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A REGIONAL GENERAL EQUILIBRIUM ANALYSIS OF THE WELFARE IMPACT OF CASH TRANSFERS: AN ANALYSIS OF PROGRESA IN MEXICO

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Abstract

Using a regionally disaggregated computable general equilibrium model, we analyze the differential welfare impacts of a cash transfer program targeted at rural areas. The direct effect of the transfers decreases regional income differentials, but the indirect effects depend on how the program is financed. Financing the program with a more efficient tax system is also less regressive and has favorable urban impacts. The less efficient instruments result in relatively higher incomes in all rural regions, but are more regressive. The increasing share of urban poverty highlights the shortcomings of rural targeting and raises the issue of horizontal equity.

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1. Introduction

Recently there has been a growing interest in developing countries in the use of direct cash transfers targeted at poor households as an important component of a more comprehensive poverty alleviation strategy.[1] In Coady and Harris (2001), in the context of Mexico's PROGRESA program, we emphasize the need to account for the indirect general equilibrium impacts of such transfers when evaluating their overall welfare impact. However, there we focus exclusively on the aggregate welfare impact of the program and the role of the "cost of public funds" as a sufficient statistic in capturing indirect general equilibrium welfare effects. In this paper we focus exclusively on the spatial distribution of the aggregate welfare impact by exploiting the regional disaggregation of the underlying computable general equilibrium model.

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, while the nature of the latter depends on such things as nature of consumption and production patterns across households and regions, the 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

[1] Mexico and Honduras introduced such a program with national coverage in 1997 and 2000 respectively. Nicaragua introduced a similar program at a pilot level in 2000. Other countries in Latin America (e.g. Columbia, Argentina and Brazil) have programs at the design stage.

example, the regional distribution of the welfare impacts is potentially important from a political economy perspective in 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 the poverty alleviation strategy.

This paper extends the work of Coady and Harris (2001) to focus on the likely spatial distribution of the welfare impact of Mexico's PROGRESA program. The program targets cash transfers to poor households in rural areas, equivalent to approximately 30% of household income.[2] In practice, the program is essentially financed by the withdrawal of food subsidies, which are regarded as being very poorly targeted. However, since we are particularly interested in understanding the implications of domestic financing of the program, we also consider alternative ways of financing the program, namely, alternative changes in the levels and structure of value-added taxes (VATs). As in Coady and Harris (2001), the general equilibrium effects are captured using the following two-step approach. First, the transfers are fed into a computable general equilibrium (CGE) model and we consider alternative ways of financing the program. Then the resulting direct and indirect income effects, as well as the price changes, are taken from the CGE model and superimposed on disaggregated household data, in order to calculate the regional impacts on mean incomes, income distribution, and welfare.

[2] In practice such transfers are made conditional on household members attending school and health clinic appointments. Here we abstract from such conditioning and focus exclusively on the pure cash transfer dimension of the program.

The structure of the paper is as follows. In Section 2 we discuss the methodology used for evaluating the differential regional welfare (and poverty) impacts of the transfers and present a brief picture of the situation prior to the introduction of cash transfers. Details of the computable general equilibrium model and the underlying database used to evaluate the transfers are presented in Section 3, along with a description of the simulations we undertake. In Section 4 we present our results on the regional distribution of the welfare impact of the transfers. Finally, section 5 summarizes and concludes.

2. The Level and Distribution of the Welfare Before the Program

In this section we present a 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 impact of the reforms on social welfare. Our analysis uses the 1996 nationally representative household survey data (ENIGH96): our indicator of welfare is adult-equivalent household per capita expenditure (henceforth called 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, ì, and some measure of inequality, *I*, as follows:

$$W = ì\ (1 - I)$$

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, i.e., we are willing to trade-off a lower mean for a more equal distribution or vice versa. Alternatively, for a given mean income, W decreases the more unequal the distribution around the mean. For our measure of inequality we use the Atkinson index, which has a basis in standard welfare theory.[3]

We group households into five regions: (1) North, (2) Central, (3) South West, (4) South East, and (5) Urban. The distribution of all households across regions is presented in Table 1. One can see that over 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 with South East having 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*(0.5) to *I*(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 around 15% to 20% of total income

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[3] See Atkinson (1970) for details, and also Deaton (1997) for a useful discussion on this approach. The Atkinson index can be written as *I* = 1 - (y_e / ì), where y_e is the "equally distributed equivalent income", i.e., the amount of income which if distributed equally would result in the same level of social welfare as the existing distribution of income. Since social welfare is decreasing in inequality (for a given distribution of income) we have y_e<ì , with their ratio decreasing the greater our aversion to inequality (i.e., the higher å). So y_e encapsulates the concern for unequal distribution. For this reason, *I* is often referred to as an "index of waste" since 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 = ì) or when we are unconcerned about the distribution of income (i.e., å = 0), in which case social welfare is adequately captured by focusing only on mean income.

inequality (with this proportion increasing in ε) indicating a substantial inequality of income within regions.[4]

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 differences in inequality levels (over plausible values of 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 welfare discussion above, it is useful also to have a picture of the distribution of poverty since later 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. Since 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" (Ravallion, 1993). By construction, the national headcount index (i.e., the percentage of households falling below the poverty line) is 33.3%, although this can vary by

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[4] 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.

region, and by design will be affected by the reforms to be analyzed below. We also present the "poverty gap" which (unlike the headcount index) measures the depth of poverty and, if multiplied by the poverty line, indicates the increase in mean income required to eliminate poverty completely. This should of course be interpreted as the minimum required since 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.[5]

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 non-poor. The distribution of poor households across regions is presented in Table 2. Using the headcount ratio (i.e., the proportion of households classified as poor) we find that within rural areas over half of households in both Central and South East are classified as poor and just over 53% of the poor are found in these two regions. Whereas only 18% of urban households are classified as poor, nearly 29% of the poor are found in urban areas. So although a relatively high percentage of rural households are poor, there is still a substantial number of poor located in urban areas. This is important since, in the reforms to be evaluated below, the poverty alleviation budget will be targeted only to rural areas, so that a significant proportion of the vulnerable population is excluded from the program.

[5] See Ravallion (1988) and Deaton (1997) for a more detailed discussion of these indices.

The total poverty gap comes out at 76 pesos per household (or 5.3% of aggregate income) so a 5.3% increase in mean incomes, with the proceeds allocated optimally over only poor households, would be required to eliminate poverty completely.[6] This compares to the poverty alleviation budget, which constitutes around 2% of total income. Alternatively, the alleviation of poverty would require an optimal lump-sum transfer from the non-poor (who account for 90% of total income) equivalent to 5.9% of their income.[7] Over 81% of this gap is concentrated in rural areas, especially in the Central and South East regions. The "poverty shares" of these two regions (and of South West) increase in moving from the poverty gap to using the severity index, suggesting that the poorest households are also located in these rural areas.

3. The CGE Model

In this section we discuss the nature of the CGE model that is used to simulate the general equilibrium responses to the program.[8] We start by describing the database that captures the regional differences within Mexico and links the various sectors of the economy together. We then discuss the structure of the baseline CGE model, which determines the channels through which the general equilibrium effects

[6] 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.

[7] 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 below.

[8] This model builds on the work of Harris (1999).

work. This includes a description of the way in which factor and product markets operate and interact to determine how equilibrium is restored after the program is implemented. This is followed by a discussion of the various policy simulations undertaken in the subsequent section, concentrating mainly on the nature and magnitude of the resulting sectoral and macroeconomic flows.

3.1 The Database and SAM

The CGE model used in this analysis relies on a social accounting matrix (SAM) of Mexico, based on 1996 data.[9] 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.[10] The data were first collected as a national SAM, which was then divided into 5 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.

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[9] The data used in constructing the SAM include: "Sistema de Cuentas Nacionales de México," INEGI, 1996, for national accounts data and other macro data; Informe Anual, Banco de México, 1996 for macro data; SAGAR, 1996 for data on crop yields and land utilization; Encuesta Nacional de Ingresos y Gastos de Hogares, INEGI, 1994, for household income and expenditure data; GTAP database for import and export data. The input-output coefficients come from a 1985 input-output table.

[10] For a detailed discussion of SAMs, see Pyatt and Round (1985).

The model includes four rural regions, North, Central, South West and South East, which produce only primary agricultural products.[11] There is one "national" urban region, which comprises all of the urban areas of Mexico, regardless of geographical location. The urban area produces processed agricultural goods and other goods and services. Appendix Table 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 South East region is poorest, more of the land used is non-irrigated, and there is less commercial farming. The Central and South West 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 6 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 6 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, due to data limitations.

[11] The 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.

The urban region produces all other goods, including processed agricultural goods. Appendix Table 2 lists the sectors used in the model.

There are 4 types of non-agricultural labor: professional, white-collar, blue-collar, and unskilled/informal (referred to in this paper 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 8 land types. There is one capital category, used by all sectors.

Each region has 3 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 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% of the agricultural returns to dry land in their region, while medium rural households receive 55% 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.

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.[12] In Appendix Table 3 we present some useful summary statistics of the data used in the analysis.

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[12] For discussion on this technique, see Robinson, Cattaneo and El-Said (2000).

3.2 Description of the CGE Model[13]

The computable general equilibrium model used in this study follows the sectoral and socio-economic structure of the SAM described above. The CGE model is neo-classical 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.

The production technology is a nested function of constant elasticity of substitution (CES) and Leontief functions. At the top level, domestic output is a linear combination of value added and intermediate inputs. Value added is a CES function of the primary factors of production (the land types, labor types and capital mentioned above) and 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 discussed in the SAM description. Producers 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. The composite consumption good is a CES function of imported and domestically produced commodities. This aggregation, known as the Armington function, permits imperfect substitutability, and therefore, two-way trade, between imported and domestically produced goods.

[13] Appendix Table 4 contains a complete listing of the CGE equations.

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). They 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 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.

Macro closure refers to the four macroeconomic accounts which 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 analysis is not based on changes in foreign inflows. The choice of government budget closure will depend on the simulation being performed; in all cases, government (dis-

)savings 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 base-line 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 propensity to save equilibrates the account. In the factor market equilibria, either a factor is immobile and the wage can vary across sectors or the factor is free to move and the wage fixed across sectors. Here, labor and land are mobile across sectors within a region, but capital is fixed. Hence the model may be thought of as medium-term in nature.

3.3 General Equilibrium Simulations

The CGE model described above is next used to simulate the PROGRESA program. The model transfers income to "poor" households in rural areas, equivalent to a 30% increase in their nominal incomes and 2% of GDP. The total welfare impact of such a program will depend, in part, on how it is financed and here we consider a number of alternatives. The actual source of finance is the elimination of food subsidies. The other alternatives considered involve various reforms of the value-added tax (VAT) system.

In the base-run, the government deficit is $12 billion.[14] The CGE model is programmed to keep this number constant. In each simulation, the method of "closing" the budget must take into account the general equilibrium consequences of the transfer. For example, although the direct cost of the PROGRESA program is $57 billion, 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 below. The CGE model permits the evaluation of each experiment in terms of its macroeconomic, sectoral and regional flows. Proportional income and price changes are also derived from the CGE model, and are presented in Table 3. Table 4 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%, 20% and 20%, respectively.[15] These subsidies cost about $58 billion, so their removal can be used to finance the PROGRESA transfer. In the experiment, the income tax, which is modeled as a lump sum tax, serves as the equilibrating variable for the government budget and it falls slightly. Removing the distorting subsidies

[14] Note that we will follow the convention of using "$" to signify Mexican pesos.

[15] 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 recreate the pre-reform environment and show the effects of removing those subsidies in order to pay for the PROGRESA transfer, as did occur in reality.

causes a slight 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 protected 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 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 South East 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 non-beneficiary 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 ½ percent point as a result of the policy. This is mainly due 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 due to their reliance on urban factor income.

Value-Added Taxes

The base data have three levels of the value added tax (VAT)[16]: 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%; and the "high" VAT rate is on *Capital Goods, Consumer Durables, Construction,* and *Commerce, Trade and Transportation*, equaling 10%. 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% and the higher rate to increase to 14.6%. Next, the VAT is increased only for those goods with the upper rate, rising to 16.1% (HVAT). Thirdly, the VAT is increased and made uniform for the goods that initially had a VAT imposed on them, with the resulting new rate equal to 11.4% (TVAT). Then, the VAT is increased and made uniform for the goods which initially had either zero VAT or the middle rate, so that these goods are now subject to a 7.2% VAT, while the high VAT rate remains at 10% (BVAT). Finally, the VAT is adjusted so that it is uniform for *all* goods, including the ones which were previously exempt, for a single VAT rate of 8.3% (SVAT). See Table 5 for a summary of these experiments.

Two of the VAT experiments slightly improve the macroeconomic indicators, namely, the uniform bottom rate on the zero and low VAT goods (i.e., BVAT), and the single uniform rate on all goods (i.e.,

[16] 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.

SVAT). The resulting VAT structures from these experiments are less distorting than 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% to 8.9%, and land returns fall by between 8.2% to 10.6%. This then dampens the income gains to recipient households, by about 5.5% 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, which move away from a uniform structure, are more inefficient, as evidenced by the slight decline in macroeconomic indicators. However, since raw agricultural production and processed agriculture are not taxed, the increased demand for these products – resulting from the increased income to rural households – raises the agricultural wages in all three experiments. This does not imply that beneficiary household incomes increase beyond the transfer payment, since these households rely heavily 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 above. And, as expected, urban households see even greater decreases in their income with the more distorting VAT systems, since the VAT rates are now higher for the goods from which they receive factor income.

4. The Spatial Distribution of Welfare After the Transfers

We now present the welfare results of our simulations, focusing on the differential regional impacts. As in Coady and Harris (2001), we use a two-step approach: the direct transfers are fed into the CGE model and the resulting impacts on household incomes (i.e. through changes in factor prices) and commodity prices are superimposed on the household data set to generate the total impact on households' real incomes, inequality of these incomes, and welfare. The results are presented in Table 6, but also in diagrammatic form in Figures 1a,b and 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% but that this growth is distributed strongly in favor of the poorest regions. For example, the poorest region, South East, exhibits an 8.8% increase in mean income. This is as expected since 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. Since the transfers were concentrated in the lowest income tercile, inequality also falls substantially, on average by 11% of the previous level. But this fall varies inversely with mean income, being strongest in the three poorest regions (at around

23%). Both of these combine to produce an average increase in welfare of 12.4%, which is similarly biased towards the poorest regions.

Focusing on the direct effect ignores the fact that the program is domestically financed. In Coady and Harris (2001) we show that the indirect welfare effects associated with domestic financing arise from:

- A *redistribution effect* reflecting the fact that someone has to pay for the transfers through taxation;
- 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
- A *distortionary effect* reflecting the "deadweight loss" that arises 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*, while the latter two capture the implications for *efficiency*. The remaining panels incorporate these indirect general equilibrium effects for alternative financing packages. Panel three 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 above (Table 5) the existing VAT structure involves a "low" zero VAT on agriculture and processed foods, a "middle" 5% rate on light and intermediate manufacturing, and a "high" 10% rate on consumer durables and capital goods. The famous Ramsey tax rule (Ramsey, 1927; Diamond and Mirrlees, 1971) provides the following rule of thumb for characterizing efficient tax systems: commodity taxes should be inversely related to own-price elasticities. 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 since 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 (Newbery and Stern, 1987; Coady, 1997).

From the above 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% 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%, when the incidence of taxation is accounted for it leads to a 2.4% *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 taxes 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% points in North but by only 1% point in South East.

Inequality also falls within the poorest regions (i.e. South East, Central and South West) so that one observes a substantial increase in welfare in these regions of between 16.8%-22.4%. 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.[17]

[17] For a discussion on the relationship between inequality and the progressivity-regressivity of tax systems, see Lambert (1999). Interpreting a decrease (increase) in inequality due to taxation as capturing progressivity

Although mean income falls by 2.4% in North, inequality also decreases by 17.6% resulting in an overall increase in welfare of 11%. 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% fall in welfare. The smaller decreases in inequality (relative to the situation ignoring taxation) in the remaining rural regions indicates that the incidence of taxation is regressive and, since all these regions also experience increases in mean incomes, welfare also increases from between 16.8%-22.4% compared to the pre-program situation. In aggregate, we observe a smaller decrease in inequality of 9.3% (compared to 11% before taxation) indicating that nationally the incidence of taxation is regressive. When combined with the 0.8% increase in mean income, this results in a 10.4% increase in welfare.

The fourth and fifth panels present, respectively, the results when the program is financed by (i) a movement to a single uniform rate (SVAT), and (ii) 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 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% compared to 0.8%). The effect on overall inequality

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(regressivity) essentially views a proportional change in all incomes as being “neutral”.

remains the same so that tax incidence is still regressive, but welfare still increases by 9.6% and 9.7% 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 1b) leading to a somewhat smaller decrease in welfare than under subsidy removal. We also observe smaller increases in mean incomes in South West and South East 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 it 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% compared to 11%). 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 6 present the impacts when the program is instead financed by VAT reforms that involve increases in the middle and high rates: (i) a proportional increase where food retains a zero rate (PVAT), (ii) a uniform top rate that involves an increase in the middle rate but a fall in the high rate (TVAT), and (iii) 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 above), thus leading to a lower increase in welfare. The regional impacts are described in Figures 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% compared to 0.1% for the other (more efficient) VAT reforms. This is exacerbated by a relatively large increase in inequality (i.e. 0.6%-1.1% compared to 0.4%) so that welfare falls by about 3% (compared to around 1.4%). In spite of this, we observe higher increases in mean income in South West and South East 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 South East, they are slightly more regressive in South West. But their resulting increase in welfare is still higher than that under the VAT alternatives considered above. 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% drop in mean income to around a 3% 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 non-food sectors. But inequality now falls by only around 12% as against around 17% under the alternative VAT structures, so that it exhibits only a slightly higher increase in welfare (i.e. 12% as against 11%). 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 finish by describing the distribution of poverty after the program under the subsidy removal. In Table 7, 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%. This decrease is biased towards the better-off rural regions, reflecting the fact that although poverty (by all measures) is lowest in these regions, their 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. The fact that the decrease is less biased towards 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 poverty line rather than to above the poverty line, with the value increasing the greater the initial distance from the poverty line.18 However, this inefficiency is offset by the lower initial poverty levels in richer areas so that we

[18] This inefficiency is not as severely "punished" using our welfare measures since income above the poverty line has some (although less) social value.

still observe a bias in poverty reduction towards 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% and 33.3% according to the headcount and severity indices respectively, compared to 19.2% and 37% previously. But the biggest changes are in North which experiences a 30.4% reduction in headcount poverty compared to 44.6% previously. The fact that this difference is not as pronounced using the severity index (52.8% compared to 58.3% 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% since 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.

5. Conclusions

In this paper we analyze the differential regional impacts that targeted transfer programs can generate. To this end, we simulate the salient features of Mexico's PROGRESA program, which targets cash transfers at poor rural households. 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, South West, and South East) 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:

- The direct impact of the transfers (i.e. before their financing is accounted for) differs regionally due 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.
- 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.
- 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 towards the

more inefficient alternatives (e.g. involving increasing taxes on luxuries).

- 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 South East and South West (compared to North and Central) under the inefficient tax systems reflects the relatively stronger negative impact of lower mean income in urban areas.
- 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% before the program to 30% 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% (5%) increase in urban poverty. This highlights the shortcomings inherent in rural targeting and raises concerns associated with horizontal equity.

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Table 1— Inequality Profile Using ENIGH96

Region	Atkinson Inequality Indices å=0.5	å=1.0	å=2.0	Population Share	Mean Income	Income Share	Welfare Index (å=2)
North	0.182	0.291	0.437	0.060	1349	0.057	759
Central	0.141	0.251	0.411	0.152	878	0.093	517
South West	0.137	0.248	0.417	0.086	975	0.059	568
South East	0.140	0.250	0.411	0.166	782	0.091	460
Urban	0.169	0.293	0.462	0.536	1868	0.700	1005
All Regions	0.187	0.323	0.506	1.000	1429	1.000	706

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

Table 2— Poverty Profile Using ENIGH96

Region	Headcount	Poverty Indices Gap	Severity	Regional Distribution of Poor Headcount	Severity
North	0.332	0.091	0.036	0.060	0.040
Central	0.529	0.199	0.098	0.240	0.272
South West	0.451	0.164	0.080	0.117	0.128
South East	0.589	0.239	0.122	0.293	0.373
Urban	0.180	0.049	0.019	0.290	0.186
All Regions	0.333	0.116	0.054	1.000	1.000

Note: Poverty line is approximately 657 pesos. N=13208 households

Table 3—CGE Changes in Nominal Income (% from base)

Households	Transfer[1]	Subsidy	VAT adjustments[2]				
			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	24.70	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	1.5	-5.81
S.West							
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
S.East							
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

[1] The program gives cash transfers to poor households in rural areas, equivalent to a 30% increase in nominal incomes. Poor, medium, and rich correspond to income terciles.
[2] See Table 5 for an explanation of VAT experiments.

Table 4—CGE Changes in Factor Prices (% from base)

Factors	Subsidy	VAT adjustments[1]				
		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	2.52	-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[2]	0.99	1.01	1.00	1.00	1.01	1.00

[1] See Table 5 for explanation of VAT experiments.
[2] An increase in the exchange rate is a depreciation.

Table 5— Description of VAT Experiments for Rural PROGRESA Program

VAT Experiment	Description	Low Rate[a] (%)	Middle Rate[b] (%)	High Rate[c] (%)
Base	--	0.0	5.0	10.0
PVAT	proportional increase in Base VAT rates	0.0	7.3	14.6
HVAT	increase in High Rate only	0.0	5.0	16.1
TVAT	uniform top rate	0.0	11.4	11.4
BVAT	uniform bottom rate	7.2	7.2	10.0
SVAT	single rate	8.3	8.3	8.3

[a] Low Rate is applied to all raw agricultural, processed agricultural and other food activities.
[b] Middle Rate is applied to *Light Manufacturing*, *Intermediate Goods*, and *Professional Services* activities.
[c] High Rate is applied to *Capital Goods*, *Consumer Durables*, *Construction*, and *Commerce*, *Trade and Transportation* activities.

Table 6—Distribution of Welfare After Rural Program Impact

	Initial			Direct Effect			Total Effect from Subsidy			Total Effect from SVAT		
Location	Mean Income	Inequality	Welfare	Mean Income	Inequality	Welfare	Mean Income	Inequality	Welfare	Mean Income	Inequality	Welfare
North	1349	0.437	759	1396	0.373	875	1317	0.360	843	1323	0.362	844
				(0.035)	-(0.172)	(0.152)	-(0.024)	-(0.176)	(0.11)	-(0.019)	-(0.172)	(0.111)
Central	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)
South West	975	0.417	568	1032	0.339	682	1001	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)
South East	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	1868	0.462	1005	1868	0.462	1005	1861	0.469	988	1847	0.464	990
				(0.)	(0.)	(0.)	-(0.004)	(0.015)	-(0.017)	-(0.011)	(0.004)	-(0.015)
All	1429	0.506	706	1458	0.456	793	1440	0.459	779	1430	0.459	774
				(0.02)	-(0.11)	(0.124)	(0.008)	-(0.093)	(0.104)	(0.001)	-(0.093)	(0.096)

Note: Numbers in parenthesis represent change from initial situation.

Table 6—Continued.

	Total Effect from BVAT			Total Effect from PVAT			Total Effect from TVAT			Total Effect from HVAT		
Location	Mean Income	Inequality	Welfare	Mean Income	Inequality	Welfare	Mean Income	Inequality	Welfare	Mean Income	Inequality	Welfare
North	1315	0.356	847	1390	0.386	853	1386	0.384	854	1391	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)
South West	986	0.336	655	1006	0.339	665	1005	0.34	663	1005	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)
South East	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	1850	0.464	992	1825	0.466	975	1824	0.465	976	1823	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	1431	0.459	774	1428	0.460	771	1428	0.46	771	1427	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 parenthesis represent change from initial situation.

Table 7—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	0.164	0.099	0.105	0.080	0.044	0.047
		-(0.31)	-(0.239)		-(0.396)	-(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 parenthesis represent change from initial situation.

Figure 1a. Regional Distribution of Income Effect

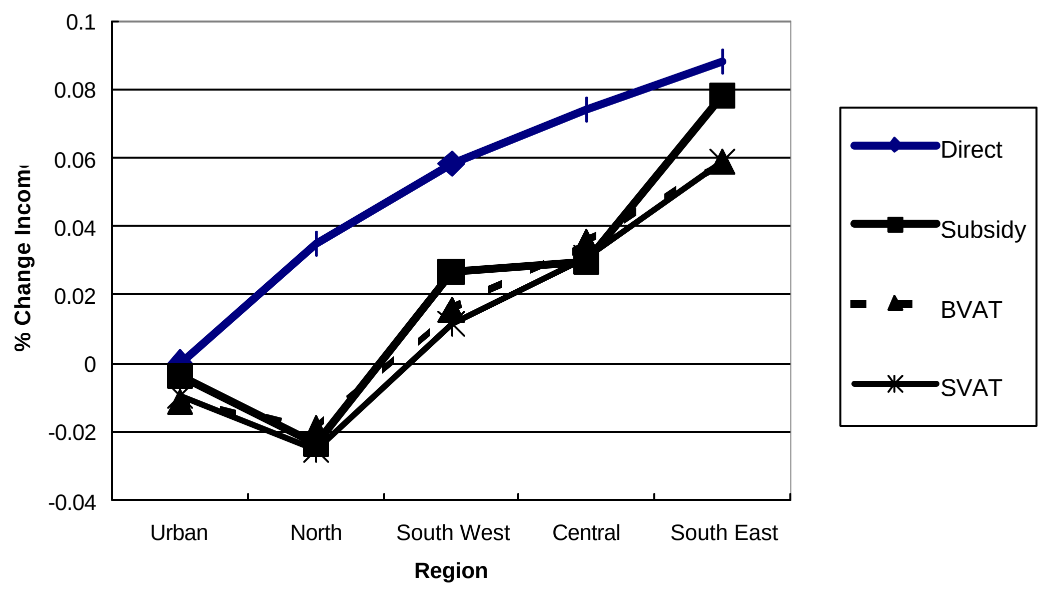
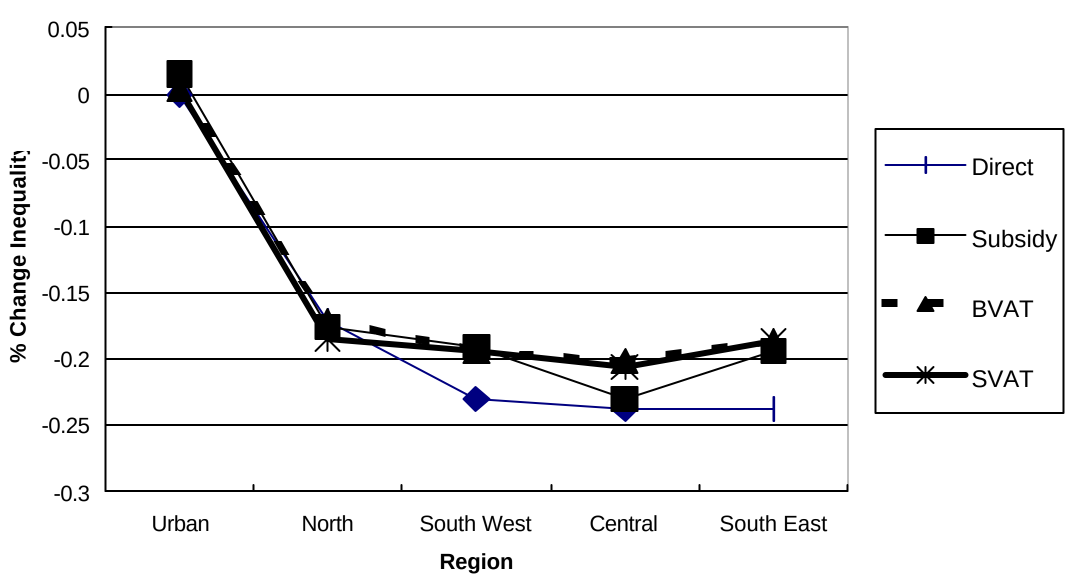


Figure 1b. Regional Distribution of Inequality Impact



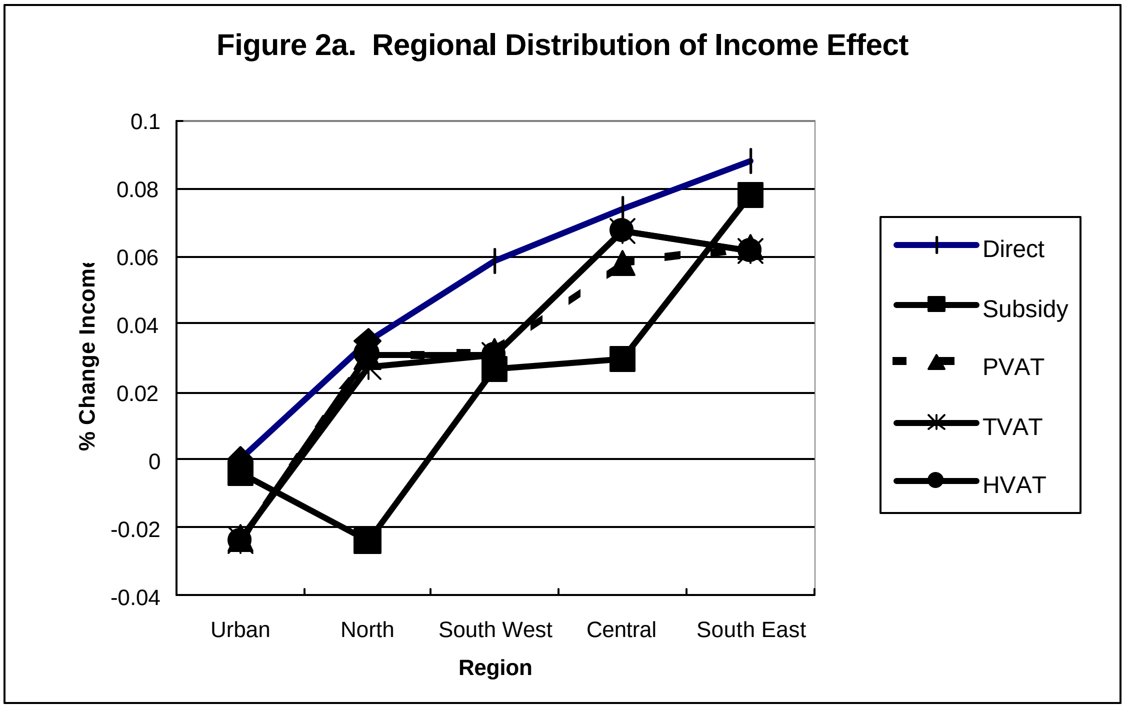


Figure 2a. Regional Distribution of Income Effect
0.1
0.08
0.06
0.04
0.02
0
-0.02
-0.04
% Change Income
Urban
North
South West
Central
South East
Region
Direct
Subsidy
PVAT
TVAT
HVAT

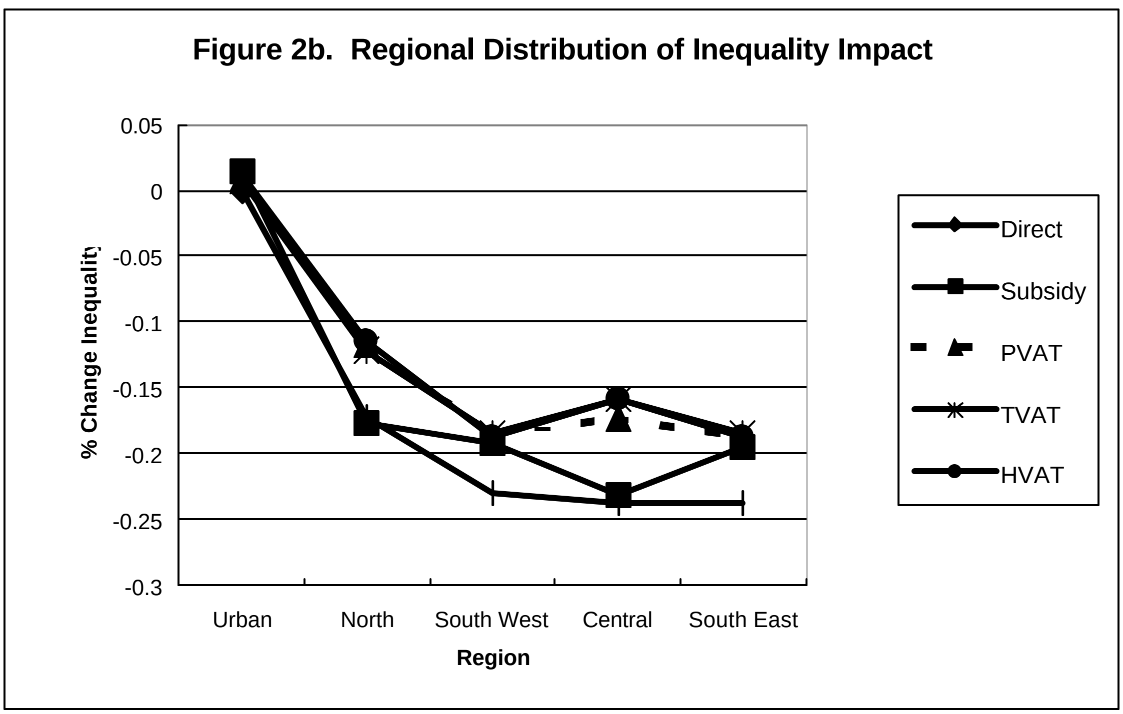


Figure 2b. Regional Distribution of Inequality Impact
0.05
0
-0.05
-0.1
-0.15
-0.2
-0.25
-0.3
% Change Inequality
Urban
North
South West
Central
South East
Region
Direct
Subsidy
PVAT
TVAT
HVAT

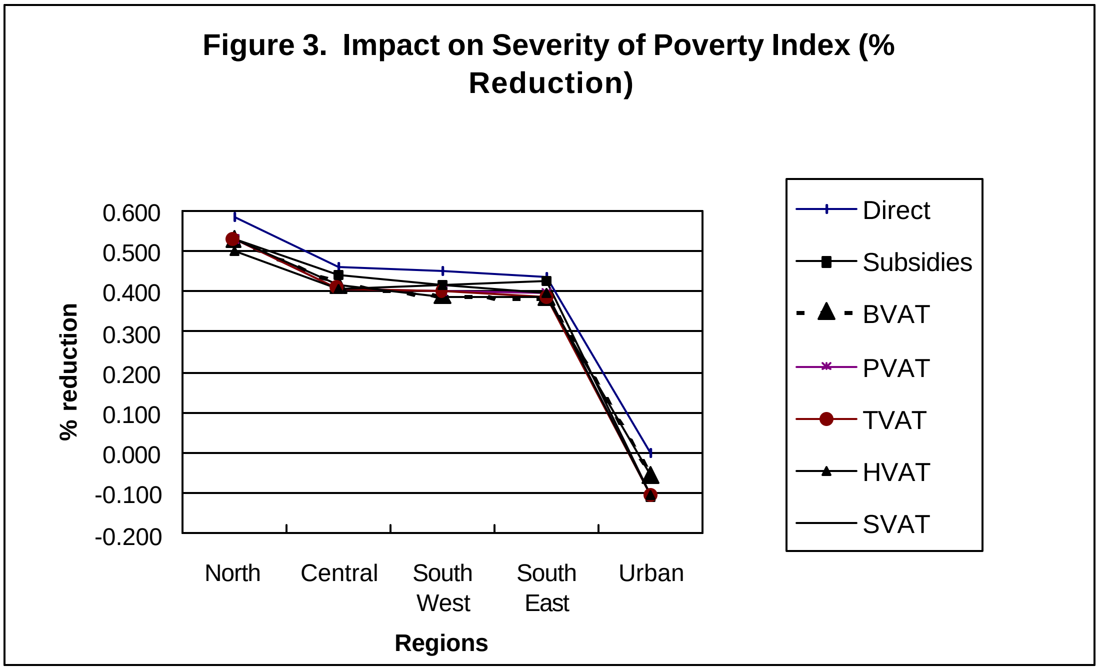


Figure 3. Impact on Severity of Poverty Index (% Reduction)
0.600
0.500
0.400
0.300
0.200
0.100
0.000
-0.100
-0.200
% reduction
North
Central
South West
South East
Urban
Regions
Direct
Subsidies
BVAT
PVAT
TVAT
HVAT
SVAT

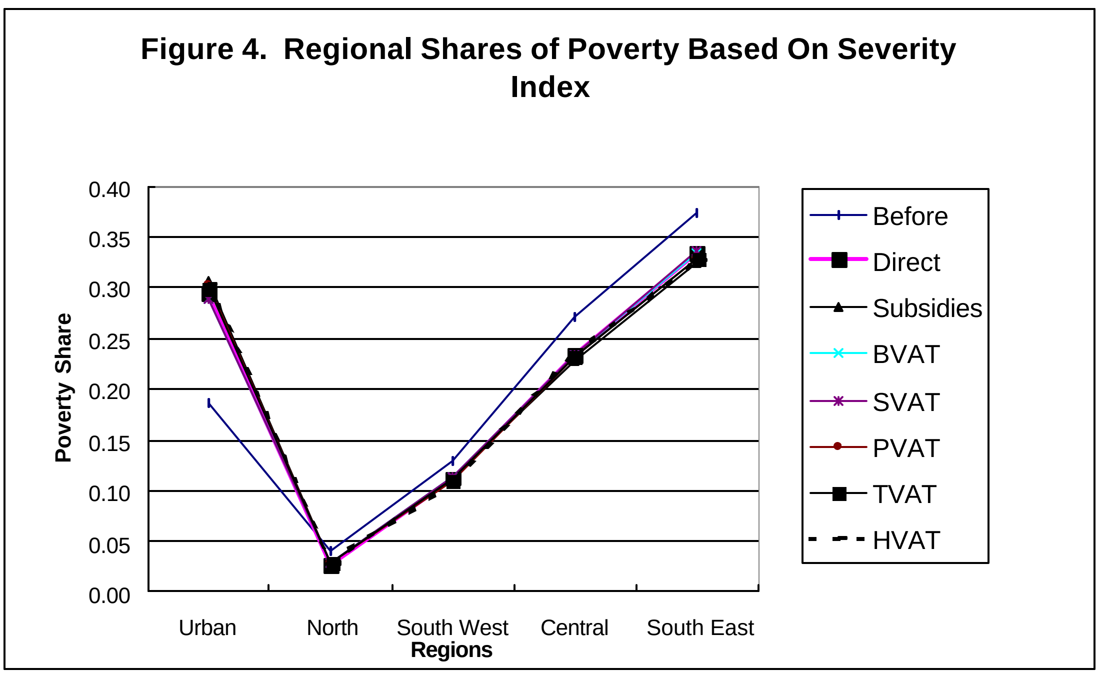


Figure 4. Regional Shares of Poverty Based On Severity Index
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Poverty Share
Urban
North
South West
Central
South East
Regions
Before
Direct
Subsidies
BVAT
SVAT
PVAT
TVAT
HVAT

Appendix Table 1—Rural Regions

1. North
   - Baja California Norte
   - Baja California Sur
   - Sonora
   - Sinaloa
   - Chihuahua
   - Coahuila
   - Nuevo Leon

2. Central
   - Durango
   - Zacatecas
   - Aguascalientes
   - San Luis Potosi
   - Guanajuato
   - Queretaro
   - Hidalgo
   - Tlaxcala
   - Puebla
   - Tamaulipas

3. Southwest
   - Nayarit
   - Jalisco
   - Colima
   - Michoacan
   - Estado de Mexico
   - Distrito Federal
   - Guerrero
   - Morelos

4. Southeast
   - Veracruz
   - Oaxaca
   - Chiapas
   - Tabasco
   - Campeche
   - Yucatan
   - Quintana Roo

Appendix Table 2—National Sectors in Model[1]

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, SesameandOthers)
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, Non-Ferrous Metal, Sand/Gravel, Minerals)
16. Consumer Items (Pharmeceuticals, Soaps, Plastic, Metal Furnishings, Household Appliances, Electronic Equipment, Automobiles and Parts)
17. Capital Goods (Metal Products, Metal Manufacturing, Non-Electronic Machines, Electronic Machines, Other Electric Goods, Transportation Materials, Mineral Manufacturing, Iron Manufacturing, Non-Ferrous 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

[1] 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.

Appendix Table 3—Summary Statistics

	Prod. Tax[1]	VAT	Sales Tax	Tariff	Export Tax	Output	Sectoral Composition (%) Dom. Supply	Imports	Exports	Exports/ Output	Imports/ Dom. Supply
Maize	0.000	--	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
Oth. Grain	-0.449	--	0.000	0.000	0.008	0.16	0.16		0.00	0.15	
Fruit & Veg	-0.001	--	0.006	0.000	0.018	0.75	0.64	0.32	0.95	23.43	8.55
Oth. 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 Manuf.	-0.308	--	0.008	0.018	0.007	1.47	1.47	0.02	0.10	1.28	0.28
Wht Manuf.	-0.308	--	0.008	0.030	0.006	1.13	1.03	0.17	0.70	11.54	2.75
Fr.Veg. Prep	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 Food	0.002	--	0.008	0.016	0.007	4.29	4.46	3.38	2.50	10.81	13.01
Light Manuf	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
Cap. Goods	0.002	0.10	0.007	0.021	0.012	7.36	9.89	46.26	30.68	77.52	80.23
Cons. 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	--	--	--	--
Prof.Services	0.007	0.05	0.008	--	--	19.96	20.15	--	--	--	--
Oth. Services	0.004	--	0.009	--	--	11.15	11.27	--	--	--	--
Commerce	0.003	0.10	0.009	--	--	19.22	19.43	--	--	--	--

[1] A negative entry for the producer tax represents a producer subsidy. The figures for the regionalized agricultural activities are weighted averages.

Appendix Table 4—Equations of CGE Model
(A listing of the sets, variables and parameters follows this table)

PRICE BLOCK
(1) $PM_{cm} = \overline{PWM_{cm}} \cdot (1 + tm_{cm}) \cdot EXR$
(2) $PE_{ce} = \overline{PWE_{ce}} \cdot (1 - te_{ce}) \cdot EXR$
(3) $PQ_c \cdot (1 - tq_c) \cdot QQ_c = PDD_c \cdot QD_c + PM_{cm} \cdot QM_{cm}$
(4) $PX_c \cdot QX_c = (PDS_{cd} \cdot QD_{cd} + PE_{ce} \cdot QE_{ce})$
(5) $PDD_c = PDS_c$
(6) $PA_a = \sum_c \theta_{a,c} \cdot PXAC_{a,c}$
(7) $PVA_a = PA_a (1 - ta_a) + insub_a - \sum_c ica_{ca} \cdot PQ_c$
(8) $CPI = \sum_c cwts_c \cdot PQ_c$
(9) $\overline{DPI} = \sum_{cd} dwts_{cd} \cdot PDS_{cd}$
SUPPLY AND TRADE BLOCK
(10) $QA_a = \alpha_a^a \left[\sum_f \delta_{f,a}^a \cdot QF_{f,a}^{-\rho_a^a} \right]^{-\frac{1}{\rho_a^a}}$
(11) $WF_f \cdot \overline{WFDIST_{f,a}} = PVA_a \cdot (1 - tva_a \cdot (1 + TVAADJ \cdot P04_a)) \cdot \alpha_a^a \cdot \left[\sum_{fp} \delta_{fp,a}^a \cdot QF_{fp,a}^{-\rho_a^a} \right]^{-\frac{1}{\rho_a^a} - 1} \cdot \delta_{f,a}^a \cdot QF_{f,a}^{-\rho_a^a - 1}$
(12) $QINT_c = \sum_a ica_{c,a} \cdot QA_a$

Appendix Table 4—continued.

(13) $QXAC_{a,c} = \theta_{a,c} \cdot \left(QA_a - \sum_{h} QAH_{a,h}\right)$
(14) $QX_{cd} = \alpha^{ac}_{cd} \cdot \sum_{a} \left(\delta^{ac}_{a,cd} \cdot QXAC_{a,cd}^{-\rho^{ac}_{c}}\right)^{-\frac{1}{\rho^{ac}_{cd}}}$
(15) $PXAC_{a,c} = PX_{c} \cdot \alpha^{ac}_{c} \cdot \left(\sum_{ap} \delta^{ac}_{ap,c} \cdot QXAC_{ap,c}^{-\rho^{ac}_{c}}\right)^{-\frac{1}{\rho^{ac}_{c}}-1} \cdot \delta^{ac}_{ap,c} \cdot QXAC_{ap,c}^{-\rho^{ac}_{c}-1}$
(16) $QX_{ce} = \alpha^{t}_{ce} \cdot \left[\delta^{t}_{ce} \cdot QE_{ce}^{\rho^{t}_{ce}} + (1-\delta^{t}_{ce}) \cdot QD_{ce}^{\rho^{t}_{ce}}\right]^{-\frac{1}{\rho^{t}_{ce}}}$
(17) $QX_{cen\&cd} = QD_{cen\&cd}$
(18) $QE_{ce} = QD_{ce} \cdot \left[\left(\frac{PE_{ce}}{PDS_{ce}}\right) \cdot \left(\frac{1-\delta^{t}_{ce}}{\delta^{t}_{ce}}\right)\right]^{-\frac{1}{\rho^{t}_{ce}-1}}$
(19) $QQ_{cm\&cd} = \alpha^{q}_{cm\&cd} \cdot \left[\delta^{q}_{cm\&cd} \cdot QM_{cm\&cd}^{-\rho^{q}_{cm\&cd}} + (1-\delta^{q}_{cm\&cd}) \cdot QD_{cm\&cd}^{-\rho^{q}_{cm\&cd}}\right]^{-\frac{1}{\rho^{q}_{cm\&cd}}}$
(20) $QQ_{cnnorcdn} = QD_{cnnorcdn}$
(21) $QM_{cm\&cd} = QD_{cm\&cd} \cdot \left[\left(\frac{PDD_{cm\&cd}}{PM_{cm\&cd}}\right) \cdot \left(\frac{\delta^{q}_{cm\&cd}}{1-\delta^{q}_{cm\&cd}}\right)\right]^{\frac{1}{1+\rho^{q}_{cm\&cd}}}$
INSTITUTION BLOCK
(22) $YF_{f} = \sum_{a} WF_{f} \cdot \overline{WFDIST_{f,a}} \cdot QF_{f,a}$
(23) $YIF_{id,f} = shif_{id,f} \cdot \left[YF_{f} - tr_{row,f} \cdot EXR\right] \cdot \left(1 - tf_{f}\right)$
(24) $YI_{id} = \sum_{f} YIF_{id,f} + \sum_{id} TRII_{id,idp} + tr_{id,gov} + tr_{id,row} \cdot EXR$
(25) $TTINS_{id} = \overline{DTAXADJ} \cdot tins_{id} \cdot \left(1 + \overline{DTINS} \cdot p01_{id}\right)$

Appendix Table 4—continued.

(26) $TRII_{id,en} = shii_{id,en} \cdot (1\text{-}\overline{SADJ} \cdot mps_{en}) \cdot (1\text{-}TTINS_{en}) \cdot YI_{en}$
(27) $TRII_{id,h} = shii_{id,h} \cdot \left[\left(1\text{-}\overline{SADJ} \cdot mps_{h}\right) \cdot \left(1\text{-}TTINS_{h}\right) \cdot YHM_{h} + YHA_{h} \right]$
(28) $YD_{h} = \left(1\text{-}\overline{SADJ} \cdot mps_{h}\right) \cdot \left[\left(1\text{-} \sum_{ins} shii_{ins,h}\right) \cdot \left(1 - TTINS_{h}\right) \cdot YHM_{h} + YHA_{h} \right]$
(29) $PQ_{c} \cdot QH_{c,h} = PQ_{c} \cdot g^{m}_{c,h} + b^{m}_{c,h} \cdot \left(YD_{h} - \sum_{cp} PQ_{cp} \cdot g^{m}_{cp,h} - \sum_{a} PA_{a} \cdot g^{h}_{a,h}\right)$
(30) $PA_{a} \cdot QAH_{a,h} = PA_{a} \cdot g^{h}_{a,h} + b^{h}_{a,h} \cdot \left(YD_{h} - \sum_{c} PQ_{c} \cdot g^{m}_{c,h} - \sum_{ap} PA_{ap} \cdot g^{h}_{ap,h}\right)$
(31) $YHA_{h} = \sum_{a} PA_{a} \cdot QAH_{a,h}$
(32) $YHM_{h} = YI_{h} - YHA_{h}$
(33) $YG = \sum_{id} TTINS_{id} \cdot YI_{id} + \sum_{a} tva_{a} \cdot (1 + TVAADJ \cdot P04_{a}) \cdot PVA_{a} \cdot QA_{a} + \sum_{a} ta_{a} \cdot PA_{a} \cdot QA_{a} + \left(\sum_{cm} tm_{cm} \cdot QM_{cm} \cdot \overline{PWM_{cm}}\right) \cdot EXR + \left(\sum_{ce} te_{ce} \cdot QE_{ce} \cdot \overline{PWE_{ce}}\right) \cdot EXR + \sum_{f} YF_{f} \cdot tf_{f} + \sum_{c} tq_{c} \cdot PQ_{c} \cdot QQ_{c} + tr_{gov,row} \cdot EXR$
(34) $EG = \sum_{c} PQ_{c} \cdot QG_{c} + \sum_{id} tr_{id,gov} + \sum_{a} insub_{a} \cdot QA_{a}$
(35) $QG_{c} = \overline{GADJ} \cdot \overline{qg_{c}}$
(36) $GSAV = YG\text{-}EG$
(37) $QINV_{c} = \overline{IADJ} \cdot \overline{qinv_{c}}$
(38) $INVEST = \sum_{c} PQ_{c} \cdot \left(QINV_{c} + \overline{qdst_{c}} \right)$

Appendix Table 4—continued.

(39)	$$\begin{aligned} SAVINGS &= \sum_{en} \overline{SADJ} \cdot mps_{en} \cdot \left(1\text{-}TTINS_{en}\right) \cdot YI_{en} \\ &+ \sum_{h} \overline{SADJ} \cdot mps_{h} \cdot \left[\left(1\text{-}TTINS_{h}\right) \cdot YHM_{h} + YHA_{h}\right] + GSAV + \overline{FSAV} \cdot EXR \end{aligned}$$
SYSTEM CONSTRAINT BLOCK	
(40)	$QQ_{c} = QINT_{c} + \sum_{h} QH_{c,h} + QG_{c} + QINV_{c} + \overline{qdst}_{c}$
(41)	$\overline{QFS}_{f} = \sum_{a} QF_{f,a}$
(42)	$\sum_{cm} \overline{PWM}_{cm} \cdot QM_{cm} + \sum_{f} tr_{row,f} = \sum_{ce} \overline{PWE}_{ce} \cdot QE_{ce} + \sum_{ins} tr_{ins,row} + \overline{FSAV}$
(43)	$SAVINGS = INVEST + WALRAS$

Appendix Table 4a—Sets, Variables and Parameters of the CGE Model.

SETS

AAC	global set

SUBSETS OF AAC

a	Activities
c	Commodities
cm(c)	Imported Commodities
cnm(c)	Non-imported Commodities
ce(c)	Exported Commodities
cne(c)	Non-exported Commodities
f	Factors
lab(f)	Labor Factors
ld(f)	Land Factors
ins	Institutions (domestic and rest of world)
id(ins)	Domestic Institutions
h(ins)	Households
en(ins)	Enterprises

PARAMETERS

a_a^a	shift parameter for CES activity production function
a_a^{ac}	shift parameter for domestic commodity aggregation fn
a_c^q	shift parameter for Armington function
a_c^t	shift parameter for CET function
$b_{a,h}^h$	LES marginal budget shares for home consumed goods (activities)
$b_{c,h}^m$	LES marginal budget shares for marketed goods (commodities)
$cwts_c$	consumer price index weights
$d_{f,a}^a$	share parameter for CES activity production function
$d_{a,c}^{ac}$	share parameter for domestic commodity aggregation fn
d_c^q	share parameter for Armington function
d_c^t	share parameter for CET function
$dwts_c$	domestic sales price weights
$g_{a,h}^h$	LES subsistence minima for home consumed goods (activities)
$g_{c,h}^m$	LES subsistence minima for marketed goods (commodities)

$ica_{c,a}$	intermediate input c per unit of 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)
$p04_{ins}$	0-1 parameter (1 for institution 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
$qmbar_c$	import quota
$\boldsymbol{r}_c^{ac}$	domestic commodity aggregation function exponent
$\boldsymbol{r}_c^{q}$	Armington function exponent
$\boldsymbol{r}_a^{a}$	CES activity production function exponent
$\boldsymbol{r}_c^{t}$	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
$\boldsymbol{q}_{a,c}$	yield of commodity c per unit of activity a
$tins_{ins}$	direct tax rate on institution ins
tm_c	tariff rates on imports
$tm2_c$	premium rate on imports
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)
DTINS	change in domestic institution tax share
DTAXADJ	direct tax 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)
PA_a	output price of activity a
PDD_c	demand price for com'y c produced & sold domestically

PDS_c	supply price for com'y c produced & 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
$QXAC_{a,c}$	output of commodity c from activity a
SADJ	savings adjustment variable for dom. inst'ons
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 non-governmental) institution i
$YIF_{ins,f}$	income of institution i from factor f

Note: A bar over a variable indicates that the variable is exogenously fixed.
A "p" added to a set symbol indicates an alias.

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