Estimates of US Within Product Demand Elasticities for Meat

Nathan Fiala*

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Abstract

The effect of prices and income on food demand can be very important from a policy perspective, especially for more expensive and input intensive products such as meat. Studies thus far have focused on choices consumers make between the aggregate categories of beef, chicken and pig products, neglecting the fact that consumers may also make consumption choices between different within types of meat. Using data on prices and consumption quantities of different types of beef, chicken and pig products in the US, I find evidence of a much stronger own price and income elasticity compared to aggregate totals, suggesting that consumers consumption choices of within products may be affecting aggregate totals.

JEL Classifications: Q11, Q18

Keywords: Meat consumption, Food demand, Income elasticity, Price elasticity

1 Introduction

Total meat consumption in the US, like for most of the world, has been growing at a steady rate for a number of years. Despite the large amount of food that American's consume, this growth is not just due to population growth, but also to an increase in per capita consumption of chicken. While people have been eating roughly the same amount of beef and pig products between 1990 and 2003, chicken continues to climb and is now just as

*Department of Economics, University of California, Irvine, 3151 Social Science Plaza, Irvine, CA 92697-5100 USA. e-mail: nfiala@uci.edu.

popular as beef. This growth can be seen in Figures 1 and 2, which show the growth in total and per capita consumption respectively for beef, chicken and pig products (from FAO (2006)). Recently though this trend has slowed; Figures 3-5 breaks each meat product down into more detailed subcategories and shows total US consumption by month from January 2001 to December 2004. This suggests that consumption of some meat products may have reached a satiation point in the US. Despite this leveling off though, there is still a high level of volatility between months.

A number of studies have looked at what determines the demand for a given meat product in the US. Gossard and York (2003) look at social characteristics that may play a role using household surveys and find that gender, ethnicity, education and location all appear to be important determinants. Income was significant for beef but not significant when looking at total meat consumption. Because of limitations in their data though, they were not able to address price elasticities. A number of other studies have looked at price elasticities using aggregate US data. Chavas (1983), James Eales and Schrader (1998), Ted Schroeder and Mintert (2000) and a number of others have estimated own price demand elasticities for beef, chicken and pig products and found values ranging from -0.27 to -0.974 (for a an excellent literature review for elasticity estimates for beef, see Ted Schroeder and Mintert (2000)). Income elasticities for these studies have likewise been diverse, ranging from not significant to 1.21.

These studies though do not take into account that consumers may make consumption choices between different within types of meat. If consumers do take different within types into account when making purchases, this could affect aggregate estimates. The goal of this paper is to test this hypothesis for the US and find if income and price elasticities for within products are in fact significant.

To my knowledge there is only one study, by Eales and Unnevehr (1988), that directly addresses this question in the US or any country. Using data from 1965 to 1985 they find

almost no significance for expenditure elasticity, but some significance for price. For my purposes here though, their study does not adequately distinguish quality as they only use 5 categories across the 3 major food products.

In this paper I will use data provided by the USDA (2006), who have been compiling monthly data since January 2001 on retail scanner prices and quantity purchased for 50 different beef, 11 different chicken and 20 different pig products. Using 4 different types of beef, 3 chicken and 2 pig, I will be able to give a more detailed description about how preferences within products affect consumption patterns.

The remainder of this paper proceeds as follows. Section 2 is a description of the data. In section 3 I will outline the model I will use to estimate elasticities. In section 4 I present and discuss the results of my estimations. Section 5 is then the conclusion.

2 Data

The data I use here constitutes a monthly time series covering January 2001 to December 2004. It encompasses both total sales by category (beef, chicken and pig) and by quality within products (such as ham and bacon, which would normally all be included under pig products). As I include a lag variable, the data size is of N = 46.

Data on prices and quantity are from USDA (2006). Prices are the average price paid by the consumer before tax for selected cuts. The data was compiled from supermarkets across the US, accounting for about 20% of supermarket sales.

Quantity is the volume sold, defined as an index weighted to the average monthly amount sold in 2001, which is set at 100. For example, in December 2002, the index for total amount of beef sold is 110, meaning that month total beef sales were 10% higher than in the average month in 2001.

Data on per capita income was calculated using monthly data from Webstract (2006) on

total US production, divided by population. Because of the aggregate nature of the data, this is the best definition of per capita income I can use, though a more disaggregate data set would be ideal.

Finally, in order to better capture the supply side effects, I use a dummy variable for subsidies. This data is collected from Group (2006), who compile data on subsidies from the USDA through the freedom of information act. From 2001 to 2003, subsidies to the meat industry were quite large while in 2004 subsidies were radically decreased. This creates a natural experiment where I can also test for the effect of these subsidies. For ham, I also include a dummy for the months of April and December, the two biggest months for consumption. Other than ham consumption in April and December, there is no evidence of seasonal affects and so I do not include seasonal dummies.

3 Model

The model I will be estimating in this paper has the following functional form:

$$C_i = \alpha_i + \beta \Delta P_i + \gamma \Delta P_{-i} + \delta \Delta I + \eta \Delta L_i + \xi D_s + \epsilon_i \tag{1}$$

Here, C is a vector of per capita consumption of commodity i, P_i is a vector of the price of the commodity, P_{-i} is a matrix of prices of other products, I is a vector of income (per capita GDP) and L_i is a lag vector of consumption for the given product. D_s is a dummy variable used for the years of high subsidies (2001 to 2003). I use a percent difference model where Δ is a percent change by month, defined as $\Delta X = (X_t - X_{t-1})/X_{t-1}$.

The advantage of a percent difference model is that it avoids potential problems of trends in consumption, prices and income. That is, there is a high correlation between these vari-

ables that may simply be the result of trends the variables may have in common. Difference models can avoid this problem by decreasing the spurious correlation across variables.

This model is a standard demand equation specification. In Fiala (2006) I argued that this model is a poor specification and should be replaced with a simultaneous equations model that accounts for both a demand and supply function. I do not use the simultaneous equation model here for two reasons. First, and most importantly, the data set I am using has a small sample size with only 47 observations. A more complicated model specification would most likely not be appropriate for the asymptotic assumptions in classical regressions. Second, while I do not report the results of a simultaneous equations estimation, the results are very similar to the model presented in Equation 1.

4 Estimation Results

As I am using a difference model, the model is already in elasticities. In order to determine how much more information the within product model can give, I estimate two different models and then compare the results. The Model 1 does not take into account differences in within products. The Model 2 differentiates across products. For both I estimate Equation 1 using an OLS and present my results in Tables 1 and 2. For all tables in this paper, * refers to significance at the 90% level, ** at 95% and *** at 99%.

Table 1 is the results of regressing total consumption of each product, beef, chicken and pig, on the cross prices of each product, per capita income and a lag for the product. Own price elasticity is negative for all products and significant for both beef and pig products. Lagged consumption is also significant and shows a persistence effect that is negative, suggesting that there is a lot of volatility in consumption choices. There is also an income effect that is quite large and significant for beef products only.

Table 2 presents the results of specifying a more detailed model using quality of product.

I have included data on a number of within meat products. Beef is now separated into beef chuck, beef rib, beef steak and ground beef (less than 84%). Chicken becomes chicken breast, boneless chicken and chicken legs. Finally, pork is broken down into bacon and ham. The results of Table 2 show an own price elasticity that is negative and significant for all products except chicken legs and bacon. The income effect and lagged consumption are still large and are now significant for all products. A number of cross price elasticities are now significant, though ground beef has a negative price effect.

The results of this estimation are suggestive that using data on within products (Model 2) can give a lot more information on consumption trends than aggregate categories (Model 1). The results show that consumers are sensitive to price changes in products from the same animal. For instance, for consumption of boneless chicken breast, the cross price elasticity with chicken legs is positive and significant. This suggests that when the price of chicken legs increases, people will move consumption to other products, including another chicken product.

An interesting result of this estimation is the significant and negative cross price elasticity of ground beef across a number of products along with a negative own price elasticity for ground beef. When the price of ground beef increases, people not only consume less ground beef but also consume less of other products. This suggests that ground beef is not a substitute for other meat products, but instead either a compliment good for other meat products, or it is a general, and imperfect, signal to consumers of the general cost of meat consumption.

5 Conclusion

There are two main contributions of this paper: an estimation of meat consumption patterns using a new and data set and a estimation of the effects of within products on the choice of

what meat products to consume. The findings suggest that distinguishing within products does matter to determining how Americans make consumption choices.

While the findings of this study are suggestive, they are not conclusive. There are a number of extensions that can be made, including a better understanding of what is causing the negative cross price elasticity of ground beef. Also, as mentioned above, the work of Gossard and York (2003) suggests that meat consumption is in fact a highly cultural choice, not simply a standard choice for all groups. An estimation of demand determinants will always be incomplete when using aggregated data as there are a number of individual specific choices that may matter. This paper is thus a preliminary study to explore the importance of defining within categories of meat consumption for aggregate estimates.

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Fig. 1: Total US consumption by product in 1000 metric tonnes.

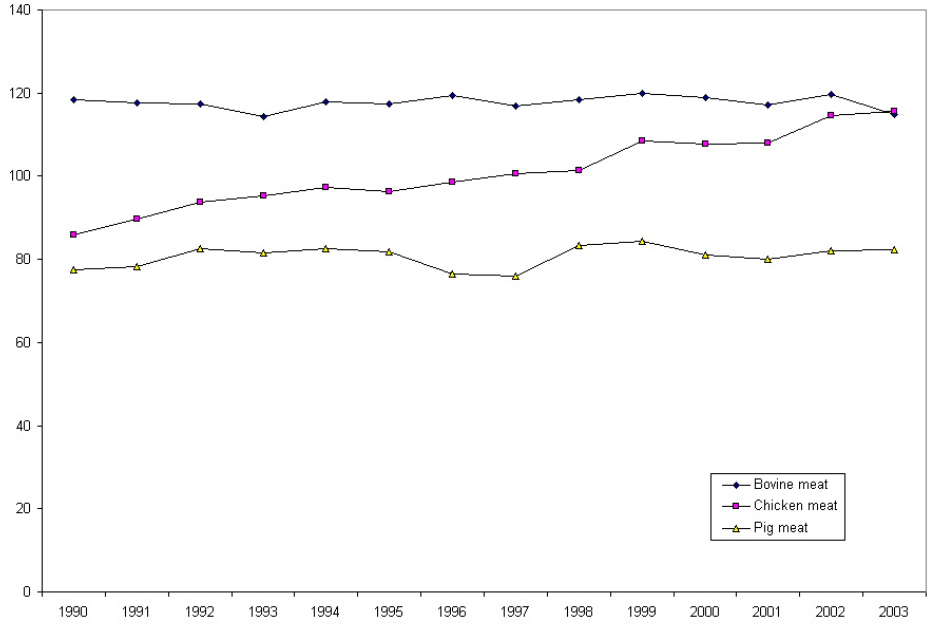

Fig. 2: Per capita US consumption by product in grams per day.

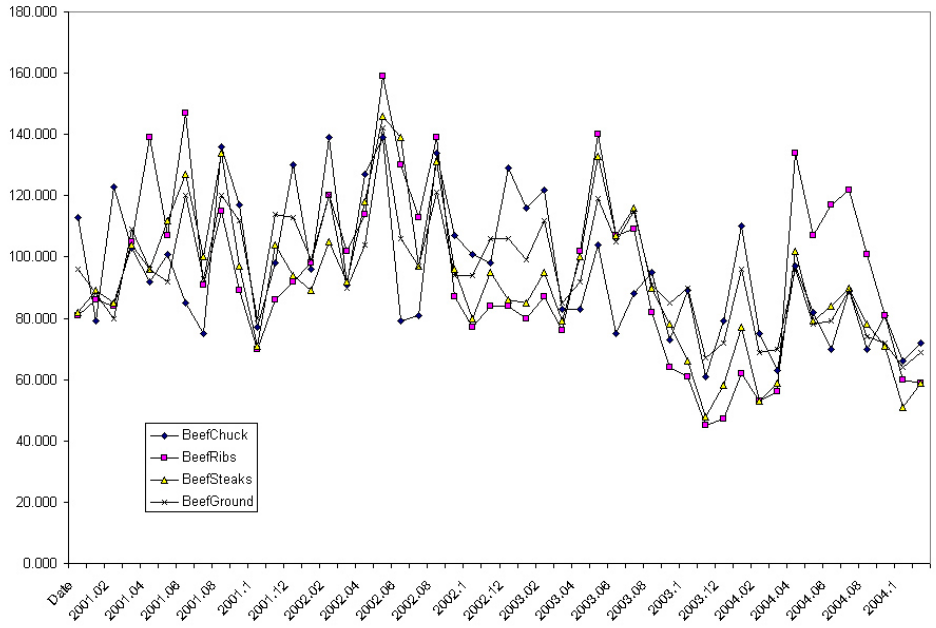

Fig. 3: Total US consumption by beef product indexed to 2001 average.

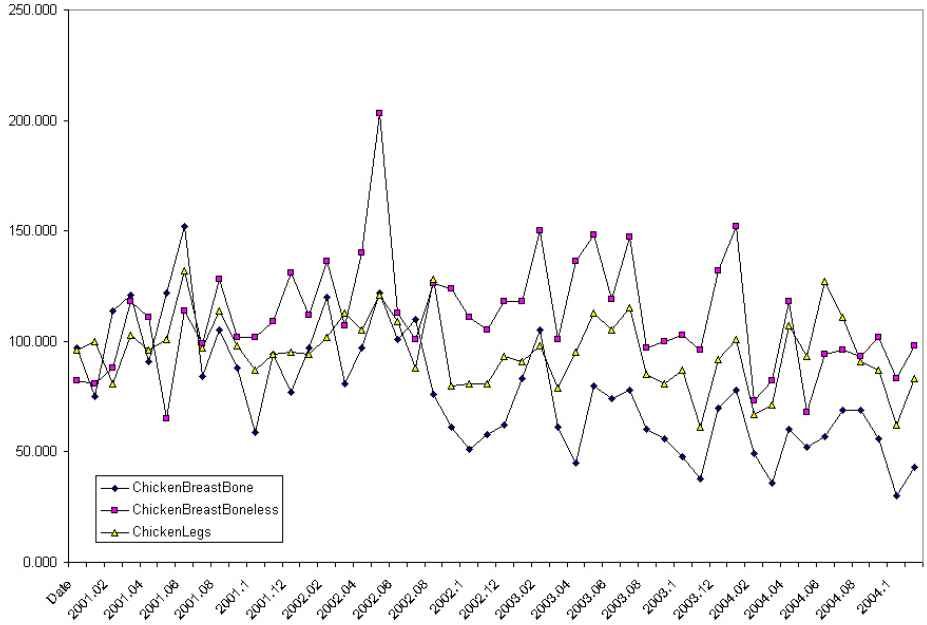

Fig. 4: Total US consumption by chicken product indexed to 2001 average.

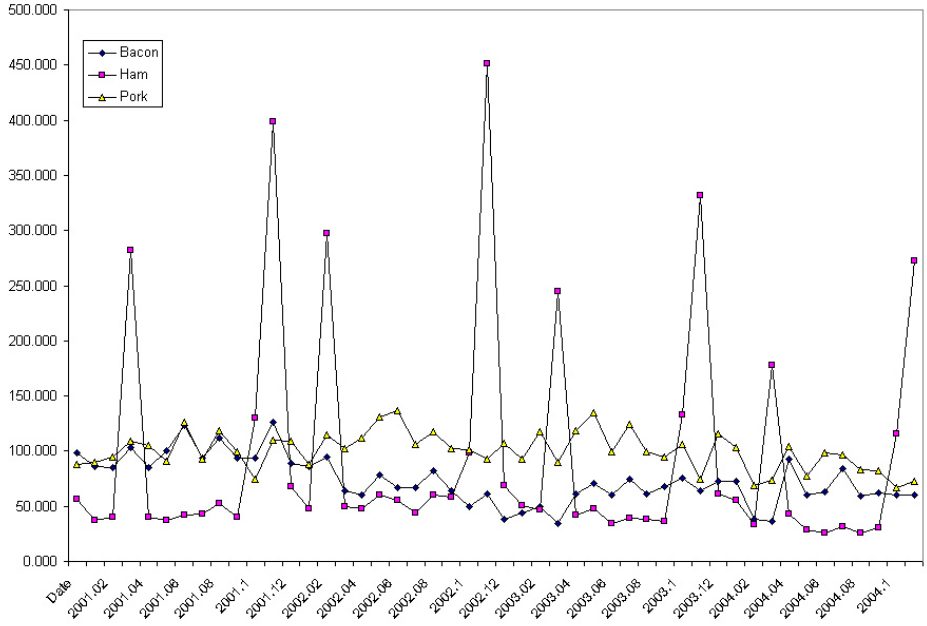

Fig. 5: Total US consumption by pig product indexed to 2001 average.

	Beef	Chicken	Pig
R^2	0.478	0.270	0.417
Beef Price	-2.069 ***	-0.710	-0.519
	(0.512)	(0.593)	(0.614)
Chicken Price	1.402 **	-0.509	0.368
	(0.583)	(0.674)	(0.686)
Pig Price	-0.111	0.212	-1.044 **
	(0.366)	(0.423)	(0.440)
Income	8.587 *	7.107	7.679
	(4.889)	(5.374)	(5.338)
Lag	-0.490 ***	-0.390 ***	-0.424 ***
	(0.127)	(0.141)	(0.132)
Subsidy Dummy	0.030	0.020	0.033
	(0.057)	(0.065)	(0.065)
Constant	0.004	0.006	-0.001
	(0.049)	(0.056)	(0.058)

Table 1: Estimation results of Model 1.

	Beef Chuck	Beef Rib	Beef Steak	Gound Beef	Chicken Breast	Boneless Chicken	Chicken Legs	Bacon	Ham
R^2	0.555	0.397	0.486	0.528	0.511	0.530	0.441	0.332	0.720
Beef Chuck Price	-1.134 **	0.295	0.369	0.418	0.309	0.600	0.558	0.569	0.005
	(0.519)	(0.589)	(0.432)	(0.352)	(0.577)	(0.465)	(0.410)	(0.689)	(2.460)
Beef Rib Price	0.097	-1.348 **	-0.624	-0.301	-0.044	-0.592	-0.030	-0.751	-2.225
	(0.506)	(0.597)	(0.439)	(0.353)	(0.579)	(0.466)	(0.421)	(0.722)	(2.439)
Beef Steak Price	-0.942	-0.633	-1.904 **	-0.618	-0.532	-0.004	-0.653	-1.231	6.242
	(0.816)	(0.946)	(0.705)	(0.572)	(0.971)	(0.762)	(0.670)	(1.123)	(3.794)
Ground Beef Price	-0.680	-1.884 **	-1.759 **	-1.956 ***	-1.318	-1.576 **	-0.909	-0.660	-0.916
	(0.799)	(0.858)	(0.668)	(0.513)	(0.904)	(0.678)	(0.608)	(1.025)	(3.382)
Chicken Breast Price	-0.164	-0.121	-0.089	-0.173	-1.615 ***	-0.401	-0.053	-0.204	0.093
	(0.330)	(0.383)	(0.285)	(0.233)	(0.380)	(0.308)	(0.270)	(0.455)	(1.664)
Boneless Chicken Price	-0.171	-0.314	-0.103	-0.056	0.146	-1.110 ***	0.081	0.183	0.660
	(0.366)	(0.457)	(0.317)	(0.255)	(0.423)	(0.340)	(0.297)	(0.534)	(1.819)
Chicken Legs Price	1.402 **	1.264 *	0.986 *	0.888 **	0.967	1.379 **	-0.247	1.372	0.097
	(0.600)	(0.697)	(0.515)	(0.419)	(0.692)	(0.554)	(0.508)	(0.821)	(2.871)
Bacon Price	0.099	2.560 *	1.605	0.676	1.284	0.762	0.577	2.770	6.573
	(1.236)	(1.511)	(1.077)	(0.870)	(1.415)	(1.143)	(1.008)	(1.894)	(5.647)
Ham Price	0.452 *	0.582 **	0.380 *	0.182	0.409	0.285	0.444 **	0.615 *	-6.482 ***
	(0.234)	(0.273)	(0.209)	(0.165)	(0.269)	(0.217)	(0.195)	(0.326)	(1.845)
Lag	-0.317 **	-0.189	-0.414 ***	-0.418 ***	-0.231	-0.393 ***	-0.440 ***	-0.406 **	0.054
	(0.138)	(0.176)	(0.150)	(0.133)	(0.141)	(0.131)	(0.150)	(0.189)	(0.182)
Income	9.917	17.925 **	14.325 **	11.863 **	10.694	9.879	11.867 *	20.157 *	5.052
	(7.569)	(8.747)	(6.420)	(5.342)	(8.466)	(6.832)	(6.052)	(10.176)	(33.874)
Subsidy Dummy	0.059	0.041	0.074	0.078	0.071	0.050	0.008	0.028	0.036
	(0.086)	(0.100)	(0.074)	(0.060)	(0.099)	(0.079)	(0.070)	(0.118)	(0.395)
Ham Dummy									1.287 *
									(0.756)
Constant	0.006	-0.003	-0.025	-0.035	-0.005	0.019	0.012	0.012	0.376
	(0.073)	(0.085)	(0.063)	(0.051)	(0.084)	(0.068)	(0.060)	(0.101)	(0.347)

Table 2: Estimation results of Model 2.