Broiler Consumption in a Transition Economy: An Application of Quantile Regression to Household Expenditure Analysis in Poland

Lukasz Holubowicz
Wyzsza Szkola Ekonomiczna w Bialymstoku
Poland

Wojciech J. Florkowski
University of Georgia, Griffin Campus
1109 Experiment Street
Griffin, GA 30223-1797   USA
Wojciech@uga.edu

and

Maciej Muczynski
Wyzsza Szkola Ekonomiczna w Bialymstoku
Poland

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Introduction
        The transition to the market economy in 1989 induced a temporary sharp decline in consumption resulting from the liberalization of prices and structural changes that the removal of the state controlled-price system. The adjustment involved the replacement of the government-controlled price system by market-driven pricing mechanism. Between 1989 and 1991, the production of poultry and consumption contracted, but starting in 1992 the economy begun a remarkable growth that continued throughout the 1990s and into the current decade. Real disposable incomes grew and the budget constraint eased. Although many households experienced a great income increase, some households continued to struggle. Income differences across households are reflected in expenditure pattern.

        This paper examines the expenditures of chicken and chicken products in Polish households relative to expenditures on other major meat types and food products. A quantile regression permits the estimation of expenditure for the various income groups providing insights that the alternative estimation methods could not give. The estimated chicken and chicken product expenditure equations provide insights into the pattern of expenditures across households at several income levels. Results show differences in expenditure indicating the relative importance of various income groups for the broiler industry. As the meat sector gains knowledge of various consumer groups to tailor marketing strategies and increase revenues, the policy decision-makers learn about the differences in the importance of broilers to households with different income levels. Such knowledge enhances the effectiveness of multiple programs, from the modification of school menus to the promotion of healthy diet.

Chicken Consumption
        Chicken is second to pork among all meat types consumed in Poland. Moreover, the consumption of chicken has been growing faster than other types of meat. The domestic meat supply between 2001 and 2008 (Figure 1) shows the growing tendency of broiler and pork, while the supply of beef has been declining. Figure 2 shows the domestic broiler production which has been growing steadily between 2002 and 2008. Recent predictions indicate that the chicken consumption in the European Union will increase by more than six percent until 2020 (wyborcza.biz, 2011) and reach 24.7 kg per person. An average Polish consumer already eats more chicken than an EU resident; in 2010 the per capita chicken consumption in Poland reached 24.5 kg vs. 23 kg in the EU.
The importance of chicken cannot be underestimated. The consumption of beef has been declining and beef has never been very popular. Although pork prices have also been fairly steady, its consumption has been flat in the recent decade. Chicken is the least expensive meat and its prices have been relatively steady until the recent feed price increase. Given the price sensitivity of Polish households, the supply of chicken is quite important in terms of meat, especially in low income households. The EU forecasts that by 2020 the region will become a net importer of chicken.

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.

A modeling method used in this paper is an instrumental variables quantile regression (IVQR) proposed by Chernozhukov and Hansen (2005) with lagged endogenous variable as an instrument. Galvao (2009) finds that conventional fixed effects estimation of the quantile regression specification suffers from bias problems like the least squares estimation. To reduce the dynamic bias in the quantile regression fixed effects estimator, he suggests the use of Chernozhukov's and Hansen's IVQR along with lagged (or lagged differences of the) regressors as instruments. Monte Carlo experiments have shown that, even in short panels, the instrumental variables estimator can substantially reduce the dynamic bias (Galvao, 2009).

In empirical studies, variables of interest (e.g., prices) are often endogenous, what makes conventional quantile regression inconsistent and hence inappropriate for reflection of causal effects of the variables on the quantiles of economic outcomes. Chernozhukov and Hansen develop a model of quantile treatment effects (QTE) in the presence of endogeneity. The principal feature of the model is the imposition of conditions which restrict the evolution of ranks across treatment states. The feature allows overcoming the endogeneity problem and recovering the true QTE through the use of instrumental variables.

The Data

The study uses data from a household panel. The data were collected between 2001 and 2008. The data were collected annually by the Main Statistical Office (Glowny Urzad Statystyczny, GUS) from a panel of about 30,000 households. The exact number of households varies slightly from year to year. The panel was representative of Poland's population and included households in each of the administrative districts and cities, towns and villages of different size. 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.

For the purpose of this study a sub-sample of 1,500 household was randomly drawn from the panel of households surveyed in 1998. For the subsequent years, 1999-2008, only the households from that original set were included in the study. The coding of the data had to be re-established because the coding system was changed several times in the period prior to the EU accession in order to assure the uniform databases.

Results

Results show distinctive differences in the amount of expenditures on broilers across income quantiles (Tables 2-5). Chicken expenditures are negatively influenced by the expenditure on veal, beef and pork across all considered quantiles, although the coefficients are not always statistically significant. The expenditures on beef lowered the expenditures on

chicken in the two highest quintiles, while veal expenditures lowered the expenditures on chicken only in the third quintile. Pork expenditures lowered the chicken expenditures in the highest and second to the lowest quintile. Seafood and freshwater fish appear to be complementary goods and led to an increase of expenditures on chicken; especially, seafood expenditure increased the latter in the two lowest quintiles, wile the freshwater fish expenditures increased chicken expenditures in all but the lowest quintile. Freshwater fish tends to be less expensive than seafood, in general.

Typically, a main dinner course includes meat, such as chicken, and side dishes. Therefore, barley and potatoes were included. Barley expenditures were statistically insignificant only in the lowest quintile and potato expenditure in the second lowest quintile. While in all other equations both variables positively influenced chicken expenditure confirming their importance to chicken expenditures and, therefore, consumption. The cooking of chicken requires commonly baking or frying. Expenditures on vegetable oil, butter and other animal fats positively influenced the expenditures on chicken suggesting complementary relationships across all quintiles, but olive oil expenditures negatively influenced the expenditures on chicken in the lowest two quintiles. Olive oil is more expensive than vegetable oils and is still relatively new in its cooking applications. The taste preferences favor the use of animal fats or butter although the use of the vegetable oil is common for both health and cost reasons. Three frequently consumed vegetables were included in the equation, i.e., onions, cucumbers, and sauerkraut, and expenditures on all three of them positively influenced the expenditures on chicken as expected. All three vegetables are often served in some form with the main dinner course.

Sugar and alcohol expenditures were included as proxies for consumption behavior. Their expenditures were positively associated with chicken expenditures. Sugar expenditures indicate a rather traditional consumption style, while alcohol accounted for lifestyle aspects of respondents. Alcohol expenditures included purchase of beer wine and spirits and likely reflected the general increasing consumption of alcohol in the period under consideration, especially beer. Beer has become a beverage of choice at dinner time among men in recent decade.

Other expenditures were positively associated with the expenditures on chicken except in the lowest quintile. This result suggests that chicken expenditure were not affected negatively by the purchase of other goods and services. The inflation mattered and was positively and significantly associated with chicken expenditures. The result was expected and the estimated coefficient was especially large in the lowest quintile indicating that households in that portion of the sample were particularly affected by the rising price level. Low income households, which already spent a relatively larger portion of their income on food than middle or high income households, increase the expenditure on chicken in response to price inflation because chicken is competitively priced. Results also confirm the existence of different regional pattern in chicken expenditures. In the two lowest quintiles, households located in eastern and southeastern districts spent less on chicken than households in the same quintiles in other districts. It is possible that such households eat different dishes, some of which are vegetarian and only flavored with animal fats. However, the accessibility is another potential factor because low income households may be located in areas with not so dense retail store network.

The membership in the EU has different effect on households falling indifferent quintiles. It negatively influenced the expenditures on chicken in the lowest quintile suggesting that besides the price increase or regional effects, the continuing exports of chicken after the accession to the EU led to lower chicken expenditure and, fair to say, lower chicken

consumption. The effect was opposite in the next quintile and insignificant in the two highest quintiles.

The magnitudes of the effects vary, especially between the households with the lower quantiles and those in the upper quantiles. The differences are particularly pronounced in consumption of other foods including various types of vegetables, foods associated with taste preferences and lifestyle (sugar and alcohol), the effect of the inflation, regional location and the EU accession.

Implications

It can be expected that an allocation of expenditure to purchases of other meat types will decrease the expenditures on chicken, especially among households that already spent less on chicken. However, an increase in expenditures on fish leads to an increase in expenditure on chicken and could signal a change towards more healthy food choices.

The expenditures on chicken by households from the lowest quintile showed particular sensitivity to the changes in the measure of the price level, CPI. The results was expected, but indicates that those that already spent relatively less on chicken are more likely to further increase their expenditures in response to increasing prices. There is little evidence that such households substitute other meat types if chicken prices increase, but, more likely, decrease their overall meat consumption including chicken.

Regional differences persist and are more pronounced among households with the relatively low expenditures on chicken. It appears that there are strong preferences for other types of meat, especially pork, in the eastern districts of Poland. Indeed another study on pork and high quality pork expenditures (Muczynski et al. 2011) seems to support this result.

The EU membership was associated with the relative decrease in the expenditures on chicken among households already spending little on this meat type. Because chicken exports have been steadily increasing during the period under consideration, it appears that even slight price increases induced by exports led to a decline in expenditures on chicken among households spending relatively less on this meat.

The meat processing sector learns about the relative importance of various quantiles distinguished by household income level. Such knowledge is important in marketing efforts and merchandising that aims at specific customer groups accounting for their ability to purchase. Consequently, the decisions based on the study results can potentially lower costs and increase revenues of producers, processors and distributors. Government agencies responsible for social welfare programs or public health and nutrition policies gained better understanding of the relative importance of the specific products for households with different income levels, the effects of regional location, and likely effects of increased exports of chicken. Because the expenditure reflects the preferences given the budget constraint, social welfare programs may accurately target household categories that would most benefit from them.

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Table 1. Descriptive statistics of the variables included in the empirical estimation

Variable	Mean	Standard dev.	Max.	Min.
Beef	14.3184	26.9346	0.00	585.00
Veal	13.1960	25.8594	0.00	422.23
Pork	8.1437	21.6242	0.00	422.80
Seafood	1.9271	8.1914	0.00	178.15
Freshwater fish	14.0984	18.9121	0.00	481.60
Barley	13.5701	23.5869	0.00	615.00
Milk	0.0596	1.2570	0.00	50.15
Skim milk	6.1076	13.0174	0.00	206.18
Olive oil	0.5298	3.3064	0.00	71.36
Vegetable oil	5.8227	6.1641	0.00	60.00
Butter	11.9978	14.2749	0.00	166.20
Other animal fat	3.2956	7.4192	0.00	120.00
Apples	8.7676	10.5679	0.00	300.00
Cucumbers	4.4079	8.6837	0.00	122.44
Onions	4.3063	7.1204	0.00	320.00
Potatoes	4.5635	14.1779	0.00	450.00
Sauerkraut	2.5309	4.7703	0.00	132.50
Imported fruit	9.8240	12.4477	0.00	165.96
Sugar	12.6549	14.1614	0.00	229.00
Alcohol	23.7636	51.9355	0.00	2392.54
Other expenditure	133.0016	265.1257	0.00	11339.48
Income from wages	1575.2990	1762.1310	0.00	35069.60
Pension	444.0001	764.1957	0.00	7676.31
Disability payments	190.5090	385.6087	0.00	2660.90
Farm income	144.2153	805.8983	0.00	32328.68
CPI	1.1312	0.0548	1.062	1.25
EU membership				
Region II				

Table 2. Quintile regression estimation results for expenditure on broilers by households in Poland, 1998-2004, (quintile=0.4).

Variable	Estimated coefficient	Standard deviation	t-statistics
Constant	-9.1930	1.0606	-8.6679***
Beef	-0.0017	0.0130	-0.1328
Veal	0.0163	0.0131	1.2467
Pork	-0.0427	0.0144	-2.9733***
Seafood	0.0610	0.0207	2.9510***
Freshwater fish	0.0340	0.0237	1.4335
Barley	0.0380	0.0276	1.3797
Milk	0.5574	0.1068	5.2173***
Skim milk	0.0175	0.0138	1.2654
Olive oil	-0.0684	0.0349	-1.9609**
Vegetable oil	0.0149	0.0158	0.9483
Butter	0.0424	0.0154	2.7466***
Other animal fat	0.0978	0.0153	6.3811***
Apples	0.0257	0.0174	1.4782
Cucumbers	0.0214	0.0147	1.4555
Onions	0.0711	0.0188	3.7921***
Potatoes	0.0270	0.0156	1.7267*
Sauerkraut	0.0454	0.0153	2.9729***
Imported fruit	0.03955	0.0175	2.2542**
Sugar	0.0286	0.0184	1.5560
Alcohol	0.0272	0.0127	2.1519**
Other expenditure[a]	0.01558	0.0277	0.5625
Income from wages	0.0094	0.0152	0.6200
Pension	0.0074	0.0106	0.7004
Disability payments	0.0238	0.0111	2.1462**
Farm income	0.4246	0.01225	34.6704***
CPI	8.9783	0.9305	9.6493***
EU membership	-0.2290	0.1031	-2.2215**
Region II	-0.2212	0.0658	-3.3590***

[a] Other expenditure = expenditure on other goods and services.
[b] Significant at $\alpha = 0.01$.
[c] Significant at $\alpha = 0.05$.
[d] Significant at $\alpha = 0.10$.

Table 3. Quintile regression estimation results for expenditure on broilers by households in Poland, 1998-2004, (quintile=0.5).

Variable	Estimated coefficient	Standard deviation	t-statistics
Constant	-3.1629	1.2951	-2.4423**
Beef	-0.0169	0.0159	-1.0677
Veal	0.0141	0.0160	0.8797
Pork	-0.0208	0.0176	-1.1825
Seafood	0.0418	0.02526	1.6533*
Freshwater fish	0.1520	0.0290	5.2479***
Barley	0.1537	0.0337	4.5655***
Milk	0.0461	0.1304	0.3536
Skim milk	0.0269	0.0168	1.5952
Olive oil	-0.1207	0.0426	-2.8355***
Vegetable oil	0.0407	0.0192	2.1154**
Butter	0.0808	0.0188	4.2855***
Other animal fat	0.0 797	0.0187	4.2581***
Apples	0.0465	0.0213	2.1899**
Cucumbers	0.0426	0.0180	2.3704**
Onions	0.1618	0.0229	7.0637***
Potatoes	0.0131	0.0191	0.6870
Sauerkraut	0.0370	0.0186	1.9852**
Imported fruit	0.0884	0.0214	4.1270***
Sugar	0.0812	0.0225	3.6126***
Alcohol	0.0353	0.0155	2.2847**
Other expenditure[a]	0.0883	0.0338	2.6121***
Income from wages	0.0139	0.0185	0.7494
Pension	0.0038	0.0130	0.2943
Disability payments	0.0229	0.0136	1.6874*
Farm income	0.0672	0.0150	4.4931***
CPI	2.8612	1.1362	2.5183**
EU membership	0.2477	0.1259	1.9685**
Region II	-0.1716	0.0804	-2.1345**

[a] Other expenditure = expenditure on other goods and services.
[b] Significant at $\alpha = 0.01$.
[c] Significant at $\alpha = 0.05$.
[d] Significant at $\alpha = 0.10$.

Table 4. Quintile regression estimation results for expenditure on broilers by households in Poland, 1998-2004, (quintile=0.75).

Variable	Estimated coefficient	Standard deviation	t-statistics
Constant	0.0341	0.3202	0.1066
Beef	-0.0148	0.0039	-3.7718***
Veal	-0.0093	0.0040	-2.3418**
Pork	-0.0119	0.0043	-2.7512***
Seafood	0.0056	0.0062	0.9010
Freshwater fish	0.0381	0.0072	5.3177***
Barley	0.0584	0.0083	7.0181***
Milk	0.0249	0.0323	0.7728
Skim milk	0.0052	0.0042	1.2368
Olive oil	-0.0129	0.0105	-1.2207
Vegetable oil	0.0154	0.0048	3.2453***
Butter	0.0255	0.0047	5.4767***
Other animal fat	0.0269	0.0046	5.7987***
Apples	0.0195	0.0053	3.7189***
Cucumbers	0.0241	0.0044	5.5334***
Onions	0.2928	0.0057	5.1707***
Potatoes	0.0108	0.0047	2.2886**
Sauerkraut	0.0119	0.0046	2.5759**
Imported fruit	0.0299	0.0053	5.6490***
Sugar	0.0239	0.0056	4.3109***
Alcohol	0.0230	0.0038	6.0132***
Other expenditure[a]	0.0293	0.0084	3.5169***
Income from wages	0.0103	0.0046	2.2504**
Pension	0.0027	0.0032	0.8567
Disability payments	-0.0034	0.0034	-1.0156
Farm income	0.0262	0.0037	7.0799***
CPI	1.1912	0.2809	4.2405
EU membership	-0.0281	0.0311	0.3667
Region II	-0.0243	0.0199	-1.2217

[a] Other expenditure = expenditure on other goods and services.
[b] Significant at $\alpha = 0.01$.
[c] Significant at $\alpha = 0.05$.
[d] Significant at $\alpha = 0.10$.

Table 5. Quintile regression estimation results for expenditure on broilers by households in Poland, 1998-2004, (quintile=0.9).

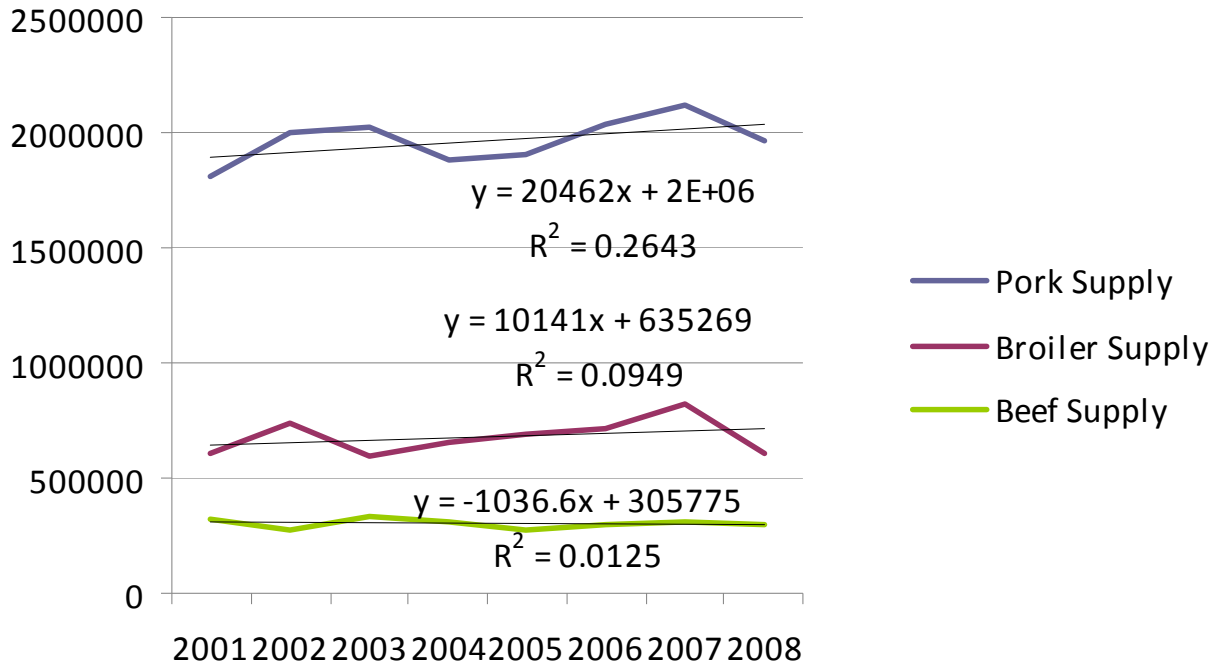| Variable	Estimated coefficient	Standard deviation	t-statistics
Constant	0.8342	0.3072	2.7151***
Beef	-0.0065	0.0038	-1.7324*
Veal	-0.0025	0.0038	-0.6624
Pork	-0.0044	0.0042	-1.0459
Seafood	0.0054	0.0060	0.9046
Freshwater fish	0.0249	0.0069	3.6183***
Barley	0.0530	0.0080	6.6330***
Milk	0.0148	0.0309	0.4795
Skim milk	0.0082	0.0040	2.0563**
Olive oil	-0.0022	0.0101	-0.2182
Vegetable oil	0.0144	0.0046	3.1475***
Butter	0.0178	0.0045	3.9880***
Other animal fat	0.0226	0.0044	5.0799***
Apples	0.0095	0.0050	1.8810*
Cucumbers	0.0127	0.0043	2.9816***
Onions	0.0211	0.0054	3.8778***
Potatoes	0.0109	0.0045	2.4117**
Sauerkraut	0.0075	0.0044	1.7042*
Imported fruit	0.0172	0.0051	3.3913***
Sugar	0.0125	0.0053	2.3360**
Alcohol	0.01712	0.0037	4.6667***
Other expenditure[a]	0.0165	0.0080	2.0561**
Income from wages	0.0076	0.0044	1.7226*
Pension	0.0010	0.0031	0.3142
Disability payments	-0..28	0.0032	-0.8610
Farm income	0.0242	0.0035	6.8140***
CPI	0.8020	0.2695	2.9755***
EU membership	-0.0242	0.0299	-0.8100
Region II	0.0301	0.0191	1.5795

[a] Other expenditure = expenditure on other goods and services.
[b] Significant at $\alpha = 0.01$.
[c] Significant at $\alpha = 0.05$.
[d] Significant at $\alpha = 0.10$.

Fig. 1. The supply of three types of meat in tons and the trend in Poland between 2001 and 2008

$y = 20462x + 2E{+}06$

$R^2 = 0.2643$

$y = 10141x + 635269$

$R^2 = 0.0949$

$y = -1036.6x + 305775$

$R^2 = 0.0125$

Pork Supply

Broiler Supply

Beef Supply

Fig. 2. Domestic broiler supply and net broiler exports and their trends, Poland, 2001-2008

$y = 30505x + 627079$
$R^2 = 0.4861$

$y = 20364x - 8190$
$R^2 = 0.9045$

Years

Tons

Net export (tons) Domestic production (tons)