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An International Comparison of the Effects of Government Agricultural Support on Food Budget Shares

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This study evaluates econometrically the effect of government support to agriculture on a measure of the affordability of food in 10 Organization for Economic Cooperation and Development (OECD) countries. The panel model we construct specifically utilizes two values calculated by the OECD: Producer Support Estimates as a percentage of gross farm receipts and the Consumer Nominal Protection Coefficient. These two variables represent transfers from taxpayers to agricultural producers through government programs and transfers from consumers to government through protectionist measures, respectively. By using dummy variables, we find implications for groups of countries on the basis of their relative levels of support and protection.

Key Words: agricultural policy, obesity

JEL Classifications: I18, Q18

In the early 21st century, the rising incidence of obesity throughout the developed world provides an illustration of an issue involving the intersection of health, agriculture, and economics. The increase in overweight and obesity in the United States is well-documented and well known. According to the Centers for Disease Control and Prevention, the percentage of obese adults in the United States increased from 14.6% in 1971 to 32.1% in 2004 (NCHS).

Although the proportion of obese adults in the U.S. population might be the highest of any nation, several developed and developing nations have also experienced similar increases in obesity. According to the Organization for Economic Cooperation and Development (OECD), when measured between 1999 and 2005, the populations of obese adults in Australia, Canada, Greece, Mexico, New Zealand, and the United Kingdom all exceeded 20%. Only the U.S. obese adult population exceeded 30%.

Numerous articles published over the last 10 years both in economics and health–and nutrition–related disciplines have attempted to determine the source of this rise in obesity. Such studies have found the fall in labor-intensive employment and the increase in food consumption among the factors leading to the rise in obesity in the United States (Cutler, Glaeser, and Shapiro; Lakdawalla and Philipson; Philipson and Posner). Primarily since the 2002 U.S. farm bill, the popular press has frequently depicted U.S. agricultural commodity programs as an important contributor to rising obesity (Meerman; Pollan). Such reports allege these support programs increase the availability of the most fattening foods at relatively low prices because the mix of crops

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receiving most of the support represents the building blocks of such foods. However, far fewer research articles in academia have empirically investigated any presupposed relationship between obesity and U.S. agricultural policy.

This paper builds on the work of Miller and Coble, who investigate a relationship between direct government payments to producers in the United States over a 35- to 40-year period. By constructing autoregressive (AR(1)) and seemingly unrelated regression (SUR) models, they determine that direct government payments to U.S. producers are not a significant factor affecting the affordability of food. Thei results hold for food in the aggregate, as well as across different food groups. Significant explanatory variables in their models include consumer incomes and advances in technology.

The model in this paper uses data from the OECD and the Food and Agriculture Organization (FAO) of the United Nations to evaluate the effects of the OECD measure of government support to agriculture, known as a producer support estimate (PSE), and the Consumer Nominal Protection Coefficient (CNPC), a complementary measure of the effects on consumers of government policies. These effects are measured for 10 OECD nations, including the United States. Other factors examined by the model include an index of agricultural productivity and the value added to each nation's economy from agriculture as a percentage of gross domestic product.

Literature Review

As noted above, many articles published in only a few years attempt to explain the sources and causes of rising obesity, as well as the extent of the problem. The United States is perhaps the most dramatic example of how this problem has increased. However, our study takes a broader look at the issue by examining OECD member countries, which is relevant because, as Bleich et al., p. 5, note, the majority of the world's obese live in the developed world. In fact, the authors find that their analysis of the OECD health database "suggests a worldwide time-related phenomenon" in the rise of obesity. Indeed, the World Health Organization (WHO) has coined the term "globesity" to describe the pervasiveness of the problem throughout the world.

Economists can examine relationships between food and overweight and obesity through the cost of food and the cost of physical activity. For our study, the effect of food prices is the most pertinent, and a considerable body of recent literature documents these results. The widely cited paper by Lakdawalla and Philipson, for example, indicates as much as 40% of the increase in the body mass index (BMI) in the United States can be explained by declines in real food prices. Mendez and Popkin observe how food choices are influenced by prices in both developing and developed countries. The study from the previous paragraph by Bleich et al. finds a correlation between lower relative food prices and increased caloric supply; moreover, increased caloric supply accounts for over 80% of adult obesity in the developed countries they examine. Senauer and Gemma note the fall in the relative price of food because of technological advances and the attempts of economists to explain the rise in obesity because of lower costs for food and higher costs for physical activity. Gelbach, Klick, and Stratmann found a statistically significant relationship between increases in the price of healthy foods and increases in BMI, although they did not find this relationship to be economically significant. Particularly relevant to this study, Loureiro and Nayga find that agricultural policies that increase consumer support estimates in OECD countries can potentially reduce obesity through higher food prices. Huffman et al. find that an increase in the price of food "reduces tendencies for obesity," which in their results leads to a reduction in mortality because of obesity. Huffman et al., pp. 21, 23, 25, also note that countries with higher real food prices tend to have fewer deaths associated with obesity. Significantly, they state, "high income countries that have pursued cheap food policies have increased the likeli-

hood of higher obesity-related mortality rates than other high income countries.''

Thus, given research demonstrating how the relative cost of food can, in many cases, affect rates of obesity, a model with factors that significantly affect the affordability of food should provide insights into obesity-related issues. Moreover, several of the studies referenced above, in addition to the article by Loureiro and Nayga, discuss potential links to obesity and agricultural policies. Mendez and Popkin note that subsidies or other incentives can be used to make healthy fruits and vegetables more affordable. They note China, as part of the nation's nutrition plan, has promoted production and consumption of soybeans as an alternative to the use of meat. Mendez and Popkin further suggest that developing countries should investigate policies that promote the use of pulse crops as protein substitutes to reduce intake of less healthy meats. Senauer and Gemma conclude that because only a fraction of retail food prices are represented by commodity costs, the effect of agricultural subsidies on food choices is probably less than might be expected. Huffman et al. discuss the cheap food policies of high-income, developed countries, stating these policies ''are bad for human health.'' These policies can include subsidized food prices or subsidies for inputs, technology, or both. They note, however, that the high-income supports of Switzerland and Japan might be exceptions. Schmidhuber's analysis finds that the OECD countries with the highest Producer Support Estimates have the lowest levels of obesity (Switzerland, South Korea, and Japan), whereas countries with lower levels of support have much higher obesity rates (United States, Australia, and New Zealand). In determining whether these factors are merely correlated or whether a causal relationship exists, he notes that developed countries usually have much higher margins between producer prices and retail food prices than developing countries because more services are included in the price. Thus, Schmidhuber notes that policies that affect producer prices in these countries would likely have little effect on consumer food choices. On the basis of the findings discussed above, we hypothesize that the model developed in this paper will generate results similar to those of Miller and Coble, not only for the United States, but for similar developed and developing nations as well.

Data

Because of our interest in the effect of agricultural policies on the affordability of food, we construct the dependent variable in the model as a ratio of two variables. The numerator of this ratio is the Consumer Price Index for food as reported by the OECD. The denominator is an index of gross national income per capita also reported by the OECD. We convert OECD's per capita measure to an index by dividing the value for each year in the data set we use by the value reported for the year 2000, which is our base year, and multiplying the result by 100. Our dependent variable therefore becomes a ratio of two indices, each with a base year of 2000, a procedure similar to the construction of the dependent variable in the SUR model of Miller and Coble. The gross national income data are available through 2004; OECD has yet to report values for Japan and Mexico for 2005.

The model uses four independent variables: an agricultural productivity index, a value-added measure, PSEs reported by OECD as a percentage of gross agricultural receipts, and the Nominal Consumer Protection Coefficient as reported by OECD. The FAO reports its agricultural productivity index on an annual basis for all of the OECD countries used in our study. The indices generally reflect an upward trend in productivity, with some notable exceptions. The index has a base period of 1999–2001, so the average value of the index over these three years equals 100.

We also obtain the value-added measure from FAO, which reports a value for each of the countries in our study annually. The measure that FAO reports is the value added to the overall economy (i.e., GDP) by individual industries—for our purposes, the value added by agriculture, forestry, hunting,

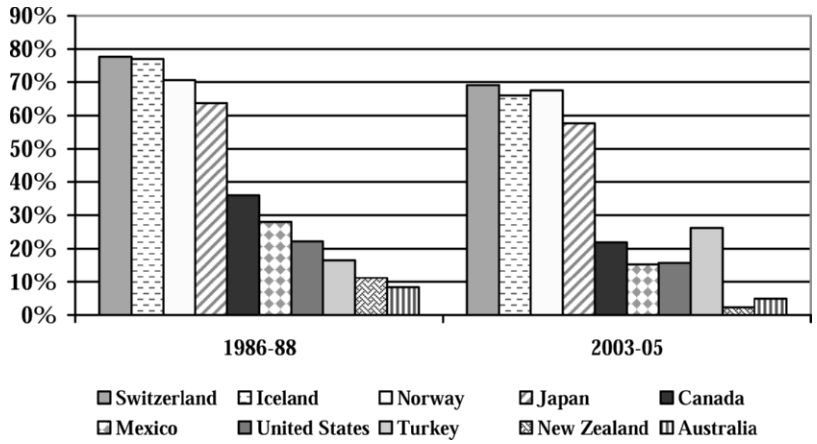

Figure 1. Producer Support Estimates as a Percentage of Gross Farm Receipts, Averages 1986–1988 and 2003–2005. Source: OECD, PSE/CSE Database 2006

and fishing. These measures represent the farm gate value of production and do not reflect the value added to agricultural commodities. To control for the size of each nation's individual economy, we reported the value added as a percentage of GDP, as reported by FAO. FAO reports this value in current U.S. dollars for each country. The purpose of including this variable is to incorporate a measure of the importance of agriculture to the economy of each nation.

The measure of agricultural support in each country in our model is the PSE as a percentage of gross agricultural receipts, values that OECD reports for each nation in our model. OECD describes its calculations of PSEs (as well as Consumer Support Estimates [CSEs]) in detail, and we will not attempt to expound on these explanations; we include this measure to represent transfers from taxpayers to agricultural producers. We use the value as a percentage of agricultural receipts to control for the size of each nation's individual economy, as with our value-added variable. The availability of PSE data from OECD prevents our model from using information before 1986, the first year for which OECD provides such data. Thus, our model uses 19 observations for each variable in each country from 1986 to 2004. Figure 1 depicts the values of the PSE data as reported by OECD, in this case, the average values over 1986–1988, the beginning of the period, and the average value at the end of the period, 2003–2005. Clearly, Figure 1 indicates that Iceland, Japan, Norway, and Switzerland provide relatively much higher levels of support compared with each country's GDP than do the other nations. This comparison holds at both the beginning and end of the period. Each country, with the exception of Turkey, has a lower value at the end of the period than at the beginning, and generally, the same relations between the measures hold.

The final independent variable included in our model is also a measure of agricultural support reported by OECD but probably not as well known: CNPC. OECD calculates NPCs for both producers and consumers, and we include the CNPC to capture the effects on consumers of a nation's protectionist agricultural policies. A value of 1.00 reflects that the domestic price equals the "border price," or the price consumers pay at the farm gate in the absence of trade restrictions. Thus, as noted by the OECD, p. 17, the CNPC is effectively "the average rate of the implicit import tax applied in the domestic market." OECD publications also describe NPC measures in detail. Figure 2 depicts the values of these coefficients in the same fashion as Figure 1 depicts the PSE percentages. Interestingly, essentially the same relationships prevail as for the PSE data. However, the four highest values in the 1986–1988 period are much lower in the 2003–2005 period,

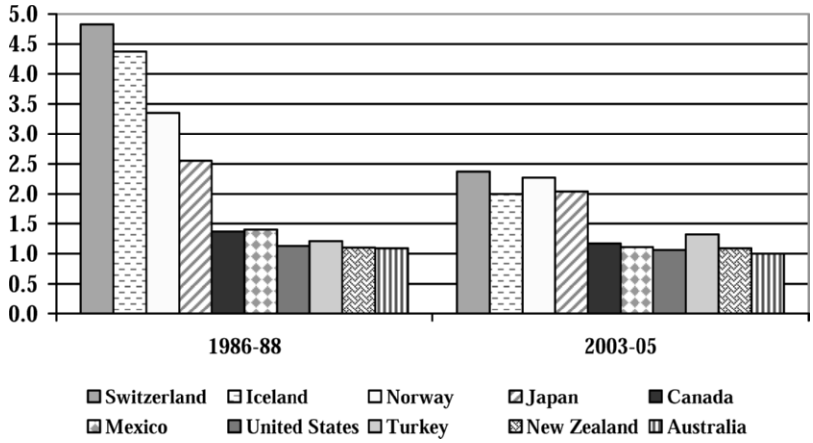

Figure 2. Consumer Nominal Protection Coefficients, Averages 1986–1988 and 2003–2005. Source: OECD, PSE/CSE Database 2006

although the same countries report the highest values. The coefficient values for the other countries are relatively low in both periods, but all countries except Turkey report lower values in the 2003–2005 period.

Model

We estimate a panel model for the 10 OECD countries with the variables as defined above. The equation for each OECD country in the model is initially

$$\text{CF}_{it} = \beta_1 + \beta_2\text{VA}_{it} + \beta_3\text{AP}_{it} + \beta_3\text{PP}_{it} + \beta_4\text{PC}_{it} + u_{it} \quad (1)$$

where, for each country i ($i = 1, 2, \ldots, 10$) in each year t ($t = 1986, 1987, \ldots, 2004$), CF is the ratio of the CPI for food to the gross national income index, VA is the percentage of GDP contributed by agriculture, PP is the PSE as a percentage of agricultural receipts, and PC is the CNPC.

However, because of the differences across OECD countries in support for and protection of agriculture, we create two sets of dummy variables as slope shifters to group these countries. The first country group consists of data for the nations of Iceland, Japan, Norway, and Switzerland, the countries that have the highest PSE and CNPC measures in our data set. Similarly, the second country group has data for the nations of Australia, New Zealand, and the United States, which have lower PSE and CNPC measures. The other countries remaining in the model are Canada, Mexico, and Turkey. Thus, with the addition of these dummy variables, the model becomes

$$\text{CF}_{it} = \beta_1 + \beta_2\text{VA}_{it} + \beta_3\text{AP}_{it} + \beta_3\text{PP}_{it} + \beta_4\text{PC}_{it} + \sum_{k=5}^{4}\beta_k\mathbf{H}_{it} + \sum_{k=9}^{4}\beta_k\mathbf{L}_{it} + u_{it} \quad (2)$$

where, for each country i ($i = 1, 2, \ldots, 10$) in each year t ($t = 1986, 1987, \ldots, 2004$), the previous variables are as defined in Equation (1), **H** is a vector of dummy variables for each independent variable for countries with relatively high support, and **L** is a vector of dummy variables for each independent variable for countries with relatively low support.

We use the SAS software package to execute a time series cross-sectional regression model according to the Parks method, which provides for an autoregressive model. Table 1 presents the results of this model. For the model in Table 1, $R^2 = .434$.

Results

The independent variable for value added to GDP by agriculture is not significant at the .05 level, indicating the relative size of each country's agriculture industry does not significantly affect our measure of food affordability. The average value as a percentage of GDP

Table 1. Results of the Panel Model Using Parks Method

Variable	Estimate[a]
Intercept	1.442* (0.674)
VA	−0.946 (0.6035)
AP	−0.005* (0.001)
PP	−0.649* (0.104)
PC	0.275* (0.045)
VAH	1.357 (1.065)
APH	0.004* (0.001)
PPH	0.061 (0.234)
PCH	−0.211* (0.048)
VAL	−0.181 (0.806)
APL	0.003* (0.001)
PPL	0.667* (0.150)
PCL	−0.393* (0.075)

[a] Numbers in parentheses are standard errors.
* Statistical significance at the $\alpha = .05$ level.

does not exceed 10% for any of the OECD countries we examined, and the values change relatively little for most of the countries over the 1986–2004 period.

The agricultural productivity index is statistically significant and negative, indicating that as a country's agricultural technology improves, food becomes more affordable by our measure. This expected finding concurs with the results of the models of Miller and Coble.

PSEs as a percentage of agricultural receipts is also a significant and negative variable at the .05 level. This variable indicates that as a country's PSE estimate becomes larger relative to agricultural receipts, food by our measure becomes more affordable. Given the levels of PSEs provided by several of the OECD countries in our model, as noted by Huffman et al. and others, this finding is not entirely unexpected.

The other variable measuring support to agriculture, the CNPC, is also significant. Its coefficient value is positive, however, indicating that protectionist measures make food relatively more expensive for consumers by our ratio variable.

The remaining variables reported in Table 1 represent the two sets of dummy variables for the group of OECD countries with relatively high support and protection measures (Iceland, Japan, Norway, and Switzerland) and those with relatively low support and protection measures (Australia, New Zealand, and the United States). Because of the nature of the panel regression model used, the significance and sign of the coefficients on these variables, one should interpret them relative to the corresponding independent variables.

Both dummy variables for valued added by agriculture lack significance, indicating that neither is significantly different from the value-added independent variable. Thus, because this variable is not significant, value added by agriculture lacks significance for any of the OECD countries in our model.

The dummy variables for agricultural productivity are both significant and positive for the "high" and "low" support countries. These coefficients indicate that, for both groups of countries, agricultural productivity has a smaller effect on our ratio variable relative to the effect on Canada, Mexico, and Turkey. The reason for this finding is not entirely clear, although the agriculture productivity indices for Japan, Norway, and Switzerland all trend down over the 1986–2004 period.

The dummy variable for PSE as a percentage of agricultural receipts for the "high"-support countries is not statistically significant, indicating that the effect of PSEs for these countries is similar to that for Canada, Mexico, and Turkey. The relatively high levels of support to agriculture provided by Iceland, Japan, Norway, and Switzerland might explain this finding. The coefficient on the dummy variable for PSEs for the "low"-support countries is significant, positive, and roughly the same size as the coefficient for the independent variable for PSEs. The finding that these two PSE variables could effectively offset each other indicates that the support provided to agricultural producers in Australia, New Zealand, and the United States has little effect on our ratio variable. Such a result is consistent with those of Miller and Coble and, given that Australia and New Zealand provide the lowest levels of support among OECD countries, makes sense.

The dummy variables for the CNPC measure are significant at the .05 level and negative for both groups of countries, indicating the effects are smaller for these countries. The negative coefficient on the CNPC dummy variable for the "high" protection countries does not offset the coefficient of the CNPC independent variable, indicating that an overall positive effect remains for this group of countries. However, the negative coefficient on the dummy variable for the "low" support countries more than offsets the coefficient of the CNPC independent variable, effectively indicating the protections in these countries—or more appropriately the lack thereof—make food relatively less expensive than in Canada, Mexico, and Turkey. The meaning of such a negative value in this context is not clear to us. Mexico and Turkey are the only two countries that have CNPC values trending up over the period we examine.

Conclusions

In this paper, we attempt to evaluate econometrically the effect of government support to agriculture on a measure of the affordability of food in 10 OECD countries. The panel model we construct specifically utilizes two values calculated by the OECD: Producer Support Estimates as a percentage of gross farm receipts and the Consumer Nominal Protection Coefficient. These two variables represent transfers from taxpayers to agricultural producers through government programs and transfers from consumers to government through protectionist measures, respectively. By the use of dummy variables, we find implications for groups of countries on the basis of their relative levels of support and protection. For Australia, New Zealand, and the United States, countries with relatively low levels of government support and few protectionist measures over the period we examine, our results indicate government involvement in agriculture has little effect on the affordability of food in these countries. These findings for the United States are consistent with those of Miller and Coble in their study on the effect of direct government payments to agricultural producers on the affordability of food.

For the other countries in our model, we find PSEs as a percentage of gross farm receipts and CNPCs both significantly affect our measure of the affordability of food. However, readers should keep some caveats in mind when assessing these results. Foremost, we note that the relative effects of support programs compared with protectionist actions affect the implications of our findings. For example, Japan provides relatively high support and protection to its agriculture, but the protection might have a larger effect than the support, affecting food prices positively as Loureiro and Nayga discuss. In addition, we grouped two sets of countries together on the basis of relative levels of support and protection to agriculture to form dummy variables. This grouping left three countries in our model not included in either dummy variable: Canada, Mexico, and Turkey. These three countries represent a rather arbitrary selection, in that Canada is more developed than Mexico and Turkey, although all three countries are relatively "middle of the road" in terms of support and protection provided to agriculture compared with the other OECD countries. However, both support and protection measures trend up and fluctuate more in Mexico and Turkey, whereas in Canada, both variables trend down and change less year to year. Thus, support and protectionist measures might not affect the affordability of food in the same way in each of these three countries.

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