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How appropriate are global models for long-run poverty assessment?

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Abstract

The major shift in global food and fuel prices in the past several years has left the world with a significantly higher level of consumer prices and especially food prices, which raises an important question of the long-run impacts of high prices on global poverty. While short run-impacts of the most important consumer prices have been assessed satisfactorily by a number of researchers, the long-run impacts are less clear due to our current lack of understanding how households respond to change in relative prices and incomes by changing their consumption and household production over extended periods of time. Many of the difficulties in assessing long-run price impacts on households have been approximated by a global or national CGE models, however, is currently not clear how well the use of a representative agent and the imperfectly estimated behavioral parameters approximate the behavior of actual households and what are the implications of the discrepancies between the representative and actual household on poverty assessment. In this paper we address some of the key issues of household behavior by contrasting the predictions of the representative agent and the household and measuring the impact of any discrepancies on poverty assessment. We find, that even though the representative agent of the GTAP model performs poorly in predicting household consumption mainly due to inflexibly specified preferences, it nevertheless improves our estimates of poverty impacts.

1 Introduction

In this paper we address some of the key components of household behavior which is often assumed to follow the pattern of the regional economy in order to facilitate analysis. For example, a large body of recent literature that deals with the poverty impacts of the recent food price crises considers the level of substitution in consumption, the ability to change output among farming households and the impacts of changing prices on wages. Because these impacts determine the overall conclusions of the analysis, it is important to understand how well our global models, namely the GTAP model, represent the behavior of individual households and what are the implications of any differences. (Ivanic and Martin 2008)

In the first part of this paper, we analyze the behavior of consumers and compare it to that predicted by the model. Specifically, we consider the observed changes in real incomes for individual households and compare them with the change predicted by the latest version of the model and the parameter file. In the second part of the paper, we compare the behavior of the farming households with the behavior of the model. Again, we observe the changes in agricultural production with the change predicted by the model. Finally, we consider the issue of wage impacts by contrasting the observed changes in wages with those predicted by the model. For each of the household behaviors that we examine, we provide a measure of fit and suggests the implications of any discrepancies for results and policy conclusions. We conclude by formulating recommendations for corrections in the modeling framework.

2 Method

2.1 Household consumption behavior

The GTAP model assumes, for various reasons, that the regional household follows CDE preferences of (Hanoch 1975) which have been estimated for a large number of countries and hence they are extremely well-fitted for the use with the global model such as GTAP. However, because each region in the model has only a single set of demand parameters aimed to represent the behavior of the

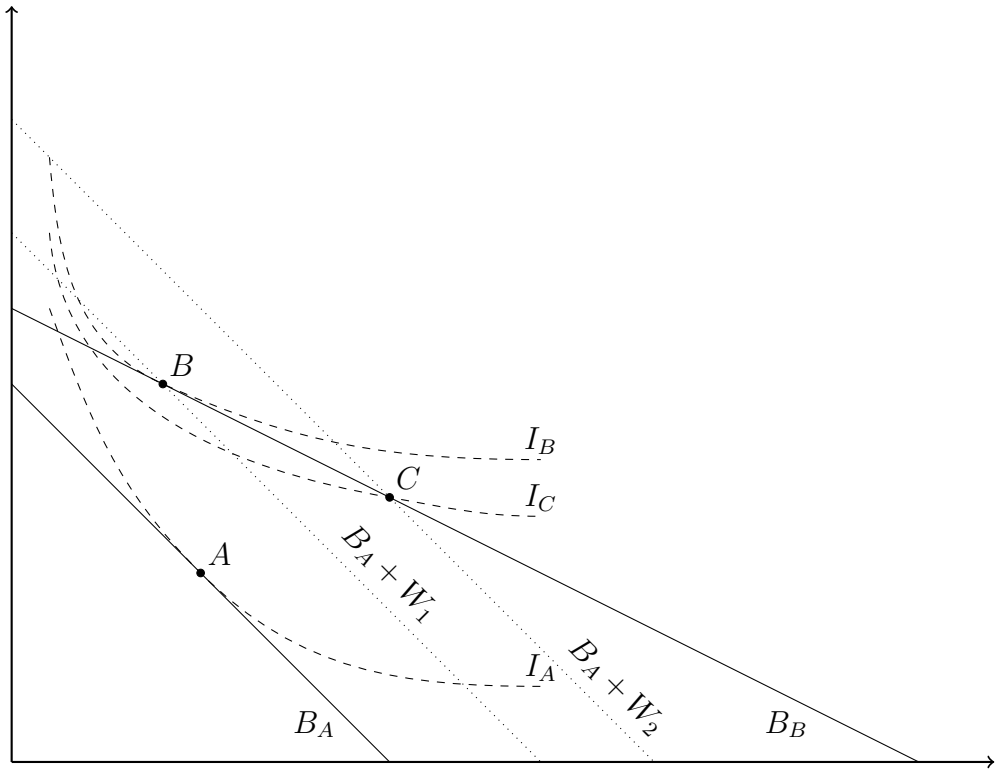


Figure 1: Measure of welfare miscalculation of a demand system

representative agent, it is possible that this single set of values may not represent households with incomes far from the average.

(Ivanic, Martin, and Zaman ming) used the parameters and preference structure assumed in GTAP to represent household consumption adjustments and the resulting welfare impacts.

In order to understand the scope of the possible misrepresentation, we compare the observed consumption adjustments with those predicted by the set of GTAP parameters. In other words, for each household h we can observe a change in the consumption quantity q_i

2.1.1 Measurement of welfare underestimation due to incorrectly specified preferences

To understand our measure of welfare calculation error, consider Figure 1. In this figure we depict the consumption bundle A that we observe a household to consume. Based on basic economic theory the observed consumption bundle lies at the tangent of the household's indifference curve I_A and its budget line B_A. In the next period, we observe a new consumption bundle B which

again is the tangent of another indifference curve I_B and the new budget line B_B which is likely to be of different slope depending on the change in relative prices. If our preference system, however, incorrectly predicted that that the household's will consume bundle C, we would be misled to believe that the household achieved a lower level of utility at some indifference curve I_C, which must be less preferred than the observed bundle B.

To measure precisely how much is bundle C inferior to bundle B in terms of original prices, we may measure the difference between the costs of bundles B and C by finding a budget $B_A - W_1$ at original prices which affords bundle B and a budget $B_A + W_2$ that affords bundle C. Because a household would be willing to give up income equal to $|W_1 - W_2|$ in order to switch from bundle C to bundle B, $|W_1 - W_2|$ measures the underestimation of welfare of household at new income and prices due to the wrong preference specification.

To calculate the impact of the underestimation of welfare due to the preference system, we first calculate the welfare change ΔW_h expressed in initial prices for each household h in our sample. We calculate this welfare change as $\Delta W_h = \sum_j \Delta q_{j,h} p_{0,j}$ where $\Delta q_{j,h}$ is the change in the quantity of j consumed by household h valued at initial prices $p_{0,j}$ for each good j. We then calculate predicted consumption bundle $q^*(j,h)$ for good j and household h. We then compare the cost of this bundle with the observed one at initial prices $p_{0,j}$ and record the absolute value of the difference as our measure of weflare underestimation U_h for each household h as $U_h = |\sum_j q_{1,j,h} p_{0,j} - \sum_j q^*_{1,j,h} p_{0,j}|$.

2.1.2 Impact of welfare measurement error on poverty estimates

Underestimation of households' welfare due to the incorrectly specified preferences may have direct impact on measures of welfare. Consider, for example, a common measure of poverty, based on the work of (Foster, Greer, and Thorbecke 1984), which expresses poverty rate r as

$$r = \frac{\sum_{h \in P} w_h}{\sum_h w_h},$$

where w_h is the weight of household h in the sample and P determines a set of households in poverty. The set P may be determined in various ways, often by comparing some welfare measure

to some predefined poverty-determining level ("poverty line"). The simplest method may include comparing the average income per household member; more complex methods may take into account the economies of scale of larger households (Lanjouw and Ravallion 1995) or they may account for different consumption needs of household members depending on their age, sex, level of work etc (Appleton, Emwanu, Kagugube, and Muwonge 1999).

Because the point of this work is to assess the role of preference misrepresentation in poverty assessment, we chose a simple method of determining the poverty status of a household which is based on a poverty line for per capita income y_p which represents the maximum level of consumption per household member in order for the household to be considered poor. The exact level of the poverty line is again determined very simply by fitting the line to the available household surveys which yields back the official poverty rate.

Using the initial (given) poverty rate r_0, we may then assess the change in poverty rate in panel data and compare it to the rate which would be obtained with incorrect preferences. Hence, we obtain two poverty rates r_1 which represents the share of households whose per capita consumption valued in initial prices in the second period is below or equal to the poverty line. We also obtain an alternative poverty rate r_1^* based on the incorrect preferences where we subtract from each household's welfare the underestimation due to the misspecified preferences.

2.1.3 Calculation of changes in expenditure using GTAP preferences

The calculation of quantity adjustments using GTAP preferences requires two steps. In the first step, we need to calibrate the CDE preferences to each household's observed consumption using the following equation by calculating household-specific vectors of income elasticities η matrices of cross-price elasticities ϵ:

$$\eta_{j,h} = \frac{I_{j,h}S_{j,h} + \sum_l \sigma_{l,h} I_{l,h} \left(1 - S_{l,h}\right)}{\sum_l \sigma_{l,h} I_{l,h}} + \left[\left(1 - S_{j,h}\right) - \sum_l \sigma_{l,h} \left(1 - S_{l,h}\right) \right];$$

$$\forall j \neq k : \epsilon_{j,k,h} = \left[(1 - S_{j,r}) + (1 - S_{k,r}) - \sum_l \sigma_{l,h}(1 - S_{l,r}) - \eta_{j,h} \right] \sigma_{k,r}$$

$$\forall j = k : \epsilon_{j,k,h} = \left[(1 - S_{j,r}) + (1 - S_{k,r}) - \sum_l \sigma_{l,h}(1 - S_{l,r}) - (1 - S_{j,h})/\sigma_{j,h} - \eta_{j,h} \right] \sigma_{k,r},$$

where S_j is the substitution parameter and I_j is the income parameter for commodity j provided in the GTAP parameter file for each country.

In the second step, we apply observed changes in prices $\hat{p}_j$ for each commodity j, observed changes in income $\hat{y}_h$ for each household h in order to determine changes in quantities consumed $\hat{q}_{j,h}$:

$$\hat{q}_{j,h} = \sum_k \hat{p}_j \epsilon_{j,k,h} + \hat{y}_h \eta_j,$$

where ϵ_h is the matrix of compensated cross-price elasticities of household h and the vector of income elasticities η.

2.2 Household agricultural production behavior

Even though the GTAP model does not assume any specific production function for farm output, various authors have used its production function to simulate the household behavior of individual households.

In order to understand the scope of the possible misrepresentation, we compare the observed consumption adjustments with those predicted by the set of GTAP parameters. In other words, for each household h we can observe a change in the consumption quantity q_i

3 Data

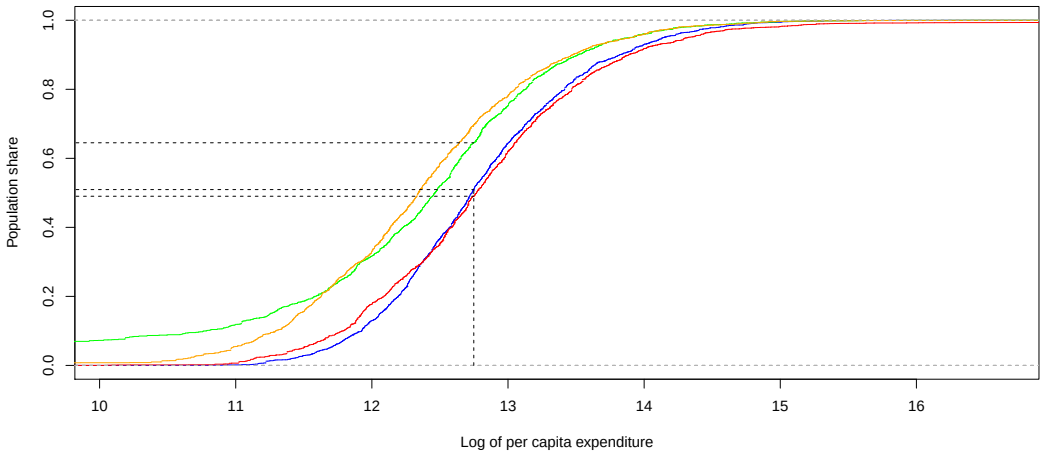
In our work, we use three recent panel survey data sets for three low-income countries: Pakistan, Uganda and Vietnam. In Pakistan, we use two panel surveys (Pakistan 2007) and (Pakistan 2009), which cover four largest provinces in Pakistan and nearly all of Pakistan's population. In Uganda we take advantage of the panel represented by (Uganda 2005) and (Uganda 2009), which are nationally

representative. Finally, in Vietnam we use (Vietnam 2006) and (Vietnam 2008) which are also nationally representative. Because all of the panels that we use span the time of the 2008 food price crisis, they are very valuable in shedding light on the the actual decisions taken by households during the crisis which include adjustments in household consumption, farm production as well as the overall household incomes.

In order to make our surveys useful for our analysis, we had to process the data to some extent. The most important part of the processing was establishing national-level average prices for all commodities consumed during each survey period. This treatment was necessary in order to assure that each commodity had a single price in each period that each household faced. Of course, there are many reasons why this may not be true, the most important reason being differences in quality. The other reason is the length of the time during which the surveys were taking, allowing for temporal changes in prices. It is relatively difficult to deal with inflation in a single survey because it requires knowing inflation at shorter time periods (monthly) and applying it to each household based on the interview date. For this reason we ignore any differences in prices due to changes in inflation. However, we are able to adjust for differences in quality simply by scaling the quantity in such a way that kept the value of consumption unchanged.

In the case of Uganda, we had to do one special adjustment due to the fact that households were able to report in each period their consumption in different units (e.g. kilograms of matoke in one period, medium bunches in period two). In order to arrive at a single price for each item, we first identify the most common unit of measurement for each commodity in both periods. Then, we convert to those units all other units that can be converted explicitly (e.g. kilograms to grams or litters to half-liters). For those commodities, where explicit conversion factor was not available (e.g. a big bunch of matoke and a small bunch of matoke), we used relative prices in each period to guess the average conversion factor specific to each commodity.

Finally, we had to provide prices and quantities for those commodities which cannot or are difficult to be quantified (e.g. expenditure on education). In order to estimate quantities of consumption, we use the available detailed inflation indices available for groups of expenditure in each of our survey countries and assume that these were the prices faced by the households.



(a) Uganda

Figure 2: Distributions of household welfare under various assumptions

4 Results

4.1 Prediction of consumption

Using our data and methodology, we calculate and plot the distributions of household welfare based on the survey household weights and household sizes in Figure 3. In the figure, we plot the initial welfare distribution in the first period of the panel and the distribution of welfare in the second period. In addition to that, we plot the welfare that the households would have obtained if their consumption were determined by the GTAP preferences. Finally, we plot an alternative distribution of welfare based on simple, Cobb-Douglas preferences.

As we can see in the Figure, the use of GTAP preferences leads to serious misrepresentation of household consumption. In fact, if we considered the consumption as predicted by GTAP, we would predict consumption which is much less preferred. However, it appears that such predictions are still better than much more simplistic views of household preferences, such as Cobb-Douglas.

4.2 Prediction of changes in welfare due to price changes

Even though CDE preferences as assumed by the GTAP model may not represent well the actual decisions in consumption of households who face changes in prices and incomes, they may be a reasonably good approximation of the benefits to household welfare due to substitution in consumption due to changes in prices. In order to investigate this aspect of the global demand systems, we measure the welfare gain that can be attributed to the substitutions in consumption that households make when they are faced with changing prices. Our analysis is based on the fact that the cost of consumption of a households that faces

Consider a household that consumes a vector of goods x and faces a vector of changes in prices p which would cause the costs of the existing consumption to rise by $y = \sum_i x_i p_i$. Deflating the changes in prices by the change in total expenditure, we obtain a vector of normalized prices $p^* = \frac{p_i}{y}$. Applying these price changes to each households we may then calculate the gains ΔW due to the adjustments of household consumption which reduces the cost of consumption as

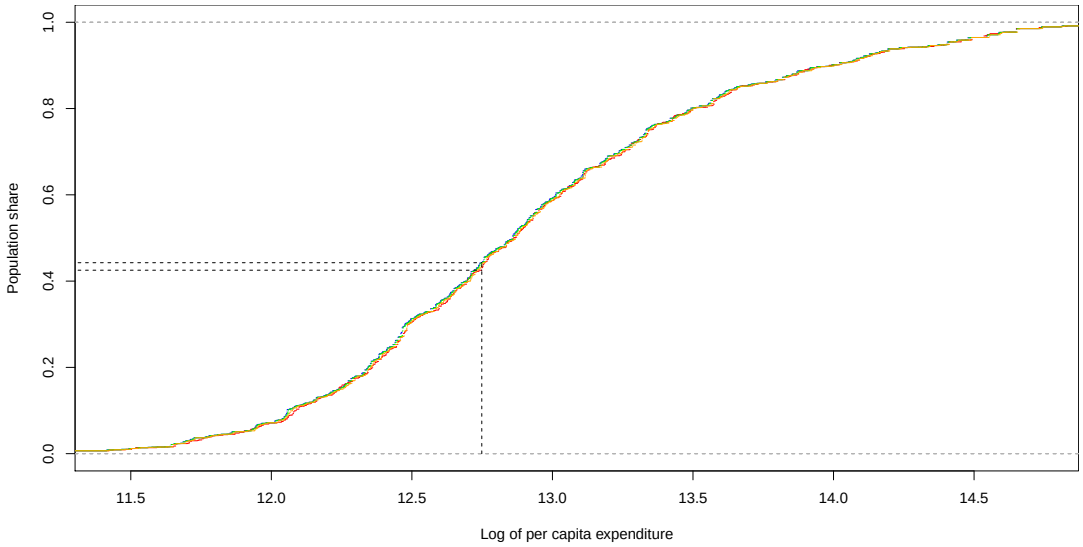
$$\mathrm{d}W = \frac{1}{2}\,\mathrm{d}p' \frac{\mathrm{d}^2 e(p,u)}{\mathrm{d}p^2}\,\mathrm{d}p,$$

where $\frac{\mathrm{d}^2 e(p,u)}{\mathrm{d}p^2}$ represents a matrix of second derivatives of the expenditure function.

In the case of the observed household data, we may substitute the matrix of second derivatives with the observed changes in consumed quantities when the household experiences no change in utility

$$\mathrm{d}W = \frac{1}{2}\,\mathrm{d}p'\,\mathrm{d}q.$$

Even though we restrict our analysis to only those households whose welfare remained largely unchanged ($\pm$ 30 percent), in each case we need to be worried that even a small change in real income of the household may affect our measure of the substitution effects. In order to eliminate these effects, we scale each households quantity in the second period by the observed change in income.



(a) Uganda

Figure 3: Distributions of household welfare under various assumptions

	results.uga * 100
Initial	44.26
Observed	42.53
GTAP	44.19
CD	43.44

5 Conclusions

In this paper we contrasted some of the key characteristics of observed household behavior with behavior suggested by a global model (GTAP). The key finding of this work is that even though household preferences may not be well approximated by simple preferences estimated for aggregate consumer behavior in global models, the use of estimated and flexible preferences is still a better representation of consumer preferences than simple Cobb-Douglas framework.

Even though it appears that preferences used in global models may not be an accurate representation of individual households' preferences and hence aggregate welfare, they perform well in predicting change in welfare due to changes in relative consumption prices.

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