0.030	0.006	1.13	1.03	0.17	0.70	11.54	2.75
Fruit and vegetable preparation	0.002	—	0.006	0.017	0.009	0.30	0.20	0.18	0.69	43.62	15.60
Sugar	0.002	—	0.005	0.034	0.023	0.40	0.41	0.35	0.30	14.09	14.94
Other foods	0.002	—	0.008	0.016	0.007	4.29	4.46	3.38	2.50	10.81	13.01
Light manufacturing	0.002	0.05	0.007	0.027	0.009	5.50	5.73	11.78	10.27	34.71	35.29
Intermediates	0.002	0.05	0.006	0.016	0.019	5.43	5.57	12.50	11.44	39.14	38.54
Capital goods	0.002	0.10	0.007	0.021	0.012	7.36	9.89	46.26	30.68	77.52	80.23
Consumer items	0.002	0.10	0.007	0.023	0.006	11.96	8.41	21.24	39.74	61.78	43.33
Construction	0.003	0.10	0.006	—	—	5.24	5.28	—	—	—	—
Professional services	0.007	0.05	0.008	—	—	19.96	20.15	—	—	—	—
Other services	0.004	—	0.009	—	—	11.15	11.27	—	—	—	—
Commerce	0.003	0.1	0.009	—	—	19.22	19.43	—	—	—	—

Note: A negative entry for the producer tax represents a producer subsidy.
Source: Harris (1999).

Table E.5 Production elasticities

	Elasticity of substitution for production function	Armington elasticities	CET elasticities
Maize	0.6	4	4
Wheat	0.6	4	4
Beans	0.6	4	4
Other grains	0.6	4	4
Fruits and vegetables	0.5	2	4
Other crops	0.5	4	4
Livestock	0.6	3	0.5
Dairy	1.5	3	3
Fruit and vegetable preparation	1.5	3	3
Wheat manufacturing	1.5	3	3
Maize manufacturing	1.5	3	3
Sugar	1.5	3	3
Other foods	1.5	3	3
Light manufacturing	2.0	0.2	2
Intermediate	0.6	0.2	2
Capital goods	0.6	0.2	2
Consumer goods	1.5	0.2	2
Construction	0.8	2	2
Professional services	0.8	2	2
Other services	2.0	2	2
Commerce	0.8	2	2

Table E.6a Marginal budget shares for home-consumed goods

Sectors\households	RP–N	RP–C	RP–SW	RP–SE	RM–N	RM–C	RM–SW	RM–SE	RR–N	RR–C	RR–SW	RR–SE
Maize	0.000	0.003	0.003	0.004	0.000	0.003	0.001	0.002	0.000	0.001	0.000	0.003
Wheat	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Beans	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Other grains	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Fruits and vegetables	0.001	0.000	0.001	0.001	0.000	0.002	0.000	0.001	0.001	0.000	0.000	0.002
Other crops	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Note: The column labels refer to the following sets of household and regions.
Households: RP (Rural Poor), RM (Rural Medium), UP (Urban Poor), UM (Urban Medium), UR (Urban Rich)
Regions: N (North), C (Central), SW (Southwest), SE (Southeast)

Table E.6b Marginal budget shares for marketed goods

Sectors\households	RP–N	RP–C	RP–SW	RP–SE	RM–N	RM–C	RM–SW	RM–SE	RR–N	RR–C	RR–SW	RR–SE
Maize	0.001	0.008	0.006	0.010	0.000	0.005	0.002	0.003	0	0.013	0.005	0
Wheat	0.002	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0	0.000	0
Beans	0.001	0.001	0.001	0.001	0.000	0.001	0.001	0.000	0.001	0.001	0.005	0.001
Other grains	0.003	0.001	0.002	0.003	0.002	0.001	0.001	0.001	0	0	0.011	0
Fruits and vegetables	0.007	0.009	0.010	0.007	0.007	0.011	0.011	0.008	0.005	0.004	0.015	0.010
Other crops	0.001	0.001	0.000	0.000	0.001	0.001	0.001	0.001	0.000	0	0.001	0.000
Livestock	0.017	0.018	0.031	0.042	0.010	0.011	0.021	0.023	0.015	0.003	0.012	0.012
Dairy	0.066	0.057	0.066	0.050	0.045	0.035	0.052	0.041	0.023	0.010	0.065	0.028
Fruit and vegetable preparation	0.014	0.010	0.011	0.006	0.010	0.009	0.009	0.006	0.003	0	0.007	0.004
Wheat manufacturing	0.018	0.027	0.025	0.027	0.013	0.019	0.024	0.023	0.020	0.007	0.021	0.016
Maize manufacturing	0.037	0.034	0.035	0.038	0.030	0.026	0.043	0.030	0.079	0.013	0.062	0.023
Sugar	0.018	0.024	0.019	0.040	0.009	0.016	0.016	0.017	0.001	0.004	0.013	0.005
Other foods	0.079	0.061	0.058	0.062	0.079	0.056	0.067	0.059	0.056	0.043	0.067	0.050
Light manufacturing	0.049	0.041	0.034	0.032	0.049	0.051	0.047	0.038	0.051	0.048	0.063	0.045
Intermediate	0.014	0.008	0.008	0.007	0.014	0.010	0.009	0.008	0.004	0.012	0.012	0.009
Capital goods	0.110	0.071	0.068	0.063	0.103	0.081	0.080	0.067	0.105	0.094	0.095	0.078
Consumer goods	0.082	0.053	0.050	0.049	0.110	0.076	0.068	0.077	0.083	0.228	0.080	0.057
Professional services	0.083	0.077	0.081	0.072	0.082	0.076	0.071	0.068	0.043	0.156	0.086	0.053
Other services	0.134	0.136	0.101	0.087	0.138	0.167	0.134	0.153	0.135	0.107	0.127	0.185
Commerce	0.264	0.360	0.391	0.399	0.297	0.342	0.344	0.374	0.373	0.256	0.251	0.418

Table E.6c Own price elasticity of home-consumed goods

Sectors/households	RP–N	RP–C	RP–SW	RP–SE	RM–N	RM–C	RM–SW	RM–SE	RR–N	RR–C	RR–SW	RR–SE
Maize	–0.1	–0.1	–0.1	–0.1	0	–0.1	–0.1	–0.1	0	–0.6	–0.6	–0.6
Wheat	–0.2	0	0	–0.2	–0.2	0	0	0	–0.6	0	0	0
Beans	–0.1	–0.1	–0.1	–0.1	–0.1	–0.1	–0.1	–0.1	–0.6	0	–0.6	–0.6
Other grains	–0.2	–0.2	0	–0.2	0	0	0	0	0	0	–0.6	0
Fruits and vegetables	–0.3	–0.3	–0.3	–0.3	–0.4	–0.4	–0.4	–0.4	–0.6	0	0	–0.6
Other crops	–0.4	–0.4	–0.4	–0.4	–0.4	–0.4	–0.4	–0.4	–0.6	0	–0.6	–0.6

Table E.6d Own price elasticity of demand for market-consumed goods

Sectors\households	RP–N	RP–C	RP–SW	RP–SE	RM–N	RM–C	RM–SW	RM–SE	RR–N	RR–C	RR–SW	RR–SE	HHUP	HHUM	HHUR
Maize	–0.10	–0.11	–0.11	–0.11	–0.10	–0.10	–0.10	–0.10	—	–0.61	–0.60	—	–0.10	–0.10	–0.60
Wheat	–0.20	–0.20	–0.20	–0.20	–0.20	–0.20	–0.20	–0.20	–0.60	—	–0.60	—	–0.20	–0.20	–0.60
Beans	–0.10	–0.10	–0.10	–0.10	–0.10	–0.10	–0.10	–0.10	–0.60	–0.60	–0.60	–0.60	–0.10	–0.10	–0.60
Other grains	–0.20	–0.20	–0.20	–0.20	–0.20	–0.20	–0.20	–0.20	—	—	–0.60	—	–0.20	–0.20	–0.60
Fruits and vegetables	–0.31	–0.31	–0.31	–0.30	–0.40	–0.41	–0.41	–0.40	–0.60	–0.60	–0.61	–0.60	–0.31	–0.40	–0.60
Other crops	–0.40	–0.40	–0.40	–0.40	–0.40	–0.40	–0.40	–0.40	–0.60	—	–0.60	–0.60	–0.30	–0.30	–0.90
Livestock	–0.90	–0.90	–0.90	–0.90	–0.80	–0.80	–0.80	–0.80	–0.70	–0.70	–0.70	–0.70	–0.90	–0.80	–0.70
Dairy	–0.91	–0.91	–0.91	–0.91	–0.81	–0.81	–0.81	–0.81	–0.71	–0.70	–0.72	–0.71	–0.91	–0.81	–0.71
Fruit and vegetable preparation	–0.90	–0.90	–0.90	–0.90	–0.90	–0.90	–0.90	–0.90	–0.80	—	–0.80	–0.80	–0.90	–0.90	–0.80
Wheat manufacturing	–0.71	–0.71	–0.71	–0.71	–0.80	–0.80	–0.80	–0.80	–0.80	–0.80	–0.80	–0.80	–0.71	–0.80	–0.80
Maize manufacturing	–0.61	–0.61	–0.61	–0.62	–0.71	–0.71	–0.71	–0.71	–0.82	–0.80	–0.81	–0.80	–0.61	–0.70	–0.80
Sugar	–0.90	–0.90	–0.90	–0.90	–0.90	–0.90	–0.90	–0.90	–0.80	–0.80	–0.80	–0.80	–0.90	–0.90	–0.80
Other foods	–0.45	–0.44	–0.43	–0.44	–0.54	–0.53	–0.53	–0.53	–0.62	–0.62	–0.63	–0.62	–0.43	–0.53	–0.62
Light manufacturing	–0.43	–0.42	–0.42	–0.42	–0.52	–0.53	–0.52	–0.52	–0.62	–0.62	–0.63	–0.62	–0.42	–0.52	–0.62
Intermediate	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Capital goods	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Consumer goods	–0.54	–0.53	–0.52	–0.52	–0.73	–0.72	–0.72	–0.72	–0.73	–0.77	–0.72	–0.72	–0.53	–0.72	–0.73
Professional services	–0.54	–0.54	–0.54	–0.54	–0.54	–0.54	–0.54	–0.53	–0.52	–0.58	–0.54	–0.53	–0.55	–0.58	–0.60
Other services	–0.91	–0.91	–0.91	–0.91	–0.91	–0.92	–0.91	–0.92	–0.83	–0.82	–0.83	–0.84	–0.91	–0.91	–0.84
Commerce	–0.93	–0.94	–0.94	–0.94	–0.93	–0.93	–0.93	–0.94	–0.87	–0.85	–0.85	–0.88	–0.94	–0.93	–0.85

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