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Do Adult Equivalence Scales Matter in Poverty Estimates? A Ghana Case Study

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This research estimates the sensitivity of the poverty measures in northern Ghana to the use of equivalence scales which control for economies of scale and household composition. Individual welfare estimated as per capita expenditures (PCE) and several methods of per adult equivalent expenditures (PAE) are compared using stochastic dominance and Lorenz curves at absolute poverty lines of $1.25 and $2.00 per daily capita. Results indicate that overall poverty measures are highly sensitive to the use of equivalence scales, and that these results are driven by a relatively young population and large household size in the region. Poverty measures for children and the elderly as well as for those in urban and rural areas are also sensitive to the use of equivalence scales.

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1. Introduction

Poverty is often estimated using the money-metric approach by constructing a consumption aggregate for the entire household. A majority of poverty studies and poverty estimates by the World Bank convert household welfare to individual welfare by estimating the poverty rate in per capita terms, thus controlling for household size (Haughton & Khandker, 2009; Datt & Ravallion, 1998; Meenakshi & Ray, 2002; Reddy, Visaria, & Asali, 2006). Estimating poverty in per capita terms, however, assumes that all goods in the household are private goods, disregarding the fact that economies of scale in consumption often do exist as household members share certain goods (Deaton A. , 2003). For example, as family size increases, families are able to take advantage of economies of scale by sharing certain goods such as housing rent and bulk discounts associated with the purchase of food and other goods. Per capita expenditures also ignore household composition, that is, the number of adults and children. This may impact results, as children usually have lower needs than adults (Short, Garner, Johnson, & Doyle, 1999; Meenakshi & Ray, 2002). For these reasons, some studies emphasize the importance of estimating poverty in not only per capita terms but also as per adult equivalent expenditures which controls for economies of scale (Pollak & Wales, 1979; Ferreira, Buse, & Chavas, 1998; Deaton & Zaidi, 2002) and the reduced needs of children (Deaton & Zaidi, 2002; Lanjouw & Ravallion, 1995; Deaton A. , 2003). When estimating poverty for certain subgroups of the population, it is useful to normalize the per adult equivalent estimates with a selected base household, which still adjusts for economies of scale and household composition but consistently provides estimates similar to per capita expenditures (Deaton & Paxson, 1997).

2. Literature Review

Previous literature shows that the use of equivalence scales which adjust for household composition and economies of scale has a mixed impact on poverty estimates. Some studies reveal that the poverty rate is relatively insensitive to the equivalence scales used (Burkhauser, Smeeding, & Merz, 1996; Short, Garner, Johnson, & Doyle, 1999; Visaria, 1980; Streak, Yu, & Van der Berg, 2009). As a result of the studies by Short et al. (1999) and Visaria (1980), Haughton and Khandker (2009) conclude that estimating poverty in per adult equivalent terms gives similar results as per capita estimates and that no consensus or satisfactory method exists to estimate equivalence scale parameters; therefore, the use of equivalence scales, while not unimportant, is not compelling in practice.

Another group of studies suggests that the use of equivalence scales which control for economies of scale and/or household composition may have a profound impact on results, especially in certain countries and contexts. Buhmann et al. (1988) in a study which compares ten high-income countries and 34 equivalence scales concludes that the choice of equivalence scales, particularly controlling for the economies of household size, affects the poverty headcount ratio. Éltetõ and Havasi (2002) reveal that the use of equivalence scales in Hungry can lead to different conclusions regarding income equality, and can increase the poverty headcount ratio considerably. Using data from Brazil, Lanjouw (2009) comes to similar conclusions, and Coulter, Cowell, and Jenkins (1992) observe that adjusting the parameter in the equivalence scales for economies of scale has a large impact on the poverty headcount ratio, poverty severity, and poverty depth using data from the United Kingdom. In conclusion, equivalence scales can have a large impact on results, and the way in which equivalence scales are defined can direct policy (Deaton A. , 2003). However, the sensitivity of poverty estimates to equivalence scales depends on the country, and equivalence scales should receive greater consideration in developing countries, particularly those with high population growth rates (Lancaster, Ray, & Valenzuela, 1999).

Less attention has been given to subgroups of the population and their sensitivity to equivalence scales. White and Masset (2002) find that children consume less than adults and that larger households take advantage of economies of scale in Vietnam; therefore, the authors suggest that poverty should be measured in per adult equivalent terms rather than per capita terms, especially when considering child poverty. Meenakshi and Ray (2002) indicate that using equivalence scales to control both household composition and size affects poverty estimates between different regions in India. In South Africa, Streak, Yu, and Van der Berg (2009) find that child poverty headcount measures are relatively insensitive to equivalence scales, but that some provincial rankings are sensitive to equivalence scales (Streak, Yu, & Van der Berg, 2009). Deaton and Paxton determine that the estimates of child poverty and elderly poverty in six countries are sensitive to the use of equivalence scales, but that these differences can be corrected by normalizing per adult equivalent estimates with a selected base household (Deaton & Paxson, 1997). Hunter, Kennedy, and Smith (2003) indicate from income data in Australia that Indigenous families have more household members and more children than non-Indigenous families, automatically increasing the poverty headcount ratio for Indigenous households when using equivalence scales (Hunter, Kennedy, & Smith, 2003).

3. Data

This paper uses data from the 2012 USAID Feed the Future population-based survey in northern Ghana. The data was collected to be used as a baseline for further evaluations relating to a reduction in poverty and hunger. The survey was conducted with collaboration between USAID Ghana Monitoring Evaluation and Technical Support Services (METSS) program, Kansas State University (KSU) and University of Cape Coast (UCC) who partnered with the Institute of Statistical, Social and Economic Research (ISSER) of the University of Ghana and the Ghana Statistical Service (GSS).

Data was collected by 82 trained enumerators in two months, July and August 2012, using the Computer-Assisted Personal Interview approach. The survey used multistage cluster sampling, by selecting 230 enumeration areas (clusters) within the zone of influence and interviewing 20 households within each enumeration area. The survey resulted in useful data from 4365 households (45 observations were dropped due to incomplete data). Data was collected on several main categories of expenditures including food, non-food, durables, and housing in order to estimate total household consumption. Food expenditure includes purchased, gifted, and home-produced food, with expenditures estimated using the purchase price for all food. The survey also collected valuable information on household nutrition and hunger, women's empowerment, dietary diversity, infant and young child feeding behaviors, and women's and child's anthropometry.

The household consumption aggregate is estimated using food, non-food, durables and housing expenditures. Expenditures that were collected within a week or month to reduce recall bias are converted to annual expenditures, and deflated using a Paasche price index which adjusts for cost of living across households. Then expenditures are converted to 2010 US$ by deflating the 2012 expenditures to the 2005 equivalents using the Ghanaian CPI, and converting to 2005 US$ using the purchasing power parity exchange rate. Finally, households are then weighted based on 229 districts so that the results are representative of the zone of influence in northern Ghana. Nearly two-thirds of total household expenditures are food, a private good while housing, a public good, makes up just above five percent of total expenditures (Table 1).

4. Methods

4.1 Poverty measures at the aggregate level

Measuring poverty as per capita expenditures automatically associates poverty with large households and those with children, asserting a relationship between household size and poverty (Deaton & Muellbauer, 1986). Deaton and Muellbauer (1986) point out, while there is strong correlation between poverty and household size, total household expenditure is positively but less than proportionately related to household size due to economies of scale and children's reduced needs. By taking household size and composition into account, per adult equivalent expenditures is an attempt at creating a more accurate poverty measurement. In this study we compare several different methods used to calculate the poverty estimates. All are based on a common equivalence scale recommended by Deaton and Zaidi (2002), defined as $A + \alpha K^{\theta}$

where A is adult household members (ages 16 and up), and K is children ages 0 to 15. The parameter α adjusts for household composition by reflecting that children usually have lower needs than adults, and θ controls for the effect of economies of scale (Deaton & Zaidi, 2002). Household expenditures are converted to individual welfare using the equation

$$(1) \qquad \frac{x}{(A+\alpha K)^{\theta}}$$

where x is expenditures, or any other welfare measure, and the parameters α and θ lie between 0 and 1. When both parameters are set to 1, the equation simply estimates poverty as per capita expenditures (PCE), indicating that children and adults have equal needs and economies of scale do not exist. The other methods estimate poverty using per adult equivalent (PAE) expenditures, with parameters determined by recommendations from Deaton and Zaidi (2002) for use in low-income countries (Deaton & Zaidi, 2002) [1], and the OECD (United Nations Economic Commission for Europe, 2011; Bellù & Liberati, 2005). The OECD equivalence scales replace A in equation (1) with $1 + \beta(A - 1)$, where β is either 0.5 or 0.7 (Deaton A. , 2003). Since almost two-thirds of the household budget is devoted to food (Table 1), a private good, economies of scale are very limited in northern Ghana and θ is set close to one (Deaton A. , 2003). The equivalence scales compared in this section are presented in Table 2.

4.2 Poverty measures for population subgroups

Equivalence scales purposely alter relative standings of large households to small households, and households with large numbers of children to those with none. This leads to an automatic increase in poverty when estimating results in per adult equivalent terms and using absolute poverty lines (Deaton & Paxson, 1997). Subgroups of the population, such as rural households or those with children, are even more sensitive to the impact of equivalence scales on

[1] There is no generally accepted method for estimating equivalences scales, and while extensive literature has attempted to determine the appropriate value of parameters, they are still typically determined arbitrarily (Deaton A. , 2003). Deaton and Zaidi (2002) based recommended parameters on Rothbarth's procedure for measuring child costs (Deaton & Zaidi, 2002; Deaton & Muellbauer, 1986).

poverty estimates. For this reason, Deaton and Zaidi (2002) recommend normalizing per adult equivalent estimates with a selected base household type around which to "pivot" so that it results in poverty estimates that are as close as possible to per capita estimates while still controlling for economies of scale and household composition. To estimate the "PAE Pivot," we use the equation

$$(2) \qquad \frac{x}{(A+\alpha K)^{\theta}} \cdot \frac{(A_0+\alpha K_0)^{\theta}}{(A_0+K_0)}$$

where x is expenditures and the parameters α and θ are set to 0.33 and 0.9 respectively. The parameters A_0 and K_0 represent the composition of the base household. For the base household, the normalized poverty measure is equal to the per capita measure. Since both the mode and median number of adults and children are 2.0, A_0 and K_0 are set to these values accordingly (Table 3).

5. Sensitivity Analysis Results

5.1 Aggregate level

Per capita and per adult equivalent expenditures are estimated using each of the six methods as described in Table 2. The results are presented in 2005 US$ and 2010 US$ terms in Table 4 and Table 5 respectively, with 2005 US$ terms used for all subsequent calculations. In estimating the poverty rate, the distribution of wealth is more important than the mean per capita expenditures. Therefore, stochastic dominance is used to run a sensitivity analysis on the results. By comparing the poverty incidence curve (or cumulative distribution function) of each of the methods, we are able to show the impact of each method on the absolute poverty rates of $1.25 and $2.00 per capita daily expenditures (Figure 1). The range of per capita expenditures reported is limited to $10 per capita per day to more easily compare the different methods.

The poverty incidence curve of all five PAE methods are below and to the right of per capita expenditures across almost the entire range of per capita daily expenditures, with the exception of several crosses at the high end of the distribution. None of the PAE methods are first-degree stochastically dominant to PCE; however, they are all second-degree stochastically dominant to PCE. The Kolmogorov-Smirnov test is also used to compare the distributions of PCE to the alternative methods and finds that none of the five PAE distributions are equal to the distribution of PCE, indicating that the PAE distributions are statistically different than the PCE estimate. Correlation coefficients between PCE and PAE are all above 0.96, suggesting that each method shifts the level of per capita expenditures uniformly across households (Table 6).

As a result, reporting per capita expenditures without the use of an adult equivalence scale will result in a much higher reported poverty rate. For example, at a poverty line of $1.25 per capita per day, using per capita expenditures will result in a headcount ratio of 22.8% compared to 9.5%, the next closest poverty rate using Deaton 1 (Figure 2). At a poverty line of $1.25, the OECD square root scale will result in a much lower poverty rate of 2.1%. Each of the PAE methods also impacts poverty depth and poverty severity (Table 7).

Using per adult equivalent expenditures also has an impact on inequality measures. The Lorenz curve indicates that inequality is similar using all five PAE measures while PCE has a much higher inequality estimate (Figure 3). The Gini coefficient also shows that equivalence scales have an impact on inequality, with a Gini coefficient for PCE of 0.516 compared to the PAE estimates between 0.446 and 0.476 (Table 7).

It is evident from these results that controlling for household size and composition in northern Ghana has an impact on each of the poverty measures when estimating overall poverty. We predict that this is because northern Ghana has a young population with 44.6% of the population under the age of 15, and a large average household size of 5.5 people. The young population is a characteristic indicative of rapid population growth. A high population growth rate is common in developing countries where the death rate begins to fall more rapidly than the birth rate, due to economic development and multiple related factors such as increased food production, improvements in trade, and advances in medicine and hygiene. This period of rapid population growth is referred to as the demographic transition, and lasts for multiple decades before the population stabilizes as birth and death rates converge (Nafziger, 2006). All indications suggest that northern Ghana is in this period of demographic transition, leading to a young population, large households, and therefore large disparity between poverty rates when using equivalence scales.

Although household size and composition are not entirely separable, we attempt to differentiate the impacts of both parameters on poverty estimates. To do this we compare PCE to the OECD square root method which essentially only corrects for household size and the Deaton 1 method which only corrects for household composition.

First, we compare how the poverty rate changes depending on household size (Figure 4). The poverty rates are identical in households with one person regardless of the method since we assume that these households do not contain children and certainly cannot take advantage of economies of scale. However, as the number of household members increases, the poverty rate increases exponentially for per capita expenditures, while it increases more reasonably for the other two methods.

Next we compare how the poverty rate changes depending on household composition or the number of children (Figure 5). Once again, there is a great divergence between the PCE and the both PAE methods.

These results reveal how the PCE method is heavily impacted by household size and composition. Alternatively, the PAE methods control for economies of scales and household size in an attempt to discover rather than assert the relationship between poverty and household size and composition (Deaton & Muellbauer, 1986). The relationship between household size and composition and poverty becomes even more important to understand when we estimate child or elderly poverty, or compare rural to urban poverty.

To investigate the matter further, we compare the mean household size and number of children per household to several different household types (Table 8). Households with children are significantly larger than those without, just as households without elderly and rural household are significantly larger than households with elderly and urban households respectively.

5.2 PAE Pivot household results

As noted previously, the use of equivalence scales has a large impact on overall poverty measures. This leads us to estimate expenditures as PAE Pivot, normalizing per adult equivalent estimates with a selected base household. While previous PAE estimates resulted in much lower poverty estimates than PCE, the PAE Pivot mean poverty headcount ratio is $3.48 per daily capita, compared to $4.01 per daily capita for PCE and $5.22 per daily capita for the nearest PAE estimate (Table 5). We run a sensitivity analysis to compare the PCE to the PAE Deaton 1 and PAE OECD square root scale, using stochastic dominance (Figure 6). The per capita daily expenditures on the x-axis are limited to $10 per capita per day to more easily compare the results.

No method is first-degree stochastically dominant to the per capita expenditures method. However, both the PAE Deaton and PAE OECD methods are below and to the right of the PCE method, and therefore are second-degree stochastically dominant. The Kolmogorov-Smirnov test is also used to compare the distributions of PCE to the alternative methods, and finds that none of the distributions of the PAE methods are equal to the PCE. Therefore, while it appears that the PAE Pivot method provides results that are more similar to the PCE method, the distributions are still statistically different. However, the PAE Pivot measures are much closer than other PAE methods to PCE (Deaton & Zaidi, 2002). The PAE Pivot method also results in a poverty gap and squared poverty gap that are only slightly higher than the PCE method (Table 7), but it does not impact inequality (Figure 7).

5.3 Results for population subgroups

5.3.1 Child and elderly poverty

As noted earlier in Table 8, households with children are significantly larger than those without, while households with elderly are significantly smaller than households without. For this reason, PAE methods result in poverty headcount ratios that are much lower than PCE measures. However, using a pivot household results in headcount ratios that are much closer to PCE (Table 9). A graphical representation of the impact of PAE Pivot on households of different size and the number of children can be seen in Figure 8 and Figure 9 repectively.

More importantly, while the PAE Pivot has only a small impact on the overall poverty rate, it still takes into account economies of scale and children's reduced needs. Therefore, the PAE Pivot method reveals that child poverty is only marginally higher (0.6%) than poverty among adults once their reduced needs are considered, rather than 6.4% higher using the PCE method. On the other hand, adjusting for household size and composition using PAE Pivot leads to elderly poverty which is 3.9% higher than adult poverty as opposed to only 0.9% lower poverty among the elderly when using PCE.

The PAE Pivot has a similar impact on the poverty gap and square poverty gap. However, PAE Pivot does not impact inequality measurements (Figure 7). Regardless of the subgroup we are looking at, the Gini coefficient of the PAE Pivot method is identical to the PAE Deaton method.

5.3.2 Rural and urban poverty

Rural household have a significantly different household size and number of children per household than urban households, as seen in Table 8. Because rural households contain more household members and children, the equivalence scale has a greater impact on rural households. For this reason, the poverty headcount ratio drops in rural households, and the difference in the headcount ratio between rural and urban households drops from 16.4% to 13.9% (Table 10).

6. Conclusion

The results show that the use of adult equivalence scales which control for household economies of scale and composition has a large impact on poverty estimates. It is determined that northern Ghana's young population and large household size are driving the results. Because household size and composition differ between different household types such as rural and urban, or those with or without children, the use of equivalence scales becomes even more compelling when comparing subgroups of the population. We find that calculating poverty measures by normalizing per adult equivalent expenditures by a standard pivot household creates poverty measures which are similar to PCE estimates. In the case of Ghana, estimating the headcount poverty ratio in per adult equivalent terms reveals a lower child poverty rate and higher elderly poverty rate in comparison to adult poverty.

Based on these results, we suggest that poverty measures estimated using PCE be subject to a sensitivity analysis using PAE measures, especially in developing countries with demographics similar to northern Ghana. Future research should explore at what point in the demographic transition the use of equivalence scales is most compelling, and which standard parameters of equivalence scales should be used to control for household size and composition.

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Tables

Table 1. Total consumption shares (real, weighted)

	Total	Rural	Urban
Food	**66.1**	**67.4**	**62.1**
Non-food	**25.1**	**24.6**	**26.6**
Education	0.9	0.8	1.3
Health	2.4	2.6	1.7
Other non-food items	21.8	21.2	23.6
Durables	**3.6**	**3.3**	**4.8**
Housing	**5.2**	**4.7**	**6.5**
Rent	3.4	3.4	3.4
Utilities	1.8	1.4	3.1
Total (Sum of food, non-food, durables, and housing)	**100.0**	**100.0**	**100.0**

Note: n = 4293; household population size = 914,515

Table 2. Parametric Representation of Equivalence Scales

	Adult weight, β	Children weight, α	Economies of scale parameter, θ
Per capita	1	1	1
Deaton and Zaidi 1	1	0.33	1
Deaton and Zaidi 2	1	0.25	0.9
OECD old scale	1+.7(A-1)	0.5	1
OECD modified scale	1+.5(A-1)	0.3	1
OECD square root scale	1	1	0.5

Table 3. Parametric Representation of Equivalence Scales

	Children weight, α	Economies of scale parameter, θ	Base adult, A_0	Base children, K_0
PCE	1	1	-	-
PAE Deaton	0.33	0.9	-	-
PAE OECD	1	0.5	-	-
PAE Pivot	0.33	0.9	2	2

Table 4. Per capita and per adult equivalent expenditures (2005USD/capita/day)

	Mean	Median[1]	Std. Deviation[1]	Minimum	Maximum
Per capita	3.59 [b, c, d, e, f]	2.21	5.30	0.10	201.43
Deaton 1	4.67 [a, c, d, e, f]	3.28	5.74	0.16	201.43
Deaton 2	5.38 [a, b, d, e, f]	3.92	6.20	0.20	201.43
OECD old scale	4.79 [a, b, c, e, f]	3.38	6.82	0.22	201.43
OECD modified scale	5.94 [a, b, c, d, f]	4.39	5.99	0.17	201.43
OECD square root scale	6.77 [a, b, c, d, e]	5.12	7.59	0.26	201.43

Note: n = 4365; household population size = 928,302; [a, b, c, d, e,] and [f] indicates significantly different mean expenditures compared Per capita, Deaton 1, Deaton 2, OECD old scale, OECD modified scale, OECD square root scale respectively at the 0.05 level using Adjusted Wald test; 1: Based only on 4293 observations.

Table 5. Per capita and per adult equivalent expenditures (2010USD/capita/day)

	Mean	Median[1]	Std. Deviation[1]	Minimum	Maximum
Per capita	4.01 [b, c, d, e, f]	2.58	5.91	0.11	224.90
Deaton 1	5.22 [a, c, d, e, f]	3.67	6.41	0.18	224.90
Deaton 2	6.01 [a, b, d, e, f]	4.38	6.92	0.22	224.90
OECD old scale	5.35 [a, b, c, e, f]	3.77	7.61	0.25	224.90
OECD modified scale	6.63 [a, b, c, d, f]	4.91	6.68	0.18	224.90
OECD square root scale	7.56 [a, b, c, d, e]	5.72	8.48	0.29	224.90

Note: n = 4365; household population size = 928,302; [a, b, c, d, e,] and [f] indicates significantly different mean expenditures compared Per capita, Deaton 1, Deaton 2, OECD old scale, OECD modified scale, OECD square root scale respectively at the 0.05 level using Adjusted Wald test; 1: Based only on 4293 observations.

Table 6. Correlation coefficients of per capita and per adult equivalent expenditures

	Per capita expenditures	Deaton 1	Deaton 2	OECD, old scale	OECD, modified scale	OECD, square root scale
Per capita expenditures	1					
Deaton 1	0.978	1				
Deaton 2	0.988	0.998	1			
OECD, old scale	0.993	0.993	0.995	1		
OECD, modified scale	0.979	0.994	0.991	0.996	1	
OECD, square root scale	0.961	0.985	0.977	0.985	0.995	1

Table 7. Comparison of PCE and PAE on the headcount ratio, poverty gap, squared poverty gap, and Gini coefficient (poverty line = $1.25 per day)

	Headcount ratio	Poverty gap	Squared poverty gap	Gini coefficient
Per capita	22.8	7.1	3.2	0.516
Deaton 1	9.5	2.7	1.1	0.475
Deaton 2	6.1	1.5	0.6	0.460
OECD old scale	9.0	2.4	1.0	0.476
OECD modified scale	3.9	1.0	0.4	0.456
OECD square root scale	2.1	0.5	0.2	0.446
PAE Pivot	21.3	6.5	2.9	0.464

Table 8. Mean household size and children per household

	With Children	Without Children	With Elderly	Without Elderly	Rural	Urban	Total
Household size	6.4***	2.1	5.5	6.3***	5.9***	4.8	5.6
Children per household	-	-	2.6	2.7	2.9***	2.0	2.7

Note: n = 4365; household population size = 928,302; *, **, and *** indicates significantly different at the 0.10, 0.05 and 0.01 levels respectively using an Adjusted Wald test.

Table 9. Headcount ratio with $1.25 poverty line (%)

	Child	Adult	Elderly
PCE	33.6	27.2	26.3
PAE Deaton	8.7	9.1	10.4
PAE OECD	2.5	2.3	2.1
PAE Pivot	26.1	25.5	29.4

Table 10. Headcount ratio with $1.25 poverty line (%)

	Rural	Urban
PCE	33.8	17.4
PAE Deaton	10.4	4.0
PAE OECD	2.8	0.7
PAE Pivot	29.1	15.2

Figures

Figure 1. Poverty incidence curve of daily per capita expenditures

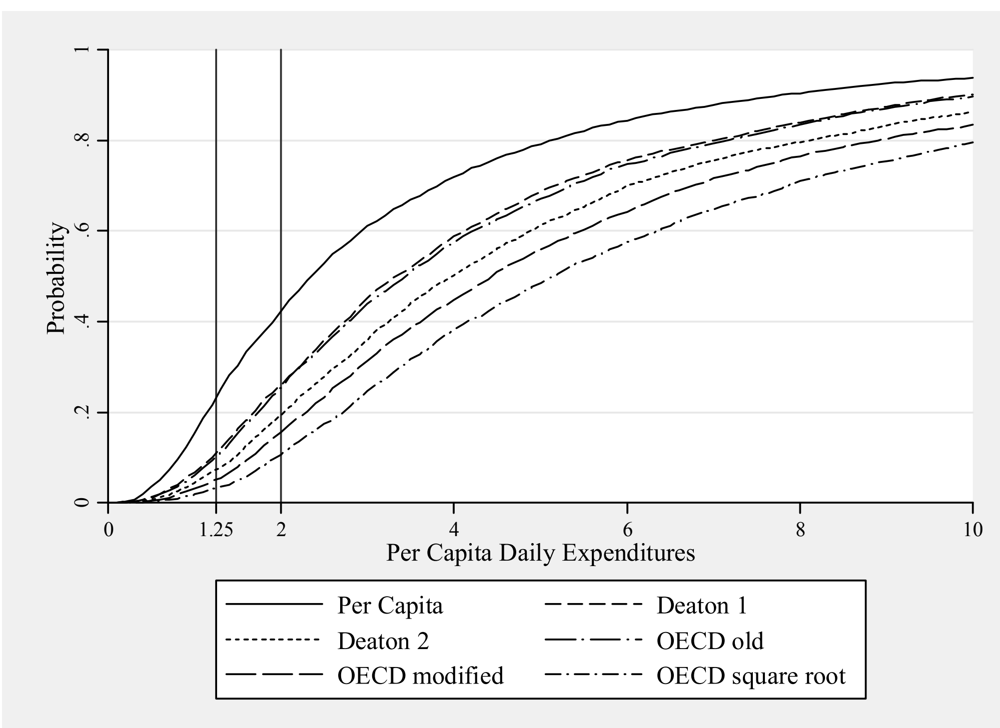
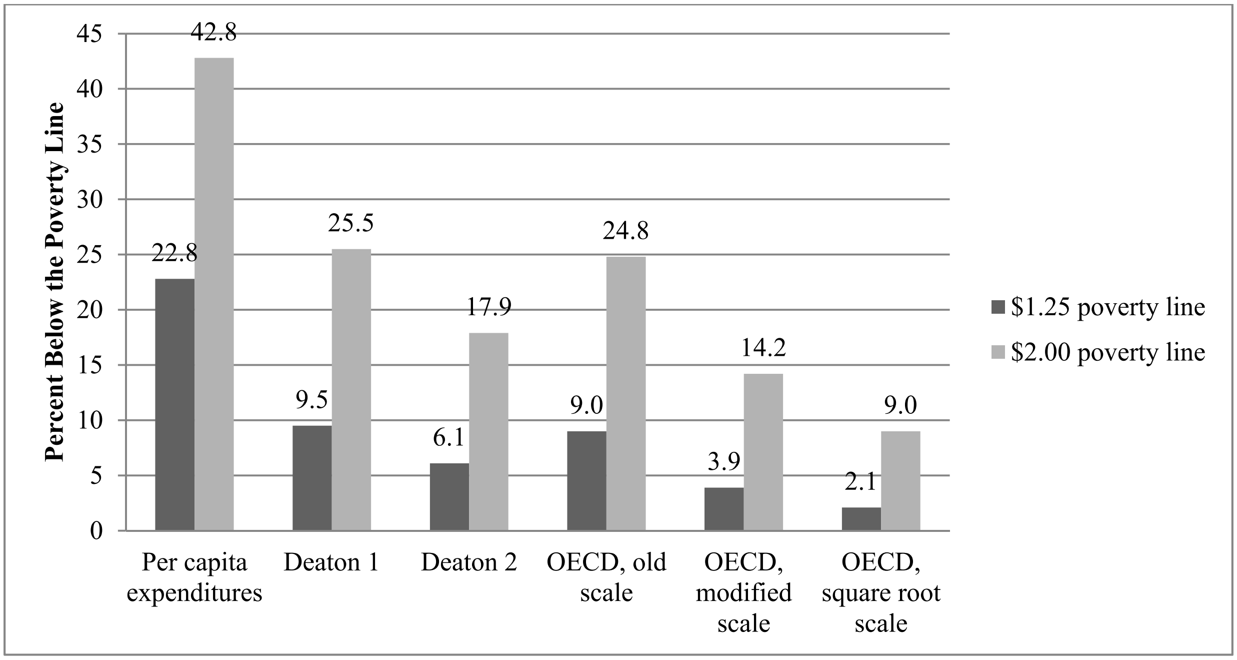


Figure 2. Comparison of PCE and PAE poverty headcount ratio (%)



Note: n = 4365; household population size = 928,302

Figure 3. Lorenz curve of daily per capita expenditures

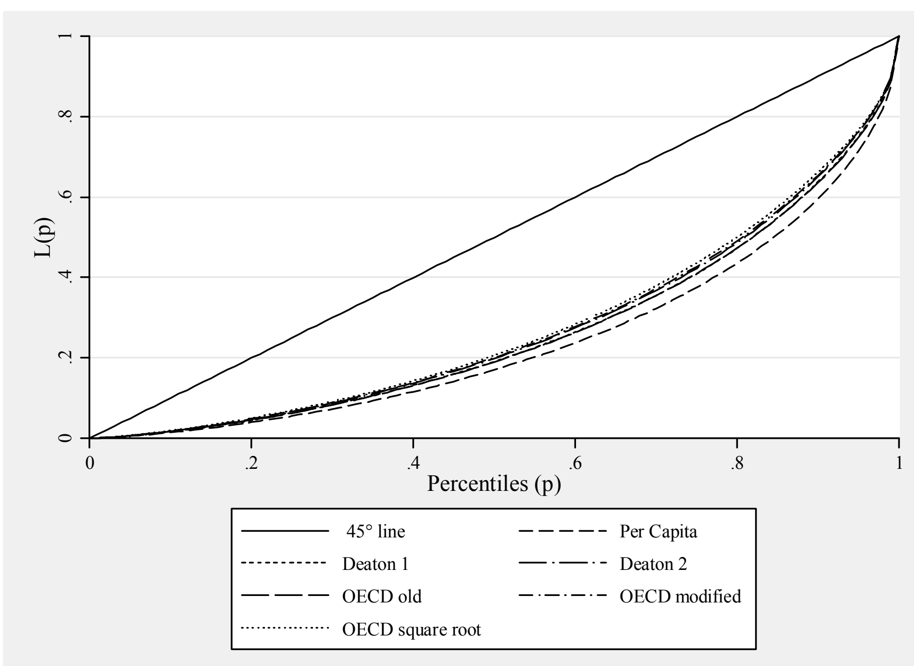
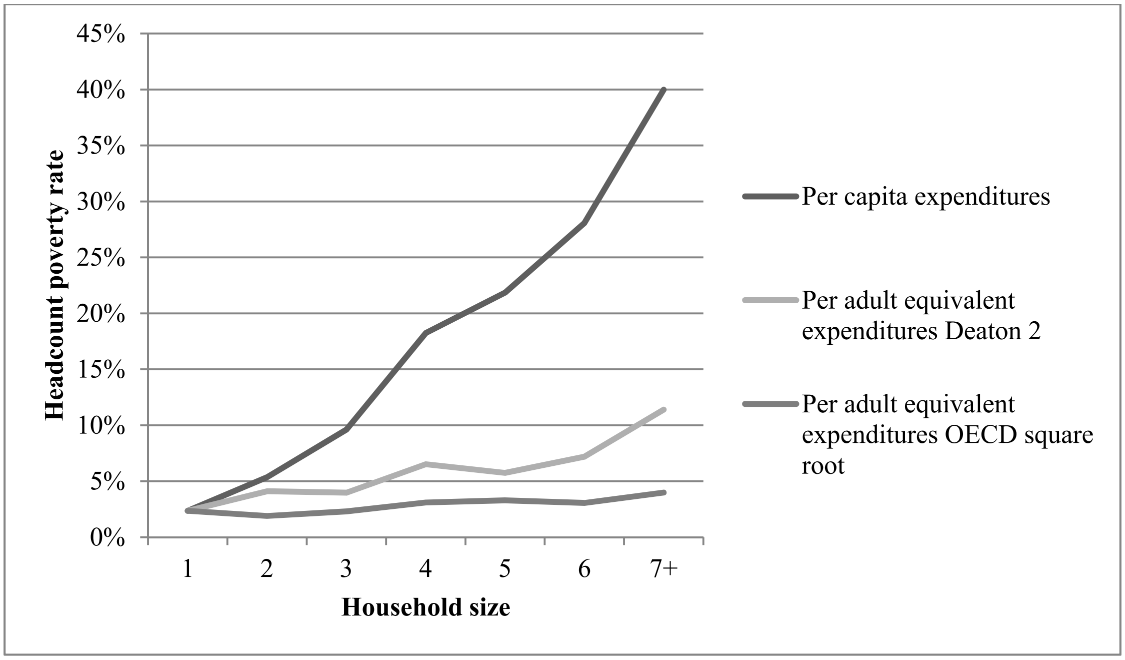
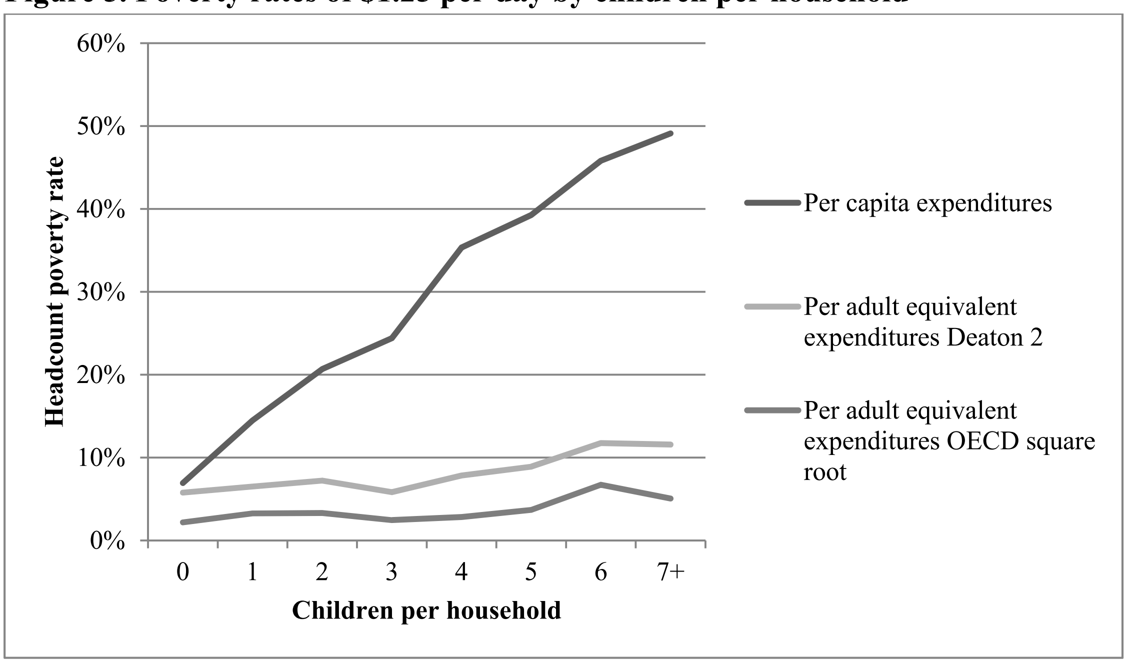


Figure 4. Poverty rates of $1.25 per day by household size



Note: n = 4365; household population size = 928,302

Figure 5. Poverty rates of $1.25 per day by children per household



Note: n = 4365; household population size = 928,302

Figure 6. Poverty incidence curve of daily per capita expenditures

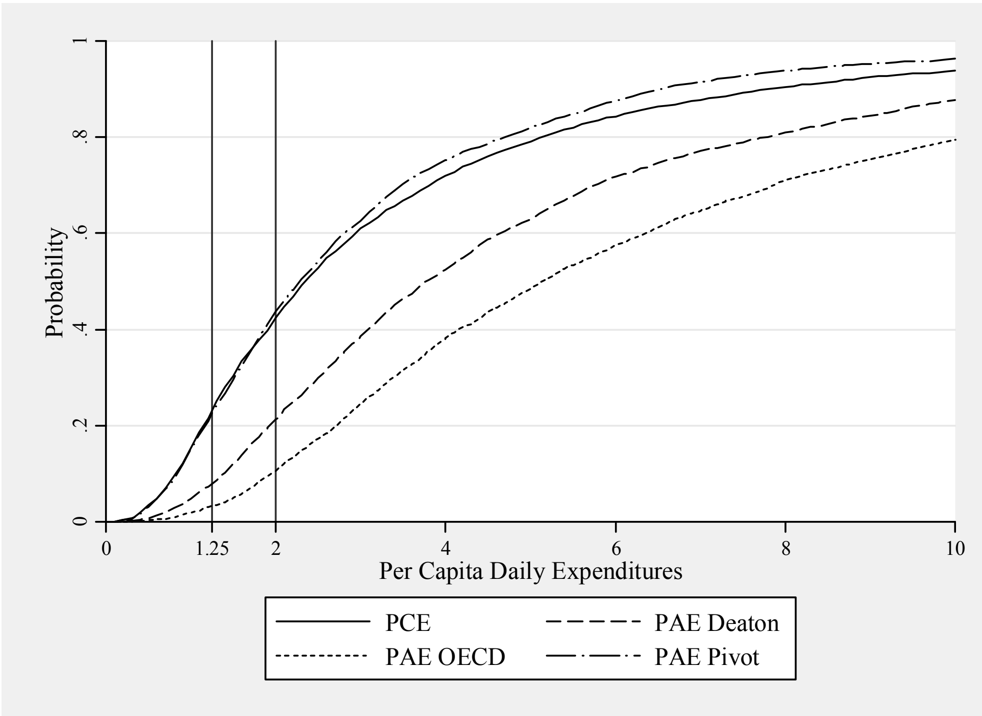


Figure 7 Lorenz curve of daily per capita expenditures

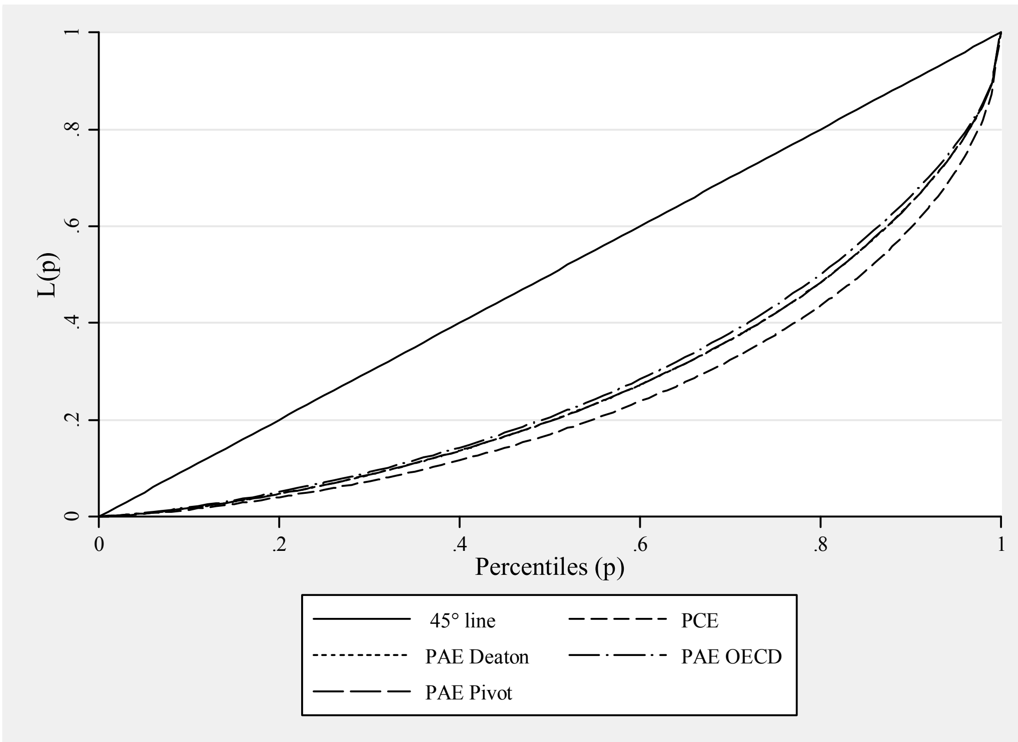
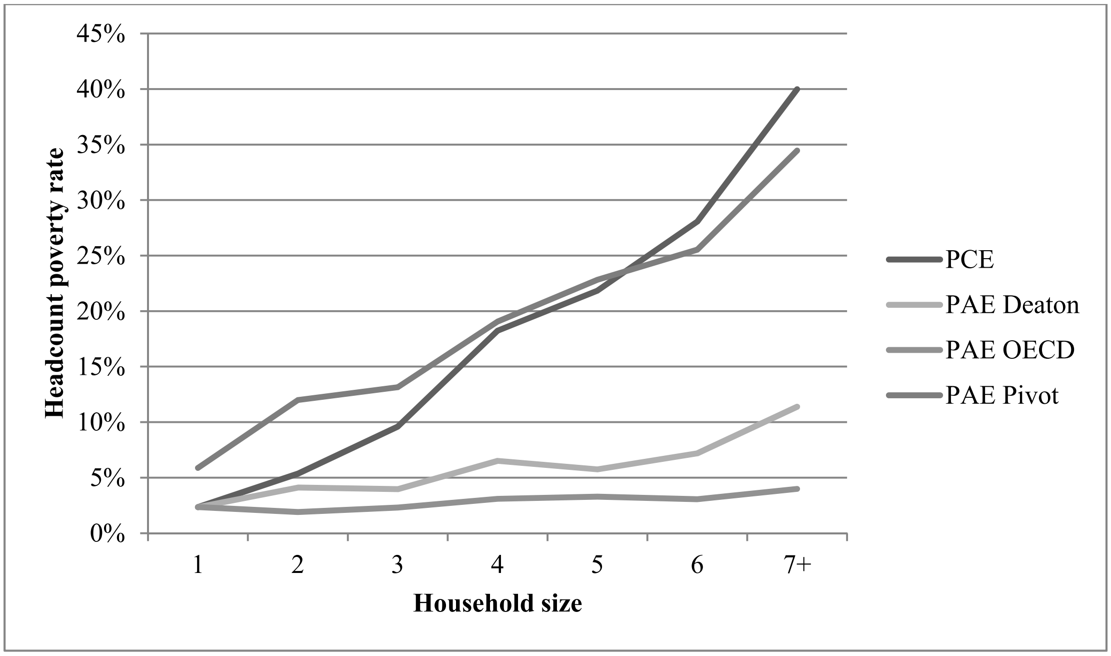
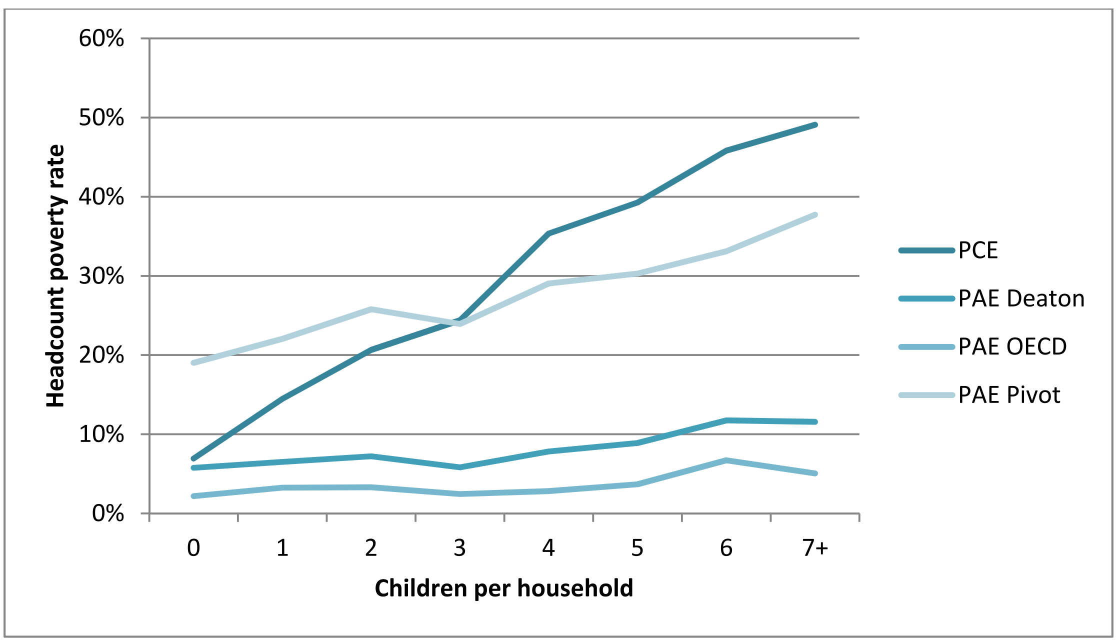


Figure 8. Poverty rates of $1.25 per day by household size



Note: n = 4365; household population size = 928,302

Figure 9. Poverty rates of $1.25 per day by children per household



Note: n = 4365; household population size = 928,302