Consumer demand for selected food items:
AIDS Model Estimates for the case of Uzbekistan

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Estimation of the dynamics of change in the structure of consumer demand for food can help to predict possible volumes of demand and thus its impact on the balance in the consumer market and effective production decisions. Modeling of dynamics patterns of consumer demand can also describe the mechanisms to encourage industries oriented to domestic consumption.

Analysis of the demand based on the **macroeconomic theory of consumption** suggests that consumption is determined by income and relative prices, and also uses a number of restrictions well known from the theory of consumer behavior, i.e. the *adding-up, homogeneity and symmetry restrictions* for the aggregate demand functions. Almost all models of consumer demand use these assumptions in the assessment of demand functions, but only recently they started to account for the used *data properties*: for some of them the use of macroeconomic nonstationary annual time series data led to the spurious regressions.

Research goal of this paper is to estimate the magnitude of the income and own price and cross-price (uncompensated and compensated) elasticities using demand restrictions from the macroecomic theory. Analysis of the consumer demand dynamics for the highly-aggregated food product groups for the stationary macroeconomic statistics for the period 2000-2013 made it possible to identify behavioral relationships at the macro level in the most populous Central Asia country (Uzbekistan).

Research literature on the analysis of consumer demand shows that the dynamics and structure of consumer expenditures for goods and services is modeled in dependence with the level of prices and incomes. The widespread interest to the choise of system of demand equations representing consumer demand for various goods has started since Stone‘s (1954) linear expenditure system. Later more widely used and the most well-known approaches became the translog system (Christensen, et al., 1975) and the system of almost ideal demand equations (AIDS), described by Deaton and Muellbauer (1980a). Among the later two approaches AIDS proved to be more popular.

The parameters of the AIDS are estimated using the Linear Approximate (LA) version of the AIDS model (with linear in logarithms equations), with constant coefficients of elasticity:

$$\mathrm{Ln}\ (w_i) = \alpha_{0i} + \alpha_{1i}\ \mathrm{Ln}\ \frac{Xi}{\bar{P}} + \Sigma\beta_{ij}\mathrm{Ln}\ (P_j)$$

where w_i – the share of expenditures for the product in total consumer expenditures, $\frac{Xi}{\bar{P}}$ - income (total consumer expenditure on group of selected food items) at constant 2000 prices, P_{j-} price index for food item j (2000=100.0).

Due to the limited length of the time series it is difficult to obtain the reliable estimates of the cross-price elasticities (and determine the lack of substitution between goods). The most acceptable form of the system of demand functions is specified using following **macroeconomic assumptions** (mentioned earlier as restrictions from macroeconomic theory).

Econometric method for the estimation of the system of demand equations employed simultaneous linear equations (AIDS model) for 8-10 separate food product groups using the seemingly unrelated regression models (SUREG command in Stata 12), which produces *two-step estimates* (Zellner 1962; Zellner and Huang 1962; Zellner 1963). Even if the equations can be estimated separately without imposing any restrictions, still SUREG is choosen to estimate model and impose specified linear constraints (for homogeneity and symmetry restrictions).

Dataset used makrostatistic data on consumer expenditures in retail turnover for numerous food items: the expenditures for all categories of considered food items in log-levels (ln_Xi), their respective price indices in log-levels (ln_Pi), and the total expenditure on included food items (ln_exp), which represents a variable of overall consumer income growth. Model included following broad food items: meat, sugar, milk, bread& cereals, potato, vegetables, fruits. The calculations used time-series data at constant 2000 prices for the period 2000-2013.

Table 1 represents the results of the ADF unit root test and reveals that all log-level variables contain unit-root and only first-differences are stationary. Therefore, the model employed variables in first-differenced format.

Tabl 1. Dickey-Fuller test for unit root

Level variables	Dfuller statistic	First differences	Dfuller statistic
l_exp	-1.274	dl_exp	-3.753
l_meat_pd	0.363	dlmeat_pd	-3.164
l_fish_pd	-0.625	dlfish_pd	-2.681
l_sugar_pd	-0.024	dlsugar_pd	-2.492
l_milk_pd	-0.204	dlmilk_pd	-4.614
l_eggs_pd	-0.803	dleggs_pd	-3.676
l_breadcereals_pd	-1.560	dlbreadcereals_pd	-2.170
l_fruits_pd	-0.997	dlfruits_pd	-4.563
l_vegetables_pd	-0.326	dlvegetables_pd	-10.283
l_oils_pd	-0.194	dloils_pd	-1.933
l_potato_pd	-1.086	dlpotato_pd	-2.910
w_meat	1.210	Dwmeat	-2.465
w_fish	-0.437	Dwfish	-2.303
w_sugar	-0.496	Dwsugar	-5.585
w_milk	-0.583	Dwmilk	-3.192
w_eggs	-3.067	Dweggs	-3.174
w_breadcereals	-0.485	Dwbreadcereals	-5.386
w_fruits	-0.625	Dwfruits	-5.015
w_vegetables	-0.905	Dwvegetables	-5.601
w_oils	0.817	Dwoils	-2.319
w_potato	-0.883	Dwpotato	-3.776
Critical Value		**Critical Value**	
1%	**-3.75**	**1%**	**-3.75**
5%	**-3.00**	**5%**	**-3.00**
10%	**-2.63**	**10%**	**-2.63**

Estimated parameters of estimated demand systems (shown in table 2) were used further to calculate compensated, uncompensated and expenditure elasticities.

Table 2. Parameters of demand functions for food

	dwmeat	dwsugar	dwmilk	dwbread& cereals	dwpotato	dwvege tables	dlfruits
dlmeat_pd	**-0.08****	- 0.09***	0.02**	0.01	0.01	0.02*	0.11
dlsugar_pd	-0.09***	**0.01**	0.00	0.04**	0.02**	0.00	0.01
dlmilk_pd	0.02**	0.00	**-0.02*****	0.01	0.00	-0.01*	0.00
dlbread& cereals_pd	0.01	0.04**	0.01	**-0.05**	0.01	-0.01	-0.02
dlpotato_pd	0.01	0.02**	0.00	0.01	**-0.01**	0.00	-0.02
dlvegetables_ pd	0.02*	0.00	-0.01*	-0.01	0.00	**-0.01**	0.00
dlfruits_pd	0.11***	0.01	0.00	-0.02	-0.02**	0.00	**-0.08**
dl_exp	**-0.19*****	**0.01**	**0.00**	**0.23****	**0.00**	**-0.08*****	**0.03**
_cons	0.00	0.00	0.00	-0.01	0.00	0.00	0.01

*** Indicates significance at 1% significance level
** Indicates significance at 5% significance level

Results of the likelihood-ratio test on the weak separability of fruits food group are given in table 3.Test rejects the null hypothesis on separability of the fruits (equality of cross-price elasticities for fruits group to zero), meaning that fruits should be included into the model. Separability tests between the rest food items all reject the null hypothesis, confirming that all considered products should be modeled together.

Table 3. Likelihood-ratio test

Likelihood-ratio test	**LR chi2(9) = 249.45**
(Assumption: Sureg_Restri~d nested in Sureg_UnRest~d) Prob > chi2 =	**0.0000**

The calculated own and cross- Hiksian (compensated) and Marshalian (uncompensated) price elasticities for each food product group are shown in tables 4 and 5, whereas calculated expenditure (income) elasticities are shown in table 6.

Table 4. Hiksian Compensated Price Elasticities

	dwmeat	dwsugar	dwmilk	dwbread& cereals	dwpotato	dwvege-tables	dwfruits
dlmeat_pd	**-0.92**	-0.83	1.20	0.36	0.45	0.49	1.49
dwsugar_pd	-0.19	**-0.80**	0.18	0.21	0.44	0.11	0.18
dlmilk_pd	0.09	0.06	**-1.91**	0.06	0.02	-0.04	-0.02
dlbread& cereals_pd	0.35	0.90	0.76	**-0.83**	0.51	0.27	0.14
dlpotato_pd	0.06	0.27	0.04	0.07	**-1.10**	0.05	-0.20
dlvegeta-bles_pd	0.16	0.16	-0.17	0.09	0.11	**-0.96**	0.09
dlfruits_pd	0.45	0.24	-0.09	0.04	-0.43	0.09	**-1.68**

Table 5. Marshalian Uncompensated Price Elasticities

	dwmeat	dwsugar	dwmilk	dwbread & cereals	dwpotato	dwvege-tables	dwfruits
dlmeat_pd	**-1.06**	-1.20	0.88	-0.21	0.14	0.41	1.05
dlsugar_pd	-0.22	**-0.88**	0.10	0.08	0.37	0.09	0.08
dlmilk_pd	0.08	0.03	**-1.93**	0.02	0.00	-0.05	-0.06
dlbread& cereals_pd	0.22	0.54	0.46	**-1.38**	0.20	0.18	-0.29
dlpotato_pd	0.04	0.22	-0.01	-0.01	**-1.14**	0.04	-0.26
dloils_pd	0.11	0.04	-0.27	-0.09	0.01	**-0.99**	-0.05
dlvege-tables_pd	0.41	0.13	-0.19	-0.13	-0.52	0.06	**-1.81**

The results show that **uncompensated (Marshalian) own price-elasticities** (which include both substitution/pure price and income effect) are the largest for milk (dairy) products and fruits (-1,93 and -1,81, accordingly). The almost unit elastic are potato (-1,14), meat (-1,06), vegetables (-0,99).

In terms of **compensated own price-elasticities, that contain only pure price effect,** milk (dairy) products and fruits are the most elastic (-1,91 and -1,68, accordingly), followed by potato (-1,10), vegetables (-0,96), meat (-0,92), and sugar (-0.80). The large income effect decreased Hiksian (compensated) own price elasticity for bread products & cereals group (-0,83), meaning that increase in price on bread products & cereals decreases real incomes of consumers the most.

Table 6. Expenditure (Income) Elasticities

	dwmeat	dwsugar	dwmilk	dwbread& cereals	dwpotato	dwvege-tables	dwfruits
dl_exp	**0.41**	**1.12**	**0.96**	**1.73**	**0.94**	**0.26**	**1.33**

Expenditure (income) elasticities of bread products & cereals (1,73), fruits (1.33), and sugar and confectionary (1,12) are greater than one, indicating that they are luxury goods. Thus, the expenditure elasticity for bread&cereals, fruits, and sugar and confectionary as the most elastic can lead to conclusion that domestic consumers will increase their consumption of bread products & cereals, fruits, and sugar and confectionary.

These elasticities on demand relations can be further used as input parameters in prediction models for food demand. For instance, estimated effect of price changes on the demand for considered food commodities can make countribution to the prediction of changes in the dynamics and structure of consumer demand for individual food groups from import and export price changes, tariff and exchange-rate and consumption tax changes.

It can be futher noted that this study yet has its own ***merits***.

First of all, it uses basic demand theory and enforces necessary properties such as homogeneity and symmetry for demand model specifications. Contrary to the single equation techniques previously used to analyze food demand relations this kind of estimates can’t be criticized as having shortcomings in the functional forms used. Theoretical demand relations on demand for food items in this study include the restrictions of adding-up, homogeneity and symmetry in the Linear Approximate (LA) version of the AIDS model.

Furthermore, analysis of the characteristics of the annual time-series data used revealed their nonstationarity (which is usual in case of macroecomic data). The reliability of the estimated parameters and elasticities was increased due to the use of differenced variables.

Obtained estimations showed a number of ***useful insights*** into the forces behind the dynamics of the consumer demand for selected food items. Primarily, relatively low **expenditure elasticity** of meat (0,41) and vegetables (0,26) indicates that by the moment they are the necessities in national diet.

On the other hand, bread products & cereals (1,73), fruits (1.33) have the highest elasticity and domestic consumers will increase their share in consumption with increase in the level of per capita income. The demand for the potato (0,94) and milk (0,96) is almost unit income elastic indicating that it will grow with the average growth rate of consumer expenditures on food.

Third, estimates of **own price** marshalian **elasticities** showed that demand for milk (dairy) products are can be highly influenced by the volatility of the consumer products price (decrease in milk price on 1 percent leads to increase of consumption by 1,93 percent), as well as for fruits (1,81).

Forth, high own price elasticities (which include both substitution/pure price and income effect) are also a characteristic of bread products & cereals food group (-1,38), but income effect (change in real incomes) for this group is the highest amongst the considered food groups (meat, sugar, milk, bread& cereals, potato, vegetables, fruits) and amounts to 40% (0.55 p.p./1.38 p.p.) of the total uncompensated price elasticity, indicating that increase in price on bread products & cereals decreases real incomes of consumers the most.

In terms of **compensated own price elasticities,** that contain only pure price effect, milk (dairy) products and fruits are the most elastic (-1,91 and -1,68, accordingly), followed by vegetables (-0,96), meat (-0,92), and sugar (-0.80).

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