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An Investigation into the Farm Households Consumption Patterns in Punjab, Pakistan

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In the present study, the consumption data of paddy and wheat growing farm households were analysed using the Almost Ideal Demand System (AIDS) model, incorporating the household composition in addition to the usual price/income variables. Although the general restrictions of demand theory were rejected, the overall results were not seriously out of line of *a priori* expectations. All the own-price elasticities were negative and most of them were significant. Paddy and wheat were found to be gross complements in consumption whereas meat and pulses emerged as gross substitutes. Dairy products and meat were regarded as luxuries by the sample farm households and expenditure on these items was curtailed in response to any addition to household size. Significant quantitative dietary impacts were found associated with change in the age composition of farm households. A more detailed analysis of consumption behaviour of rural families may be merited; this may explore alternative groupings of consumption goods, additional socio-economic factors or use of panel data.

INTRODUCTION

For a wide range of development policy issues, it is important to understand how the individual consumer or household responds to changes in relative prices, real income and a household's socio-economic characteristics. The analysis of consumption patterns of households growing food crops is of special interest to agricultural policy-makers. This is because changes in agricultural price policy affect farm income which in turn alters the household consumption of commodities grown as well as the demand for other consumer goods supplied by the non-farm sector.[1] The main objective of the present study is to estimate the responsiveness of farm households in terms of their consumption of major food items[2] when faced with

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[1]This stated mechanism works through the *profit effect* within the Agricultural Household Models (AHM) framework. However, if profits are relatively insensitive to change in exogenous prices and constitute small part of full-income and if the consumption of farm produced commodity is relatively insensitive to changes in full-income, then the AHM may not yield different results from conventional supply and demand analysis [Singh *et al.* (1986), p. 29)].

[2]In this analysis, only those basic food commodities were included for which sample farmers reported prices. Therefore, some other essential food items such as fruits and vegetables were excluded in this estimation. Moreover, non-food expenses such as spendings on clothes, shoes, household repair, marriages etc. are also not considered in this analysis.

changes in prices, income or the age composition of the household. The analysis is based on consumption data collected from (177) paddy and wheat growing farm households of Daska, Gujranwala and Ferozwala tehsils in the rice-wheat zone of irrigated Punjab. The collected information pertains to consumption expenditures during 1995.

EMPIRICAL DEMAND ANALYSIS

Methodologically, two approaches are used for estimating demand equations. The first consists of specifying estimable single-equation demand functions in a pragmatic fashion without recourse to economic theory.[3] In the second approach named as complete demand system, all products are treated symmetrically and simultaneously estimated. Using the second approach, a number of demand systems have been proposed during the past fifty years under the primal, dual and flexible functional form settings but two of them have become very popular because of their relative empirical expediency. These are the Linear Expenditure System (LES) developed by Stone (1954) and the Almost Ideal Demand System (AIDS) developed by Deaton and Muellbauer (1980).[4] The latter has been widely applied in empirical research and its application has not been limited to standard consumption analysis but has also been used to analyse the demand side of an Agricultural Household Model (AHM).

Further developments in the AIDS model are still on-going. For example, Bollino (1987) has proposed a generalised version of AIDS, naming it the GAIDS. Bollino and Violi (1990) introduced a hybrid model, combining the Translog and AIDS models, called the generalised version of the Almost Ideal and Translog demand system or GAITL. Green and Alston (1990) corrected the Stone's Index for a case when prices are exactly (linearly) proportional to the index value. Moschini (1995) modified the Stone's Index for computing a price index in a situation where different measurement units are used for various commodities. However, these modifications are not widely used in the empirical analysis.

SPECIFICATION OF THE MODEL AND ESTIMATION

In consumption analysis, the choice of demand system is of primary importance because it has direct relationship with the nature of parameters or

[3]In Pakistan, a number of studies analysed the household consumption patterns using Household Income and Expenditure Survey Data (HIES). Majority of them were based on the single equation estimates, for instance, Ranis (1961); Rahman (1963); Bussink (1970); Khan (1970); Malik (1982); Cheema and Malik (1985) and Malik and Ahmad (1985). These studies have concentrated on estimating and testing the validity of the relationship between income and expenditure on different commodities [Burney and Khan (1991)].

[4]In Pakistan, Mukhtar (1985); Ahmad and Ludlow (1987); Ahmad *et al.* (1988) and Ali (1993) have used LES whereas Ali (1985) has used Extended LES and Alderman (1988) have applied AIDS for analysing the household consumption behaviour in Pakistan.

elasticities obtained [King (1979)]. For the present study, AIDS was preferred because of its theoretical superiority, being flexible in allowing, but not requiring, the general restrictions of demand theory to hold. In addition, in contrast to the LES model, it permits a full range of commodities (complementary and substitute goods, normal and inferior goods) to be analysed.

The estimation of AIDS was carried out using a system of equations comprising household budget shares for various commodity groups. The commodities included in the analysis were: paddy, wheat, meat (beef, mutton and chicken), pulses (lentils, chick peas, mash and mung bean), dairy products (liquid milk, yogurt and desi ghee) and others (sweeteners i.e. sugar and *gur*,[5] vegetable ghee/cooking oil and fuel). Thus, the system to be estimated consisted of a set of 6 budget share equations, i.e. one budget share equation for each item or commodity group. Since all budget shares sum up to unity they form a singular system of equations that cannot be estimated directly. Hence to make the system non-singular, one of the share equations has to be dropped arbitrarily.

For *i*th commodity, the budget share equation used for empirical estimation was,

$$w_i = \alpha_i + \sum_{i=j=1}^{6} \gamma_{ij} \log p_j + \beta_i \log\left[\frac{M}{P}\right] + \sum_{h=1}^{3} \theta_{ih} H_h \qquad \ldots \qquad \ldots \qquad (1)$$

where

w_i = Budget share for *i*th commodity group.
M = Per capita expenditure on all consumption items included in the model.
P = Stones' index estimated as $\log P = \sum w_j \log P_j$
H_h = No. of household members of type *h*:
h = 1, children (aged $\leq$ 5 years).
= 2, adolescents (aged 5–15 years).
= 3, adults (aged over 15 years).
p_j = Price/unit or aggregate price of consumption items in group *j*.
i,j = 1, paddy.
= 2, wheat.
= 3, meats.
= 4, pulses.
= 5, milk.
= 6, others.
α_i, γ_{ij}, β_i and θ_{ih} are parameters to be estimated.

For a group containing two or more commodities such as meat, following Adulavidhaya *et al.* (1984), the aggregate price of a group of consumption items was

[5]*Gur* is raw sugar, available in the form of lumps. The sugarcane crop is mainly grown in the mixed cropping zone of Punjab.

computed by using the following formula:

$$P_{cg} = \prod_{i=1}^{n} P_{cgi}^{w_i} \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (2)$$

where

$$w_i = \frac{P_{cgi}\, Q_{cgi}}{\sum_{i=1}^{n} P_{cgi}\, Q_{cgi}}$$

and

P_{cg} = The aggregate price (Rs/kg) of a consumption group.
P_{cgi} = The money price (Rs/kg) of the *i*th item in a consumption group.
Q_{cgi} = The quantity in kilograms of the *i*th item in a consumption group.

Regarding the general restrictions for the AIDS model, adding-up requires that $\sum_i \gamma_{ij} = 0$, $\sum_i \beta_i = 0$, homogeneity implies $\sum_j \gamma_{ij} = 0$ and symmetry implies $\gamma_{ij} = \gamma_{ji}$. The uncompensated own-price (ε_{ii}), cross-price (ε_{ij}), income (η_i) and household age composition elasticities (ϕ_i) were computed from the parameter estimates using following expressions:

$$\varepsilon_{ii} = -1 + \frac{(\gamma_{ii} - \beta_i w_i)}{w_i} \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (3)$$

$$\varepsilon_{ij} = \frac{(\gamma_{ij} - \beta_i w_j)}{w_i} \quad \text{for } i \neq j \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (4)$$

$$\eta_i = \frac{\beta_i}{w_i} + 1 \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (5)$$

$$\phi_{ih} = \frac{\theta_{ih} H_h - \beta_i \left[\frac{H_h}{N}\right]}{w_i} \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (6)$$

where N is the total family size.

Moreover, the impact of a change in family composition on the household income (i.e. the change in expenditure on *i*th good as a percent of household income) was estimated using the following equation (for derivation, see annex):

$$\Omega_{ih} = \left[\theta_{ih} - \beta_i \log\left[\frac{N+1}{N}\right]\right] * 100 \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (7)$$

RESULTS AND DISCUSSION

Descriptive statistics about the budget shares of various commodity groups, their aggregate prices and the age composition of the sample households are presented in Table 1. It can be observed that cereals (i.e. paddy and wheat) constituted more than 22 percent of household expenditure whereas milk and its products were major consumption items having average budget shares of more than 43 percent. The coefficients of variations for prices of various commodity groups ranged between 8 and 43 percent. The largest variation was observed for the aggregated price of meat. This is attributed to large differences in the price of various meat types such as beef, mutton and chicken. Wheat prices exhibited the least variation. Regarding age composition, the average sample household was composed of 1.34 children, 2.29 adolescents and 5.67 adults.

Table 1

Descriptive Statistics About Budget Shares of Various Commodity Groups, Their Respective Aggregated Prices and Age Composition of Farm Households in the Study Area

Commodity Group (%)	Mean	Standard Deviation	Coefficient Variation
Average Budget Shares (%)			
Paddy	10.34	4.76	46.03
Wheat	11.92	3.86	32.38
Meat	12.12	9.07	74.83
Pulses	5.90	3.14	53.22
Milk and Its Products	43.17	11.30	26.18
Others[1]	16.55	5.75	34.74
Prices/Unit			
Paddy (Rs/40 Kg)	213.61	21.73	10.17
Wheat (Rs/40 Kg)	154.49	11.69	7.57
Meat (Rs/Kg)	61.16	26.19	42.82
Pulses (Rs/Kg)	28.11	2.88	10.25
Milk (Rs/Litre)	8.81	0.85	9.65
Others (Rs/Unit)	34.12	5.41	15.86
Household Composition by Age (Nos./Household)			
Children ($\leq$ 5 Years)	1.34	1.33	99.01
Adolescents (5–15 Years)	2.29	1.98	86.36
Adults (> 15 Years)	5.67	2.53	44.69

[1]The items included under the category 'others' are sweeteners, fats and fuel.

The restrictions of homogeneity and homogeneity with symmetry were tested using the likelihood ratio test (Table 2). Both sets of restrictions were rejected. In empirical research, such rejection of the restrictions implied by the demand theory is not uncommon. For example, the rejection of homogeneity has been reported by Blanciforti and Green (1983). The rejection of symmetry with homogeneity has also been recorded by Mergos and Donatos (1989). Moreover, Deaton and Muellbauer (1980) stated that if homogeneity does not hold, it is not possible to know whether we should expect symmetry to hold. In the context of the present study, a number of reasons for rejecting the restrictions may be offered: the theory is inappropriate (the sample households do not maximise utility), the model is mis-specified (for example, the commodity aggregation is inappropriate), or there may be measurement errors in the data. The latter may be the most likely explanation here, since the collected data were based on memory recall of the sample farmers and so errors in reporting could not be ruled out. An additional factor may be relative lack of variation in some of the price series.

Table 2

Likelihood Ratio Test of the Homogeneity and Homogeneity with Symmetry Restrictions for the Almost Ideal Demand System

	Homogeneity	Homogeneity with Symmetry
Likelihood Function Value of Un-restricted Model	1776.47	1776.47
Likelihood Function Value of Restricted Model	1766.17	1752.93
Likelihood Ratio Statistics	20.60	47.08
Critical Value at 5 Percent Significance Level	11.07	24.99
No. of Restrictions	5	15
Decision:	Homogeneity is Rejected	Homo. with Symm. is Rejected

The Estimated Elasticities and their Implications

The parameter estimates of the preferred (unrestricted AIDS) model are presented in Table 3. The estimated elasticities and impacts of change in age composition of the family on household expenditure on various goods are presented in Tables 4 and 5 respectively. All own-price elasticity estimates had correct (negative) signs. With the exception of paddy, all the own-price elasticities were highly significant. Of the 30 cross-price elasticities, 14 were positive, signifying gross substitutes, and the other 16 were negative, indicating complementary consumer goods. However, majority of the cross-price elasticity estimates were non-significant. All estimated income-elasticities were positive and statistically significant.

Table 3

Parameter Estimates of the Preferred AIDS Model

Parameters	Estimates	Standard Errors	Parameters	Estimates	Standard Errors
α_1	0.20590	0.23214	α_4	0.48556	0.18236
β_1	–0.07579	0.00689	β_4	–0.02338	0.00542
γ_{11}	0.07158	0.02707	γ_{41}	–0.04082	0.02126
γ_{12}	–0.01374	0.03771	γ_{42}	–0.01547	0.02962
γ_{13}	–0.00303	0.00204	γ_{43}	–0.00228	0.00160
γ_{14}	–0.00624	0.01021	γ_{44}	0.02567	0.00802
γ_{15}	–0.00007	0.02865	γ_{45}	–0.05438	0.02251
γ_{16}	0.00173	0.01763	γ_{46}	0.01206	0.01385
θ_{11}	–0.00246	0.00224	θ_{41}	–0.00289	0.00176
θ_{12}	–0.00101	0.00140	θ_{42}	–0.00015	0.00110
θ_{13}	–0.00155	0.00111	θ_{43}	–0.00189	0.00087
α_2	0.82546	0.17913	α_5	0.39916	0.36430
β_2	–0.05754	0.00532	β_5	0.24153	0.01082
γ_{21}	–0.06176	0.02088	γ_{51}	–0.04691	0.04247
γ_{22}	0.03948	0.02909	γ_{52}	–0.07739	0.05917
γ_{23}	–0.00377	0.00157	γ_{53}	–0.01652	0.00320
γ_{24}	–0.00654	0.00788	γ_{54}	–0.03311	0.01602
γ_{25}	–0.05018	0.02211	γ_{55}	0.12669	0.04496
γ_{26}	–0.04227	0.01361	γ_{56}	–0.18551	0.02767
θ_{21}	–0.02926	0.00173	θ_{51}	0.00657	0.00352
θ_{22}	0.00097	0.00108	θ_{52}	0.00205	0.00220
θ_{23}	0.00119	0.00086	θ_{53}	0.00167	0.00174
α_3	–1.46460	0.48578	α_6	0.54847	0.19564
β_3	0.01139	0.01443	β_6	–0.09621	0.00581
γ_{31}	0.17253	0.05664	γ_{61}	–0.09463	0.02281
γ_{32}	0.02720	0.07890	γ_{62}	0.03993	0.03178
γ_{33}	0.03138	0.00427	γ_{63}	–0.00577	0.00172
γ_{34}	0.01081	0.02136	γ_{64}	0.00941	0.00860
γ_{35}	–0.00085	0.05996	γ_{65}	–0.02122	0.02415
γ_{36}	0.09280	0.03689	γ_{66}	0.12119	0.01486
θ_{31}	–0.00144	0.00469	θ_{61}	0.00315	0.00189
θ_{32}	–0.00287	0.00293	θ_{62}	0.00102	0.00118
θ_{33}	–0.00018	0.00232	θ_{63}	0.00076	0.00094
Number of Observations = 177					

Table 4

Matrix of the Estimated Income and Price Elasticities of Demand for Various Consumer Goods in the Study Area

Household Consumption Items/ Comm. Groups	Income	With Respect to the Prices of						Household Composition		
		Paddy	Wheat	Meats	Pulses	Milk	Others	Children (≤ 5 Years)	Adolescents (> 5–15 Years)	Adult (> 15 Years)
Paddy	0.2667	**–0.2317**	–0.4552	0.0595	–0.0171	0.3159	0.1381	0.0735	0.1579	0.3629
	(0.0667)	**(0.2625)**	(0.3643)	(0.0231)	(0.0990)	(0.2745)	(0.1704)	(0.0292)	(0.0337)	(0.0172)
Wheat	0.5175	–0.4680	**–0.6114**	0.0268	–0.0264	–0.2125	–0.2746	0.0366	0.1371	0.3516
	(0.0446)	(0.1756)	**(0.2437)**	(0.0154)	(0.0662)	(0.1836)	(0.1140)	(0.0195)	(0.0226)	(0.0476)
Meats	1.0941	1.4142	0.2133	**–0.7524**	0.0837	–0.0476	0.7504	–0.0294	–0.0772	–0.0659
	(0.1191)	(0.4686)	(0.6504)	**(0.0412)**	(0.1768)	(0.4902)	(0.3042)	(0.0521)	(0.0602)	(0.1272)
Pulses	0.6039	–0.6507	–0.2149	0.0093	**–0.5415**	–0.7505	0.2699	–0.0084	0.0914	0.0598
	(0.0918)	(0.3612)	(0.5013)	(0.0318)	**(0.1363)**	(0.3778)	(0.2345)	(0.0402)	(0.0464)	(0.0980)
Milk	1.5595	–0.1665	–0.2460	–0.1060	–0.1097	**–0.9481**	–0.5223	–0.0600	–0.1267	–0.3198
	(0.0251)	(0.0986)	(0.1369)	(0.0087)	(0.0372)	**(0.1032)**	(0.0640)	(0.0110)	(0.0126)	(0.0268)
Others[1]	0.4186	–0.5117	0.3106	0.0356	0.0912	0.1228	**–0.1715**	0.1088	0.1569	0.3812
	(0.0351)	(0.1382)	(0.1918)	(0.0122)	(0.0521)	(0.1445)	**(0.0897)**	(0.0154)	(0.0178)	(0.0375)

Figures in parentheses are standard errors of the elasticity estimates computed at mean values.

[1] The items included under the category 'others' are sweeteners, fats and fuel.

Table 5

Percent Change in Household Income Spent on Various Commodities Due to Change in Family Composition

Household Consumption Items/ Commodity Group	Household Composition		
	Children (≤ 5 Years)	Adolescents (> 5–15 Years)	Adults (> 15 Years)
	……impact as percent of H/H income……		
Paddy	0.528	0.673	0.619
Wheat	0.295	0.685	0.707
Meats	–0.260	–0.403	–0.134
Pulses	–0.050	0.224	0.050
Milk	–1.810	–2.262	–2.299
Other	1.298	1.085	1.058

Among food grains, the own-price elasticity of wheat was much higher than paddy implying that sampled households were relatively more responsive to changes in the price of wheat compared to paddy. But both paddy and wheat were price inelastic, possibly reflecting the fact that they were integral items of the household diet whereas their cross-price elasticities were negative indicating that they were the gross complements in consumption.[6] Regarding the consumption of protein goods, the own-price elasticity of meat was higher than the own-price elasticity of pulses. The positive value of their cross-price elasticities implied that they were gross substitutes[7] but the estimates were statistically non-significant. Estimates for the income elasticities of meat and dairy products implied that these items were luxuries[8] ($\eta_i > 1$). A rise in household income would lead to relatively higher consumption of pulses and wheat.

When considering the impact of change in age composition on household consumption, particular attention focuses on the sign of the coefficient of the respective age group variable. If, for example, a child is added to the household, holding all other variables (including income) constant, the child will place a specific, additional demand on the household's consumption of food items (a "hungry mouths" effect) but since the household in a monetary sense is now worse off, the child will reduce the household's demand for (normal) food products (a "real income" effect). What is measured here is the combined impact of these responses. Thus, it is found that the demand for all commodities except meat and milk increases with the addition of a household member in each category (the hungry mouths effect

[6]Ahmad *et al.* (1988) also reported similar findings for rural consumers of Pakistan using Household Income and Expenditure Survey data for 1979. They used the Extended Linear Expenditure System model.

[7]Two goods are said to be gross substitutes if $(\delta X_i/\delta P_i) > 0$.

[8]Ali and Abedullah (1998) also reported similar findings for Pakistan using AIDS model.

outweighs the real income effect). The negative sign for milk and meat for household composition implies that the farm household curtails the expenditure on these luxurious items with the addition of members of various age groups. Moreover, for all commodities included, a consistent positive association between the magnitude of the elasticity estimates and various age groups can be observed. In other words, the magnitudes of elasticity estimates for children are smaller as compared with the adolescents and adults. This implies that a change in age composition of the family causes significant quantitative effect in the consumption patterns of the households.

On the other hand, adding a child (H_1) *ceteris paribus* reduces expenditure on meat, pulses and milk by 0.26, 0.05 and 1.81 percent of household income (i.e. the real income effect is outweighing the 'hungry mouths' effect) while the addition of an adolescent or adult increases expenses on the staple rice, wheat and pulses. The impact on expenditure of the 'luxury' meat and milk was negative for adolescents and adults (Table 5).

In summary, the pattern of food demand that has emerged from this empirical analysis suggests that changes in the prices of milk, meat and wheat will bring major changes in the diet of the sample households. On the other hand, a significant increase in the demand of milk, meats and pulses can be expected following an increase in the household income. Increases in household size *ceteris paribus* reduces the consumption of dairy products and meat but increases the demand for other food products. A change in the household age composition brings significant changes in the quantities of various commodities consumed.

Do these results have any policy relevance? Well, there are some indications. For instance, rice and wheat are generally considered consumption substitutes but were found complementary in this study. The income elasticities suggest that as rural income grows, there is relatively less demand for own consumption of rice and wheat, and greater demand for meat and milk. In the longer term, one might foresee the farm resources moving away from production of staples towards greater livestock production. Perhaps, there may be some public concern over dietary impacts in the absence of control over the prices of essential food items or lack of greater income generation opportunities for the farming families. Similarly, if the dependency ratio (children to adults) is increasing generally in rural areas, policy-makers may anticipate the impacts in a more general way.

CONCLUDING REMARKS

The empirical analysis of farm household consumption patterns reported here has yielded broadly satisfactory results both in terms of economic theory and statistical fit. All the own-price elasticities had theoretically consistent signs. Both paddy and wheat were confirmed as an essential part of the household diet as well as being complementary to one another. On the other hand, meat and pulses were found to be gross substitutes. An increase in the household income will induce substantial

expansion in household demand for meat and dairy products but consumption of these foods will decline if household size grew *ceteris paribus*. These results accord with common sense.

However, the rejection of the general restrictions of demand theory is worrisome and suggests that further analysis may be merited. One possibility would be to investigate other commodity groupings or to incorporate additional socio-economic factors in the model. The use of panel data, which would record through multi-visits, household consumption over time, could also be explored; in this way, more variation, particularly in the price data, would be introduced. Nevertheless, it is expected that results and general arguments advanced here would be quite robust and despite the limitations of the present study, it should positively contribute to the discussions on issues concerning consumption patterns of farm households in Pakistan.

Annexure

ESTIMATING THE IMPACT OF AN INCREASE IN H_h ON HOUSEHOLD EXPENDITURE

By ignoring prices, the Equation (1) can be written as

$$w_i = \alpha_i + \beta_i \log\left[\frac{M'}{N}\right] + \sum_{h=1}^{3} \theta_{ih} H_h \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \text{(i)}$$

where

M' = Total household expenditure on all consumption items included in the model, i.e. $M' = M \,.\, N$

N = Household size = $\sum_{h=1}^{3} H_h$

Equation (i) can now be written as

$$w_i = \alpha_i + \beta_i \log M' - \beta_i \log N + \sum_{h=1}^{3} \theta_{ih} H_h \quad \ldots \quad \ldots \quad \ldots \quad \text{(ii)}$$

Adding a member to type H_h, *ceteris paribus:*

$$w_i' = \alpha_i + \beta_i \log M' - \beta_i \log(N+1) + \theta_{il} H_1 + \ldots + \ldots + \theta_{ih}(H_h + 1) \quad \ldots \quad \text{(iii)}$$

Subtracting Equation (iii) from Equation (ii), we get,

$$\left(w_i' - w_i\right) = -\beta_i \log\left[\frac{N+1}{N}\right] + \theta_{ih} \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \text{(iv)}$$

where $\left(w_i' - w_i\right)$ denotes change in expenditure on *i*th good due to change in family composition in its H_h category, as

$$\left(w_i' - w_i\right) = \left[\frac{E_i'}{M'} - \frac{E_i}{M'}\right] = \left[\frac{E_i' - E_i}{M'}\right] \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \text{(v)}$$

where E_i is the total household expenditure on *i*th commodity. In percentage terms, Equation (iv) can be written as,

$$\Omega_{ih} = \left(w_i' - w_i\right)*100 = \left[-\beta_i \log\left[\frac{N+1}{N}\right] + \theta_{ih}\right]*100 \quad \ldots \quad \ldots \quad \text{(vi)}$$

where Ω_{ih} denotes the change in expenditure on good *i* as a percent of household income, i.e. Equation 7 in the text.

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