

# Linking Representative Household Models with Household Surveys for Poverty Analysis

## A Comparison of Alternative Methodologies

Pierre-Richard Agénor\*, Derek H. C. Chen,\*\*  
and Michael Grimm\*\*\*

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### Abstract

We compare three approaches to linking macro models with representative households and micro household income data in terms of their implications for measuring the poverty and distributional effects of poverty reduction strategies. These approaches are a simple micro-accounting method, an extension of that method to account for changes in employment structure, and the Beta distribution approach. Even though in our simulation exercises the three methods do not lead to fundamentally different results in absolute terms, we show that potential differences in the measurement of distributional and poverty effects of policy shocks can be very large.

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\*The World Bank and Department of Economics, Yale University; \*\*The World Bank; and \*\*\*Department of Economics, University of Göttingen and DIAL Paris. We are grateful to various colleagues and seminar participants for comments and discussions. The views expressed in this paper do not necessarily represent those of the World Bank.

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# 1 Introduction

In recent years renewed efforts have been made (at the World Bank and elsewhere) to develop new policy tools aimed at better understanding the channels through which adjustment policies affect the poor and the possible trade-offs that poverty reduction strategies may entail regarding the sequencing of policy reforms. One approach consists in using disaggregated computable general equilibrium (CGE) models that integrate several representative household groups (RHG). These models try to capture a variety of channels through which stabilization policies and structural reforms affect growth, income inequality, and poverty.

A case in point is the Integrated Macroeconomic Model for Poverty Analysis (IMMPA) model developed by Agénor (2003*a*), Agénor, Izquierdo and Fofack (2003), and Agénor, Fernandes and Haddad (2003). IMMPA models are typically based on a parsimonious five-good structure (rural, urban informal, urban private formal, urban public formal, and imported goods) and distinguish between a fairly small number of representative households. For instance, in Mini-IMMPA there are only five categories of households, consisting of workers in the rural sector, workers in the urban informal economy, urban unskilled workers in the formal sector, urban skilled workers in the formal sector, and capitalists-rentiers (see Agénor (2003*a*)). Data from a household survey are classified into the categories of households contained in the structural component of the model. Following a policy or exogenous shock, real growth rates in per capita consumption and disposable income for all categories of households are obtained from the structural model, up to the end of the simulation horizon. These growth rates are applied separately to (disposable) income and consumption expenditure for each household in the survey, giving therefore a new vector of absolute income and consumption levels for each individual in each category or group of households. Poverty and income distribution indicators are then calculated with these new data, after updating the initial poverty lines (using the prices indexes generated by the structural component of the model), to reflect changes in the price of the consumption basket and purchasing power of income. Because changes in within-group distribution are ignored, these indicators reflect essentially changes across groups.

While appealing from a practical point of view, this approach is open to the criticism that it does not account for heterogeneity among agents within groups and introduces only in a partial manner the relevant changes that

occur at the macro level as a result of shocks (most importantly, changes in employment) to the micro component of the analysis. More generally, the assumption that within-group rank ordering of households and individuals are unchanged and unaffected by policy shocks implies that workers are withdrawn from the sector of origin in a representative manner (leaving the distribution of income there unchanged) and that, as they move from one sector to another, they assume the income distribution characteristics of the sector of destination (in particular, the variance of income in that sector is assumed to apply to all new entrants).<sup>1</sup> Thus, some workers may be poor not because of their personal characteristics, but rather because of the economic circumstances that characterize their sector of employment. At the same time, however, the nature of the practical gains entailed by dropping the assumption of a stable within-group distribution and accounting fully for heterogeneity at the micro level remain a matter of debate. In a context where skills and resources are limited, it is thus important to compare alternative approaches, using standard poverty and income distribution measures.

This paper contributes to this debate by comparing three approaches aimed at linking macro and micro levels to analyze the poverty and distributional effects of policy and exogenous shocks in applied general equilibrium models. The first approach is the one followed in most of the IMMPA applications described earlier, and consist of introducing group-specific changes in income and consumption in a household income survey and computing post-shock poverty and distributional indicators on the basis of the “adjusted” household data. The second approach extends the first in the sense that it does not only incorporate changes in income and consumption occurring at the macro level in the household survey, but it also accounts for changes in the employment structure predicted by the macro component. This is done by modifying the weight given to each household in the survey. The third approach, which was pioneered by Adelman and Robinson (1978) and Dervis, de Melo and Robinson (1982), and more recently by Decaluwé, Dumont and Savard (1999), and Decaluwé, Patry, Savard, and Thorbecke (1999), imposes a fixed, parametrically estimated distribution of income within each group and assumes that shocks shift the mean of these distributions without, however, modifying their shape. Poverty indicators are then computed based on

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<sup>1</sup>It also implies that income transfers between households in any given group are ignored. In practice, intra-group income reallocation may be large in periods of hardship and may represent an important factor in understanding the poverty effects of adverse economic shocks.

these distributions. To illustrate and compare these three approaches we use the Mini-IMMPA framework developed by Agénor (2003*a*). In contrast to the original IMMPA framework, Mini-IMMPA focuses only on the “real” side of the economy and provides an even more detailed treatment of the labor market—an important feature for comparing the first and second approaches alluded earlier. We use a calibrated prototype version for a “typical” middle-income developing country.

The remainder of the paper is organized as follows. Section II provides a brief discussion of the standard ‘Representative Household Groups’ (RHG) framework. Section III presents the three alternative approaches to micro-macro linkages that we intent to compare. Section IV outlines the structure of Mini-IMMPA, the RHG framework that we use for our comparisons. Section V presents the simulation results of various policy-induced shocks on income distribution and poverty and uses them to compare the three approaches presented in section III. The last section summarizes our main results and suggests further extensions of our analysis.

## 2 Macro-RHG Models and Poverty Analysis

Most macroeconomic models that have been recently developed to quantify poverty reduction strategies distinguish several broad categories of agents such as households, firms, the government, sometimes the central bank and commercial banks, and the rest of the world. On the production side, there is often a distinction between the rural and urban sectors. Within the rural sector, the tradable and nontradable goods sectors may be distinguished. The urban sector is often viewed as consisting of an informal sector, a formal private sector, and a formal public sector. Households are generally disaggregated in several so-called “representative household groups” or RHGs, according to their education level (skilled and unskilled), their location (rural and urban), and their sector of employment. By distinguishing between rural and urban sectors and by accounting for migration dynamics, some models also allow the user to study separately the evolution of poverty in urban and rural areas and its relation with output and employment fluctuations across sectors.

In this type of models, referred to as “Macro-RHG models” in what follows, the distributional and poverty effects of shocks (exogenous or policy induced) are generally based on the association between group-specific mean

incomes and the state of poverty. For instance, if the mean income of workers in the rural tradable goods sector is below the poverty line, all workers in this sector are considered poor. Likewise, inequality indicators in this framework are based only on the distance between group-specific means. Therefore, within-group heterogeneity (that is, dispersion around group means) is completely ignored.

However, a common observation is that the contribution of within-group income inequality to overall income inequality is much more important than that of between-group inequality, even if households are disaggregated in relatively small groups and part of the intra-group inequality can be attributed to measurement errors and idiosyncratic, transitory elements of income. If, for instance, Ivorian households are classified in ten groups according to sector of activity and educational attainment of the household head, more than 80 percent of the variance of household incomes per capita is within groups. Likewise, in the case of Indonesia a similar classification in ten groups leaves 74 percent of the total variance unexplained. Or, if we separate Malagasy households in 14 even groups, we state still 76 percent of the total variance within groups.<sup>2</sup> Furthermore, inequality changes within groups may be at least as important as changes between groups. Because, by definition, Macro-RHG models do not account for intra-group heterogeneity, they cannot provide much insight in the analysis of the impact of government policy or exogenous shocks on income distribution.

### **3 Integrating Survey Data in Macro-RHG Models**

In what follows we present three different approaches to linking Macro-RHG models with information from a Household Income Survey, such as an Integrated Survey (IS) or Living Standard Measurement Survey (LSMS). The first two approaches are so-called ‘micro-accounting’ approaches. This term refers to a special kind of micro-simulation models which works directly with all the observations gathered in a household survey, but does not take explicitly into account the behavior of agents at the micro level. Under the third approach, the Macro-RHG model supplies the household module with

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<sup>2</sup>These estimates are derived from computations by the authors, based on household surveys of the respective countries.

group-specific changes in mean income. The household survey provides additional information on income dispersion in each group, which is assumed fixed across different simulations.

### 3.1 A Simple Micro-Accounting Method

Macro-RHG models can be relatively easily connected with a household income survey to compute poverty and inequality indicators over a sample of actual households and not only over group-specific means as in the standard Macro-RHG framework. The advantage of this method is that now a uniform intra-group distribution is not assumed but instead use is made of the distribution observed for the sample of actual households. In general this method follows five steps:<sup>3</sup>

1. Classify the available sample into the categories of households distinguished by the macro model (using information on the main source of income of the household head, for instance).
2. Retain from the macro model nominal growth rates in per capita consumption or disposable income induced by a shock for all categories of households.
3. Apply these growth rates separately to the per capita disposable income or consumption expenditure of each household in the household survey. This provides absolute income or consumption expenditure levels following the shock.
4. Adjust poverty lines (expressed in monetary units) using changes in consumer prices given by the macro model (possibly separately for the rural and urban sectors, or even separately for each household group). Then, using the new absolute nominal levels of income and consumption for each group, calculate standard income distribution measures such as the headcount index, the poverty gap, and the Gini coefficient.
5. Compare the post-shock poverty and income distribution indicators with the baseline values to assess the impact of the shock on the poor.

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<sup>3</sup>See on this approach the detailed description in Agénor, Izquierdo and Fofack (2003). A similar method is followed by Löfgren, Robinson and El-Said (2002), and Coady and Harris (2001).

To measure poverty we use the Foster, Greer and Thorbecke’s (FGT) poverty measure  $P_\alpha$  (see Foster, Greer and Thorbecke (1984)):

$$P_{\alpha t} = \frac{1}{N} \sum_{y_{it}=0}^{z_t} \left( \frac{z_t - y_{it}}{z_t} \right)^\alpha, \quad (1)$$

where  $\alpha$  is a poverty-aversion parameter,  $N$  the total number of households in the survey,  $y_{it}$  household  $i$ ’s income or consumption in period  $t$ , and  $z_t$  the poverty line in period  $t$ .  $\alpha = 0$  yields the headcount ratio, that is, the percentage of poor households.  $\alpha = 1$  yields the poverty gap index, that is, the average distance between income and the poverty line (where for non-poor households this distance is set to zero) as a fraction of the poverty line. These measures can be calculated for each household category  $j$ , as well as for the total population.

To measure inequality we use the Gini coefficient and the Theil index.<sup>4</sup> The Gini coefficient is given by:

$$G_t = 1 + \frac{1}{N} - \frac{2}{\bar{y}_t N^2} \sum_{i=1}^N (N - i + 1) y_{it}, \quad (2)$$

where households are ranked in ascending order of  $y_{it}$  and  $\bar{y}_t$  is mean household income or consumption in period  $t$ .

The Theil index is given by:

$$T_t = \sum_{i=1}^N \frac{1}{N} \frac{y_{it}}{\bar{y}_t} \ln \left( \frac{y_{it}}{\bar{y}_t} \right). \quad (3)$$

Figure 1 summarizes the whole procedure, where each step is represented by a box. This approach to micro-macro linkage is “top-down” as there are no feedback effects from the household survey to the Macro-RHG model, i.e. market equilibria are entirely simulated on the macro-side without accounting for any further heterogeneity in behavior within groups.

[Insert Figure 1 here]

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<sup>4</sup>For details on these indicators, see for instance Cowell (1999). Whereas the Gini coefficient is most sensitive to income differences around the middle (or, more precisely, the mode) of the distribution, the Theil index is most sensitive to income differences at the top of the distribution.

This method is not entirely satisfactory to the extent that per capita consumption and income in the household sample are adjusted to the corresponding levels in the macro model, but that the employment structure is not. This implies that labor market mobility affects poverty and income distribution only through relative income changes induced by, among other things, changes in the employment structure at the macro level. When the changes are transmitted to the household survey, it is thus assumed that each individual remains in his or her initial activity. If the Macro-RHG model is dynamic, the same problem arises for other dimensions of the population structure; the urban-rural distribution and the age structure may change in the macro component, but these changes are not taken into account when the link with the household survey is established. Furthermore, as noted earlier, the application of group-specific, instead of household-specific, real growth rates of consumption or income assumes that the intra-group distribution of consumption and disposable income remains constant after a shock.

To set up the procedure described above, we use instead of an actual household income and expenditure survey a “fictitious” one, that we built as follows. First, we produced a sample of 5,000 observations, where the share of each household category (five in our case, see below) corresponds exactly to that in our macro model.<sup>5</sup> We considered each observation to represent one household. Second, using a random number generator and a log-normal distribution, we drew values for disposable income and consumption expenditure for each household. We imposed as parameters for each group the initial values for average disposable income and average consumption expenditure (as specified for the numerical solution of the macro model) as mean and standard deviation, except for skilled workers in the formal urban sector and for capitalists and rentiers, for which we imposed a standard deviation equal to 0.8 times the mean.<sup>6</sup> Third, we set (somewhat arbitrarily) the income poverty line for the rural sector such that the percentage of poor households in the rural sector is 50 percent. We then assumed the poverty line in urban areas to be 15 percent higher. Rural and urban poverty lines for

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<sup>5</sup>More specifically, the shares are 28.1 percent workers in the agricultural sector (rural), 45.3 percent workers in the informal urban sector, 13.7 percent unskilled workers in the formal urban sector, 9.9 percent skilled workers in the formal urban sector, and 3.0 percent capitalists and rentiers.

<sup>6</sup>This is done to limit the number of skilled workers in the formal urban sector and capitalists and rentiers who have less income and consumption expenditure than workers in the informal urban sector or unskilled workers in the formal urban sector.

consumption expenditure were calculated in the same way. This procedure produced an economy-wide income-based headcount index of 38.6 percent and an economy-wide consumption-based headcount index of 41.1 percent. For simplicity, we assumed that poverty lines remain constant in real terms for the whole horizon of the simulation period.

### 3.2 An Extension with Reweighting Techniques

To feed also changes in the employment structure into the household survey, we combine now the micro-accounting method described above with reweighting techniques.<sup>7</sup> The employment variable accounts in our illustrative example for three dimensions of the population structure: residence (rural or urban), sector of employment (agriculture, informal, or formal), and educational attainment (skilled and unskilled). It is intuitively clear that large changes in the employment structure may have strong effects on income distribution. Whereas in the first approach we have to assume that (the sum of) within-group inequality remains constant over time, in this approach it will change to the extent that population and income shares of each group change over time.

In our approach reweighting is done through special statistical procedures that alter the distribution of desired characteristics  $X_i$  (the linkage variables) of the population by adjusting the weight attached to each of the  $N$  households indexed with  $i$ .<sup>8</sup> In general, the problem is to find an  $n$ -vector  $\mathbf{w}'$  of adjustment factors optimizing an objective function  $Z(\mathbf{w}', \mathbf{w})$ —a function evaluating the distance between the new adjustment factors  $w'_i$  to be computed, and the available factors  $w_i$ —satisfying a certain number  $m$  of restrictions summarized in the form  $\mathbf{X}\mathbf{w}' = \mathbf{r}$ :

$$\text{Min } Z(\mathbf{w}', \mathbf{w}), \tag{4}$$

$$\text{s.t. } \mathbf{X}_{(m,n)}\mathbf{w}'_{(n)} = \mathbf{r}_{(m)}. \tag{5}$$

This adjustment problem is a simultaneous one, where for even a quite large number of characteristics just one single weighting factor has to be computed for each household, which after summing up fulfills consistently

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<sup>7</sup>The method that we describe can of course be extended to account for other changes in the population structure as well; see Allie and Murphy (2000).

<sup>8</sup>On reweighting techniques in general, see for instance Landt et al. (1994).

all hierarchical restrictions simultaneously (see Merz (1994)). These statistical procedures preserve the joint distribution of the other characteristics. Put differently, instead of estimating econometric models to run simulations, reweighting (or “static ageing”) takes macro aggregates and then adjusts the underlying distribution to produce projections of the population distribution over time (or before and after a shock). The underlying characteristics are held constant, while the weights given to different parts of the sample are changed. It is important to note, however, that reweighting assumes that the characteristics within a weighted group do not change over time. Therefore, if large changes occur in a variable that was not included in the macro weights, errors might arise. For instance, a weighting scheme where weights are applied according to whether a family has children or not would overestimate the number of children if the fertility rate fell as a result of a reduction in the number of large families rather than a smaller number of families with children.

Given that at this stage we want to reweight only with respect to changes in the employment structure without imposing any additional constraints, the procedure is relatively straightforward, because we have only one condition in the minimization problem. The procedure is summarized in Figure 2. We use the same artificial household survey as in the first approach. In a real country case the procedure may be extended to account for other changes in the population structure as well, coming either directly from the Macro-RHG model (as for instance the population growth rate) or taken from external sources such as the United Nations’ demographic projections. Appendix A points out some of these issues and shows also how reweighting procedures could be used to achieve consistency between a Macro-RHG model and real household survey data in the base year.

[Insert Figure 2 here]

Under the reweighting procedure, we calculate the household group-specific FGT poverty measures as before, but when calculating it for the urban population and the total population we now account for changes in the employment structure with respect to the initial period. The FGT poverty measures then become:

$$P_{\alpha t} = \frac{\sum_j P_{\alpha jt} w_{jt}}{\sum_j w_{jt}}, \quad (6)$$

where the index  $j$  stands for the different household categories and  $w_{jt}$  for their respective share in the total population in period  $t$ . In the micro-accounting method presented earlier, the implicit assumption was that the coefficients  $w_{jt}$  remain constant over time.

Likewise, we can calculate the inequality measures by weighing each household with its group and period-specific weight  $f_{jt}$ , where  $f_{jt} = w_{jt}/N_j$  with  $w_{jt}$  is the share of group  $j$  in the population at period  $t$  and  $N_j$  the size of group  $j$  in the initial period. In period  $t = 0$ ,  $f_{j0}$  is thus equal to  $1/N$  for each household.

### 3.3 The Use of Distribution Functions

#### 3.3.1 Methodology

The third approach uses specific parametric distributions to describe the dispersion of income within each group. The parameters of these distributions are generally estimated using real household survey data. We use again our fictitious sample of household incomes and consumption expenditure. In contrast to the two approaches presented above, once the parameters are estimated, the survey data are not used anymore to evaluate the distributional effects of shocks. Following a shock, the fitted distributions are only shifted according to the changes of the group-specific mean incomes; to the right (increase in income or consumption) or to the left (decrease in income or consumption) without modifying the shape of the distributions. The poverty indicators are also computed using the estimated shape parameters, without once again relying on the survey data. The overall distribution of income is generated empirically by summing the separate within-group distributions and is then used to generate overall measures of poverty and inequality.

It is important to note that in this approach and in the two former approaches changes in income are not distributed in the same way within groups. Whereas in the first two, we suppose usually that the *relative* increase is uniform over the whole distribution (that is, the absolute change is proportional to the initial income), in the distribution function approach the *absolute* increase is assumed to be uniform over the whole distribution (that is, the relative increase is the higher the lower the initial income). Nevertheless, with the distribution function approach we also assume that intra-group inequality remains unaffected by a shock to income or consumption levels, as in the other two approaches.

As in Decaluwé, Patry, Savard and Thorbecke (1999) and Decaluwé, Dumont and Savard (1999), we use Beta distribution functions to describe the within-group distributions. Of course, it would be more logical to use the log-normal distributions from which our data is drawn, but in a real country case the assumption of Beta distributions may be more convenient, because of their higher degree of flexibility.<sup>9</sup>

The Beta density distribution is a continuous function taking values between 0 and 1 and has as formula:<sup>10</sup>

$$I(x; \beta_1, \beta_2) = \frac{1}{B(\beta_1, \beta_2)} x^{\beta_1-1} (1-x)^{\beta_2-1}, \quad (7)$$

where  $B(\beta_1, \beta_2)$  is the beta function with the formula:

$$B(\beta_1, \beta_2) = \int_0^1 x^{\beta_1-1} (1-x)^{\beta_2-1} dx. \quad (8)$$

The parameters  $\beta_1$  and  $\beta_2$  are positive. To normalize a given variable, say, income  $y_i$ , to values between 0 and 1, we impose the transformation

$$x_i = \frac{y_i - mn}{mx - mn}, \quad (9)$$

where  $mn$  and  $mx$  are the minimum and maximum values, respectively, of the distribution of  $y_i$ .

The parameters  $\beta_1$  and  $\beta_2$  have the following moments estimators:<sup>11</sup>

$$\hat{\beta}_1 = \bar{x} \left( \frac{\bar{x}(1-\bar{x})}{s^2} - 1 \right), \quad \hat{\beta}_2 = (1-\bar{x}) \left( \frac{\bar{x}(1-\bar{x})}{s^2} - 1 \right), \quad (10)$$

where  $\bar{x}$  stands for the sample mean and  $s^2$  represents the sample variance.

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<sup>9</sup>Boccanfuso, Decaluwé and Savard (2002) compared six alternative functional forms to model within-group distributions. They concluded that no single form is more appropriate in all cases or groups of households. However, the authors advocate, especially when detailed disaggregation is required, rather flexible forms as the Beta function, which allows, for instance, distributions to be very negatively skewed.

<sup>10</sup>See the description in “A thesaurus of Mathematics”, University of Cambridge, at <http://www.thesaurus.maths.org>.

<sup>11</sup>See the internet website “Scientific Resources: Statistics–Econometrics–Forecasting”, at <http://www.xycoon.com/index.htm>. Alternatively, one can estimate the parameters with Maximum Likelihood techniques.

The FGT poverty measures expressed in terms of the Beta density distribution function given in equation (7) become:

$$P_{\alpha jt} = \int_0^{z'_{tj}} \left( \frac{z'_{tj} - x}{z'_{tj}} \right)^\alpha I(x; \hat{\beta}_{1j} \hat{\beta}_{2j}) dx, \quad (11)$$

where  $z'_{tj}$  is the group and period-specific normalized poverty line, defined as  $z'_{tj} = (z_{tj} - mn_j)/(mx_j - mn_j)$ . Thus, equation (11) allows us to compare the poverty levels obtained in the post-simulation case with those prevailing in the pre-simulation case. To calculate the poverty measures for the urban or the total population at  $t$ , we can either weigh the group-specific poverty measures of equation (11) by their initial population shares,  $w_{j0}$ , or by their population shares at  $t$ ,  $w_{jt}$ , as in equation (6).

Given that the household survey data are discarded once the shape parameters are estimated, and given that the distribution function approach assumes implicitly that intra-group inequality is not changing following a shock, we limit now the measurement of inequality to between-group inequality. The Theil index allows an exact decomposition of total inequality between within- and between-group inequality.<sup>12</sup> Between-group inequality,  $T_{Bt}$ , can be calculated as:

$$T_{Bt} = \sum_j s_{jt} \ln \left( \frac{\bar{y}_{jt}}{\bar{y}_t} \right). \quad (12)$$

Therefore between-group inequality depends only on  $s_{jt}$ , the share of total income held by group  $j$ ,  $\bar{y}_{jt}$ , the mean income in group  $j$ , and  $\bar{y}_t$ , the overall mean of income. Of course, to estimate changes in overall inequality, one may measure intra-group inequality with the survey that is used to estimate the shape parameters in the first place, and then add this measure in each period to between-group inequality. Figure 3 summarizes the simulation procedure when using the Beta distribution method.

[insert Figure 3 here]

### 3.3.2 Estimation Results and Goodness-of-fit

Table A1 in Appendix B presents the estimated shape parameters of the Beta density distribution function for both disposable income and consumption expenditure, using our fictitious household survey. Initial experiments

<sup>12</sup>See for instance Shorrocks (1984), Deaton (1997), and Cowell (1999).

indicated that the estimation results were very sensitive to outliers. To increase the goodness-of-fit of our estimates, we eliminated for each group the five highest and five lowest values of the distribution. Table A2 in Appendix B compares the “observed” values for the poverty measures  $P_0$  and  $P_1$  for income and consumption with the predicted values using both sets of estimated shape parameters, that is, with and without dropping the extreme values (as defined above). Figures A1 and A2 show the corresponding “observed” and “fitted” (after dropping extreme values) cumulative distribution functions.

From Table A2 it can be seen that if we correct the data for outliers the fit is quite acceptable for  $P_0$ —at least for households in the rural sector and households in the informal urban sector. However, for the other three groups, the deviations are significant. One explanation for this outcome is that the population size is smaller for these groups, and thus the estimated shape parameters are less reliable. The poverty gap ratio is much more difficult to fit. Here the predicted indicators lie more than 40 percent above the observed values. It is interesting to see that in our case the predictions of the Beta distributions lead always to an overestimation of  $P_0$  and  $P_1$  (except for capitalists and rentiers), compared to the indicators that are directly measured from the survey data. Figures A1 and A2 show that the quality of the prediction depends also strongly on where the poverty line is drawn. The fitted curve crosses the observed curve for the first time around a cumulated population of 40 to 50 percent. If the poverty line is close to this intersection, than the prediction of  $P_1$  would be of course quite good.

## 4 The Macro-RHG Framework

Mini-IMMPA is a simplified version of the Integrated Macroeconomic Model for Poverty Analysis developed by Agénor, Izquierdo and Fofack (2003), and Agénor, Fernandes, and Haddad (2003). Although Mini-IMMPA focuses only on the “real” side, it offers a more detailed treatment of the labor market, accounting for features such as employment subsidies and job security provisions. Given its focus on the real side, the building blocks of the “structural” component of Mini-IMMPA consist of the production side, employment, the demand side, external trade, sectoral and aggregate prices, income formation, consumption and savings, private investment, and the public sector. As noted earlier, households are defined according to the skills composition of the workforce and the sector of employment. There is one rural household,

comprising all workers employed in the rural sector. In the urban sector there are two types of unskilled households, those working in the informal sector and those employed in the formal sector. The fourth type of households consists of skilled workers employed in the formal urban economy (in both the private and public sectors). Finally, there are capitalists-rentiers whose income comes from firms' earnings in the urban private sector. The following description of the model is kept quite short; for a more detailed presentation the reader is referred to Agénor (2003*a*).

## 4.1 Production and the Labor Market

The basic distinction on the production side is that between rural and urban sectors. In the rural economy firms produce one good, which is sold domestically or exported. The urban economy consists of both formal and informal components. The informal economy produces nontraded services. The formal urban economy is separated between production of a private good, and a nontraded public good.

For all activities the production technology is represented by value added functions and fixed (Leontief) intermediate input coefficients. With exception of the public sector, the value added functions are represented by sets of nested constant elasticity of substitution (CES) functions and Cobb-Douglas (CD) functions. The rural sector uses land (assumed to be in fixed supply), unskilled labor, and the economy-wide stock of public physical capital. Production exhibits decreasing returns to scale with respect to the two latter inputs. Value added in the informal sector requires only unskilled labor and is subject to decreasing returns to scale. Urban private formal production uses as inputs both skilled and unskilled labor, as well as private and public physical capital. Skilled labor and private physical capital are assumed to have a higher degree of complementarity than private physical capital and unskilled labor. Furthermore, it is assumed that public capital is subject to congestion effects, that is, the positive externality associated with public capital decreases as its usage by the urban population increases. Value added in the public sector is measured from the government wage bill. Employment levels of skilled and unskilled workers in that sector are treated as predetermined variables. Firms in the rural and the private formal sector allocate their output to exports or the domestic market according to a production possibility frontier, defined by a constant elasticity of transformation (CET) function. Assuming imperfect substitutability, the ratio between exports and

domestic sales depends on the relative prices of exported and domestic goods and the elasticity of substitution between these goods.

The demand for labor in the rural sector is derived from first-order conditions for profit maximization. Labor demand is related positively to the level of net output and negatively to the product wage (the nominal wage deflated by the net output price). The nominal wage in the rural sector adjusts to clear the labor market. The supply of labor in the rural sector is predetermined at any given point in time, but grows over time at the exogenous population growth rate net of worker migration to urban areas. Following Harris and Todaro (1970), the incentives to migrate are taken to depend negatively on the ratio of the average expected wage in rural areas relative to the wage prevailing in urban areas. Unskilled workers in the urban economy may be employed either in the private formal sector, in which case they are paid a minimum wage, or they can enter the informal economy and receive the average income in that sector. Potential migrants are uncertain as to which type of job they will be able to get, and therefore weigh wages in each sector by the probability of finding a job in that sector.

Both the government and private firms in the formal and informal urban sectors use unskilled labor in production. The public sector is assumed to hire an exogenous level of unskilled workers at a fixed nominal wage, whereas the demand for unskilled labor by the formal private sector is determined by firms' profit maximization subject to the given minimum wage. In order to avoid corner solutions, the wage rate paid to unskilled labor in the formal urban sector is assumed to be systematically greater than the real wage rate paid in the informal sector. Consequently, unskilled workers in the urban area will always seek employment in the private formal sector first, given the assumption of complete job turnover in each period. The informal labor market clears continuously; in addition, mobility of the unskilled labor force between the formal and the informal sectors is taken to be imperfect and determined by expectations on income opportunities formed on the basis of prevailing conditions in the labor market.

The supply of unskilled labor in the urban sector grows as a result of “natural” urban population growth (given that individuals are born unskilled) and migration of unskilled labor from the rural economy, as discussed earlier. Moreover, some urban unskilled workers acquire skills and leave the unskilled labor force to increase the supply of qualified labor in the formal economy. Skilled workers are not employed in the informal economy—perhaps as a result of either a high reservation wage or “adverse signaling” considerations.

The acquisition of skills by unskilled workers takes place through an education technology operated by the public sector. Specifically, the flow of unskilled workers who become skilled is taken to be a CES function of the “effective” number of teachers in the public sector and the government stock of capital in education.

Wages for skilled labor in the private sector are determined on the basis of the “monopoly union” framework, where a centralized labor union maximizes a utility function that depends on deviations of both employment and the consumption wage from their target levels, subject to the firm’s labor demand schedule. The union’s target real wage is assumed to be related positively to skilled wages in the public sector and negatively to the skilled unemployment rate, and the real firing cost per skilled worker. The higher the firing cost, the greater the incentive for the union to reduce its wage demands, in order to encourage firms to hire. Both the minimum wage and nominal wages in the public sector are taken as to be fully indexed on the urban consumption price index.

## 4.2 Composition of Demand and Prices

As noted above, both the informal and public sector goods are nontradables, and both markets clear continuously. In each sector, total supply is thus equal to gross production. Rural and private formal urban goods, by contrast, compete with imported goods. For the rural, public, and informal sector goods, aggregate demand consists of intermediate consumption and private demand for final consumption. Aggregate demand of the private formal good consists of intermediate consumption, final consumption by households and the public sector, and private investment. Other current government spending on goods and public investment expenditure are spent only on the private formal sector good. Each category of households determines final consumption for each type of good so as to maximize a Stone-Geary utility function. Total private investment consists of purchases of urban private sector goods. In standard fashion, the ratio of imports to both categories of domestic goods depends on the relative prices of these goods and the elasticity of substitution between these goods, given the assumption of imperfect substitutability.

The world prices of imported and exported goods are taken to be exogenously given. The domestic currency price of these goods is obtained by adjusting the world price by the exchange rate, with import prices also adjusted by the tariff rate. Prices of domestic sales in the rural and urban

private sectors adjust to equilibrate supply and demand. For the informal and public sectors, where production does not compete with imports, the domestic market price is simply equal to the gross output price. The consumption price index is constructed separately for rural households and urban (skilled and unskilled) households. They are computed as the weighted average of price changes over all consumed goods, where the weights reflect the composition of spending by each group in the base period.

### **4.3 Profits and Income**

Firms' profits are defined as revenue minus total labor costs. Profits of urban private sector firms account for both working capital costs and salaries paid to both categories of workers, as well as payroll taxes on unskilled employment and firing costs for both categories of workers. Household income is based on the return to labor (salaries), distributed profits, and government transfers. Households in both the rural sector and the informal urban economy own the firms in which they are employed. Urban formal sector households receive no profits because skilled and unskilled workers in that sector do not own the production units in which they are employed. Firms in the private urban sector pay income taxes, and interest on their foreign borrowing. A portion of their net profits are retained for the purpose of financing investment; the remainder is transferred to capitalists and rentiers. Each category of households saves a fixed fraction of its disposable income and allocates the rest to consumption.

### **4.4 Investment-Savings Balance**

Capital accumulation occurs only in the urban private sector. The desired capital stock by firms in the private urban sector is determined so as to equate the after-tax rate of return on capital, plus capital gains due to changes in the price of capital and minus depreciation, to the opportunity cost of investment, which (assuming the absence of "effective" restrictions to capital mobility) is here taken to be the world interest rate. Actual investment in each period is determined by a partial adjustment process, and is given as a function of the ratio between the desired capital stock and last period's capital stock.

The aggregate identity between savings and investment is specified as follows. Total gross investment in physical capital measured in nominal terms is

financed by firms' after-tax retained earnings, total after-tax household savings, "primary" government savings (that is, before investment), and foreign borrowing by firms and the government. In the simulations the aggregate investment-savings identity is solved residually for total private investment. In that sense, then, the basic model is "savings driven."

## 4.5 Public Sector and the Balance of Payments

Government expenditures consist of government consumption, which only has demand-side effects, and public investment, which has both demand- and supply-side effects. Public investment consists of investment in infrastructure, education, and health. Investment in infrastructure is defined as the expenditure affecting the accumulation of public infrastructure capital, which includes public assets such as roads, power plants and railroads. Investment in education affects the stock of public education capital, which consists of assets such as school buildings and other infrastructure affecting skills acquisition. In a similar fashion, investment in health adds to the stock of public assets such as hospitals and other government infrastructure affecting health. Infrastructure and health capital affect the production process in the private sector as they both combine to produce the stock of government capital.

All value added in the production of public goods is distributed as wages. The government fiscal balance is thus defined as total tax revenues minus the wage bill on school teachers, government transfers to households, total employment subsidies to firms in the private formal sector, other real current expenditures on goods and services, real investment spending, and interest payments on loans from abroad. Total tax revenues consist of revenue generated by import tariffs, sales taxes, income taxes, and payroll taxes.

The external constraint implies that any current account surplus (or deficit) must be compensated by a net outflow (or inflow) of foreign capital, given by the sum of changes in net foreign borrowing by the government and private firms. In the simulations reported below, we assume that public foreign borrowing is exogenous, and that private foreign borrowing adjusts to equilibrate the balance of payments.

## 5 Comparing Shocks with Alternative Linkages

Mini-IMMPA can be used to analyze a variety of policy and exogenous shocks. To compare the performance of the three alternative approaches to micro-macro linkages discussed above, the growth, employment and poverty effects of two types of labor market policies are examined in this section: a cut in the minimum wage and an increase in the employment subsidy on unskilled labor. Both experiments relate to critical policy issues in developing countries (for details, see Agénor (2003*a*)). As an indicator of living standards, we consider in what follows only disposable household income per capita.

### 5.1 Reduction in the Minimum Wage

The simulation results associated with a permanent 7 percent reduction in the minimum wage are illustrated in Tables 1 and 2 for the first 10 periods after the shock.<sup>13</sup> This time period is referred to below as the “adjustment period.” Table 1 provides data on the most important macroeconomic indicators, the government budget balance, and the labor market. Table 2 presents data on consumer prices, disposable income for each household group, and poverty and distributional indicators for the income variable, all in absolute deviations from the baseline solution. The experiment assumes that the government borrows domestically to finance its deficit—implying therefore (as discussed earlier) an offsetting adjustment in the investment of private firms, in order to maintain the aggregate balance between savings and investment. We first comment on the general results of this simulation and then compare more specifically the effects on poverty and inequality, as measured by the three different methods.

[Insert Tables 1 and 2 here]

The impact effect of the reduction in the minimum wage is an increase in the demand for unskilled labor in the private sector of almost 3.4 percent in the first year and approximately 7 to 9 percent in the following years. The

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<sup>13</sup>This reduction means that the minimum wage decreases from 1.23 times the poverty line to 1.14 times the poverty line.

increase in demand is met by the existing pool of unskilled workers seeking employment in the urban sector. As a result, the unskilled unemployment rate drops significantly, by 2.2 percentage points in the first year and by more than 8 percentage points in the following years, which reduces unemployment for this segment of workers to almost zero. The cut in the minimum wage, by reducing the relative cost of unskilled labor, leads to substitution among production factors not only on impact but also over time. Because unskilled labor has a relatively high elasticity of substitution with respect to the composite factor consisting of skilled labor and physical capital, the lower cost of that category of labor gives private firms in the formal sector an incentive to substitute away from skilled labor and physical capital. In turn, the fall in the demand for that category of labor puts downward pressure on skilled wages, which drop by 5.2 percent in the first period. On impact, labor supply is fixed in the rural sector and the informal economy, so the level of employment does not change in either sector—and neither does the level of activity (real value added in both sectors is constant). The rise in real disposable income (by 2.1 percent in the rural sector and 4 percent in the informal sector) and real consumption of rural and informal sector households leads to higher value added prices and higher wages in both sectors. But value added prices go up by slightly more than wages in the second and subsequent periods, implying a fall in the product wage in both sectors and a rise in employment.

Over time, changes in wage differentials affect both rural-urban and formal-informal migration flows, and therefore the supply of labor in the various production sectors. The expected unskilled wage in the formal economy is constant on impact. Despite the increase in unskilled employment in the private sector in the first period (and thus the increase in the probability of finding a job), the fall in the minimum wage is such that the urban expected wage falls. Moreover, because rural sector wages rise, the expected urban-rural wage differential (measured in proportion of the rural wage) falls by more than 12 percentage points in the second period, with this differential narrowing over time. As a result, the inflow of unskilled workers into the formal sector (measured in proportion of the total formal urban labor supply) falls by about 3.6 percent in period 2. In the following periods, except in period 4, this inflow remains however slightly higher than in the baseline, given the increased probability of finding a job. The reduction in the inflow of labor leads to an increase in informal sector wages throughout the adjustment period, by 3.1 percent in period 2, 3.9 percent in period 3, and so on. This increase in the informal sector wage, coupled with the reduction in the min-

imum wage, leads to a sharp fall in period 2 in the expected formal-informal wage differential, which tends to reduce the supply of unskilled labor in the formal private sector (by 3.6 percent in period 2, and about 2.5 percent at the end of the adjustment period), that is, the number of workers willing to queue for employment in the urban private sector. This, coupled with the sustained effect of the cut in the minimum wage on labor demand, explains the large effect on unemployment.

Although the behavior of nominal wages in the rural sector reflects essentially changes in value added prices on impact (as noted earlier), over time it is also affected by changes in labor demand and migration flows. After an initial increase in nominal wages, lower migration flows to urban areas begin to put downward pressure on rural wages, which end up falling (in nominal terms) by 2.9 percent in period 9 and 3.5 percent in the last period. As also indicated earlier, the reduction in the cost of unskilled labor induces a substitution away from skilled labor, which brings a sustained fall in skilled wages in nominal terms (by about 4.8 percent in the long run). However, the overall effect on labor demand is not large; skilled employment in the private formal sector falls in the long run by only about 0.4 percent. And because the supply of skilled labor remains roughly constant throughout (public investment in education and the number of school teachers are held constant at their baseline values), the skilled unemployment rate rises by only 0.2 percentage points. The reason for the small effect on skilled employment is that the direct substitution effect associated with the reduction in the minimum wage is offset by a fall in the skilled wage, resulting from general equilibrium effects.

The effect on aggregate output (or real GDP) is slightly positive in the periods following the shock, at about 0.3 percent, and close to zero over the rest of the adjustment period. Changes in real output (as measured by real value added) are also positive in the urban informal sector and the urban formal sector in the periods after the shock, but slightly negative at the end of the simulation horizon. In contrast, in the rural sector, changes in real output are positive throughout the simulation period and actually tend to grow slightly over time, as a result of the gradual fall in rural sector wages.

On the fiscal side, total revenue falls by about 0.4 percentage points as a share of GDP during the adjustment period, mostly as a result of indirect taxes changing at a slower pace than nominal GDP. From the aggregate balance between investment and savings, given that public investment remains essentially constant and the closure rule, private investment decreases by 7.5

percent. There is therefore a significant “crowding out” effect. In addition, profits of private firms suffer from lower disposable income of skilled workers, capitalists and rentiers.

Despite relatively large changes in disposable income, overall poverty indicators change relatively little during the adjustment period. This is, of course, related to the fact that the aggregate growth and income effects of the shock are fairly limited and involve essentially a re-allocation of resources across sectors. However, there are significant differences among household groups. The proportion of poor households in rural areas increases by 1.7 percentage points, whereas the poverty gap (the average distance between income and the poverty line as fraction of the poverty line) rises by 1 percentage point. Although disposable income of capitalists and rentiers drops significantly, and the incidence of poverty increases by 0.7 percentage point toward the end of the adjustment period, the poverty gap changes only in the short run, but is almost unaffected in the long run. For unskilled workers, both measures of poverty indicate an improvement in the longer run, especially for those workers involved in the informal sector. However, for unskilled workers in the formal sector, poverty increases on impact—by about 0.6 percentage point. There is therefore a potential *short-run trade-off* emerging between unemployment and poverty: although the reduction in the minimum wage lowers open unskilled unemployment in the formal sector, it also increases poverty for that category of households.<sup>14</sup> For skilled workers in the formal sector, poverty tends to increase slightly, in both the short and the long run by approximately 1 percentage point. Overall, therefore, poverty increases in rural areas and decreases in urban areas, resulting in a slight decrease in poverty at the economy-wide level. Changes in the income-based Gini coefficient indicate that income distribution is affected only modestly by a cut in the minimum wage; the degree of inequality falls by only a small amount in the long run. This effect is directly related to the sharp reduction in disposable income experienced by skilled workers and capitalists and rentiers, relative to other household groups.

Let us now examine in more detail the differences concerning the impact on poverty and inequality as measured by the three approaches to micro-macro linkages presented in section III. With the simple micro-accounting method (in which if changes in disposable income are feed into the household survey without taking into account changes in the employment structure

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<sup>14</sup>See Agénor (2003b) for a more detailed discussion of unemployment-poverty trade-offs.

and thus in the size of relative groups), poverty is overestimated on impact compared to the more elaborate approach based on reweighting techniques, but as we can see from Table 2 this differences becomes smaller over the adjustment period. This holds regardless of whether we look at the headcount ratio or the poverty gap. The difference represents between 0.10 and 0.25 percentage points, which may not seem that large; however, it is equivalent to up to 20 percent of the total change in poverty relative to the initial period. In terms of absolute deviations from the baseline, the discrepancy is smaller, because the baseline projection is affected by a bias in the same direction, but, likewise, in relative terms, it is not negligible. Figure 4 traces the absolute deviations from the baseline measured by the simple micro-accounting method relative to the absolute deviations from the baseline measured by the micro-accounting method combined with reweighting techniques, for both  $P_0$  and  $P_1$ . For urban households, as well as all households put together, the change is overestimated over the entire adjustment period. The difference amounts to up to 9 percent for urban households (with a peak in the second period) and to almost up to 20 percent for all households together (with a peak at the end of the adjustment period). However, for urban households the discrepancy is almost zero in period 10. The pattern of differences with  $P_0$  and  $P_1$  is very similar. The decrease in inequality is also overestimated if changes in the employment structure are not taken into account. Again, in absolute terms the difference is not large, but given the small change in inequality the relative difference is.

[Insert Figure 4 here]

One reason why we do not observe even more pronounced differences between both methods is due to the fact that the employment structure is not very much affected by the cut in the minimum wage. Therefore, in this case, it does not appear to matter much whether we reweigh or not to account for changes in the employment structure. However, this results from the fact that the labor market structure and the parameters that we impose on Mini-IMMPA imply a fairly strong degree of segmentation between the different sectors of the labor market, with only limited mobility between them. The degree of mobility from rural to urban areas, and from the urban informal sector to the formal sector, responds only to a limited extent to changes in relative wages, and the speed at which skills are acquired by unskilled workers

are driven by public investment in education infrastructure and the number of teachers, neither one of which changes during the adjustment period. Were we to use higher elasticities of migration flows to relative wages, or were we to account for the impact of changes in relative wages on the decision to acquire skills, the model would yield much larger changes in the composition of employment and the differences between the first and second approaches to micro-macro linkages would be much larger.

As outlined in section III, the Beta distribution approach poses problems if we are interested in calculating exact levels of poverty. As indicated earlier, there are significant differences between the poverty level in the base year predicted by the Beta distribution approach and the actual, survey-based measure. If we compare now the micro-accounting framework with the Beta distribution approach, we can see from Table 2 that the latter indicates always the same direction of changes in  $P_0$  and  $P_1$  as the micro-accounting framework. When aggregating the predicted group-specific distributions (as discussed in Section III), reweighting by changes in the population shares matters, as before. However, we can also see that the Beta distribution approach overestimates systematically (except for capitalists and rentiers) changes in the FGT indicators. Figure 5 shows again the relative differences with respect to the micro-accounting framework combined with reweighting techniques. For workers in the rural sector, the discrepancy fluctuates and is between plus-minus 50 percent, but lower in the beginning and at the end of the adjustment period. For workers in the urban informal sector, the indicated change for  $P_1$  lies systematically between 25 to 30 percent above, whereas for unskilled workers the difference is between 100 to 250 percent for  $P_0$  and nearly 100 percent for  $P_1$  above. For skilled workers in the urban sector, the deviations are equivalent to up to 6 times the change indicated by the micro-accounting plus reweighting method, but they are small for  $P_0$  in the beginning, in the middle and at the end of the adjustment period.

[Insert Figure 5 here]

In addition, the Beta distribution approach appears to induce a bias concerning poverty differentials between groups. Skilled workers seem to have almost the same headcount ratio and poverty gap as unskilled workers, which is not the case if we use the micro-accounting approach. For stronger or other shocks, the Beta distribution approach may even induce a different ranking of household groups.

With the Beta distribution approach, as noted earlier, we can only measure changes in between-group inequality. Between-group inequality amounts in our artificial survey to approximately 25 percent of total inequality, but given that we expand incomes for each household with group-specific growth rates, total within-group inequality changes only slightly and insofar as we change the weights given to each within-group distribution. The change computed by the Beta distribution method is slightly higher than that computed by the micro-accounting method, but both are consistent when it comes to the direction of the change.

## 5.2 Increase in Employment Subsidies

The simulation results associated with a permanent, doubling of the nominal employment subsidy on unskilled labor (that is, an increase in the subsidy rate from 5 to 10 percentage points of the nominal minimum wage) are illustrated in Tables 3 and 4 for the first 10 periods after the shock, as before. This subsidy is paid on a per worker basis. We assume that the government changes nothing else in the tax and transfer system, implying therefore an offsetting adjustment in the investment of private firms, in order to maintain the aggregate balance between savings and investment. Again, we first comment on the general results of this simulation and then compare more specifically the effects on poverty and inequality as they are measured by the three different methods.

[Insert Tables 3 and 4 here]

The impact effect of an increase in the employment subsidy is qualitatively similar to a cut in the minimum wage: by reducing the effective cost of unskilled labor, it tends to increase immediately the demand for that category of labor—in the present case by 0.5 percent in the first year, and by about 2.6 percent on average during the adjustment period. The unskilled unemployment rate drops by 0.4 percentage points in the first year and 2.0 percentage points in the second year, and then remains at about 1.2 to 1.6 percentage points below the baseline in the long run. The reduction in the “effective” cost of unskilled labor leads firms in the private formal urban sector to substitute away from skilled labor and physical capital, leading to a reduction in skilled wages by about 2.5 percent in nominal terms and a reduction in the price of value added in the private formal sector. In the present

case, the skilled nominal wage falls by more than the price of value added in the private formal sector, implying a fall in the skilled product wage, which stimulates the demand for that category of labor. Thus, the adverse impact of the substitution effect induced by the reduction in the cost of unskilled labor on the demand for skilled labor is dampened. Overall, skilled employment falls by about 0.2 percent on impact and in the longer run, bringing with it a concomitant increase in the skilled unemployment rate.

The (expected) urban-rural wage differential (expressed as percentage of the rural wage) drops by 1.4 and 1.6 percentage points in the first and second period after the shock, then decreases to zero in period 7, and eventually becomes positive by 0.7 percentage points in the long run. The expected formal-informal wage differential (expressed as percentage of the informal wage) decreases also in the first period after the shock by 2.1 percentage points and then adjusts to plus 0.6 percentage point in the medium and long run. This evolution is qualitatively similar to the one described in the previous experiment, although the magnitude of the initial effects are not as large. The reason is that the increase in unskilled employment raises the probability of finding a job in the private sector, thereby increasing the expected formal sector wage. As a result, there is an increase in the supply of unskilled job seekers in the formal economy by slightly more than 1 percent in the long run, which therefore mitigates the initial reduction in unemployment. However, because of the increase in the informal sector wage (itself due to the reduction in labor supply in the informal economy), the expected formal-informal wage differential increases only slightly—thereby mitigating the incentives to seek employment in the formal sector.

The overall effect on aggregate real output is, again, fairly small.<sup>15</sup> The government budget is of course significantly affected, with indirect tax revenue falling by about 0.3 percentage points of GDP. As with the reduction in the minimum wage, private investment decreases significantly. This is again due to lower profits resulting from lower disposable income of skilled workers, as well as capitalists and rentiers, and the crowding-out effect resulting from the higher government deficit.

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<sup>15</sup>An important feature of the long-run adjustment process, however, is a slight reduction in the size of the urban informal and formal sectors, and an expansion of the rural sector. This result is therefore consistent with the widely-held view that reducing the tax burden (or paying a subsidy) on the formal sector is essential to limit the growth of the informal sector.

In the short run the drop in poverty of rural households and urban unskilled households in the informal and formal sectors is quite significant. In the long run, however, poverty decreases only slightly for urban informal and formal unskilled workers, and even increases in the rural sector (despite the small increase in employment) as well as for urban skilled workers, and capitalist and rentiers. These effects are qualitatively very similar to those observed for the cut in the minimum wage, but much smaller in magnitude. As with the cut in the minimum wage, inequality of the distribution of disposable income decreases, but less than in the previous simulation. At the end of the adjustment period the difference to the baseline is even close to zero.

To what extent do these results depend on the method used to link the micro with the macro level? As before, the simple micro-accounting method overstates  $P_0$  and  $P_1$  with respect to the second method, which combines micro-accounting with reweighting (see Table 4). Again, because changes in the employment structure following the shock are small, the absolute differences are also small, lying between 0.12 and 0.25 percentage points. In relative terms, however, this corresponds to differences of between 15 to almost 100 percent of the total change occurring between periods 1 and 10. Figure 6 shows again the absolute deviations from the baseline measured by the simple micro-accounting method relative to the absolute deviations from the baseline measured by the micro-accounting method combined with reweighting techniques. For both poverty indicators,  $P_0$  and  $P_1$ , and for urban households and all households together, the change with respect to the baseline is overestimated in the short run (by approximately 5 percent) and underestimated in the long run (also by approximately 5 percent). If the household survey is not reweighted, the decrease in inequality is slightly underestimated; the difference between the two approaches is again very small in absolute terms but large in relative terms.

[Insert Figure 6 here]

If we compare the micro-accounting framework with the Beta distribution approach, our results again show that the latter indicates always the same direction of changes in  $P_0$  and  $P_1$  as the former (except for  $P_1$  in period 1 for unskilled workers in the urban formal sector). Figure 7 shows that for workers in the rural sector the Beta distribution approach indicates for  $P_0$

and  $P_1$  in the short term a much higher change, and then in the medium term a much lower change, with respect to the baseline. However, at the end of the adjustment period both methods lead almost to the same change. For unskilled workers in the urban informal sector, changes in  $P_0$  and  $P_1$  are overestimated, for  $P_0$  in the long run by more than 30 percent, and for  $P_1$  by 20 to 30 percent throughout the adjustment period. For unskilled workers in the urban formal sector, the change of  $P_0$  fluctuates around the change indicated by the micro-accounting framework and amounts in some periods to more than 300 percent of the latter. The indicated direction of the change of  $P_1$  is on impact even the opposite of that indicated by the micro-accounting method; it goes afterward in the correct direction, but it overestimates continuously by almost 100 percent. For skilled workers in the urban formal sector, changes in both poverty indicators as measured by the Beta distribution method are more than 2 to 10 times higher than those measured by the micro-accounting method, but the deviations decrease over time. For capitalists and rentiers, the micro-accounting method shows a slight increase of  $P_0$  and  $P_1$ , except through periods 6 to 8, the Beta distribution approach shows no change at all after the second period.

Both experiments, the cut in the minimum wage and the increase in the employment subsidy, lead to qualitatively similar results. A low impact on aggregate output, an increase of rural poverty and a decrease of urban poverty. In rural areas the increase in labor supply, resulting from lower incentives to migrate to urban areas, puts pressure on wages. In urban areas lower unemployment leads to less poverty. In sum, both policies result in a slight decrease of poverty on the economy wide level. These changes are indicated in a qualitative, but not in magnitude, similar way by the three macro-micro linkages we compared.

[Insert Figure 7 here]

## 6 Conclusions

The purpose of this study was to compare three approaches to model linkages between a macroeconomic model with representative households and micro household income data to evaluate the distributional and poverty effects of poverty reduction strategies and other exogenous shocks. The three methods

were evaluated by performing a set of simulations with Mini-IMMPA, a disaggregated dynamic computable general equilibrium model that can readily be linked to a household survey, two typical labor market policies: a cut in the minimum wage and an increase in employment subsidies for unskilled labor. The results of these simulations were discussed and the three methods compared.

The distributional and poverty effects indicated by the three approaches are not fundamentally different, they differ neither in the direction of the effects nor in the ranking of the different household categories with respect to poverty. However, from both a conceptual and practical point of view, it is tempting to view the micro-accounting method combined with reweighting for changes in the employments structure as constituting the most appealing method among the three, despite the fact that it has its own shortcomings. The reason is that the simple micro-accounting method ignores changes in the employment structure, whereas the distribution approach relies on approximated instead of real income distributions and depends therefore on the quality of the corresponding estimates of the shape parameters. Our results indicate that the two other methods, and especially the Beta distribution approach, induces significant differences concerning the magnitude of poverty changes. In addition, as noted earlier, the distribution approach may not be adapted if one is interested in the exact level of poverty and not only in changes relative to the baseline. Of course, the problem of predicting the initial levels might partly be due to the fact that we try to model with Beta distributions our artificial household data generated by log-normal distributions. The Beta distribution approach might work better with real household data. However, the nonparametric method, that is, the extended micro-accounting framework can readily be used with actual survey data. Given the performance of standard micro-computers and statistical software nowadays, there is really no need to use the distribution approach, except perhaps for very large household surveys. However, economists who advocate this approach suggest to use it if the sample of households is small, because then the fitted distribution is smooth even if the observed one is not. The smoothing thus avoids, so goes the argument, the possibility that small shifts in the income distribution would lead to huge changes in the poverty measure. The problem with this argument is that the estimated distribution parameters, as Table A2 indicates, are not very reliable if they are estimated over a small sample of households (compare the observed and fitted poverty measures for the group of skilled workers in the formal urban

sector and of capitalists-rentiers). Therefore the parametric approach runs the risk of producing biased results.

The potential errors when using the simple micro-accounting framework or the distribution framework are of course much more important if policies with strong effects on the employment structure and the group-specific income levels are analyzed. For instance, if the minimum wage was reduced by 50 percent in our model, then the employment structure would change dramatically. The share of rural workers would be divided by two, the share of informal workers would increase by 25 percent and the share of formal unskilled workers would double. Poverty indicators calculated by both methods would differ by more than 10 percentage points whether these changes are taken into account or not. Other policies that form part of poverty reduction strategies, such as changes in the composition of public investment for instance, might in the long run also be connected with important variations in the composition of employment. Alternatively, as noted earlier, changes in the employment structure would be a lot larger than those obtained in our experiments if migration flows responded more rapidly and significantly to changes in relative wages.

As mentioned above, the micro-accounting framework combined with reweighting for changes in the employment structure has also its shortcomings. First, one might think, especially when conducting dynamic analyses, of extending this framework by reweighting for changes in other dimensions of the population structure (for instance, age structure, household size, gender) as well. This issue will be addressed in future work. Then, a further step in taking into account individual and household heterogeneity and to allow the intra-group distributions to vary explicitly would imply reliance on a micro-simulation model that accounts for labor supply decisions and earnings at the level of the household, or better, the individual. The difference with the reweighting approach is that then we would not change the weights of individuals, but we would shift them from one sector to another using behavioral functions econometrically estimated.<sup>16</sup> However, the drawback of this type of modelling is that the use of a microeconomic model of income

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<sup>16</sup>Existing examples in the field of poverty analysis include Cogneau (2001), Cogneau and Robilliard (2001), Cockburn (2001), Robilliard, Bourguignon, and Robinson (2001), Bourguignon, Robilliard, and Robinson (2002), Grimm (2002), and Cogneau and Grimm (2002). In general, the application of micro-simulation techniques to developing countries is rather new and raises a number of specific problems, as discussed by Bourguignon, Pereira da Silva, and Stern (2002) and Cogneau, Grimm, and Robilliard (2003).

generation needs for econometric estimation as well as simulation a powerful statistical data analyzing software packages (beside the software usually used to solve Macro-RHG models) and may therefore be more difficult to standardize. By contrast, the micro-accounting framework combined with reweighting for changes in the employment structure preserves a high degree of user-friendliness, which may help its eventual adoption by researchers and policy advisers in developing countries.

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## Appendix A

### Reweighting when using Real Survey Data

In a specific country application it might be necessary, in a first step, to ensure consistency between the Macro-RHG model and the household survey data in the base year.<sup>17</sup> Computed macro aggregates, such as household production, income, or consumption, from household survey data almost never match published national accounts data even though sample weights are designed to represent the national population. In particular, it is possible that the composition of employment, output, and the inter-group income distribution generated by the Macro-RHG model and the household survey are different. Many reasons are offered to explain this mismatch. On the household survey side, there may be sampling errors due to inadequate survey design and/or measurement errors, because it is difficult to get accurate responses from households concerning economic variables. On the national accounts side, while supply-side information on output and income for some sectors is based on high-quality survey or census data for agriculture and industry, information for subsistence farmers and informal producers is harder to obtain and usually of lower quality. However, there are also good reasons why household data and national accounts data for some variables do not match. For instance, consumption in national accounts is typically determined as a residual and is thus contaminated by errors and omissions elsewhere in the accounts. In other words, the concept of national accounts data and household survey data is not the same for some variables. In practice, researchers often end up treating one source or the other as the “correct” or “most reliable”—despite the fact that it is likely that both sources of information are subject to errors. Another issue when working with real household data is that it may be important to account for, besides changes in the employment structure (which includes region of residence, education, and sector of activity), other policy target variables as well. Most poverty profiles show that age of the household head, sex of the household head as well as household size are very important variables in this respect. Changes in the population structure are of course particularly important when the Macro-RHG model is dynamic. The information about these additional changes may come either directly from the Macro-RHG model or taken from external sources such as the United Nations’ demographic projections for age structure.

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<sup>17</sup>See Robilliard and Robinson (1999) for instance, who reconcile a Malagasy household survey and national accounts data.

In this case, if the reweighting procedure includes more than one dimension of the population structure and if constraints are put on the moments of some variables then this procedure becomes slightly more difficult. In general reweighting can be done in two ways: either by the simple matching of matrices constructed for the reference data and the data that has to be adjusted (see for instance Landt et al. (1994)) or by the explicit use of minimum distance functions, which calculate weights such that they match certain criteria with respect to the distance between the initial and the adjusted distribution of weights (see for instance Merz (1994)).

## Appendix B

### Estimated Shape Parameters and Fitted Poverty Measures with Beta Distribution Functions

Table A1  
Parameters for the beta density distribution function  
Moments estimates

	RU	UI	UU	US	KAP
Household Consumption Expenditure Per Capita					
$\bar{y}$	0.080	0.097	0.122	0.229	0.306
$\min(y)$	0.006	0.008	0.013	0.035	0.076
$\max(y)$	0.454	0.680	0.699	1.089	0.932
$\bar{x}$	0.164	0.132	0.159	0.184	0.269
$s^2$	0.025	0.018	0.024	0.024	0.047
$\hat{\beta}_1$	0.739	0.731	0.710	0.944	0.855
$\hat{\beta}_2$	3.768	4.799	3.759	4.192	2.323
Disposable Household Income Per Capita					
$\bar{c}$	0.089	0.111	0.134	0.280	0.426
$\min(c)$	0.007	0.009	0.012	0.045	0.071
$\max(c)$	0.625	0.880	0.612	1.228	1.175
$\bar{x}$	0.134	0.117	0.203	0.199	0.321
$s^2$	0.017	0.013	0.032	0.028	0.058
$\hat{\beta}_1$	0.753	0.818	0.820	0.936	0.880
$\hat{\beta}_2$	4.881	6.188	3.230	3.776	1.858
Sample size	1397	2253	674	486	140

*Notes:* ‘RU’ stands for workers in the agricultural sector (rural), ‘UI’ for workers in the informal urban sector, ‘UU’ for unskilled workers in the formal urban sector, ‘US’ for skilled workers in the formal urban sector, and ‘KAP’ for capitalists-rentiers.

*Source:* Estimations by the authors.

Table A2  
Observed and fitted poverty measures  
using the estimated shape parameters of the Beta distribution,  
without (nco) and with correction of outliers (co)

	Head count ratio			Gap ratio		
	Obs.	Fit. (nco)	Fit. (co)	Obs.	Fit. (nco)	Fit. (co)
<b>Disposable Household Income Per Capita</b>						
RU	50.04	50.90	49.09	20.57	30.90	29.20
UI	43.35	51.59	45.66	17.41	31.69	26.57
UU	32.16	37.89	36.48	13.03	21.39	20.62
US	4.44	14.88	9.60	1.15	7.50	4.99
KAP	3.33	4.66	0.00	0.40	2.44	0.00
<b>Household Consumption Expenditure Per Capita</b>						
RU	50.11	50.82	49.38	20.77	29.72	29.66
UI	46.40	48.40	48.32	19.31	28.34	29.01
UU	37.72	47.45	40.31	13.89	29.83	24.32
US	8.27	18.73	12.93	2.02	9.58	6.65
KAP	2.00	8.59	0.00	0.45	4.41	0.00

*Notes:* ‘RU’ stands for workers in the agricultural sector (rural), ‘UI’ for workers in the informal urban sector, ‘UU’ for unskilled workers in the formal urban sector, ‘US’ for skilled workers in the formal urban sector, and ‘KAP’ for capitalists-rentiers.

*Source:* Estimations and simulations by the authors.

[insert Figure A1 here]

Figure 1  
Simple Micro-accounting Method

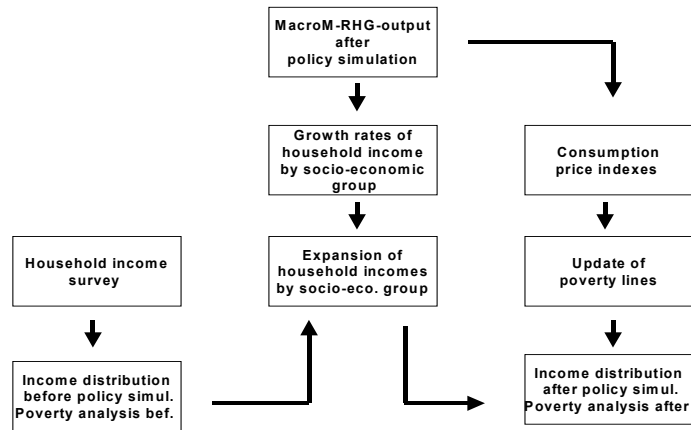


Figure 2  
Reweighting Method

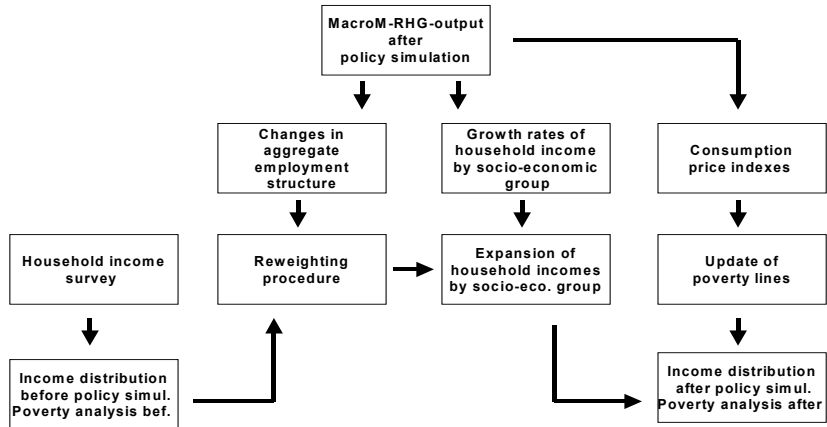
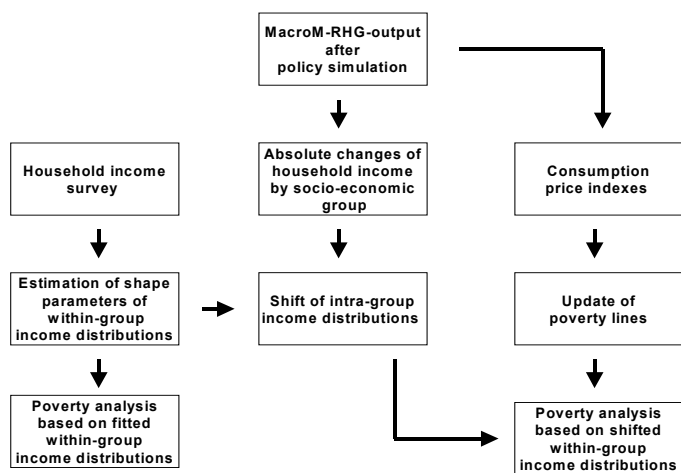


Figure 3  
Beta Distribution Method



**Table 1**  
**Mini-IMMPA: Simulation Results**  
**7 Percent Cut in Unskilled Labor Minimum Wage**  
**(Percentage deviations from baseline, unless otherwise indicated)**

	Periods									
	1	2	3	4	5	6	7	8	9	10
<b>Macroeconomic Indicators</b>										
GDP at market prices	-0,1	0,5	0,3	0,3	0,2	0,1	0,1	0,0	-0,1	-0,1
Value added at factor cost	0,2	0,7	0,5	0,4	0,4	0,3	0,2	0,2	0,1	0,1
Value added in rural sector	0,0	0,2	0,4	0,6	0,8	1,0	1,1	1,3	1,4	1,5
Value added in urban informal sector	0,0	0,7	0,4	0,3	0,1	0,0	-0,1	-0,2	-0,3	-0,4
Value added in urban formal sector	0,5	1,0	0,7	0,6	0,5	0,3	0,2	0,1	0,0	-0,1
Private Consumption	0,5	0,9	0,8	0,8	0,7	0,7	0,7	0,6	0,6	0,6
Private Investment	-10,7	-5,9	-7,2	-7,1	-7,2	-7,3	-7,4	-7,5	-7,5	-7,5
Disposable income	0,4	0,8	0,7	0,7	0,7	0,6	0,6	0,6	0,6	0,5
<b>Government Budget Balance (% of GDP)<sup>1</sup></b>										
Total revenue	-0,7	-0,5	-0,5	-0,5	-0,5	-0,5	-0,4	-0,4	-0,4	-0,4
Direct taxes	-0,2	-0,1	-0,1	-0,1	-0,1	-0,1	-0,1	-0,1	-0,1	-0,1
Indirect taxes	-0,5	-0,3	-0,4	-0,4	-0,4	-0,3	-0,3	-0,3	-0,3	-0,3
Total expenditure	-0,1	-0,3	-0,2	-0,2	-0,1	-0,1	-0,1	-0,1	0,0	0,0
Consumption	0,0	-0,1	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Investment	-0,1	-0,1	-0,1	-0,1	-0,1	-0,1	-0,1	-0,1	-0,1	0,0
Transfers to households	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Foreign interest payments	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Total financing	0,5	0,2	0,3	0,3	0,3	0,3	0,4	0,4	0,4	0,4
Foreign financing	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Domestic borrowing	0,5	0,2	0,3	0,3	0,3	0,3	0,4	0,4	0,4	0,4
<b>Labor Market</b>										
Nominal wages										
Agricultural sector	3,7	3,9	2,3	1,3	0,3	-0,6	-1,4	-2,2	-2,9	-3,5
Informal sector	5,4	3,1	3,9	4,0	4,2	4,3	4,4	4,5	4,6	4,7
Private formal sector										
Unskilled	-7,0	-7,0	-7,0	-7,0	-7,0	-7,0	-7,0	-7,0	-7,0	-7,0
Skilled	-5,2	-3,8	-4,3	-4,3	-4,4	-4,5	-4,6	-4,7	-4,8	-4,8
Public sector										
Unskilled	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Skilled	0,1	0,1	0,1	0,1	0,1	0,1	0,1	0,1	0,1	0,1
Employment										
Agricultural sector	0,0	0,3	0,6	0,8	1,0	1,2	1,4	1,6	1,7	1,8
Informal sector	0,0	0,9	0,5	0,3	0,2	0,0	-0,1	-0,2	-0,3	-0,4
Private formal sector										
Unskilled	3,4	7,6	7,0	7,5	7,8	8,1	8,4	8,8	9,1	9,4
Skilled	-0,5	-0,3	-0,4	-0,4	-0,4	-0,4	-0,4	-0,4	-0,4	-0,4
Public sector										
Unskilled	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Skilled	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Labor supply (urban formal sector)										
Unskilled	0,0	-3,6	-2,9	-3,0	-3,0	-2,9	-2,8	-2,7	-2,5	-2,4
Skilled	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Unemployment rate (urban formal sector) <sup>1</sup>										
Unskilled	-2,2	-8,6	-7,4	-7,9	-8,0	-8,2	-8,3	-8,4	-8,4	-8,5
Skilled	0,2	0,2	0,2	0,2	0,2	0,2	0,2	0,2	0,2	0,2
Real wage differentials <sup>1</sup>										
Expected urban-rural (% of rural wage)	0,0	-12,7	-14,7	-12,5	-11,3	-10,0	-8,9	-7,9	-6,9	-6,0
Expected formal-informal (% of informal wage)	0,0	-9,5	2,1	-0,5	0,2	0,2	0,3	0,3	0,4	0,4
Migration <sup>1</sup>										
Rural-urban (% of urban labor supply)	0,0	-0,1	-0,1	-0,1	-0,1	-0,1	-0,1	-0,1	-0,1	0,0
Formal-informal (% of formal urban labor supply)	0,0	-3,6	0,8	-0,2	0,1	0,1	0,1	0,1	0,1	0,2

<sup>1</sup> Absolute deviation from base line <sup>2</sup> real terms

**Table 2**  
**Mini-IMMPA: Price, Poverty and Distributional Indicators**  
**7 Percent Cut in Unskilled Labor Minimum Wage**  
(In absolute deviations from baseline, unless otherwise indicated)

	Periods									
	1	2	3	4	5	6	7	8	9	10
<b>Consumer Prices</b>										
Rural CPI	1,31	1,09	0,94	0,79	0,65	0,52	0,40	0,28	0,18	0,08
Urban CPI	0,74	0,54	0,55	0,51	0,48	0,45	0,42	0,39	0,36	0,34
<b>Cum. Growth of Real Disposable Income <sup>1</sup></b>										
Rural households	2,08	2,76	1,77	1,20	0,60	0,07	-0,43	-0,89	-1,31	-1,69
Urban households	0,01	0,35	0,43	0,56	0,66	0,76	0,86	0,94	1,03	1,10
Informal	4,03	2,98	3,37	3,42	3,50	3,55	3,59	3,61	3,61	3,61
Formal unskilled	-2,55	-0,36	-0,65	-0,38	-0,23	-0,04	0,14	0,32	0,49	0,67
Formal skilled	-2,55	-1,90	-2,12	-2,15	-2,21	-2,26	-2,31	-2,35	-2,39	-2,43
Capitalists and rentiers	-6,09	-3,81	-3,88	-3,43	-3,08	-2,71	-2,34	-1,98	-1,62	-1,26
<b>Household Shares</b>										
Rural households	0,00	0,07	0,15	0,22	0,29	0,34	0,39	0,44	0,47	0,51
Urban households	0,00	-0,07	-0,15	-0,22	-0,29	-0,34	-0,39	-0,44	-0,47	-0,51
Informal	0,00	0,39	0,21	0,16	0,08	0,01	-0,05	-0,11	-0,17	-0,22
Formal unskilled	0,00	-0,47	-0,36	-0,38	-0,37	-0,36	-0,34	-0,32	-0,30	-0,28
Formal skilled	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Capitalists and rentiers	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
<b>Poverty and Distributional Indicators (Income-based)</b>										
Poverty Line <sup>1</sup>										
Rural	1,31	1,09	0,94	0,79	0,65	0,52	0,40	0,28	0,18	0,08
Urban	0,75	0,55	0,55	0,51	0,48	0,45	0,42	0,39	0,37	0,34
<b>Micro-accounting approach with and without reweighting</b>										
Poverty Headcount										
Rural households	-1,14	-1,14	-0,64	-0,28	0,21	0,64	1,14	1,42	1,49	1,71
Urban households (without reweighting)	-1,34	-0,92	-1,17	-1,17	-1,28	-1,34	-1,34	-1,25	-1,22	-1,28
Urban households (with reweighting)	-1,34	-0,84	-1,14	-1,14	-1,26	-1,32	-1,32	-1,23	-1,22	-1,29
Informal	-2,61	-1,55	-1,86	-1,94	-1,99	-2,08	-2,12	-2,17	-2,17	-2,12
Formal unskilled	0,58	-0,88	-0,44	-0,44	-0,58	-0,73	-0,73	-0,73	-0,58	-0,58
Formal skilled	1,01	1,21	0,20	0,60	0,20	0,60	0,81	1,81	1,61	1,01
Capitalists and rentiers	1,33	1,33	1,33	1,33	1,33	0,67	0,67	0,00	0,67	0,67
Economy (without reweighting)	-1,28	-0,98	-1,02	-0,92	-0,86	-0,78	-0,64	-0,50	-0,46	-0,44
Economy (with reweighting)	-1,29	-0,92	-0,98	-0,87	-0,81	-0,72	-0,58	-0,42	-0,39	-0,37
Poverty Gap										
Rural households	-0,60	-0,71	-0,35	-0,11	0,12	0,34	0,54	0,72	0,88	1,03
Urban households (without reweighting)	-0,59	-0,50	-0,58	-0,62	-0,66	-0,69	-0,72	-0,74	-0,75	-0,77
Urban households (with reweighting)	-0,60	-0,47	-0,57	-0,60	-0,65	-0,68	-0,71	-0,73	-0,75	-0,77
Informal	-1,15	-0,64	-0,84	-0,87	-0,93	-0,97	-1,01	-1,03	-1,07	-1,09
Formal unskilled	0,54	-0,61	-0,41	-0,49	-0,51	-0,54	-0,55	-0,57	-0,58	-0,58
Formal skilled	0,14	0,12	0,15	0,15	0,16	0,16	0,18	0,19	0,22	0,24
Capitalists and rentiers	0,23	0,14	0,14	0,11	0,10	0,08	0,07	0,06	0,05	0,04
Economy (without reweighting)	-0,59	-0,56	-0,52	-0,48	-0,44	-0,40	-0,36	-0,33	-0,29	-0,26
Economy (with reweighting)	-0,60	-0,53	-0,50	-0,45	-0,41	-0,37	-0,34	-0,30	-0,26	-0,23
Overall Inequality										
Gini-coefficient (without reweighting)	-0,0074	-0,0053	-0,0052	-0,0046	-0,0041	-0,0036	-0,0031	-0,0026	-0,0022	-0,0018
Gini-coefficient (with reweighting)	-0,0075	-0,0053	-0,0051	-0,0045	-0,0040	-0,0035	-0,0031	-0,0026	-0,0022	-0,0018
Theil-index (without reweighting)	-0,0153	-0,0116	-0,0111	-0,0099	-0,0089	-0,0079	-0,0069	-0,0059	-0,0050	-0,0041
Theil-index (with reweighting)	-0,0155	-0,0113	-0,0109	-0,0097	-0,0087	-0,0076	-0,0066	-0,0057	-0,0048	-0,0039
<b>Beta-distribution approach with and without reweighting</b>										
Poverty Headcount										
Rural households	-1,18	-1,36	-0,72	-0,30	0,12	0,50	0,84	1,16	1,44	1,70
Urban households (without reweighting)	-0,87	-0,97	-1,10	-1,22	-1,30	-1,37	-1,42	-1,46	-1,49	-1,51
Urban households (with reweighting)	-0,88	-0,88	-1,05	-1,17	-1,25	-1,32	-1,37	-1,42	-1,45	-1,48
Informal	-2,41	-1,31	-1,71	-1,77	-1,87	-1,95	-2,02	-2,07	-2,11	-2,15
Formal unskilled	1,33	-1,91	-1,29	-1,53	-1,57	-1,62	-1,66	-1,68	-1,69	-1,69
Formal skilled	1,70	1,22	1,30	1,27	1,25	1,24	1,22	1,20	1,19	1,17
Capitalists and rentiers	3,82	1,37	1,09	0,19	0,00	0,00	0,00	0,00	0,00	0,00
Economy (without reweighting)	-0,96	-1,08	-0,99	-0,96	-0,90	-0,84	-0,78	-0,72	-0,66	-0,61
Economy (with reweighting)	-0,96	-1,01	-0,94	-0,90	-0,84	-0,78	-0,72	-0,66	-0,60	-0,54
Poverty Gap										
Rural households	-0,76	-0,87	-0,46	-0,19	0,08	0,32	0,54	0,75	0,93	1,09
Urban households (without reweighting)	-0,60	-0,62	-0,71	-0,78	-0,83	-0,87	-0,90	-0,92	-0,94	-0,96
Urban households (with reweighting)	-0,61	-0,57	-0,68	-0,74	-0,80	-0,84	-0,87	-0,90	-0,92	-0,94
Informal	-1,52	-0,83	-1,08	-1,12	-1,18	-1,23	-1,28	-1,31	-1,34	-1,36
Formal unskilled	0,79	-1,13	-0,77	-0,91	-0,93	-0,97	-0,99	-1,00	-1,01	-1,01
Formal skilled	0,91	0,66	0,71	0,69	0,68	0,68	0,67	0,66	0,66	0,65
Capitalists and rentiers	1,99	0,71	0,57	0,10	0,00	0,00	0,00	0,00	0,00	0,00
Economy (without reweighting)	-0,64	-0,69	-0,64	-0,61	-0,57	-0,53	-0,49	-0,45	-0,42	-0,38
Economy (with reweighting)	-0,65	-0,65	-0,61	-0,58	-0,54	-0,49	-0,45	-0,41	-0,38	-0,34
Between-group Inequality										
Theil-index (without reweighting)	-0,0173	-0,0127	-0,0124	-0,0111	-0,0100	-0,0089	-0,0078	-0,0068	-0,0058	-0,0048
Theil-index (with reweighting)	-0,0174	-0,0127	-0,0124	-0,0110	-0,0099	-0,0088	-0,0078	-0,0068	-0,0058	-0,0048

<sup>1</sup> Percentage deviations from the base line <sup>2</sup> Gini Coefficients and Theil Indices measure between-group inequality

**Table 3**  
**Mini-IMMPA: Simulation Results**  
**100 Percent Increase (from 5 to 10 percent of the min. wage) in Employment Subsidy on Unskilled Labor**  
**(Percentage deviations from baseline, unless otherwise indicated)**

	Periods									
	1	2	3	4	5	6	7	8	9	10
<b>Macroeconomic Indicators</b>										
GDP at market prices	-0,1	0,0	-0,1	-0,1	-0,2	-0,2	-0,2	-0,3	-0,3	-0,3
Value added at factor cost	0,0	0,1	0,0	0,0	-0,1	-0,1	-0,1	-0,2	-0,2	-0,3
Value added in rural sector	0,0	0,0	0,0	0,1	0,1	0,1	0,1	0,1	0,1	0,1
Value added in urban informal sector	0,0	0,2	0,0	0,0	-0,1	-0,1	-0,2	-0,2	-0,2	-0,3
Value added in urban formal sector	0,1	0,1	0,0	-0,1	-0,2	-0,2	-0,3	-0,4	-0,4	-0,5
Private Consumption	0,4	0,5	0,4	0,4	0,3	0,3	0,2	0,2	0,2	0,2
Private Investment	-6,0	-4,5	-4,8	-4,6	-4,5	-4,4	-4,4	-4,3	-4,2	-4,1
Disposable income	0,3	0,4	0,3	0,3	0,3	0,2	0,2	0,2	0,2	0,1
<b>Government Budget Balance (% of GDP)<sup>1</sup></b>										
Total revenue	-0,5	-0,4	-0,4	-0,4	-0,4	-0,3	-0,3	-0,3	-0,3	-0,3
Direct taxes	-0,1	-0,1	-0,1	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Indirect taxes	-0,4	-0,3	-0,3	-0,3	-0,3	-0,3	-0,3	-0,3	-0,3	-0,3
Total expenditure	0,0	-0,1	0,0	0,0	0,0	0,0	0,0	0,0	0,1	0,1
Consumption	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Investment	-0,1	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Transfers to households	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Foreign interest payments	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Total financing	0,4	0,3	0,4	0,4	0,4	0,4	0,4	0,4	0,4	0,4
Foreign financing	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Domestic borrowing	0,4	0,3	0,4	0,4	0,4	0,4	0,4	0,4	0,4	0,4
<b>Labor Market</b>										
Nominal wages										
Agricultural sector	1,6	1,6	1,1	0,8	0,5	0,3	0,1	-0,1	-0,2	-0,4
Informal sector	2,5	1,8	1,9	1,8	1,7	1,7	1,6	1,5	1,5	1,4
Private formal sector										
Unskilled	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Skilled	-2,5	-2,1	-2,3	-2,3	-2,4	-2,4	-2,5	-2,5	-2,5	-2,5
Public sector										
Unskilled	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Skilled	0,1	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Employment										
Agricultural sector	0,0	0,0	0,1	0,1	0,1	0,1	0,1	0,1	0,1	0,1
Informal sector	0,0	0,2	0,1	0,0	-0,1	-0,1	-0,2	-0,2	-0,3	-0,3
Private formal sector										
Unskilled	0,5	1,9	1,9	2,2	2,4	2,7	2,9	3,1	3,3	3,5
Skilled	-0,2	-0,2	-0,2	-0,2	-0,2	-0,2	-0,2	-0,2	-0,2	-0,2
Public sector										
Unskilled	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Skilled	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Labor supply (urban formal sector)										
Unskilled	0,0	-0,8	-0,3	-0,1	0,1	0,3	0,5	0,7	1,0	1,2
Skilled	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Unemployment rate (urban formal sector) <sup>1</sup>										
Unskilled	-0,4	-2,0	-1,5	-1,6	-1,5	-1,5	-1,4	-1,3	-1,3	-1,2
Skilled	0,1	0,1	0,1	0,1	0,1	0,1	0,1	0,1	0,1	0,1
Real wage differentials <sup>1</sup>										
Expected urban-rural (% of rural wage)	0,0	-1,4	-1,6	-1,0	-0,6	-0,3	0,0	0,3	0,5	0,7
Expected formal-informal (% of informal wage)	0,0	-2,1	1,2	0,5	0,6	0,6	0,6	0,6	0,6	0,5
Migration <sup>1</sup>										
Rural-urban (% of urban labor supply)	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Formal-informal (% of formal urban labor supply)	0,0	-0,8	0,5	0,2	0,2	0,2	0,2	0,2	0,2	0,2

<sup>1</sup> Absolute deviation from base line <sup>2</sup> real terms

**Table 4**  
**Mini-IMMPA: Price, Poverty and Distributional Indicators**  
**100 Percent Increase (from 5 to 10 percent of the min. wage) in Employment Subsidy on Unskilled Labor**  
**(In absolute deviations from baseline, unless otherwise indicated)**

	Periods									
	1	2	3	4	5	6	7	8	9	10
<b>Consumer Prices</b>										
Rural CPI	0,59	0,50	0,44	0,38	0,32	0,27	0,22	0,18	0,15	0,12
Urban CPI	0,34	0,27	0,25	0,23	0,21	0,19	0,17	0,15	0,14	0,12
<b>Cum. Growth of Real Disposable Income <sup>1</sup></b>										
Rural households	0,88	0,99	0,66	0,46	0,26	0,09	-0,06	-0,19	-0,30	-0,40
Urban households	0,19	0,26	0,26	0,27	0,27	0,28	0,28	0,28	0,28	0,27
Informal	1,91	1,48	1,48	1,37	1,28	1,20	1,11	1,02	0,94	0,86
Formal unskilled	0,03	0,78	0,80	0,98	1,11	1,25	1,38	1,50	1,62	1,73
Formal skilled	-1,22	-1,05	-1,13	-1,15	-1,17	-1,19	-1,21	-1,23	-1,24	-1,25
Capitalists and rentiers	-2,92	-2,14	-2,05	-1,81	-1,62	-1,42	-1,24	-1,07	-0,91	-0,75
<b>Household Shares</b>										
Rural households	0,00	0,01	0,02	0,02	0,03	0,03	0,03	0,02	0,02	0,02
Urban households	0,00	-0,01	-0,02	-0,02	-0,03	-0,03	-0,03	-0,02	-0,02	-0,02
Informal	0,00	0,09	0,02	0,00	-0,04	-0,06	-0,09	-0,11	-0,13	-0,15
Formal unskilled	0,00	-0,10	-0,04	-0,02	0,01	0,04	0,06	0,09	0,11	0,13
Formal skilled	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Capitalists and rentiers	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
<b>Poverty and Distributional Indicators (Income-based)</b>										
Poverty Line <sup>1</sup>										
Rural	0,59	0,50	0,44	0,38	0,32	0,27	0,22	0,18	0,15	0,12
Urban	0,34	0,27	0,26	0,23	0,21	0,19	0,17	0,15	0,14	0,12
<b>Micro-accounting approach with and without reweighting</b>										
Poverty Headcount										
Rural households	-0,50	-0,50	-0,28	-0,21	-0,14	0,00	0,14	0,21	0,21	0,21
Urban households (without reweighting)	-0,70	-0,45	-0,47	-0,39	-0,42	-0,47	-0,47	-0,25	-0,25	-0,17
Urban households (with reweighting)	-0,70	-0,42	-0,47	-0,39	-0,42	-0,48	-0,49	-0,26	-0,26	-0,18
Informal	-1,24	-0,75	-0,80	-0,75	-0,71	-0,66	-0,66	-0,62	-0,57	-0,44
Formal unskilled	0,00	-0,44	-0,15	0,00	-0,15	-0,29	-0,29	0,00	-0,15	-0,15
Formal skilled	0,20	0,60	0,20	0,40	0,20	0,00	0,00	1,01	0,81	0,81
Capitalists and rentiers	1,33	0,67	0,67	0,67	0,67	0,00	0,00	0,00	0,67	0,67
Economy (without reweighting)	-0,64	-0,46	-0,42	-0,34	-0,34	-0,34	-0,30	-0,12	-0,12	-0,06
Economy (with reweighting)	-0,64	-0,44	-0,41	-0,34	-0,34	-0,34	-0,31	-0,12	-0,12	-0,07
Poverty Gap										
Rural households	-0,26	-0,28	-0,17	-0,11	-0,05	0,00	0,04	0,08	0,11	0,14
Urban households (without reweighting)	-0,34	-0,28	-0,29	-0,28	-0,27	-0,26	-0,25	-0,24	-0,23	-0,21
Urban households (with reweighting)	-0,34	-0,28	-0,29	-0,28	-0,27	-0,26	-0,25	-0,24	-0,23	-0,22
Informal	-0,56	-0,38	-0,42	-0,40	-0,40	-0,38	-0,37	-0,36	-0,35	-0,34
Formal unskilled	0,01	-0,29	-0,20	-0,20	-0,19	-0,17	-0,15	-0,14	-0,12	-0,10
Formal skilled	0,06	0,06	0,08	0,08	0,08	0,08	0,09	0,10	0,11	0,12
Capitalists and rentiers	0,10	0,07	0,06	0,05	0,04	0,04	0,03	0,03	0,02	0,02
Economy (without reweighting)	-0,31	-0,28	-0,26	-0,23	-0,21	-0,19	-0,17	-0,15	-0,13	-0,12
Economy (with reweighting)	-0,31	-0,28	-0,25	-0,23	-0,21	-0,19	-0,17	-0,15	-0,14	-0,12
Overall Inequality										
Gini-coefficient (without reweighting)	-0,0036	-0,0028	-0,0027	-0,0024	-0,0022	-0,0019	-0,0017	-0,0016	-0,0014	-0,0012
Gini-coefficient (with reweighting)	-0,0036	-0,0028	-0,0027	-0,0024	-0,0022	-0,0020	-0,0018	-0,0016	-0,0015	-0,0013
Theil-index (without reweighting)	-0,0076	-0,0062	-0,0058	-0,0052	-0,0047	-0,0042	-0,0037	-0,0033	-0,0029	-0,0026
Theil-index (with reweighting)	-0,0077	-0,0061	-0,0058	-0,0052	-0,0048	-0,0043	-0,0039	-0,0035	-0,0031	-0,0028
<b>Beta-distribution approach with and without reweighting</b>										
Poverty Headcount										
Rural households	-0,50	-0,53	-0,35	-0,24	-0,13	-0,03	0,05	0,11	0,17	0,22
Urban households (without reweighting)	-0,56	-0,55	-0,54	-0,52	-0,50	-0,48	-0,45	-0,42	-0,40	-0,37
Urban households (with reweighting)	-0,56	-0,53	-0,53	-0,51	-0,49	-0,47	-0,45	-0,42	-0,40	-0,38
Informal	-1,12	-0,76	-0,82	-0,79	-0,77	-0,74	-0,72	-0,69	-0,66	-0,63
Formal unskilled	-0,05	-0,88	-0,63	-0,63	-0,56	-0,51	-0,46	-0,41	-0,36	-0,30
Formal skilled	0,82	0,67	0,69	0,68	0,67	0,66	0,65	0,63	0,62	0,61
Capitalists and rentiers	0,82	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Economy (without reweighting)	-0,55	-0,55	-0,49	-0,44	-0,39	-0,35	-0,31	-0,27	-0,24	-0,21
Economy (with reweighting)	-0,54	-0,53	-0,48	-0,43	-0,39	-0,35	-0,31	-0,27	-0,24	-0,21
Poverty Gap										
Rural households	-0,32	-0,34	-0,22	-0,15	-0,08	-0,02	0,03	0,07	0,11	0,14
Urban households (without reweighting)	-0,37	-0,35	-0,35	-0,33	-0,32	-0,31	-0,29	-0,27	-0,26	-0,24
Urban households (with reweighting)	-0,37	-0,34	-0,34	-0,33	-0,32	-0,30	-0,29	-0,28	-0,26	-0,25
Informal	-0,71	-0,48	-0,52	-0,50	-0,49	-0,47	-0,46	-0,44	-0,42	-0,40
Formal unskilled	-0,03	-0,52	-0,37	-0,37	-0,34	-0,31	-0,28	-0,24	-0,21	-0,18
Formal skilled	0,44	0,36	0,38	0,37	0,36	0,36	0,35	0,35	0,34	0,34
Capitalists and rentiers	0,43	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Economy (without reweighting)	-0,36	-0,35	-0,31	-0,28	-0,25	-0,23	-0,20	-0,18	-0,15	-0,13
Economy (with reweighting)	-0,36	-0,34	-0,31	-0,28	-0,25	-0,22	-0,20	-0,18	-0,16	-0,14
Between-group Inequality										
Theil-index (without reweighting)	-0,0085	-0,0068	-0,0064	-0,0058	-0,0052	-0,0047	-0,0042	-0,0038	-0,0033	-0,0029
Theil-index (with reweighting)	-0,0086	-0,0068	-0,0065	-0,0058	-0,0053	-0,0048	-0,0043	-0,0039	-0,0035	-0,0031

<sup>1</sup> Percentage deviations from the base line <sup>2</sup> Gini Coefficients and Theil Indices measure between-group inequality

Figure 4  
 Comparison of the poverty impact measured by the simple micro-accounting method relative to that measured by the micro-accounting method combined with reweighting techniques  
 (Ratio of absolute deviations from baseline)



Figure 5  
 Comparison of the poverty impact measured by the the BETA distribution method relative to that measured by the micro-accounting method combined with reweighting techniques  
 (Ratio of absolute deviations from baseline)

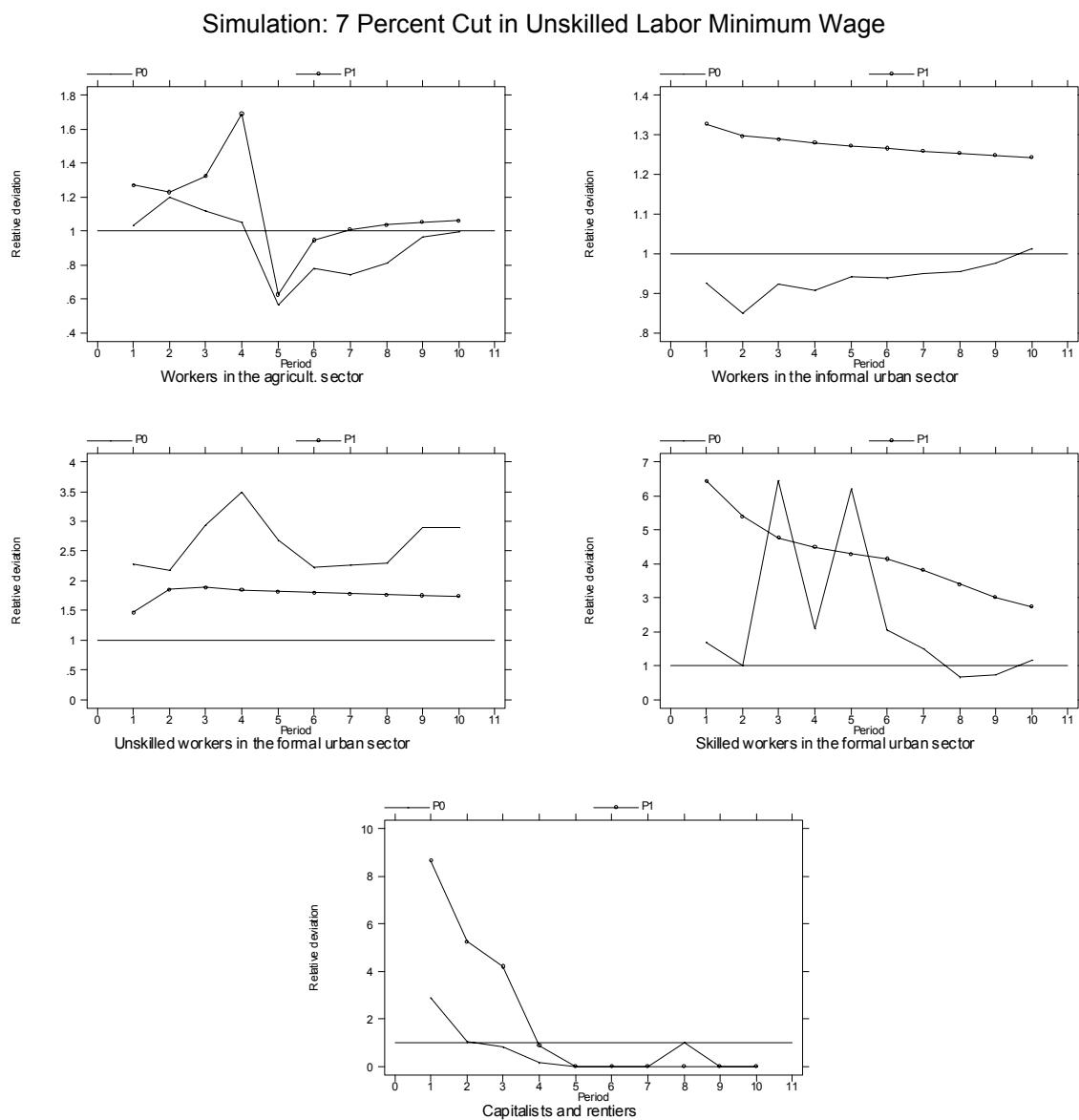


Figure 6

Comparison of the poverty impact measured by the simple micro-accounting method relative to that measured by the micro-accounting method combined with reweighting techniques (Ratio of absolute deviations from baseline)

Simulation: 100 Percent Increase in Employment Subsidy on Unskilled Labor

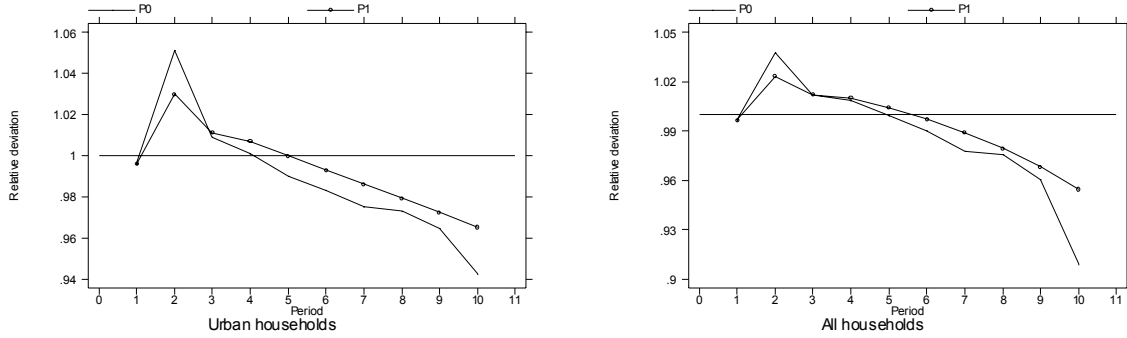


Figure 7

Comparison of the poverty impact measured by the the BETA distribution method relative to that measured by the micro-accounting method combined with reweighting techniques (Ratio of absolute deviations from baseline)

Simulation: 100 Percent Increase in Employment Subsidy on Unskilled Labor

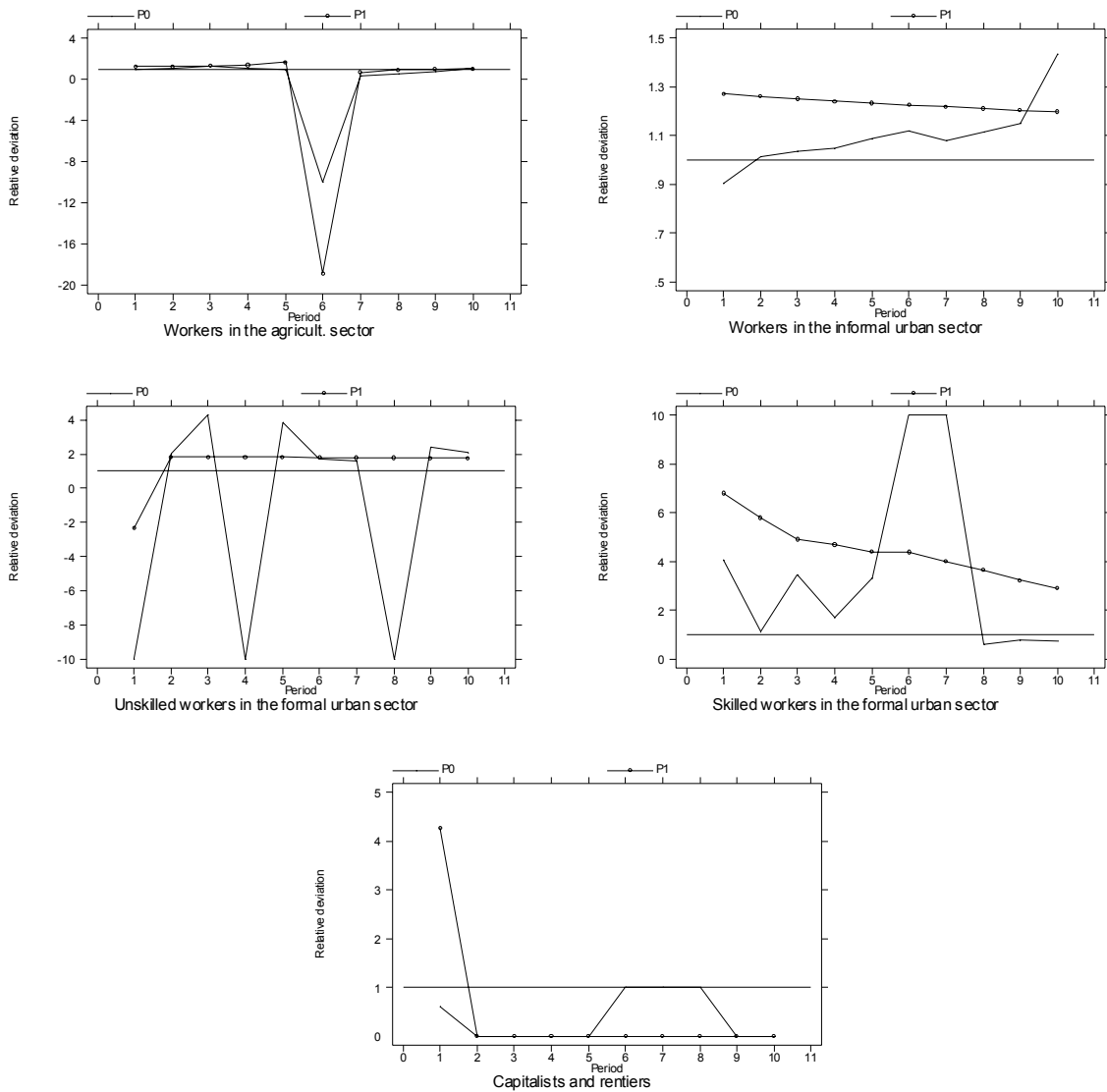


Figure A1  
 Observed and by a Beta-distribution fitted cumulative distribution function  
 of normalized disposable income for each category of households  
 (vertical line = corresponding normalized poverty line)

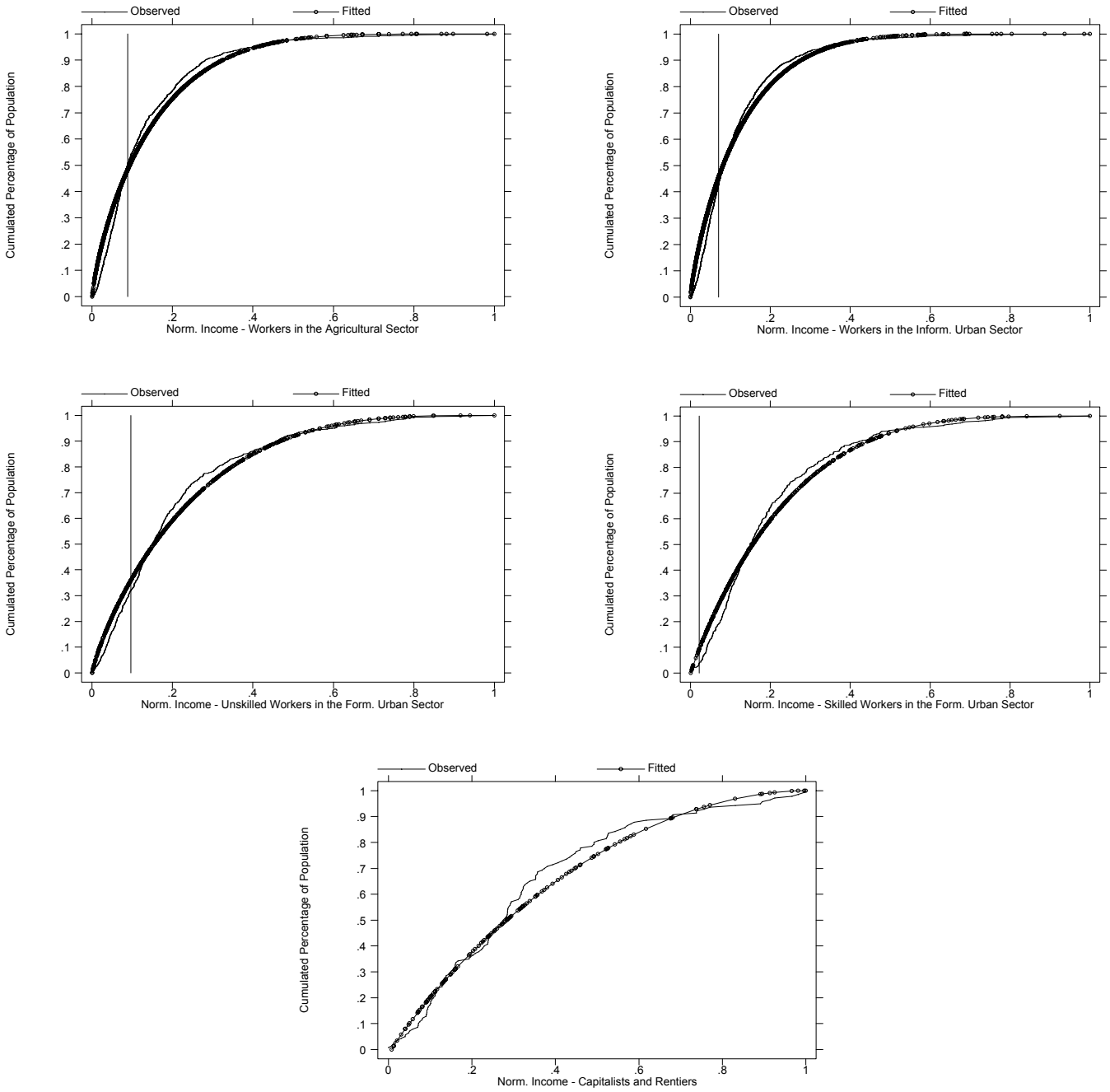


Figure A2  
 Observed and by a Beta-distribution fitted cumulative distribution function  
 of normalized consumption for each category of households  
 (vertical line = corresponding normalized poverty line)

