Wojciech J. Florkowski[*], Łukasz Hołubowicz[**], Maciej Muczyński[**]

[*]*University of Georgia, USA,* [**]*Higher School of Economics in Bialystok*

FACTORS DETERMINING APPLE EXPENDITURE AMONG HOUSEHOLDS OF DIFFERENT INCOME LEVEL IN POLAND[1]

CZYNNIKI DETERMINUJĄCE WYDATKI NA JABŁKA W GOSPODARSTWACH DOMOWYCH RÓŻNIĄCYCH SIĘ POZIOMEM DOCHODÓW W POLSCE

Key words: quintile regression, panel data, regional differences
Słowa kluczowe: regresja kwantylowa, dane panelowe, różnice regionalne

Abstract. The study identifies consumer and household characteristics that determine the expenditure on fresh apples, the most important fruit in terms of volume consumed. Using data from the national household panel and applying the quantile regression five equations were estimated for households with the different income level and source. Low income households lower their expenditure on apples in response to the increase in the aggregate measure of the price level, but increase their expenditure to a larger extent in response to an increase in their income than households from higher income categories.

Introduction

Poland is the largest apple producer in the European Union (EU) and apples lead the country's fruit production. Between 2005 and 2009 Poland produced an average of 2,215,000 tons of apples [FAOstat 2011]. Although the annual production fluctuates due to weather events, the variety of apples supplied to Polish consumers is substantial. About 50 different varieties are produced commercially in Poland and about 25 varieties are produced in large volume [Łysiak 2011]. Polish growers continually test and adapt new varieties, improve storage facilities, and strive to apply marketing programs and merchandising techniques to effectively compete with the increasingly divers fresh fruit market in Poland. In 1990 the average per capita fruit consumption was 28.9 kg, reached 51.1 kg per capita in 2000 and amounted to 55 kg per capita in 2008 [Rocznik Statystyczny... 1999, 2010], but was still below the level of fruit consumption recommended by the Instytut Żywienia i Żywności (the Institute of Food and Nutrition). The dramatic increase in fruit consumption occurred mainly due to an increase in the consumption of imported fruit. The consumption of apples in the period 1991-1995 was 21.2 kg per capita and 23 kg in the period 2000-2002 [Strojewska 2004]. More recently, the per capita apple consumption which amounted to 18 kg in 2009 declined to 14 kg per capita in 2010 [Anonymous 2011], while the average consumption in the EU was 21 kg of apples per person.

This article examines the expenditures on apples by Polish households between 1998 and 2008, the period immediately preceding and after the accession to the EU. Poland as a large apple producing country would gain access to the large fresh fruit market within the EU. The objective is to identify the profiles of households and their expenditures on apples between two groups of households, namely those at or below the poverty level and those above it, wile accounting for the effects of joining the EU. The identified household characteristics provide insights about the importance of apples to households that could be affected by the changes in the domestic supply of apples following the broadened access of Polish apples to markets within the EU. Because domestic apples are available year-round and typically are less expensive than other fresh fruit (except for the late spring-early summer period or years of crop failure), low income households may have a different apple purchase pattern than the higher income households. Results of the analysis serve multiple purposes, from the formulation of marketing strategies by growers and distributors to welfare policy formulation aimed at assuring adequate and nutritious diet of all consumers. Although growers benefit from price increases, households which heavily depend on apples in their fresh fruit consumption are negatively affected by rising prices.

The modeling approach

A quantile regression technique offers insights that the ols technique cannot provide by painting a more comprehensive picture of the effect of the predictors on the response variable than those offered by a linear regression. In a linear regression, an estimated coefficient represents the change in the response variable produced by a unit change in the predictor variable associated with that coefficient. The quantile regression parameter quantifies the change in a specified quantile of the response variable produced by a unit change in the predictor variable [Despa 2007]. Consequently, the effects account for the variation in the predictor variable alleviating the potential bias resulting from assessing the impact using the mean value. Such approach offers potentially valuable practical insights.

Koenker and Bassett [1978] proposed the quantile regression approach which turned out to be a breakthrough in regression analysis. They extended the Laplace's median regression (least absolute deviation estimator) and generalized the ordinary sample quantiles to the regression setting [Chernozhukov 2005]. Each quantile regression characterizes a particular (center or tail) point of the conditional distribution, thus, together results of different quantile regressions provide a complete description of the underlying conditional distribution. Such analysis is particularly useful when the conditional distribution is heterogeneous and does not have a "standard" shape, such as an asymmetric, fat-tailed, or truncated distribution. Quantile regression has gained much attention in the literature, recently [Kuan 2007].

For an outcome Y and set of factors D affecting the outcome, the conventional linear conditional quantile model may be defined as:

$$Y = D`\gamma(U^*), \qquad U^*|D \sim \text{Uniform}(0, 1) \tag{1}$$

where: $\tau \, 7 \rangle \, D'\gamma(\tau)$ is strictly increasing and continuous in τ. Doksum [1974] interprets the disturbance U^* as individual ability or proneness. By construction, $D'\gamma(\tau)$ is the τ-quantile of Y conditional on D. This model generalizes the usual linear regression model $Y = D'\gamma 0 + \gamma 1(U^*)$ by allowing quantile-specific effects of covariates D. For a given quantile indexed by $\tau \in (0, 1)$, the quantile specific effects $\gamma(\tau)$ can be estimated using quantile regression methods [Chernozhukov, Hansen 2005].

The results of the quantile regression estimation are particularly useful in generating insights applicable in policy formulation. A policy-maker prefers to know the difference between the ten percent and the 90 percent quantiles in terms of expenditure on apples in anticipation of the increase of the main fresh fruit prices that will determined the fresh fruit consumption by the poorest households.

The data and variable selection

The study uses data from a household panel collected between 1998 and 2004. The data are collected annually by the Main Statistical Office (GUS) from a nationally representative panel of about 30,000 households. The exact number of households varies slightly from year to year, from 31,756 in 1998 to 36,163 in 2000. The summary of the panel data is publicly available, but the detailed household data used in this study had to be extracted from the GUS data base at the request of researchers. The data were collected from each of the 16 administrative provinces or „wojewodztwo," the largest unit in the administrative division of the country. The sample was divided into two groups according to the level of income. The threshold was the value of minimal income published by the Instytut Spraw Socjalnych as listed for year 2006 times 2.5. Households with that level of income or lower were classified as poverty households.

The data are the expenditure on specific foods or food categories as well as expenditures on other goods and services. The explanatory variables included expenditure on major foods or food categories, fruit or fruit categories that could substitute for apples, and the expenditure on all other goods and services. All expenditure were measured in zlotys per month and referred to the month preceding the month of data collection by the Main Statistical Office (GUS). To identify what factors influence the expenditure on apples, the consideration was given to expenditure on main types of foods and on other types of fruits, which could substitute for apples. In addition, the data accounted for the various types of main household income, among them, income from wages, pensions, disability payments, and farm income. The differences in main income source are important because income determines the ability to exercise the preferences for a particular food. To account for the potential effect of inflation, the consumer price inflation index (CPI) was added.

Table 1. Quintile regression results of apples expenditure by Polish households between 1998-2008
Tabela 1. Wyniki regresji kwantylowej wydatków na jabłka polskich gospodarstw domowych w latach 1998-2008

Variable/*Zmienna*	Above proverty level/*Powyżej minimum socjalnego*							
	Tau=0.4		Tau=0.5		Tau=0.75		Tau=0.9	
	estimated coefficient/ *współ-czynnik*	t-statis-tics/ *t-staty-styka*	estimated coefficient/ *współ-czynnik*	t-statis-tics/ *t-staty-styka*	estimated coefficient/ *współ-czynnik*	t-statis-tics/ *t-staty-styka*	estimated coefficient/ *współ-czynnik*	t-statis-tics/ *t-staty-styka*
Constant/*Stała*	1.2380	2.91[a]	0.8432	2.95[a]	1.0583	3.51[a]	0.9817	3.39[a]
Beef/*Wołowina*	0.0085	1.56	0.0073	2.01[b]	0.0038	0.99	0.0051	1.37
Veal/*Cielęcina*	0.0066	1.23	0.0026	0.73	0.0022	0.57	0.0037	1.01
Pork/*Wieprzowina*	0.0093	1.62	0.0080	2.06[b]	0.0045	1.10	0.0115	2.91[a]
Broilers/*Drób*	1.0105	1.96[c]	0.0096	2.69[a]	0.0057	1.50	0.0071	1.94[c]
Seafood/*Owoce morza*	-0.0125	-1.66[c]	-0.0116	-2.29[b]	-0.0089	-1.66[c]	-0.0003	-0.07
Freshwater fish/*Ryby*	0.0737	7.63[a]	0.0500	7.69[a]	0.0322	4.70[a]	0.0244	3.69[a]
Barley/*Jęczmień*	0.0117	0.95	0.0166	2.01[b]	0.0164	1.88[c]	0.0080	0.96
Pasta/*Makaron*	0.0055	0.39	0.0109	1.12	0.0124	1.22	0.0069	0.70
Milk/*Mleko*	-0.0238	-0.61	-0.0365	-1.38	-0.0425	-1.53	-0.0427	-1.59
Skim milk/*Odtł. mleko*	0.0161	2.86[a]	0.0111	2.94[a]	0.0098	2.46[b]	0.0058	1.51
Potatoes/*Ziemniaki*	0.0108	1.68[c]	0.0129	2.97[a]	0.0097	2.11[b]	0.0107	2.42[b]
Sugar/*Cukier*	0.0328	4.46[a]	0.0248	5.03[a]	0.0078	1.49	0.0031	0.63
Alcohol/*Alkohol*	-0.0179	-3.31[a]	-0.0120	-3.29[a]	-0.0110	-2.86[a]	-0.0060	-1.62
Other goods & serices/ *Pozostałe dobra i usługi*	0.0996	6.92[a]	0.0785	8.12[a]	0.0356	3.49[a]	0.0305	3.11[a]
Banana/*Banany*	0.0386	6.09[a]	0.0279	6.56[a]	0.0114	2.54[b]	0.0077	1.79[c]
Pear/*Brzoskwinie*	0.0659	7.29[a]	0.0521	8.58[a]	0.0333	5.19[a]	0.0245	3.97[a]
Plum/*Śliwki*	0.0665	7.06[a]	0.0540	8.53[a]	0.0396	5.93[a]	0.0389	6.05[a]
Other stone fruit/ *Pozostałe owoce twarde*	-0.0844	-11.06[a]	-0.0663	-12.92[a]	-0.0268	-4.94[a]	-0.0169	-3.24[a]
Berries/*Jagody*	-0.0328	-5.35[a]	-0.0253	-6.14[a]	-0.0205	-4.72[a]	-0.0173	-4.13[a]
Mixed fruit/*Mieszanka owoców*	0.0200	2.58[b]	0.0110	2.12[b]	0.0089	1.61	0.0112	2.11[b]
Dry fruit/*Suszone owoce*	-0.0025	-0.32	0.0096	1.85[c]	0.0050	0.90	0.0004	0.08
Citrus/*Cytrusy*	0.0657	9.32[a]	0.0475	10.03[a]	0.0344	6.87[a]	0.0270	5.61[a]
Region I/*Region I*	0.0528	1.75[c]	0.0310	1.53	0.0458	2.14[b]	0.0430	2.09[b]
Region III/*Region III*	0.0564	1.82[c]	0.0189	0.90	0.0580	2.63[a]	0.0387	1.83[c]
Income/*Przychód*	0.0065	0.81	-0.0027	-0.51	0.0083	1.46	-2.5064	-0.01
Pension/*Emerytura*	0.0088	2.03[b]	0.0079	2.71[a]	0.0099	3.21[a]	0.0101	3.38[a]
Disability payments/*Renta*	-0.0082	-1.67[c]	-0.0063	-1.91[c]	0.0013	0.38	-0.0006	-0.16
Farm income/*Dochód z gosp. rolnego*	0.0205	4.06[a]	0.0191	5.62[a]	0.0203	5.66[a]	0.0200	5.79[a]
Other farm income/ *Inne dochody*	-0.3101	-1.33	-0.0100	-0.06	-0.2708	-1.64	-0.1996	-1.25
Location/*Miejsce*	-0.6137	0.33	-0.0151	-0.49	0.0240	0.74	0.0162	0.52
EU membership/*UE*	0.0586	1.36	0.0154	0.53	-0.0061	-0.20	-0.0313	-1.07
Number of people/ *Liczba osób*	-0.0011	-0.15	-0.0032	-0.69	-0.0018	-0.36	-0.0006	-0.13
Education/*Wykształcenie*	0.0006	0.29	-0.0003	-0.20	-0.0001	-0.65	-0.0004	-0.31
CPI/*CPI*	-0.6137	-1.66[c]	-0.0822	-0.33	0.0587	0.22	0.3621	1.44

[a] Significant at: α=0.01, [b] α=0.05, [c] α=0.1./*Istotność przy: [a] α=0.01, [b] α=0.05, [c] α=0.1.*
Source: own study
Źródło: opracowanie własne

Table 2. Quintile regression results of apples expenditure by Polish households between 1998-2008
Tabela 2. Wyniki regresji kwantylowej wydatków na jabłka polskich gospodarstw domowych w latach 1998-2008

Variable/*Zmienna*	Below proverty level/*Poniżej minimum socjalnego*							
	Tau=0.4		Tau=0.5		Tau=0.75		Tau=0.9	
	estimated coefficient/ *współ-czynnik*	t-statis-tics/ *t-staty-styka*	estimated coefficient/ *współ-czynnik*	t-statis-tics/ *t-staty-styka*	estimated coefficient/ *współ-czynnik*	t-statis-tics/ *t-staty-styka*	estimated coefficient/ *współ-czynnik*	t-statis-tics/ *t-staty-styka*
Constant/*Stała*	-0.3132	-0.59	0.2463	0.63	0.6165	1.71[c]	0.6576	1.89[c]
Beef/*Wołowina*	0.0097	1.73[c]	0.0076	1.84[c]	0.0063	1.64	0.0063	1.71[c]
Veal/*Cielęcina*	0.0008	0.14	-3.8984	-0.01	0.0023	0.60	0.0026	0.69
Pork/*Wieprzowina*	0.0064	1.01	0.0053	1.14	0.0027	0.63	0.0039	0.93
Broilers/*Drób*	0.0189	3.41[a]	0.0163	3.98	0.0127	3.36[a]	0.0099	2.71[a]
Seafood/*Owoce morza*	0.0025	0.23	-0.0024	-0.31	-0.0026	-0.36	0.0020	0.29
Freshwater fish/*Ryby*	0.1091	10.70[a]	0.0616	8.22[a]	0.0342	4.93[a]	0.0254	3.79[a]
Barley/*Jęczmień*	0.0090	0.79	0.0170	2.04[b]	0.0137	1.78[b]	0.0103	1.39
Pasta/*Makaron*	0.0126	0.68	0.0143	1.06	0.0130	1.04	0.0245	2.03[b]
Milk/*Mleko*	-0.0471	-0.88	-0.0322	-0.82	-0.0778	-2.13[b]	-0.1080	-3.06[a]
Skim milk/*Odtł. mleko*	0.0183	3.01[a]	0.0101	2.26[b]	0.0057	1.37	0.0099	2.48[b]
Potatoes/*Ziemniaki*	0.0138	2.05[b]	0.0111	2.25[b]	0.0071	1.55	0.0073	1.65[c]
Sugar/*Cukier*	0.0218	2.73[a]	0.0163	2.79[a]	0.0055	1.02	0.0021	0.40
Alcohol/*Alkohol*	-0.0088	-1.60	-0.0033	-0.82	-0.0049	-1.31	-0.0052	-1.43
Other goods and serices/ *Pozostałe dobra i usługi*	0.0629	5.86[a]	0.0459	5.82[a]	0.0322	4.41	0.0258	3.65[a]
Banana/*Banany*	0.0357	5.37[a]	0.0225	4.60[a]	0.0085	1.89[c]	0.0074	1.70[c]
Pear/*Brzoskwinie*	0.0656	5.43[c]	0.0495	5.57[a]	0.0233	2.83[a]	0.0335	4.22[a]
Plum/*Śliwki*	0.0822	7.78[a]	0.0636	8.19[a]	0.0506	7.04[a]	0.0272	3.93[a]
Other stone fruit/ *Pozostałe owoce twarde*	-0.0822	-8.87[a]	-0.0507	-7.45[a]	-0.0265	-4.21[a]	-0.0162	-2.66[a]
Berries/*Jagody*	-0.0873	-12.35[a]	-0.0509	-9.80[a]	-0.0277	-5.75[a]	-0.0166	-3.58[a]
Mixed fruit/*Mieszanka owoców*	0.0259	2.59[a]	0.0242	3.30[a]	0.0224	3.30[a]	0.0182	2.77[a]
Dry fruit/*Suszone owoce*	0.0078	0.73	0.0081	1.03	0.0130	1.80[c]	0.0090	1.29
Citrus/*Cytrusy*	0.05135	7.65[a]	0.0367	7.44[a]	0.0273	5.98[a]	0.0174	3.94[a]
Region I/*Region I*	0.0378	1.22	0.0316	1.39	0.0526	2.50[b]	0.0470	2.31[b]
Region III/*Region III*	-0.0031	-0.10	-0.0071	-0.30	0.0071	0.32	0.0246	1.16
Income/*Przychód*	0.0060	0.98	0.0034	0.75	-0.0008	-0.20	0.0064	1.59
Pension/*Emerytura*	0.0042	0.85	0.0065	1.80[c]	0.0008	0.25	0.0003	0.09
Disability payments/*Renta*	0.0018	0.37	6.2025	0.02	-0.0025	-0.77	0.0025	0.81
Farm income/*Dochód z gosp. rolnego*	0.0226	4.13[a]	0.0216	5.37[a]	0.0226	6.07[a]	0.0220	6.12[a]
Other farm income/ *Inne dochody*	-0.1402	-0.60	-0.0073	-0.04	0.0629	0.40	-0.0689	-0.45
Location/*Miejsce*	0.0350	0.77	0.0143	0.43	0.0010	0.03	0.0097	0.32
EU membership/*UE*	-0.1090	-2.36[b]	-0.0776	-2.29[b]	-0.0460	-1.47	-0.0405	-1.34
Number of people/ *Liczba osób*	0.0012	0.16	0.0058	1.05	0.0122	2.27[b]	0.0149	3.00[a]
Education/*Wykształcenie*	-0.0023	-1.12	0.0004	0.25	0.0001	0.09	-0.0004	-0.29
CPI/*CPI*	0.8335	1.83[c]	0.5252	1.57	0.3008	0.97	0.4355	1.46

Explanations: see tab. 1/*Objaśnienia: jak w tab. 1*
Source: own study
Źródło: opracowanie własne

The effect of the location of the respondent's residence matters in food consumption. The 16 provinces of Poland were divided into three groups according to their production of apples. Districts consistently producing large volume of apples include Mazowieckie and Lubelskie [Przybyla 2011]. Regions were specified as the binary variables and to avoid the identification problem one region was omitted from the estimation.

Results

Table 1 shows the estimation results for four quintiles, namely 40th, 50th, 75th and 90th quintiles. The selection of tau values was arbitrary and corresponds to 40 percent of the sample observations (0.4), one half (0.5) and the top ten percent of the observations (0.9), among others. The set of explanatory variables was the same for each quantile regression.

The differences in the statistical significance of variables across quintiles and between income groups were limited. The expenditures on several foods and food categories appear to repeatedly influence the expenditures on apples regardless of the classification of household according to income or the quintile. From the standpoint of exploring the differences between households classified according to the poverty threshold income and the likely interest of apple producers and distributors, the focus is on the effects of income types, CPI, the EU accession and location considering the typical apple crop of the district. Consistent positive effect on apple expenditures was exerted by the farm income in all quintiles in both groups of households. The effect showed the tendency to decrease across quintiles. Among better-off households, the pension also positively influenced apple expenditures in the three lower quintiles. Overall, the results indicate that among farm and pensioner households the expenditures on apples will increase in response to income increase.

The CPI significantly affected the expenditure on apples in the two lowest quantiles in both groups of households, but the directional effect was quite different. It is plausible that the price inflation forced the poorest households to increase the expenditures on apples because apples dominated the fresh fruit purchase of such households due to their accessibility and price-competitiveness. In the lowest quintile of households from the higher income category the increasing price level negatively influenced the expenditure on apples, possibly because such households likely considered other fresh fruit as a substitute for apples if prices increased asymmetrically. The market expansion opportunity created by the EU accession lowered the expenditures in the two lowest quintiles among poor households suggesting that perhaps apples have become more expensive and less available to them. Although insignificant statistically, the coefficient of the EU accession was negative in the other two quintiles of the low income group.

The regional location influenced the expenditure on apples. Households of the two highest quantiles among those below the minimal income level spent more on apples if they resided in regions with low apple production. Among households with more than minimal income level, the expenditure on apples increased (except 50th quintile) if they were located in regions with limited apple production or large apple production as compared to the regions with the in-between production level. In the first case, apples likely were supplied in smaller volume leading to slightly higher prices and reflected in higher expenditures, while in the latter case, in the presence of large supply, prices were low encouraging higher purchases captured by the positive influence on expenditures.

Implications

Low income households, especially those with the sever budget constraint (from the 40th and 50th quintile) seem to be most affected by factors inducing a decrease in apples supply leading to higher prices. Their apple expenditures decreased in response to an increase in the price level increase, the expansion of market after the accession to the EU, and by the limited apple production in their region. Apples are the most popular fresh fruit and for poor household likely the most often consumed fruit, therefore, such household become vulnerable to price increases that are not compensated by a proportionate income increase. The case of poor households and apple expenditures in Poland is not unique, but rather consistent with the effects observed in other countries. The asymmetry of effects from price increases induced by supply changes on households with different income levels is difficult to remedy. It is likely that poor households already receive transfer payments from the government and increasing them in response to price fluctuations is complicated, especially if the price increase is transitory. However, if the decrease in apple expenditure leads consumption chan-

ges and health problems, than, under conditions of the government-paid health system, some form of intervention may be justified. Until recently the EU provided funds for schools enabling them to serve apples to children, some inevitably from the poor households, but the program was terminated in Poland. Moreover, the last few years were characterized by poor crops if not in Poland then in other EU countries maintaining a high apple price level.

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Streszczenie

Celem artykułu było zidentyfikowanie cech konsumenta oraz gospodarstwa domowego, które istotnie wpływają na wielkość wydatków na zakup jabłek, najważniejszego świeżego owocu spożywanego w Polsce. Wykorzystując dane za lata 2001-2008 zebrane z GUS, obliczono pięć równań metodą regresji kwantylowej, aby porównać istotność zmiennych objaśniających dla gospodarstw domowych o różnej wielkości i źródle dochodów. Gospodarstwa domowe o najniższych dochodach zmniejszają wydatki na jabłka w odpowiedzi na rosnący poziom cen. Natomiast zwiększają wydatki kiedy rosną ich dochody w większym stopniu niż gospodarstwa domowe z wyższych kategorii dochodów.

Corresponding address:
prof. Wojciech J. Florkowski
University of Georgia, Griffin Campus
Agricultural and Applied Economics
1109 Experiment Street
Griffin, GA 30223-1797 USA
tel. 770 228 7231, x112
e-mail: wojciech@uga.edu