A Simple Test of Liquidity Constraints and Whether the Poor Pay More

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Abstract

Is the cost of living higher for the poor? Recent studies based on unit values (the ratio of expenditure to quantity) suggest that poor households pay substantially higher prices because liquidity constraints force them to purchase goods in small quantities and not realize bulk discounts. Unit values are subject to several biases and reflect economizing choices made by households, so they may not reliably estimate the bulk discount schedule facing the poor. Instead, this paper uses individual transaction records in household expenditure diaries, which report not only expenditure and quantity but also the brand (if available), unit size and number purchased in each transaction. The bulk discount schedule is estimated for four foods (rice, canned meat, canned fish and chicken) that make up one-third of the total food budget in a survey in urban Papua New Guinea. For each food the regressions are based on the dominant brand(s) so there is no quality variation and the estimated price schedule only reflects discounts due to variations in purchase quantity. All four foods have precisely measured but small elasticities of unit price with respect to quantity purchased. In contrast, unit value methods used in previous studies gave inaccurate measures of the price schedule for bulk buying. Because the poor do buy smaller quantities in each purchase, the unit value methods tend to overstate the extent to which the poor pay more for their food.

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I. **Introduction**

Is the cost of living higher for the poor? Several recent studies suggest that poor households in developing countries pay higher prices because liquidity constraints force them to purchase goods in small quantities and not realize bulk discounts. For example, in rural Karnataka households appear to face a price schedule for pulses where a 10 percent increase in the quantity purchased reduces the unit value (the ratio of expenditure to quantity) by between 3.2 and 8.6 percent (Rao, 2000). While the effects are smaller for other foods they are still sufficiently large that when combined with the tendency of the poor to buy smaller quantitities there is a 7.4 percent decrease in the food price index as household income doubles. Similarly, in Colombia the unit values for rice, beans and carrots are up to 27 percent higher when households purchase the smaller units typically used by the poor (Attanasio and Frayne, 2006).

If these effects are genuine, studies that assume a single price within local areas ignore a potentially important source of inequality. Rao (2000) calculates that Gini coefficients are from 12-23 percent higher once account is taken of the higher prices faced by the poor. Variations in price according to unit size may also invalidate the assumptions used by some methods to estimate demand responses from unit values (Deaton, 1988). In terms of policy, these bulk discounts suggest that improving the efficacy of markets may simultaneously help both equity and efficiency (Muller, 2002). Interventions such as consumption loans and group buying schemes that enable the poor to relax their liquidity constraints and capture bulk discounts could be especially attractive.

But despite the best effort of econometricians, it is doubtful that accurate estimates of the bulk discount schedule facing households can be obtained just from data on unit values. Poorer households are likely to have lower unit values because they purchase lower quality items (Prais and Houthakker, 1955), possibly offsetting any tendency for them to pay more because of unrealized bulk discounts. Moreover, unit values aggregate over many purchases occurring during a survey reference period so it is not possible to know what quantity was purchased in each transaction. Attempts to identify the price schedule by instrumenting for demand face the problem that some of the commonly used instruments like family size and composition also affect the opportunity cost of shopping more frequently to search for lower prices by (McKenzie and Schargrodsky, 2005). Doubts about the inferences coming from unit values are heightened by the fact that price comparisons across stores do not find significant evidence of the poor paying more (Musgrove and Galindo, 1988; Kaufman, et al, 1997).

A potentially superior but neglected source of data for testing whether liquidity constraints force the poor to pay more for food is the record of individual transactions in the expenditure diaries of Household Budget Surveys. These surveys have been used in many developing countries in Africa (e.g., Botswana, Cameroon, Mozambique and Zimbabwe), Asia (e.g. Bangladesh, Cambodia, and Malaysia) and Latin America (e.g. Argentina, Colombia and Venezuela).[1] The format of diaries differs somewhat but in at least some surveys respondents record not only expenditure and quantity but also the brand (if available), unit size and the number purchased in each transaction.

[1] Details of many of these surveys are in ILO (1994).

The transactions-level data in these expenditure diaries allow quality effects to be removed by restricting attention to the same brand and specification. Transactions also are the right level of aggregation for estimating bulk discount schedules, which depend on the amount purchased on *each* occasion rather than the total amount purchased over some period. In contrast, standard household survey data treat, say, a single 10 kilogram purchase, which may attract a bulk discount, as identical to purchases of one kilogram per day for 10 days, even though they are unlikely to attract bulk discounts.

In this paper, information on individual transactions is used from a diary-keeping household survey in urban Papua New Guinea. The bulk discount schedule is estimated for four foods (rice, chicken, canned meat and canned fish) that make up one-third of the total food budget. For each food the regressions are based on the dominant brand(s) so there is no quality variation.[2] All four foods have precisely measured but small elasticities of unit price with respect to quantity purchased. The poor, on average, are shown to purchase smaller quantities in each transaction, so the overall effect is that they face slightly higher prices.

These estimates from individual transaction records are contrasted with the estimates that come from applying approaches used elsewhere on unit values. The unit value methods give inaccurate estimates of the bulk discount schedule in this setting with a general pattern of overstating the extent to which the poor pay more for their food. In addition, the information on individual transactions is used to examine whether the tendency of the poor to buy smaller units reflects liquidity constraints. The results suggest that poor consumers often buy more than one of a small-sized unit in the same transaction, indicating that they had sufficient liquidity on hand to buy a single larger unit at a cheaper unit price if they had so desired. Hence, liquidity constraints may not be the only explanation for why the poor buy in smaller sizes and pay a higher price to do so. Alternatively, we provide a behavioral explanation of self-discipline for the purchasing pattern of the poor and its empirical evidence.

II. Previous Literature

The question of whether the poor pay more for food has remained in the literature in economics and economic geography for more than four decades.[3] In this time, two broad approaches have been used; store surveys that compare the prices of identical goods in rich and poor neighborhoods, and household surveys that compare unit values (the ratio of expenditure to quantity) across rich and poor households. Both approaches have their advantages. Store surveys can ensure that like is compared with like by choosing a representative brand, package size and any other distinguishing feature for each selected food. However the characteristics of purchasers are not known, and have to be proxied by neighborhood characteristics such as the share of poor households in the community. Household surveys capture buyer characteristics but lack the fine

[2] The use of branded food products should not limit the applicability of the results to other developing countries. The share of packaged foods is already over one-third in countries like Indonesia, Malaysia and Thailand and is being driven by the rapid rise in supermarkets. For example, over 60 percent of retail food sales in Latin America are now through supermarkets, versus only 10-20 percent prior to 1980 (Reardon, Timmer, Barrett, and Berdegué, 2003). Growth of the supermarket sector is even more rapid in East and Southeast Asia and is not limited to major cities and to the rich and middle class, but instead is penetrating deeply into the food markets of the poor.

[3] Early studies in the U.S. include Alexis and Simon (1967) and Goodman (1968). The first study in a developing country appears to be Musgrove and Galindo (1988).

detail on purchases needed to compare like with like, as the following quotation from Prais and Houthakker (1955, p.110) indicates:

> "An item of expenditure in a family-budget schedule is to be regarded as the sum of a number of varieties of the commodity each of different quality and sold at a different price."

The approach of surveying stores has been used most frequently in the United States. This literature finds that prices vary with store type (supermarkets cheaper than convenience stores) and location (suburbs cheaper than rural and central city areas). However, prices do not vary with neighborhood income, given location (Hall, 1983; MacDonald and Nelson, 1991). Moreover, even if store mix and location are not held constant, the gradients are sufficiently flat that prices facing poor households for the *same* food items are likely to be less than one percent more than those facing nonpoor households (Kaufman et al, 1997, p.8).

A similar conclusion is reached in a developing country context by Musgrove and Galindo (1988), who report results from a survey for 14 different foods in 498 retail outlets in Northeast Brazil. Prices were reported for standard quantities, although it is not discussed if they were also for standard brands. Prices for the same item were largely the same across the various cities, towns and neighborhoods, and also across the various store types in the survey, leading to the conclusion:

> "Overall, there is no evidence that the poor pay more than their nonpoor neighbors simply because of where they live or where they shop…" Musgrove and Galindo (1988, p.101).

Moreover, in contradiction to any story about liquidity constraints forcing the poor to buy small and pay more, this survey found that for all products except soybean oil, sales for part-units were charged at the same price per gram as the standard package.

Of course the actual price paid by the poor depends not only on the same-item prices they face but also on various economizing choices they make over the particular items they purchase. These include buying lower quality and unbranded varieties, buying larger package sizes, and using coupons and shopping for sale items. As an example of the combined effect of these strategies, Kaufman et al (1997) calculate that in the United States low-income households typically pay only 90 percent of the cost per unit of the average household. Similarly, in Argentina during the 2002 economic crisis consumers reacted by both downgrading the quality of their purchases but also by increasing the frequency of their shopping in order to search for lower prices (McKenzie and Schargrodsky, 2005). The greater shopping frequency of poor households was also found for the United States by Kunreuther (1973).[4]

[4] The role of search is also emphasized by Frankel and Gould (2001) who find a U-shaped relationship between food prices and neighborhood income levels in the United States. They argue that rich households will spend less time searching for the lowest prices because of the opportunity cost of their time, while poor households may lack the means to search if they do not have access to a car. So prices are lower, the greater the proportion of the population whose income is between the poverty line and two times the poverty line. One proxy for this effect used in the results below is the neighborhood inequality level.

III. **Price-Quantity Schedule Models**

In contrast to the very small price differences by income groups found in the literature on store surveys, recent studies using household surveys claim that bulk discounting gives potentially large differences in prices between rich and poor households. The key studies in this recent literature are Rao (1997), Attanasio and Frayne (2006) and Beatty (2006). Before discussing each in turn, it is worth considering a quotation that highlights the difficulty in using unit values to compare food prices across income groups:

> "[F]or purposes of food-cost comparisons, household surveys are not designed to obtain the level of item detail available in store surveys—typically aggregating to less than 100 relatively broad food groupings. Food groups in a household survey may contain a wide range of food items and quality variations having significant unit-cost differences. Consequently, per-unit food costs may vary widely across households depending on the set of brands and package sizes that a household purchases in a food category as well as price differences for similar items."
> Kaufman et al (1997, p.1).

The aim of the recent literature using unit values is to identify the price schedule that sellers offer to buyers. This schedule depends on the quantity of specific food *i* purchased *in a specific transaction t, q_{it}* and other supply shifters Z_{it}^{s}

$$\ln(p_{it}) = \chi_s Z_{it}^{s} + \theta \ln(q_{it}) + u_{it}^{s} \qquad (1)$$

The gradient of the price schedule is given by the parameter θ, which will be less than zero in the presence of bulk discounts.

The problem with using household surveys to estimate (1) is that neither p_{it} nor q_{it} is observed. Instead of p_{it} and q_{it} conventional household surveys provide total expenditure and total quantity purchased for a broad food type (or a food group), $Q_i = \sum_{t \in T} Q_{it}$ where Q_{it} aggregate over various brands or qualities (q_{it}). The ratio of these two – a unit value – varies both with prices and with the quality of the items chosen within the group (eg., steak rather than hamburger in the "beef" group). Hence, unit values, v_i, can be written as: $\ln(v_i) = \ln(p_i) + \ln(\pi_i)$, where π_i is a measure of quality.

The approach used by Rao (1997) is to estimate:

$$\ln(v_i) = \mu_k + \theta' \ln(Q_i) + \varepsilon_i \qquad (2)$$

where μ_k is a set of village-level fixed effects, which proxy for the supply shifters Z_{it}^{s}. Both OLS and instrumental variables are used, where the latter is to ensure that it is a supply curve rather than a demand curve being traced out from the equilibrium points.[5] But neither estimation method solves the problem that equation (2) equals equation (1), and hence $\theta' = \theta$, only if $\pi_i = 1$ and $Q_i = q_{it}$. The survey used by Rao (1997) had unusually detailed food groups, with five types of legume distinguished, two types of rice and two types of sugar. Moreover, the recall period

[5] The instruments used are log household income, the number of adult equivalents in the household, and the amount of land owned by the family.

was only one week so the assumptions of no quality effects and only one purchase occasion may be more defensible in this setting than it typically would be.

Attanasio and Frayne (2006) follow the same approach as Rao in arguing that one can identify θ by regressing unit values on several controls for supply conditions and the quantity purchased, which in turn is instrumented by demographic variables. Once again this neglects the fact that bulk discounts depend on the quantity of a specific food *i* in a specific transaction, q_{it} rather than the total quantity of a food group over the duration of the survey, Q_i. One innovation of Attanasio and Frayne (henceforth AF) is to follow an approach introduced by Deaton (1988) in modeling the unobservable quality, π_i as a function of observable household total expenditure, *x* and quality demand shifters, Z_i^q

$$\ln(\pi_i) = \chi_q Z_i^q + \gamma \ln(x) + u_i^q \tag{3}$$

The resulting equation models unit values as depending on total quantity, Q_i, and total expenditures, *x* (both of which are endogenous) and the exogenous supply and quality demand shifters:

$$\ln(v_i) = \chi_s Z_i^s + \chi_q Z_i^q + \theta'' \ln(Q_i) + \gamma \ln(x) + u_i^s + u_i^q. \tag{4}$$

Household composition is used to instrument for Q_i while the log of expected household income is used to instrument for *x*. AF also use a variant of equation (4) that excludes ln(*x*) under the assumption that there are no quality effects in the commodities they consider (beans, carrots, and rice). However, even if this approach deals successfully with the quality issue, it still involves an assumption that $Q_i = q_{it}$ if $\theta'' = \theta$.

In contrast to the two earlier studies, Beatty (2010) uses the data on transaction quantities rather than total quantities which enables him to use Q_{it} and its corresponding unit value v_{it}. So, it is possible to identify what quantity was purchased in each transaction instead of total quantities and its unit values aggregate over many purchases occurring during a survey reference period. Combined with the Deaton's approach to control π_{it} in v_{it}, Beatty's specification is

$$\ln(v_{it}) = \chi_s Z_{it}^s + \chi_q Z_{it}^q + \theta \ln Q_{it} + \gamma \ln(x) + u_{it}^s + u_{it}^q. \tag{5}$$

Similar to AF's estimation, for two potentially endogenous explanatory variables, Q_{it} and *x*. Beatty uses household size and demographic composition, household income and the number of meals purchased at restaurants as the instruments. The specifications used by these previous studies reflect the specific data available, which explains why q_{it} and Q_i (*or* Q_{it}) are conflated in those studies. A common weakness in these models is the assumption that demographics are a valid instrument for quantity demanded. If there is a distribution of prices in the market, household members may spend time searching for the best bargains, as McKenzie and Schargrodsky (2005) show and this means that household size and demographic structure influence the supply shifters.

Another factor ignored by the previous approaches is that the relative price of quality changes with variation in unit size. For sellers to offer a smaller quantity they need to pass on a per unit transactions cost to the buyer, such as a repackaging cost. As Alchian and Allen (1969 p.63-4) first pointed out, such costs lower the relative price of, and raise the relative demand for, high-quality goods.[6] Figure 1 gives a hypothetical example for high and low quality varieties of rice, where there is a 25c/kg discount for the low quality variety. The packaging costs of breaking 25kg sacks of rice into smaller consumer packs is the same, regardless of quality, and is shown by the unit price per kg going up by 24 cents when comparing a one kg pack with a 25 kg sack. Consequently a buyer of one kg rice packs faces relative prices of 1.34 bags of low quality rice per bag of high quality rice, while the buyer of 25 kg sacks faces a relative price of 1.5 sacks of low quality rice per sack of high quality rice. Small packages will tend to be of the high quality variety, large sacks of the low quality variety and a regression on unit values will give a gradient for package size that is too steep because it confuses quality choice (driven by relative prices rather than incomes) with the bulk discounting schedule.

Figure 1: Impact of Unit Quantity on Relative Price of Quality

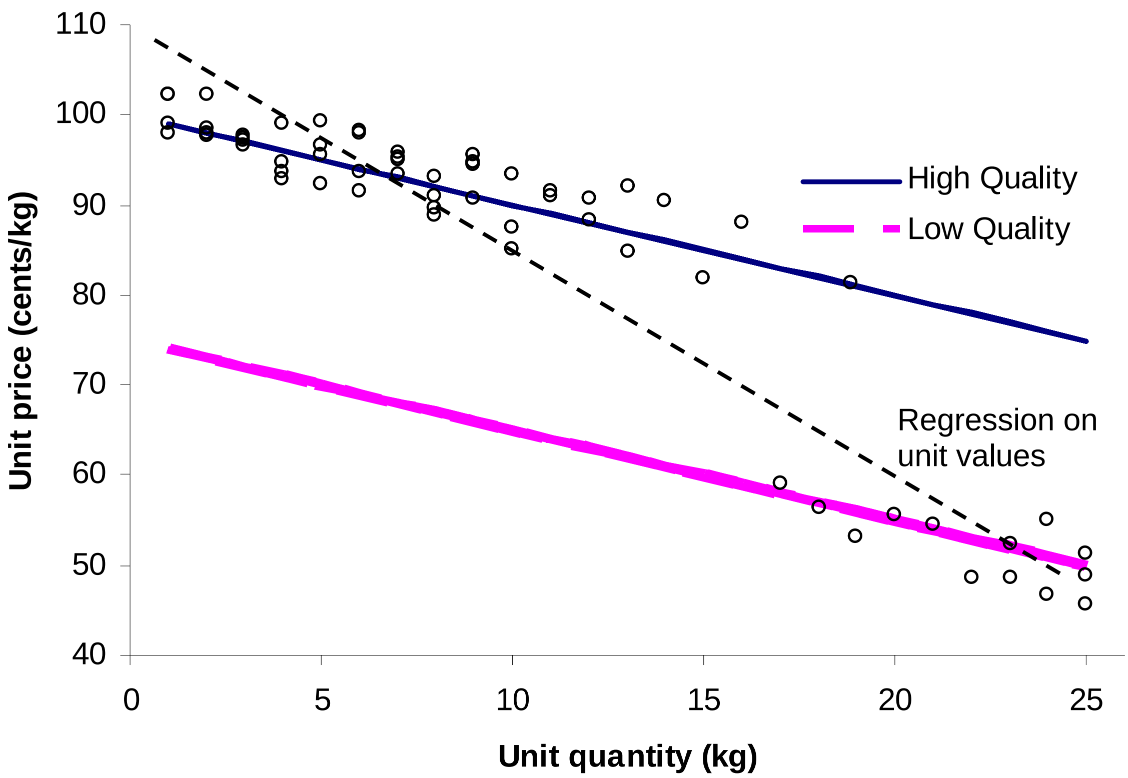

Figure 1 also illustrates another problem with using household-level data to estimate a transaction-level relationship. There should be many more transactions for small units than for large ones and a sample of transactions (or of shelf spaces in stores) would properly weight the data to reflect this. However, household survey data gives equal weight to the household who buys one 20kg unit and to the household who buys 20 one kg units in separate purchases. The

[6] This is known as "shipping the good apples out" (Borcherding, and Silberberg, 1978). For example, suppose that two qualities of apples are produced in one locality and exported to another locality with a common, constant cost of transporting both types of apples to the market. The demand for good apples must increase as transport costs increase, since their price (including transportation costs) relative to the bad apples has decreased. Empirical confirmation of this prediction is provided by Hummels and Skiba (2004) in the context of international trade.

reason being that there is no way to distinguish these two cases because all that is typically available from a household survey is the total quantity and expenditure over the reference period.

To overcome these drawbacks of the unit value framework, a different source of data are used to provide information on *transactions level* prices which enable us to remove quality effects by restricting attention to the same brand at the right level of aggregation for estimating bulk discount schedules of specification (1). Results from these new data are then compared with the results from unit value approaches.

IV. Empirical Results

4.1 Data

The data are from the Papua New Guinea Urban Household Survey (UHS), carried out in the late 1980s in a variety of towns, urban villages and squatter settlements ranging in population from 200,000 down to a few hundred. The data were collected with personal income and expenditure diaries, rather than by recall. Each adult in the household kept a diary for two weeks, noting full details on every item of expenditure, including the total value of the purchase, the quantity, the brand, and the package size and number of units. These details were included so that the statistics office could select the most widely purchased specification when designing the regimen of prices to collect for their CPI and the same motivation sees similar details collected in diary surveys in other countries.

Figure 2 provides an example of the sort of information available in the expenditure diaries. After being completed by the respondents the details on each transaction in the diaries were assigned to a four digit commodity code. The extract shown here relates to Group 126 “canned meat”. The most prevalent specification within this group is “canned corned meat” (code 1261) where the dominant brand is “Ox and Palm” which is sold predominantly in 340 gram cans. If attention is restricted to this dominant brand and specification, there is no quality variation of the sort that potentially interferes with the use of unit values as a proxy for market price. Because these reports of the prices paid for each transaction are coming from volunteer households rather than trained price surveyors, it is likely that there will be measurement error that causes some outliers. So the records are trimmed by removing the lowest and highest one percent of unit prices, and median regressions are also used to provide results that may be more robust to outliers.

Figure 2: Example of Pricing Information Available From Expenditure Diaries

Commodity	Expenditure	Number	Brand	Size	Unit
1261	276	2	OX&PALM	340	G
1265	135	1	TDUCK	397	G
1261	264	2	OX&PALM	340	G
1261	135	1	OX&PALM	340	G
1261	140	1	OX&PALM	340	G
1265	98	1	MALING	14	G
1261	330	2	OX&PALM	340	G
1263	85	1	TULIP	340	G
1261	135	1	OX&PALM	340	G
1261	136	1	OX&PALM	340	G
1263	85	1	TULIP	340	G
1261	145	1	OX&PALM	340	G
1261	140				
1261	718	6	OX&PALM	340	G
1261	135	1	OX&PALM	340	G
1262	80	1	CBEEF	200	G
1262	135	1	GLOBE	340	G
1262	150	1	GLOBE	340	G

In the analysis that follows attention is restricted to detailed specifications of each food, to be certain that it is purchase size and not quality differences that influence the unit price. The first item is "Trukai" brand short-grain rice. This is available in pack sizes of 0.5kg, 1kg, 2kg, 5kg, 10kg, 25kg and a 1x20kg bale. Rice accounted for 13 percent of the average urban household's food budget, and the market share for the "Trukai" brand was over 95 percent. The second item is "Ox and Palm" brand canned, corned beef, available in can sizes of 200g and 340g, and also in cartons of 24 cans. Canned meat accounted for eight percent of the average food budget, and "Ox and Palm" brand had a market share of approximately 75 percent. The third item is "777" brand canned mackerel in oil, available in can sizes of 155g, 200g, and 425g, and also in cartons of 24 cans. Canned fish accounted for seven percent of the average household's food budget, and "777" brand mackerel had a market share of approximately two-thirds. The fourth item is frozen whole chickens, which range in weight from 0.7kg to 1.8kg. Unlike the other foods, no single brand dominates the frozen chicken market so all three major brands are included and brand dummy variables are included in the regression of chicken unit prices on purchase quantities. Chicken products took seven percent of the average food budget, with about three-quarters of this allocated to whole, frozen chickens.

In addition to these finely detailed product specifications the analysis also considers four food groups at a slightly broader (3-digit) level: Rice, Canned Meat, Canned Fish, and Chicken. These are more typical of the aggregation level used with unit values and provide the data used for comparing with the results estimated from transactions-level prices. Descriptive statistics for these four food groups are reported in Table 1. It is clear that buyers have scope to vary both the unit quantity and the number of units purchased in each transaction. The variation in unit quantity is greatest for Rice, with a coefficient of variation of 1.71 reflecting the greater range of package sizes for rice than for the other three groups. The number of units purchased in each transaction ranges from 1.4 for Canned Meat to 1.8 for Rice. It is also clear that multiple purchase occasions occur during the 14 day diary-keeping period, ranging from 2.5 for Chicken through to 4.6 for Canned Fish.

Table 1: Descriptive Statistics

		Rice	Canned Meat	Canned Fish	Chicken
(1)	Quantity per unit (kg)	2.73	0.33	0.38	0.87
		(4.68)	(0.06)	(0.14)	(0.47)
(2)	Units per purchase (number)	1.76	1.44	1.70	1.52
		(1.54)	(0.95)	(2.00)	(0.92)
(3)	Quantity per purchase (kg)	3.55	0.48	0.64	1.25
		(4.91)	(0.33)	(0.76)	(0.96)
(4)	Purchase occasions per 14 days	4.37	3.57	4.63	2.48
		(3.28)	(2.66)	(3.54)	(1.85)
(5)	Total quantity per household	15.51	1.72	2.96	3.10
		(13.71)	(1.53)	(2.62)	(3.34)
(6)	Total expenditure per household (toea)	922.15	626.64	467.38	971.16
		(746.86)	(558.12)	(385.37)	(933.76)
(7)	Unit value (toea per kg)	62.91	368.17	166.86	335.60
		(12.26)	(58.36)	(38.89)	(93.14)
	Number of diary transactions	1466	2683	3781	1156
	Number of purchasing households	335	751	817	467

Note: Data are trimmed by removing the highest and lowest one percent of unit values. Standard deviation in ( ).

The final point of note in Table 1 is that even before restricting attention to the finely detailed representative brands described above, these four food groups are fairly homogenous commodities by the standards of the previous literature. Specifically, the coefficient of variation (c.o.v.) of the unit values only ranges from 0.16 (Canned Meat) to 0.28 (Chicken) and averages 0.22. This is similar to the variation in unit values for the foods used by Rao (1997), whose c.o.v. ranged from 0.10 to 0.45 and averaged 0.24. In contrast, the foods used by Beatty (2006) have unit values whose c.o.v. ranges from 0.22 to 0.50 and those used by AF appear to have c.o.v. ranging from 6.2 to 12.2. Thus the current data should be more favorable to unit value methods than some of the samples where these methods have been applied.

4.2 Previous Specifications of the Price-Quantity Schedule Estimation

Table 2 summarises the specifications used by the previous studies of bulk discounts that work with unit values, and the implementation of those specifications on the current sample. It is not possible to match every control and instrumental variable with the same definition used in the original study. However, the results from applying previous unit value methods to the current data should still be informative about possible directions of bias when only these data are available rather than the more appropriate transaction-level data.

Table 2: Specifications for Estimating Price-Quantity Schedules from Unit Values

	Endogenous RHS variables	Exogenous variables	Instruments
Original Studies			
Rao	ln total quantity[a]	village dummy variables	family weekly income[a] number adult equivalents[a] land area owned by family[a]
Attanasio and Frayne	ln total quantity ln total expenditure	village dummies settlement type dummies distance to village center population density village altitude village area	household composition by age group ln expected household income
Beatty	ln transaction-level quantity ln total food expenditure	month, year and region dummies cluster dummies	ln household size ln household income % of household age 5, 5-17 and >60 years old Presence of a car, presence of freezer and pensioner dummy
Current replication of original studies			
Rao	ln total quantity	Census Division dummies	number adult equivalents ln household income dummy for land owned for food gardens
Attanasio and Frayne	ln total quantity ln total expenditure	Census Division dummies settlement type dummies distance to town center	% of household of each sex age 0-6, 7-14, 15-49 ln household income
Beatty	ln transaction-level quantity ln total food expenditure	month/year dummies Census Division dummies	ln household size ln household income ln spending on meals % of household age 0-14, and >51 years old

[a] OLS results are also reported, so the instruments used for only one of the reported specifications.

4.3 Estimated Price-Quantity Schedules

The elasticities of unit price with respect to purchase quantity from the transactions-level data are reported in Table 3. The results come from a double log specification, with a variety of other control variables used, as described in the table. The choice of control variables does not make much difference and nor does the use of instrumental variables rather than OLS (additionally, the Hausman test statistics are insignificant). Using medians rather than means makes some difference, especially for 777 brand canned mackerel, suggesting the possible influence of outliers even after the highest and lowest one percent of unit prices have been trimmed from the sample.

Table 3: Price-Quantity Schedules Estimated from Transaction-Level Data

	Esti-mator	Control Variables	Trukai Rice	Ox and Palm Canned Corned Beef	777 Canned Mackerel	Frozen Chicken[a]
(1)	OLS	Census Division (CD) fixed effects	-0.062 (0.006)**	-0.027 (0.013)*	-0.136 (0.010)**	-0.097 (0.025)**
(2)	LAD	Census Division (CD) fixed effects	-0.056 (0.000)**	-0.000 (0.000)	-0.073 (0.000)**	-0.074 (0.027)**
(3)	OLS	(1) plus average price for the town (from CPI)	-0.061 (0.006)**	-0.028 (0.012)*	-0.139 (0.010)**	-0.097 (0.025)**
(4)	OLS	(3) plus log TEXP and demographics	-0.061 (0.005)**	-0.031 (0.013)*	-0.141 (0.010)**	-0.109 (0.024)**
(5)	OLS	Price, log TEXP, demogs, HH and CD attributes[b]	-0.061 (0.005)**	-0.033 (0.012)**	-0.149 (0.009)**	-0.112 (0.024)**
(6)	IV[c]	Census Division fixed effects	-0.114 (0.055)* [0.32]	-0.090 (0.136) [0.61]	-0.045 (0.109) [0.38]	-0.053 (0.207) [0.83]

Note: Coefficients are the elasticity of unit price with respect to the quantity purchased in each transaction. The full results for the regressions are reported in Appendix Tables 1-4.
Robust standard errors in ( ) are adjusted for clustering by household. + significant at 10%; *at 5%; **at 1%
[a] The specification includes dummy variables for three different brands.
[b] The household attributes are whether a food garden and a refrigerator are available. The community attributes are the type of community (village or informal settlement, with formal urban area as the excluded category), the distance to the town center, and the Gini coefficient for expenditure inequality in the Census Division.
[c] Log quantity instrumented with eight household demographic composition variables. All over-identification tests were statistically insignificant. The *p*-value for Hausman tests comparing coefficients in row (1) and row (6) is reported in [ ].

The gradient of the price schedule for bulk purchases is rather flat. The elasticities are only -0.03 and -0.06 for canned corned beef and rice, and -0.10 and -0.14 for frozen chicken and canned mackerel. Each of these elasticities is precisely estimated, so they are all statistically significant even if their economic significance may be muted. Taking a budget share weighted average, the elasticity of unit price with respect to purchase quantity is -0.076 at the mean and -0.050 at the median.

These elasticities can be combined with the elasticity of transaction quantity with respect to income (measured by per capita expenditure) to see how much more the poor pay. These elasticities of average purchase size with respect to per capita household total expenditure range from 0.06 for rice to 0.18 for canned meat (see Table 5 below). The two sets of elasticities can be multiplied together to give the elasticity of unit price with respect to household income. The two-stage method used to estimate this elasticity ensures that it is due only to bulk discounts and not to any quality differences in the food purchases made by large and small households. For rice, the income--price elasticity is -0.004; for canned corned beef it is -0.005; for canned mackerel it is -0.021; and for frozen chickens it is -0.007. The budget share weighted average of these elasticities is -0.008, so a doubling of household income would, on average, reduce the unit price paid for these four foods by 0.8 percent

The results are rather different when the various unit value methods are used to estimate the gradient of the price schedule for bulk discounting. While some of the unit value methods do a reasonable job of estimating the gradient for Rice and Chicken, all of the methods do a poor (and imprecise) job of estimating the gradients for Canned Meat and Canned Fish (Table 4).

Table 4: Price-Quantity Schedules Estimated from Household-Level and Transaction-Level Unit Values

	Specification	Esti-mator	Rice	Canned Meat	Canned Fish	Chicken
(1)	Rao	IV	-0.069 (0.021)**	0.031 (0.018)+	-0.010 (0.021)	0.132 (0.082)
(2)	Rao	OLS	-0.057 (0.008)**	0.009 (0.008)	-0.055 (0.009)**	-0.096 (0.016)**
(3)	Attanasio and Frayne excluding total expenditure	IV	-0.062 (0.022)**	-0.015 (0.025)	-0.006 (0.020)	-0.331 (0.127)**
(4)	Attanasio and Frayne including total expenditure	IV	-0.070 (0.037)+	-0.128 (0.094)	-0.024 (0.032)	-0.493 (0.210)*
(5)	Beatty	IV	-0.030 (0.057)	0.280** (0.108)	0.035 (0.077)	-0.312** (0.134)

Note: Coefficients are the elasticity of unit value with respect to the total quantity purchased over the survey reference period (14 days). The full results for the regressions are reported in Appendix Tables 5-8. Robust standard errors in ( ). + significant at 10%; *at 5%; **at 1%

The poorest results come from the specification used by Beatty (equation (5)). These estimates greatly overstate the bulk discount schedule for chicken, while giving imprecise estimates for the other three foods. The AF specifications work better, especially when total expenditure is not included as an explanatory variable. However this may reflect the fact that the food groups in the sample here are relatively homogenous and so the value of the expenditure regressor as a control for quality is less apparent. It may also reflect the fact that quality effects cannot be captured as simply relying on income, and also may depend on other factors such as the relative price of quality (Figure 1).

4.4 Whether the Poor Pay More and A Test of Liquidity Constraints

Our empirical results indicate that bulk discounts exist for all four goods on a transaction level. Next, we turn to the policy relevant question whether these bulk discounts are used by the poor. We investigate this one for four foods and the food basket as a whole. To be consistent with the previous studies, we construct an expensiveness index for each food type and the food basket purchased by a household by following Aguiar and Hurst (2007) and Beatty (2010).

The expensiveness index for a specific food i purchased by household j is defined as the ratio of the actual expenditure during the survey reference period (T) relative to the expected cost of the food at the average unit price paid by all households (J) in the sample. The actual expenditure of food i by household j is

$$\chi_i^j = \sum_{t \in T} p_{it}^j q_{it}^j \quad (6)$$

Next, we calculate the average unit price over the all transactions for all households as in

$$\overline{p}_i = \sum_{j\in J, t\in T} \left(\frac{\chi_{it}^j}{\overline{q}_i} \right), \qquad (7)$$

where $\overline{q}_i = \sum_{j\in J, t\in T} q_{it}^j$ is the total quantity of food i purchased during the survey period by all households in the sample. With this average unit price, the expected average cost of food i by a houhold j is constructed as in

$$\tilde{\chi}_i^j = \sum_{t\in T} \overline{p}_i q_{it}^j \qquad (8)$$

The expensiveness index for a food i purchased by household j is defined as the ratio of two as in

$$I_i^j = \frac{\chi_i^j}{\tilde{\chi}_i^j} \qquad (9)$$

After normalizing the index into one by using the average expensiveness index for all households, if an index value for a food (eg., rice) is above one implies that the corresponding household pays more than the average. With the present bulk discounts, if the index is higher for the poor, then it could be interpreted that the poor pay more by purchasing smaller quantities of food i possibly due to binding liquidity constraints. We also construct the expensiveness index for the food basket of all four foods. With the different degree of bulk discounts in each food, an index value for the food basket also tells us the share of the greater bulk discounted goods in their food basket for the poor.

The regression results of the log of expensiveness index with respect to log per capita income with household demographics as controls are reported in Table 5. Based on unit prices, poorer households pay more per occasion for the food basket as a whole, although the effect is statistically significant only for rice and chicken. Conversely, based on household-level and transaction-level unit values, poorer households pay less for each food and for the whole food basket. This result could be expected since poorer households are likely to have lower unit values from purchasing lower quality items and it could offset any tendency for them to pay more because of unrealized bulk discounts. The results in Table 5 may seem consistent with a story about liquidity constraints because the poor appear to pay more at the transaction level. However these regressions only show the negative association between income and the unit prices and they do not distinguish whether liquidity constraints force the poor to purchase goods in small quantities and not realize bulk discounts.

Table 5: Log of Expensiveness Index Regression Estimates on log Per Capita Income

Expensiveness Index Components	Rice	Canned Meat	Canned Fish	Chicken	Food Basket
(1) Household-Level Unit Values (v_i):	0.003	0.009	0.042**	0.017**	---
	(0.008)	(0.007)	(0.018)	(0.007)	
(2) Transaction-Level Unit Values (v_{it})	0.009**	0.012**	0.008**	0.016**	0.011**
	(0.003)	(0.003)	(0.002)	(0.006)	(0.001)
(3) Transaction-Level Unit Prices (p_{it})	-0.015+	0.001	-0.011*	0.006	-0.010**
	(0.008)	(0.010)	(0.005)	(0.010)	(0.004)

Note: Covariates are eight household demographic composition variables and the Census Division dummies. + significant at 10%; *at 5%; **at 1%

Another feature of the PNG data used in this study is that the data has the full details on package size and number of units at the transaction level. So, we can have more direct evidence on the lack of liquidity constraints by examining demand *within* a purchase occasion, where there is a choice between buying either more smaller units or fewer larger units. This evidence is clearest for rice, which has the largest variety of package sizes (0.5kg, 1kg, 2kg, 5kg, 10kg, 25kg and a 1x20kg bale).

Yet despite the greater bulk discount from buying a single large bag of rice consumers seem to prefer buying multiple smaller bags in the same purchase occasion (Table 6). Clearly the buyers had sufficient liquidity to buy the larger bag at the cheaper unit price, since the cost of two (or more) of the smaller bags exceeds the cost of a single larger bag. So liquidity constraints do not seem to be a binding influence on purchasing behaviour for rice. This purchasing pattern occurs throughout the income distribution (Table 6). Thus the tendency of the poor to buy small and pay (slightly) more per unit for doing so may reflect factors other than liquidity constraints.

Table 6: Number of One Kilogram Rice Bags Bought in Single Purchase Occasion (% of Total Number Bought)

Number per purchase	Poorest Quartile	Quartile II	Quartile III	Richest Quartile	Total Sample
1	41.2	53.1	38.5	36.9	42.6
2	44.1	34.9	47.4	43.8	42.4
3	7.0	7.0	5.6	10.3	7.4
4	5.1	3.1	5.1	4.7	4.5
5	1.8	0.8	1.3	2.1	1.5
6+	0.7	1.2	2.1	2.1	1.5
Total Number	272	258	234	233	997

Discussions with urban Papua New Guineans suggest behavioral reasons for this purchasing pattern. This is a setting where there are strong social norms about sharing food and cash between households, especially within clan groups, and where there is widespread undernutrition.[7] Hence, many households will cook a one kilogram bag of rice per meal, regardless of how many people come to eat – if more guests come everyone has a smaller meal and if fewer come there are slightly more generous helpings and perhaps leftovers for the next day's meal. This 'rule of thumb' cooking helps act as a disciplining device so that households with food are not overrun by those without. Indeed, many households resort to shopping everyday in the neighborhood tradestores rather than buying in bulk on fortnightly pay day to ensure that their food is rationed out until the next pay day.

This self-disciplining behavioral hypothesis can be further investigated by using the full details on the number of units at a transaction level. If the buyers who bought multiple smaller bags in the same purchase occasion had actually used the bulk discounts from buying the larger bag at the cheaper unit price, then the expensiveness index values for those buyers could have been lower. We construct this hypothetical expensiveness index for rice and the regression result of the log of hypothetical index on log per capita income with the same set of covariates used in Table 5 is summarized as

$$\underset{}{\ln(I) = \underset{(0.005)}{0.004}\ln(\textit{per capita income}) + \textit{controls}} \qquad R^2 = 0.11 \;\; N = 1342 \tag{10}$$

The sign of the estimated coefficient of log per capita income has been changed from negative (the poor pay more) to positive (the poor pay less). The income coefficient estimates from this hypothetical expensiveness index for rice is 0.004, compared with -0.015 when no extra information on the number of units at the same transactions are used. The equality between the two income coefficient estimates is strongly rejected (p-value=0.008). Thus, the negative association between income and expensiveness index value does not appear only from binding liquidity constraints of the poor.

Next, we proceed further to test more formally the self-discipline explanation discussed in the above. We add some adequate covariates which could capture an incentive for self-disciplining purchasing patterns to the specification used in Table 5 and equation (10). The variables that we used here are the actual number of person-meals and the number of person-meals that would be expected given the number of adult and child in a household. With two difference variables between the actual number and the expected number for adults and children as additional covariates in the regression of expensiveness index, the difference of two income coefficient estimates changes from -0.019 to -0.010 and the latter is no longer rejected (p-value=0.133). Thus, there could be a tendency to buy multiple smaller bags for some poor households since they have a strong self-discipline incentive for the larger difference between the actual number of person-meals and the expected number of person-meals. Hence, liquidity constraints may not be the only explanation for why the poor buy in smaller sizes and pay a higher price to do so.

V. Conclusions

This research has examined whether poor households in developing countries face higher food prices because liquidity constraints force them to purchase goods in small quantities and not

[7] Gibson and Rozelle (2002) report that the poorest quartile of the urban population consumes only 70 percent of energy requirements and calories for the second quartile are also below requirement.

realize bulk discounts. A neglected source of data – the transaction level records from the expenditure diaries used in household budget surveys – was used to estimate the bulk discount schedule for four foods in urban Papua New Guinea. There is a small discount for buying in bulk, which when combined with the propensity of richer households to buy larger quantities in each transaction, gives an elasticity of food prices with respect to household income of -0.012 percent.

This rather small price disadvantage facing the poor would be overstated if unit values were used instead of transaction-level unit prices. The overstatement occurs even when using the methods recently developed by Rao (1997), Attanasio and Frayne (2006) and Beatty (2010) for estimating bulk discount schedules from unit values. It is not clear whether this overestimation would hold in other samples and it would be a useful exercise to repeat the current comparisons on surveys from other countries that also have transactions-level data available.

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Appendix Table 1: Regression Results for Rice Prices

	(1)	(2)	(3)	(4)	(5)
Log transaction quantity	-0.062	-0.056	-0.061	-0.061	-0.061
	(0.006)**	(0.000)**	(0.006)**	(0.005)**	(0.005)**
Log rice price (CPI for town)			0.935	0.890	0.971
			(0.163)**	(0.173)**	(0.140)**
Log total household expenditure				-0.002	-0.003
				(0.009)	(0.010)
Number of females: 0-6 years				-0.003	-0.002
				(0.006)	(0.006)
Number of males: 0-6 years				0.001	0.001
				(0.006)	(0.006)
Number of females: 7-14 years				-0.007	-0.006
				(0.006)	(0.006)
Number of males: 7-14 years				0.000	0.002
				(0.005)	(0.005)
Number of females: 15-49 years				-0.004	-0.003
				(0.008)	(0.008)
Number of males: 15-49 years				0.001	0.001
				(0.005)	(0.005)
Number of females: 50+ years				-0.005	-0.004
				(0.017)	(0.017)
Number of males: 50+ years				0.002	0.004
				(0.013)	(0.013)
Household has own food garden					0.001
					(0.011)
Has refrigerator					0.007
					(0.011)
Traditional village or settlement					-0.008
					(0.012)
Log kilometers to town center					0.003
					(0.007)
Gini for PCX (Census Division)					0.786
					(0.598)
Census Division fixed effects	Yes	Yes	Yes	Yes	No
Constant	4.415	4.382	0.332	0.558	-0.118
	(0.033)**	(0.001)**	(0.712)	(0.767)	(0.798)
R-squared	0.202	0.236	0.231	0.233	0.231
Zero slopes *F*-test	62.61**		69.37**	29.63**	27.21**

Note: Dependent variable is the logarithm of the price per kilogram for rice. Coefficients in columns (1), (3), (4) and (5) are from OLS estimates, and in column (2) from LAD estimates. *N*=1342 transactions.
Robust standard errors in ( ) are adjusted for clustering by household. + significant at 10%; *at 5%; **at 1%

Appendix Table 2: Regression Results for Canned Corned Beef (CCB) Prices

	(1)	(2)	(3)	(4)	(5)
Log transaction quantity	-0.027	-0.000	-0.028	-0.031	-0.033
	(0.013)*	(0.000)	(0.012)*	(0.013)*	(0.012)**
Log CCB price (CPI for town)			1.106	1.178	0.967
			(0.262)**	(0.261)**	(0.097)**
Log total household expenditure				0.016	0.015
				(0.011)	(0.011)
Number of females: 0-6 years				0.007	0.004
				(0.006)	(0.006)
Number of males: 0-6 years				0.005	0.005
				(0.006)	(0.007)
Number of females: 7-14 years				0.010	0.011
				(0.005)*	(0.005)*
Number of males: 7-14 years				-0.002	-0.004
				(0.007)	(0.008)
Number of females: 15-49 years				-0.006	-0.004
				(0.006)	(0.006)
Number of males: 15-49 years				0.001	0.001
				(0.003)	(0.004)
Number of females: 50+ years				0.004	0.009
				(0.018)	(0.015)
Number of males: 50+ years				0.005	0.003
				(0.012)	(0.012)
Household has own food garden					-0.004
					(0.013)
Has refrigerator					-0.010
					(0.011)
Traditional village or settlement					0.011
					(0.013)
Log kilometers to town center					-0.022
					(0.006)**
Gini for PCX (Census Division)					-0.046
					(0.095)
Census Division fixed effects	Yes	Yes	Yes	Yes	No
Constant	5.882	5.907	-0.664	-1.266	0.029
	(0.022)**	(0.000)**	(1.554)	(1.563)	(0.583)
R-squared	0.163	0.184	0.198	0.211	0.187
Zero slopes *F*-test	11.25**		13.44**	62.94**	14.35**

Note: Dependent variable is the logarithm of the price per kilogram for canned corned beef. Coefficients in columns (1), (3), (4) and (5) are from OLS estimates, and in column (2) from LAD estimates. *N*=942 transactions.
Robust standard errors in ( ) are adjusted for clustering by household. + significant at 10%; *at 5%; **at 1%

Appendix Table 3: Regression Results for Canned Fish Prices

	(1)	(2)	(3)	(4)	(5)
Log transaction quantity	-0.136	-0.073	-0.139	-0.141	-0.149
	(0.010)**	(0.000)**	(0.010)**	(0.010)**	(0.009)**
Log canned fish price (from CPI)			0.626	0.618	0.883
			(0.125)**	(0.127)**	(0.062)**
Log total household expenditure				0.010	0.009
				(0.010)	(0.010)
Number of females: 0-6 years				0.001	-0.001
				(0.005)	(0.006)
Number of males: 0-6 years				0.007	0.006
				(0.006)	(0.005)
Number of females: 7-14 years				0.002	0.002
				(0.005)	(0.005)
Number of males: 7-14 years				0.006	0.007
				(0.005)	(0.005)
Number of females: 15-49 years				-0.004	-0.002
				(0.006)	(0.006)
Number of males: 15-49 years				0.002	0.002
				(0.003)	(0.003)
Number of females: 50+ years				0.006	-0.002
				(0.015)	(0.016)
Number of males: 50+ years				-0.027	-0.007
				(0.013)*	(0.013)
Household has own food garden					0.014
					(0.013)
Has refrigerator					0.002
					(0.011)
Traditional village or settlement					-0.041
					(0.013)**
Log kilometers to town center					-0.002
					(0.008)
Gini for PCX (Census Division)					-0.387
					(0.131)**
Census Division fixed effects	Yes	Yes	Yes	Yes	No
Constant	4.907	4.983	1.769	1.700	0.605
	(0.030)**	(0.000)**	(0.628)**	(0.651)**	(0.334)+
R-squared	0.338	0.245	0.352	0.357	0.340
Zero slopes *F*-test	42.97**		45.41**	30.01**	38.26**

Note: Dependent variable is the logarithm of the price per kilogram for canned fish. Coefficients in columns (1), (3), (4) and (5) are from OLS estimates, and in column (2) from LAD estimates. *N*=1804 transactions.
Robust standard errors in ( ) are adjusted for clustering by household. + significant at 10%; *at 5%; **at 1%

Appendix Table 4: Regression Results for Frozen Chicken Prices

	(1)	(2)	(3)	(4)	(5)
Log transaction quantity	-0.097	-0.074	-0.097	-0.109	-0.112
	(0.025)**	(0.027)**	(0.025)**	(0.024)**	(0.024)**
Log frozen chicken price			-0.132	-0.153	-0.154
			(0.454)	(0.437)	(0.328)
Log total household expenditure				0.055	0.019
				(0.025)*	(0.027)
Number of females: 0-6 years				-0.025	-0.036
				(0.018)	(0.019)+
Number of males: 0-6 years				-0.004	-0.012
				(0.016)	(0.016)
Number of females: 7-14 years				-0.013	-0.008
				(0.017)	(0.016)
Number of males: 7-14 years				-0.024	-0.015
				(0.021)	(0.020)
Number of females: 15-49 years				0.001	0.005
				(0.018)	(0.018)
Number of males: 15-49 years				0.003	0.007
				(0.009)	(0.009)
Number of females: 50+ years				0.020	0.056
				(0.065)	(0.061)
Number of males: 50+ years				0.001	-0.007
				(0.040)	(0.042)
Household has own food garden					0.057
					(0.036)
Has refrigerator					0.037
					(0.029)
Traditional village or settlement					-0.066
					(0.043)
Log kilometers to town center					-0.008
					(0.021)
Gini for PCX (Census Division)					0.282
					(0.301)
Census Division fixed effects	Yes	Yes	Yes	Yes	No
Brand name fixed effects	Yes	Yes	Yes	Yes	Yes
Constant	5.714	5.763	6.363	5.904	6.337
	(0.116)**	(0.106)**	(2.227)**	(2.131)**	(1.631)**
R-squared	0.179	0.121	0.179	0.228	0.183
Zero slopes *F*-test	9.65**		8.80**	7.66**	3.91**

Note: Dependent variable is the logarithm of the price per kilogram for frozen chicken. Coefficients in columns (1), (3), (4) and (5) are from OLS estimates, and in column (2) from LAD estimates. N=257 transactions.
Robust standard errors in ( ) are adjusted for clustering by household. + significant at 10%; *at 5%; **at 1%

Appendix Table 5: Regression Results for Rice Unit Values

	(1)	(2)	(3)	(4)	(5)	(6)
ln quantity (*Q*)	-0.057	-0.069	-0.062	-0.070	0.044	-0.032
	(0.008)**	(0.021)**	(0.022)**	(0.037)+	(0.090)	(0.056)
ln total expenditure (*x*)				0.009		
				(0.030)		
ln number of purchase occasions (*n*)					-0.171	0.032
					(0.151)	(0.056)
ln food expenditure (x_f)					-0.003	-0.016
					(0.034)	(0.023)
ln km to town center			0.002	0.003		
			(0.013)	(0.014)		
live in village/settlement			-0.007	-0.001		
			(0.016)	(0.026)		
Census Div fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Month/year fixed effects	No	No	No	No	Yes	Yes
Constant	4.499	4.521	4.513	4.438	4.567	4.554
	(0.042)**	(0.055)**	(0.053)**	(0.243)**	(0.289)**	(0.190)**
R-squared	0.32	0.31	0.32	0.31	-0.30	0.39
Zero slopes *F*-test	39.10**	31.00**	21.70**	18.19**	4.68**	10.41**
First-stage *F* ln(*Q*)		19.67**	7.07**	6.41**	15.19**	4.60**
First-stage *F* ln(*x*)				20.91**		
First-stage *F* ln(x_f)					68.73**	68.73**
First-stage *F* ln(*n*)					5.43**	4.60**
Over-identification test		0.73	3.72	3.78	0.21	6.31+
Hausman test	0.33					

Note: Dependent variable is the logarithm of the unit value for rice, for *N*=335 households.
Robust standard errors in ( ). + significant at 10%; *at 5%; **at 1%

Appendix Table 6: Regression Results for Canned Meat Unit Values

	(1)	(2)	(3)	(4)	(5)	(6)
ln quantity (*Q*)	0.009	0.031	-0.015	-0.128	0.142	0.164
	(0.008)	(0.018)+	(0.025)	(0.094)	(0.106)	(0.093)+
ln total expenditure (*x*)				0.104		
				(0.063)+		
ln number of purchase occasions (*n*)					-0.238	-0.164
					(0.110)*	(0.093)+
ln food expenditure (x_f)					0.037	-0.016
					(0.065)	(0.024)
ln km to town center			0.016	0.015		
			(0.011)	(0.012)		
live in village/settlement			-0.019	-0.021		
			(0.015)	(0.018)		
Census Div fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Month/year fixed effects	No	No	No	No	Yes	Yes
Constant	5.851	5.841	5.854	4.837	5.625	6.043
	(0.030)**	(0.030)**	(0.030)**	(0.609)**	(0.571)**	(0.283)**
R-squared	0.15	0.14	0.14	-0.16	-0.07	0.05
Zero slopes *F*-test	8.89**	9.08**	8.02**	6.19**	3.86**	3.91**
First-stage *F* ln(*Q*)		40.64**	8.28**	11.77**	24.32**	9.59**
First-stage *F* ln(*x*)				62.50**		
First-stage *F* ln(x_f)					164.96**	164.96**
First-stage *F* ln(*n*)					18.01**	9.59**
Over-identification test		4.75+	4.21	3.58	2.02	2.80
Hausman test	1.85					

Notes: Dependent variable is the logarithm of the unit value for canned meat, for *N*=751 households. Robust standard errors in ( ). + significant at 10%; *at 5%; **at 1%

Appendix Table 7: Regression Results for Canned Fish Unit Values

	(1)	(2)	(3)	(4)	(5)	(6)
ln quantity (Q)	-0.055	-0.010	-0.006	-0.024	-0.021	0.023
	(0.009)**	(0.021)	(0.020)	(0.032)	(0.080)	(0.082)
ln total expenditure (x)				0.019		
				(0.023)		
ln number of purchase occasions (n)					-0.051	-0.023
					(0.079)	(0.082)
ln food expenditure (x_f)					0.032	0.003
					(0.024)	(0.022)
ln km to town center			0.004	0.006		
			(0.011)	(0.011)		
live in village/settlement			-0.021	-0.012		
			(0.014)	(0.017)		
Census Div fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Month/year fixed effects	No	No	No	No	Yes	Yes
Constant	5.050	5.021	5.017	4.833	4.711	4.937
	(0.040)**	(0.043)**	(0.043)**	(0.233)**	(0.258)**	(0.247)**
R-squared	0.39	0.36	0.35	0.38	0.39	0.36
Zero slopes F-test	28.35**	26.04**	23.28**	22.85**	16.12**	16.04**
First-stage F ln(Q)		41.56**	14.91**	13.73**	23.37**	8.71**
First-stage F ln(x)				69.89**		
First-stage F ln(x_f)					177.83**	177.83**
First-stage F ln(n)					20.66**	8.71**
Over-identification test		5.93+	6.83	7.02	1.81	7.48+
Hausman test	5.50*					

Notes: Dependent variable is the logarithm of the unit value for canned fish, for N=817 households.
Robust standard errors in ( ). + significant at 10%; *at 5%; **at 1%

Appendix Table 8: Regression Results for Chicken Unit Values

	(1)	(2)	(3)	(4)	(5)	(6)
ln quantity (*Q*)	-0.096	0.132	-0.331	-0.493	-0.387	-0.473
	(0.016)**	(0.082)	(0.127)**	(0.210)*	(0.237)	(0.235)*
ln total expenditure (*x*)				0.312		
				(0.139)*		
ln number of purchase occasions (*n*)					0.696	0.473
					(0.277)*	(0.235)*
ln food expenditure (x_f)					-0.084	0.103
					(0.129)	(0.052)*
ln km to town center			0.029	0.003		
			(0.026)	(0.038)		
live in village/settlement			-0.163	-0.142		
			(0.057)**	(0.060)*		
Census Div fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Month/year fixed effects	No	No	No	No	Yes	Yes
Constant						
R-squared	0.12	-0.21	-0.18	-0.59	0.10	0.33
Zero slopes *F*-test	3.86**	1.08	1.97*	2.46**	4.83**	12.11**
First-stage *F* ln(*Q*)		10.53**	1.49	3.40**	10.06**	3.52**
First-stage *F* ln(*x*)				26.53**		
First-stage *F* ln(x_f)					68.77**	68.77**
First-stage *F* ln(*n*)					10.50**	3.52**
Over-identification test		4.64	5.09	4.89	1.25	5.07
Hausman test	10.62**					

Notes: Dependent variable is the logarithm of the unit value for chicken, for *N*=467 households.
Robust standard errors in ( ). + significant at 10%; *at 5%; **at 1%