What impact has food price inflation had on consumer welfare? A global analysis *

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Abstract

The impact of rising global food prices on consumer welfare is investigated. A quadratic AIDS model is estimated using data spanning countries at various levels of economic development. Statistical comparison suggests the QUAIDS model is preferred over the non-linear AIDS model. Estimated parameters are used to calibrate a QUAIDS indirect utility function and base utility for welfare analysis. Compensated variation associated with recently observed food price inflation for different foods in different income cohorts of countries is calculated. Per capita compensated variation increases with per capita expenditure. However, per capita compensated variation expressed as a percent of per capita expenditure falls as one moves from less developed to more developed countries. Aggregate compensating variation associated with annualized food price inflation between 2005 and 2008 is estimated at US$515 billion globally

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Introduction

Food price inflation is a renewed issue in many countries. Indeed, notable food price increases have caught the attention of the media, NGOs and government agencies alike (Alexander and Hurt 2007; Blas 2007; Economic Research Service 2007; Food and Agriculture Organization 2007; MacCartney 2007). Increased demand for grain and oilseed crops as an input to bio-fuel production is often cited as a cause of this price inflation while other factors, such a droughts and price cycles, continue to play a role. Moreover, some expect bio-fuel driven pressure to further increase food prices (Elobeid et al. 2006). At the same time, an emerging theme from recent trade negotiations is that global food prices will likely rise in the face of multilateral trade liberalization (Fabiosa et al. 2005). Regardless of the source, food price increases will have an impact on consumer expenditure patterns, as well as consumer welfare across different countries. Moreover, predictions of these welfare impacts are important pieces of the policy debate related not just to trade liberalization, but also to bio-fuels. To this end, recognize that economists have a vast toolkit from which to draw when measuring welfare effects. Often, partial or general equilibrium models are used for such analysis. However, partial equilibrium welfare analysis can often be imprecise, while general equilibrium models often use producer prices or embody restrictive technologies or preference structures which might limit the extent to which one can assess impacts on final consumers directly.

Consequently, some economists use demand systems to develop expenditure functions which can then be used for ex ante welfare analysis (see, for example, Banks et al. 1997; Beach and Holt 2001; Wong and Park 2007). One issue in this regard is the role of functional form in accurately measuring consumer welfare effects arising from shocks. In this respect, economists have spent considerable time and effort modelling consumer demand for final goods and services, both within and across countries. Agri-food goods are no exception, with many examples of demand systems estimated using time series, cross-section, or panel data (recent innovative examples include: Moro and Sckokaiz 2000; Ben Kaabia and Gil 2001; Galdeano 2005; Alfonzo and Peterson 2006; Seale and Regmi 2006; Akbay et al. 2007; and Tonsor and Marsh 2007). The above mentioned papers notwithstanding, much of the previous consumer demand analysis has used empirically tractable demand systems, including the Linear Expenditure System, the Rotterdam model and the Almost Ideal Demand System. Such historical inertia is problematic given the limitations of these models used.

The AIDS model is a rank two-demand system,[1] while the Rotterdam model

[1] Gorman (1980) proved that the rank of a rational, exactly aggregable demand system is at most three; such demand systems are referred to as full rank demand systems. The notion of demand system rank was latter extended and defined as the "maximum function space spanned by the Engel curves of the demand system," (Lewbel 1991, p. 711). The concept of

has constant marginal budget shares.[2] Such weaknesses limit the application of these models to data sets that show wide variation in expenditure levels. Moreover, recently developed demand systems offer not only more flexible expenditure responses (or scale responses in the case of inverse demand systems), but also more flexible price (or quantity) effects (see for example: Moro and Sckokaiz 2000; Beach and Holt 2001; Ryan and Wales 1999; Piggott 2003; Beatty and Lafrance 2005; Matsuda 2006; Wong and Park 2007; Moschini and Rizzi 2007; and Tonsor and Marsh 2007). Use of demand systems with more flexible price and expenditure effects should enable more accurate estimation of consumer welfare effects arising from exogenous shocks. As an example of accuracy gains in welfare measurement, note that Banks et al. (1997) show that the welfare bias arising from the AIDS model when the quadratic AIDS model is preferred ranges from -15 percent to nearly 30 percent, and that use of the AIDS model led to underestimation of compensating variation at low expenditure levels, but over estimation at high expenditure levels.

This paper uses a demand system to first model consumer demand for final goods using data spanning a broad range of countries, and then uses the estimated model to assess the impact of food price inflation on the composition of consumer's food expenditure and on compensated variation across a range of countries. The specific demand system is Bank's et al.'s (1997) Quadratic AIDS model (QUAIDS). The data are from the 1996 International Comparisons Project (ICP), which contains expenditure data for final goods and services in countries spanning the development spectrum. The value of using the QUAIDS model relates to its flexible (and more general) price and expenditure responses compared to other demand systems. Such flexibility is advantageous when modeling international demand patterns, as one may suspect that scope exists for differing price and expenditure responses at different points in the development spectrum. Such differences might arise from cultural differences, differences in the scope and attributes of goods available in the market place, and other institutional and development based features.

The choice of the QUAIDS model stems from recent generalizations of the AIDS model. Specifically, Banks et al. (1997) generalize PIGLOG preferences by introducing a term that is quadratic in the logarithm of real expenditure into Deaton and Muellbauers (1980) Almost Ideal Demand System (AIDS) model. They show that for exactly aggregable, rank-three demands, the resulting demand system is quadratic in the logarithm of real expenditure. The QUAIDS model allows for more general price and expenditure effects than the AIDS. In addition, the QUAIDS model is a rank three demand system that nests the AIDS models as special cases. As such, one would be able to test the rank of

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rank is useful in developing a taxonomy of demand systems according to Engel curve shape. Rank one demands, the most restrictive demand systems, are independent of income; rank two demand systems are less restrictive, allowing linear Engel curves not necessarily through the origin; while rank three demand systems are even less restrictive, allowing for non-linear Engel responses.

[2] A marginal budget share is "the fraction of an additional dollar of expenditure spent on each good" (Pollak and Wales 1992, p.5).

the demand system, as supported by the data. The ability to undertake demand system rank tests will add further to economists' understanding of the structure of consumer preferences, and ability to predict accurately the impact of shocks on welfare.

The paper proceeds as follows. The QUAIDS model is presented in the next section, followed by discussion of the data and econometric methods. The analysis proceeds by estimating the QUAIDS model using the 1996 ICP data and reports results of tests of the restrictions for the non-linear AIDS model. Differences in price end expenditure elasticities at various points of the development spectrum are then illustrated. Because our data are from 1996, but food price inflation is a more recent phenomenon, we then update each country's ICP prices and expenditure to 2005 by multiplying: 1) the vector of each country's ICP prices by a country specific inflation rate (from 1996 to 2005); and 2) per capita ICP expenditure by the proportional change in that country's real per capita GDP from 1996 to 2005. We then use the estimated demand system parameters and the updated prices and expenditure to establish a baseline level of utility at 2005 prices and expenditure (and associated budget shares). Once the baseline is established, the price of the food goods are multiplied by food price inflation factors. The expenditure function for the estimated QUAIDS model is then simulated at these shocked prices and the baseline level of utility and compensating variation is calculated. Emphasis is placed on the impact of such price inflation in consumer welfare and how these differences vary across countries.

Quadratic Almost Ideal Demand System

Before discussing the QUAIDS model, it is important to explicitly state that a representative consumer is assumed. Furthermore, a static utility maximization problem underlies the approach used to modeling consumer demands. It is also assumed that the representative individuals labour market participation decision is separable from their decisions related to consumption of final goods and services. By way of introduction, note that Banks et al.s (1997) Quadratic AIDS model (RAIDS), written in share form, appears as:

$$w_i = \alpha_i + \sum_j \beta_{ij} ln(p_j) + \gamma_i ln\left[\frac{Y}{a(\mathbf{P})}\right] + \delta_i/b(\mathbf{P}) ln\left[\frac{Y}{a(\mathbf{P})}\right]^2 \qquad (1)$$

where α_i, β_{ij}, γ_i and δ_i are unknown parameters, w_i are budget shares indexed on goods (i), p_i are prices, Y is expenditure, while $ln(a(\mathbf{P}))$ is the translog price index with intercept normalized to zero and $b(\mathbf{P}) = \prod_i p_i^{\gamma_i}$. Adding up requires $\sum_i \alpha_i = 1$, $\sum \beta_{ij} = 0$, $\sum_i \gamma_i = 0$, $\sum_i \delta_i = 0$, symmetry requires $\beta_{ij} = \beta_{ji}$, while homogeneity requires $\sum_j \beta_{ij} = 0$. The generality embodied by QUAIDS is achieved by estimating $(n+6)(n-1)/2$ parameters. This differs from other flexible function forms (i.e. AIDS and Translog, inter alia) which typically have

$(n+4)(n-1)/2$ parameters. Note that if $\delta_i = 0$ for all goods, then QUAIDS becomes the non-linear AIDS model (a rank two demand system). Given these are linear, parametric restrictions, and given their nested structure, one can use nested tests to test the null hypothesis of restrictions associated with demand models of lower order rank, and hence less general preference structures.

Methods & Data

The 1996 International Comparisons Project (ICP) data are used for estimation. These data are useful in analyzing international demand patterns since they are provided in identical units (i.e., international dollars). The raw data are composed of real and nominal expenditure on 26 final goods and services in 114 countries (which range in expenditure levels from Nepal to the USA). For estimation, non-durable goods are assumed weakly separable from durable goods and services. These non-durables are then aggregated into five goods: grain based food products (G), livestock based food products (L), fruits and vegetables (FV), other food (OF) and other non-durables (OND). Expenditure on each aggregate good is computed as the sum of nominal expenditure on each good in the aggregate group. Total per capita expenditure equals total nominal expenditure on non-durables divided by population. Unit prices for each good equals nominal expenditure divided by real expenditure, and have been normalized on the respective sample means. Nominal expenditure is defined in exchange rate converted US dollars, while real expenditure is defined in purchasing power parity converted international dollars. Finally, budget shares are computed as the ratio of nominal expenditure on the good to total nominal expenditure.

The QUAIDS model is estimated with adding-up, symmetry and homogeneity of degree zero as maintained hypotheses. Given the cross-equation nature of these restrictions and the non-linear structure of the model, iterated, non-linear, seemingly unrelated regression (ISUR) in SHAZAM is used to estimate the system in (1). For estimation, a regression error is appended to each equation. The n vector of residuals, $\tilde{\mathbf{v}}_t$, is assumed to be independently and identically distributed across observations as a multivariate normal with expectation $E[\tilde{\mathbf{v}}_\mathbf{t}] = 0$ and finite covariance matrix given by $E[\tilde{\mathbf{v}}_\mathbf{t}\tilde{\mathbf{v}}'_\mathbf{s}] = \tilde{\mathbf{\Sigma}}$ for all $t \neq s$, 0 otherwise. By the adding up property of demands $\tilde{\mathbf{\Sigma}}$ is singular. Dropping the last equation from each system allows one to define $\mathbf{\Sigma}$ (an (n-1)x(n-1) covariance matrix) in terms of the n-1 vector $\mathbf{v}_t$.

Estimation results

Table 1 shows the coefficients for the QUAIDS model estimated using the 1996 ICP data and correlation coefficients (ρ) between the actual and fitted budget shares. Given the cross-sectional nature of the data, the correlation coefficients suggest a reasonable good fit of the data. What is more, nine of 22 estimated parameters are significant (at the ten percent level of better). Most notably amongst these are the δ_i terms, which are significant in the grain (G) and livestock (L) equations, thus providing some evidence supporting the choice of a rank-three demand system over a lower rank system. Moreover, the null hypothesis that $\delta_i = 0$ for all i (i.e. the test of the restrictions which lead to the rank-two AIDS model) cannot be rejected at the five percent level when tested using a Likelihood Ratio Test ($\chi^2 = 33.88$ with four degrees of freedom), thus providing more concrete evidence against the AIDS model. With one exception, monotonicity and negativity are satisfied at all points of the data (and at the means). The exception is Bermuda, a high income country, which is excluded from the post-estimation simulation because of the violation of the negativity property.

Table 1. Parameters of the Quadratic Almost Ideal Demand System model estimated using Iterated Non-linear Seemingly Unrelated Regression and data from the 1996 International Comparisons Project (asymptotic t-statistics shown in parentheses)

	α_i	$\beta_{i,G}$	$\beta_{i,L}$	$\beta_{i,FV}$	$\beta_{i,OF}$	γ_i	δ_i	ρ
G	1.09	-0.18	0.15	0.05	0.04	-0.22	0.01	0.67
	(8.75)	(-3.27)	(4.29)	(1.18)	(1.49)	(-5.93)	(4.09)	
L	-0.51		-0.16	-0.04	-0.01	0.22	-0.02	0.26
	(-4.57)		(-3.35)	(-1.03)	(-0.32)	(7.00)	(-7.43)	
FV	0.08			-0.01	-0.01	0.04	-0.01	0.31
	(0.52)			(-0.30)	(-0.27)	(0.93)	(-1.59)	
OF	0.04				-0.02	0.04	-0.01	0.26
	(0.31)				(-1.18)	(1.07)	(-1.59)	

Note: ρ is the correlation between the actual and fitted budget share.

Table 2 shows conditional uncompensated price and Engel elasticities evaluates at the means of the data, as well as the means of the fitted shares. Except for other food, all own-price effects are inelastic, while that for other food is elastic. As well, except for grain and livestock, all pairs of food goods have gross substitute relationships, while grain and livestock are gross complements. Engel elasticities suggest that other non-durables are luxuries, while the food goods are all expenditure normal goods. Differences in these uncompensated price elasticities across per capita expenditure levels are important. Using the World Bank's 1996 categorization of countries as low income (Low), lower-middle income (L.M), upper-middle income (U.M) and high (including OECD) income (High), Table 3 shows the uncompensated own-price and Engel elasticities for all five goods. Across countries with large per capita expenditure levels, we see that demand for grain, livestock, and fruit and vegetables becomes more own-price inelastic, an effect which is more pronounced for grain and livestock, while demand for other food becomes more own-price elastic and demand for other non-durables becomes less inelastic.

Table 2. Conditional uncompensated price & Engel elasticities evaluated at the means

	Grain	Livestock	F&V	OFood	ONdur	Engel
Grain	-0.86	-0.22	0.15	0.14	0.12	0.67
Livestock	-0.16	-0.71	0.07	0.17	-0.09	0.71
F&V	0.17	0.14	-0.91	0.08	-0.10	0.62
OFood	0.18	0.33	0.08	-1.12	-0.21	0.74
ONdur	-0.05	-0.15	-0.10	-0.10	-0.93	1.33
Fitted share	0.13	0.19	0.11	0.09	0.48	

Table 3. Means of the conditional uncompensated elasticities by income cohort

Income cohort	Grain	Livestock	F&V	OFood	ONdur
Low	-0.97	-1.08	-0.99	-1.13	-0.94
L.M.	-0.87	-0.91	-0.96	-1.13	-0.94
U.M.	-0.88	-0.76	-0.90	-1.15	-0.94
High	-0.55	-0.46	-0.81	-1.16	-0.95

Conditional compensated elasticities shown in Table 4 show that except for other food, all compensated own-price effects are inelastic, and that all non-durable goods are net substitutes except for grain and livestock (which are net complements). As with the unconditional elasticities, the compensated own-price elasticities show important differences across different income cohorts. Specifically, in moving from low to high income countries, compensated demands for: grain, livestock and fruit and vegetables becomes more inelastic (an effect which, like the uncompensated demands, is more pronounced for grain and livestock); other foods becomes more elastic; while demand for other non-durables is more inelastic.

Table 4. Conditional compensated elasticities evaluated at the means

	Grain	Livestock	F&V	OFood	ONdur
Grain	-0.78	-0.09	0.23	0.20	0.44
Livestock	-0.07	-0.57	0.15	0.24	0.25
F&V	0.25	0.25	-0.84	0.14	0.20
OFood	0.27	0.47	0.16	-1.05	0.15
ONdur	0.12	0.09	0.05	0.03	-0.29

Table 5. Means of the conditional compensated elasticities by income cohort

Income cohort	Grain	Livestock	F&V	OFood	ONdur
Low	-0.84	-0.86	-0.86	-1.02	-0.53
L.M.	-0.81	-0.71	-0.86	-1.04	-0.39
U.M.	-0.84	-0.63	-0.85	-1.09	-0.23
High	-0.53	-0.38	-0.79	-1.12	-0.09

Welfare Analysis of Price Inflation

Six different food price inflation scenarios are undertaken. Recall that because our data are from 1996, but food price inflation is a more recent phenomenon, we update each country's ICP prices and expenditure to 2005 terms by multiplying: 1) the vector of each country's prices by a country specific inflation rate (from 1996 to 2005); and 2) each country's respective level of per capita expenditure in 1996 by the proportional change in that country's real per capita GDP from 1996 to 2005. Each country's inflation rate is calculated as the percent change in the all item CPI for that country between 1996 and 2005. The CPI and GDP figures are obtained from the IMFs International Financial Statistics Yearbook. Data is either missing or incomplete for some of the countries in the 1996 ICP data (namely Antigua-Barbuda, Azerbaijan, Belarus, Bermuda, Guinea, Hong Kong, Lebanon, Tajikistan, Turkmenistan, Ukraine and Uzbekistan), as such these countries are dropped from the welfare analysis. (Also note that the extremely high rates of inflation (and rates of change in inflation) in Zimbabwe make it difficult to pin-point a meaningful rate of inflation for Zimbabwe; as such, it is dropped from the analysis that follows.) We then use the estimated demand system parameters and the updated prices and expenditure to establish a baseline level of utility at 2005 prices and expenditure (and associated budget shares). Once the baseline is established, the price of the food goods are multiplied by food price inflation factors. The expenditure function for the estimated QUAIDS model is then simulated at these prices and the baseline level of utility and compensating variation is calculated.

The food price inflation factor used in the compensating variation calculation varies across the scenarios. Using the change in the FAO's food price index (FPI), scenario 1 assumes that the annualized rate of inflation for all food goods is 18 percent per annum. This 18 percent is based one the annualized growth in the FAO food price increase between 2005 (FAO FPI of 115) and 2008 (FAO FPI of 191).

Recognize that the rate of food price inflation is not the same for each good. To account for this, scenario 2 uses annualized rates of inflation specific for each food good. These good specific rates of inflation are calculated from the individual elements of the FAO price index for foods. Note, however, that the FAO food price index does not include a price index for fruit and vegetables, and so scenario 2 assumes no food price inflation for fruit and vegetables (we address this issue later). The rates of inflation for the various food goods are shown in the "All" row Table 6.

Scenario 3 accounts for differences in food price inflation across goods and countries by adjusting the food specific rates of inflation for each income cohort. Using country specific rates of food price inflation published in the 2007 OECD-FAO Agricultural Outlook, we calculate a scalar for each income cohort and use this scalar to adjust the food specific rate of inflation from scenario 2 for different income cohorts (see Table 6). For instance, for countries in the low income cohort group, the assumed rate of annualized inflation for grain-based food products in 36 percent. This rate of inflation is derived by multiplying the global rate of inflation for grains (32 percent) by the scalar factor for low-income cohort countries (103).

Table 6. Food price inflation factors

Income cohort	Scalar	Grain	Livestock	F&V	OFood
All		32%	11%	0%	19%
Low	103%	36%	14%	0%	23%
L.M.	103%	37%	15%	0%	23%
U.M.	101%	34%	12%	0%	21%
High	95%	26%	5%	0%	13%

It is important to recognize that while rates of inflation for fruits and vegetables are not available, this does not mean the price of fruits and vegetables has not increased. To account for this potential, scenario 4 replicates scenario 3, but with the zero percent inflation for fruits and vegetables replaced with the 18 percent rate of inflation (the average rate of inflation for food) from scenario 1. Scenarios 5 and 6 then explore the sensitivity of this assumption by replacing the 18 percent with the minimum (five percent) and the maximum (37 percent) rate of inflation from scenario 3, respectively.

Table 7 shows the mean value of the baseline (i.e. at 2005 prices and per capita expenditure) and shocked budget shares. Several important points stand out. First, the impact of food price inflation appears to come at the expense of other non-durable goods and, depending on the scenario, livestock. The latter is not surprising as increases in the price of food will have real-income (expenditure) effects with will likely lead to a substitution away from livestock based products to other food goods. indeed, this is the case; the budget shares for grain, fruit and vegetables, and other food increase in each scenario. Nevertheless, the proportional impact on livestock's share of non-durable expenditure is small in comparison to the other food goods.

While differences between scenarios 4, 5 and 6 suggest it is important to determine a more accurate rate of inflation for fruits and vegetables, the differences between the proportional changes of the budget shares in scenario 1, 2, 3 and 4 suggest that focusing on scenario 4 (which has an "average" rate of inflation for fruits and vegetables) is appropriate. As such, much of the discussion which follows focuses on scenario 4.

Table 7. Simulation analysis: Mean baseline budget shares and percent change from baseline

	Grain	Livestock	F&V	Ofood	Ondur
Base	13.95	17.35	11.07	9.22	48.41
Scenario 1	14.93	17.69	11.69	9.78	45.91
	6.99%	1.93%	5.66%	6.05%	-5.15%
Scenario 2	14.58	17.43	11.84	9.76	46.39
	4.52%	0.45%	6.95%	5.86%	-4.17%
Scenario 3	14.69	17.32	11.83	9.76	46.40
	5.27%	-0.18%	6.89%	5.81%	-4.14%
Scenario 4	15.17	17.30	11.92	9.84	45.78
	8.71%	-0.31%	7.70%	6.65%	-5.43%
Scenario 5	14.83	17.32	11.86	9.78	46.22
	6.28%	-0.21%	7.13%	6.06%	-4.52%
Scenario 6	15.60	17.27	12.00	9.90	45.23
	11.83%	-0.47%	8.40%	7.39%	-6.57%

Table 8 shows the income cohort breakdown of shocked budget shares from scenario 4, as well as the percent change in these budget shares relative to the baseline. Note that the proportional change in other non-durable's budget share becomes smaller as one moves from the low to high income cohort. Such a results suggests that the relative "cost" at which food price inflation occurs (in terms of foregoing purchase of other non-durables) is smaller in higher income countries. Nevertheless, the proportional impact within the food goods is larger and positive for grains, fruits and vegetables and other food; moreover, these proportional changes increase from low to high-income cohorts, while the proportional change in livestock's share falls and then rises. The latter suggests that, within the food group and for low and lower-middle income countries, increases in the budget share for grain, fruits and vegetables and other food comes at the expense of livestock goods.

Table 8. Mean budget shares and percent change from baseline across income cohorts (scenario 4)

	Grain	Livestock	F&V	Ofood	Ondur
Low	25.28	17.99	15.98	12.30	28.45
	7.30%	-3.40%	4.82%	4.57%	-7.65%
L.M.	18.14	18.85	13.66	11.08	38.27
	8.80%	-1.16%	6.90%	6.33%	-6.79%
U.M.	9.57	18.41	10.70	8.76	52.56
	8.97%	3.36%	10.89%	9.35%	-5.71%
High	5.55	13.90	6.65	6.63	67.28
	14.55%	1.95%	13.50%	8.76%	-3.30%

Table 9 shows the mean value of per capita compensating variation by scenario and income cohort, and as a percent of per capita expenditure on non-durables. Regardless of the scenario considered, the mean value of the income cohort specific compensating variation increases in absolute value as one moves from low to high income cohorts, while the relative value of compensating variation becomes smaller. It is this relative impact of the size of compensating variation that is most important.

Table 9: Mean per capita compensating variation across income cohorts and as a percent of per capita expenditure on non-durables

Income	Scenario					
cohort	1	2	3	4	5	6
Low	\$43.69	\$38.15	\$44.52	\$55.20	\$47.64	\$65.05
	12.21%	11.15%	12.95%	15.95%	13.83%	18.72%
L.M.	\$115.39	\$94.72	\$114.92	\$142.60	\$123.01	\$168.13
	10.37%	8.89%	10.72%	13.21%	11.45%	15.51%
U.M.	\$209.53	\$158.81	\$171.30	\$220.65	\$185.71	\$266.28
	7.78%	5.93%	6.39%	8.24%	6.93%	9.94%
High	\$420.40	\$311.10	\$203.72	\$287.90	\$228.22	\$366.40
	5.39%	3.99%	2.62%	3.71%	2.94%	4.73%

To further illustrate inter-country differences in compensating variation, Figure 1 plots per capita compensating variation from scenario 4, while figure 2 plots per capita compensating variation as a percent of per capita expenditure on non-durable goods. Indeed, the generally patter exhibited in Table 9 is further reinforced by Figures 1 and 2

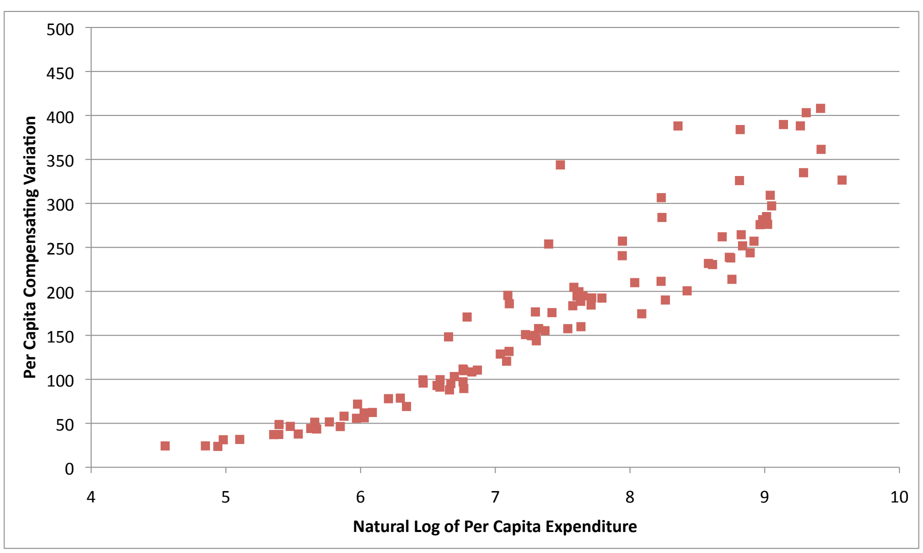

Figure 1. Per capita compensating variation (from scenario 4)

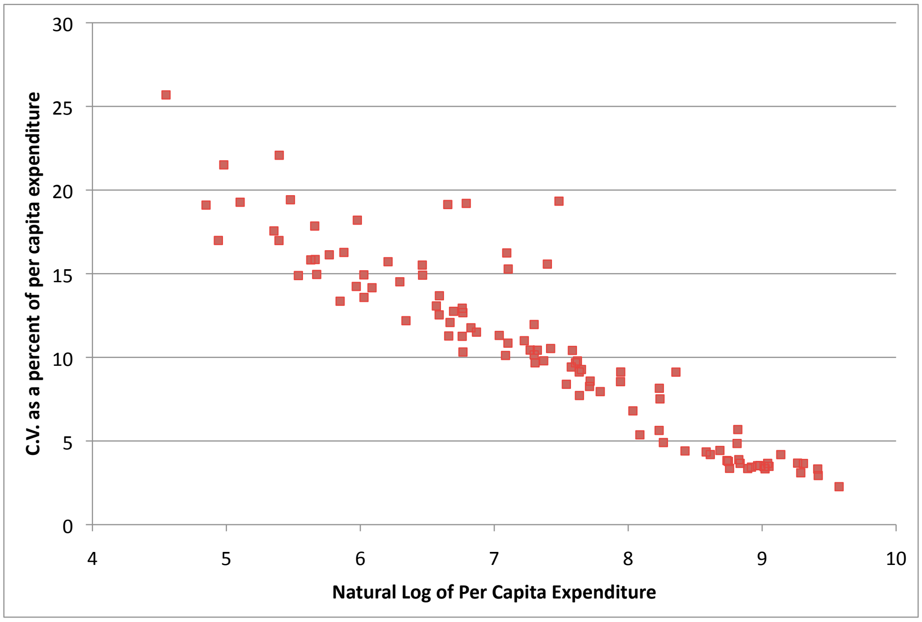

Figure 2. Per capita compensating variation (from scenario 4) as a percent of per capita expenditure on non-durable goods (from scenario 4)

Lastly, aggregate compensating variation (calculated as per capita variation times population) is reported in Table 20. For the countries included in this analysis, the impact of food price inflation (on an annual basis) is equal to $515 billion dollars (U.S.) per annum. Across income cohorts, aggregate compensating variation is lowest in low-income countries ($37.7 billion per annum), followed by upper-middle income countries ($86.9 billion per annum), lower-middle income countries ($135.6 billion per annum) and then high income countries ($254.7 billion per annum). While useful to gauge the overall magnitude of the impact of annualized, recognize that these values reflect differences in the number of countries in each income cohort and the size of each country's population. Important in this respect, is that fact that the 1996 ICP data does not include India and China. As such, the estimates of the aggregate compensating variation should be viewed as a lower bound to the actual size of these welfare effects

Table 10. Aggregate value of compensating variation across income cohorts (scenario 4)

Income cohort	Aggregate C.V (billions)
All	$515.1
Low	$37.7
L.M.	$135.6
U.M.	$86.9
High	$254.7

Conclusions

This paper uses a quadratic AIDS model (QUAIDS) and data from the 1996 International Comparisons Project (ICP) to model consumer demands for final goods and services across the development spectrum. The estimated model is then employed to calculate the compensating variation associated with recently observed inflation in the price of four food goods. QUAIDS model is employed because it possesses more general price and expenditure responses than other lower-rank demand systems. Such flexibility is advantageous when modeling international demand patterns, as one may suspect scope exists for different responses to exogenous shocks according to a country's position in the development spectrum.

Likelihood ratio tests indicate the QUAIDS model is preferred over the non-linear AIDS model. More fundamentally, results illustrate that for the sample of countries and goods considered, rank three demands systems appear appropriate when modeling demands with data spanning a wide range of consumer expenditure. Welfare analysis highlights the large relative impact of food price increases on consumers in lower income countries. One conclusion to draw from the welfare analysis is that continued increases in demand for grains and oilseeds for the biofuel sector, and hence continued pressure of the price of these inputs, will be on the backs of those in poorer countries. Recent civil strife in countries such as Mexico underscores the very real impact modest food price changes can affect. Moreover, results also illustrate that food price rises associated with multilateral trade liberalization could also serve to harm those in less wealthy countries.

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