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# The Potential for High-Value Agricultural Products Under the North American Free Trade Agreement: The Case of Beef in Mexico and Canada: Comment

**Jong-Ying Lee and Mark G. Brown**

In his recent article, Onianwa used the absolute price version of the Rotterdam demand model to estimate Mexican and Canadian import demands for U.S. beef products. The specification of the Rotterdam model allows straightforward testing of the basic theoretical properties of demand. Based on theory, a system of demand equations should obey adding up, homogeneity, symmetry, and negativity (Theil 1971, 1975; Deaton and Muellbauer). Adding up is guaranteed or automatically satisfied in the Rotterdam model and other similar demand models like the almost ideal demand system (AIDS). Hence, adding up cannot be tested. Negativity can be checked by calculating the eigenvalues of the Rotterdam Slutsky matrix (all eigenvalues should be nonpositive). The remaining two properties, homogeneity and symmetry, can be straightforwardly tested by using the likelihood ratio test, as in the present paper, or the Wald or Lagrange multiplier tests; homogeneity can also be tested separately for each demand equation using the $F$-test.

Unfortunately, in Onianwa's specification of the Rotterdam model, prices were incorrectly deflated [see equation (5), p. 379, in Onianwa's article] for testing homogeneity and symmetry. Below, we will demonstrate that deflating prices by a price or price index outside the Rotterdam demand system, such as the consumer price index (CPI), results in incorrect tests of the homogeneity and symmetry hypotheses, and is unnecessary when homogeneity restrictions are imposed.

First, we show how deflation of prices and income occurs in the Rotterdam model. The relative price version of the Rotterdam model (Theil 1975, p. 27) can be specified as

$$(1) \qquad w_i \mathrm{dlog}\, q_i = \theta_i(\mathrm{dlog}\, m - \Sigma_k w_k \mathrm{dlog}\, p_k) + \Sigma_j \upsilon_{ij}(\mathrm{dlog}\, p_j - \Sigma_k \theta_k \mathrm{dlog}\, p_k),$$

where the subscripts $i$ and $j$ indicate products ($i, j = 1, \ldots, n$); $p$, $q$, and $w$ denote price, quantity, and budget share, respectively; $m = \Sigma_i p_i q_i$ (i.e., total expenditure or income); $\theta_i = p_i(\partial q_i/\partial m)$ (marginal propensity to consume); and $\upsilon_{ij} = (\lambda/m)p_i u^{ij} p_j$, where $\lambda$ is the Lagrangian multiplier, and $u^{ij}$ is the $i,j$th element of the inverse of the Hessian. The time subscripts are omitted for simplicity.

Note that the income and price variables in the relative price version of the Rotterdam model are deflated by the Divisia price index ($\Sigma_k\ w_k \mathrm{dlog}\, p_k$) and the Frisch price index ($\Sigma_k\ \theta_k \mathrm{dlog}\, p_k$), respectively. In other words, real income and price variables are used in the relative price version of the Rotterdam model. In this specification of the Rotterdam model, homogeneity is imposed and not testable, provided the data are constructed so as to satisfy the adding-up condition as is commonly practiced; in this case, real income, dlog $m - \Sigma_k w_k$ dlog $p_k$, is replaced by dlog $Q = \Sigma_k w_k$ dlog $q_k$, and $\Sigma_k\ \theta_k = 1$. It should also be noted that Rotterdam model (1) is not

The authors are research economists with the Economic Research Department, Florida Department of Citrus, at University of Florida, Gainesville.

identified unless the $\upsilon_{ij}$s are restricted in some manner (Theil 1971, pp. 579–80).

A version of the Rotterdam model that allows for testing homogeneity is the absolute price version of the Rotterdam model which can be derived from (1) as follows:

$$(2) \qquad w_i \text{dlog } q_i = \theta_i \text{dlog } Q + \Sigma_j \pi_{ij} \text{dlog } p_j,$$

where $\pi_{ij} = \upsilon_{ij} - \phi\theta_i\theta_j$ (the Slutsky coefficient of the Rotterdam model), and $\phi$ is a factor of proportionality (Theil 1975, pp. 47–48). Note that adding up requires $\Sigma_i \theta_i = 1$, and $\Sigma_i \pi_{ij} = 0$; homogeneity requires $\Sigma_j \pi_{ij} = 0$; and symmetry requires $\pi_{ij} = \pi_{ji}$.

Homogeneity is also known as absence of money illusion. That is, if all prices and income double (or increase proportionally), demand for each product is unchanged; i.e., only relative prices matter. One way to impose homogeneity in Marshallian demand specifications is to divide or deflate all prices and income by one of the products' price—say the price for product $n$ (i.e., $p_i/p_n$ and $m/p_n$). In Hicksian or compensated demand specifications, like the Rotterdam model, we only need to deflate prices (i.e., $p_i/p_n$); in the log differences of the Rotterdam model, homogeneity can thus be imposed by dlog $p_i$ − dlog $p_n$, where $i = 1, \ldots, n - 1$. Of course, this way of imposing homogeneity would be equivalent to imposing $\Sigma_j \pi_{ij} = 0$.

Is it necessary to deflate prices by the CPI in the paper in question? Presumably this deflation of prices was done to make prices real. However, this way of specifying real prices is not necessary, since the homogeneity restriction $\Sigma_j \pi_{ij} = 0$ already deflates prices. If deflation by the CPI is made and homogeneity is imposed, the CPI cancels out; i.e., dlog($p_i$/*CPI*) − dlog($p_n$/*CPI*) = dlog $p_i$ − dlog $p_n$. That is, deflation of prices by the CPI is redundant.[1]

[1] In Onianwa's article, the demand system is viewed as a subsystem of beef products. The CPI can be viewed as representing prices outside the subsystem. The subsystem can be tied to the remaining goods that the CPI apparently is meant to represent through a two-stage model as, for example, in a study of alcoholic beverages by Duffy. As shown in Duffy's study, the theoretically and consistent two-stage model specification does not simply deflate prices by the CPI as in Onianwa's study.

When price variables are deflated by the CPI in equation (2) above, as described in equation (5) of Onianwa's study, the above model becomes

$$(3) \qquad w_i \text{dlog } q_i = \theta_i \text{dlog } Q + \Sigma_j \pi_{ij} \text{dlog}(p_j/CPI)$$
$$= \theta_i \text{dlog } Q + \Sigma_j \pi_{ij} \text{dlog } p_j + \beta_i \text{dlog } CPI,$$

where dlog $CPI = \log(CPI_t/CPI_{t-1})$, and $\beta_i = -\Sigma_j \pi_{ij}$.

Equation (3) shows that deflation of prices by the CPI in the Rotterdam model is equivalent to adding the term $\beta_i$ dlog *CPI* to equation (2) under the restriction that $\beta_i = -\Sigma_j \pi_{ij}$. For testing homogeneity, or homogeneity and symmetry, the additional term $\beta_i$ dlog *CPI* in equation (3) creates a problem. Namely, homogeneity (homogeneity and symmetry) is a test of restrictions $\Sigma_j \pi_{ij} = 0$ ($\Sigma_j \pi_{ij} = 0$, and $\pi_{ij} = \pi_{ji}$) in Rotterdam model (2), not in the ad hoc specification defined as model (3). That is, the unrestricted model is (2), not (3); and the restricted model is (2), or redundantly (3), with $\Sigma_j \pi_{ij} = 0$ imposed. The addition of the term $\beta_i$ dlog *CPI* can be expected to change the likelihood value of the unrestricted model, and perhaps may alter one's conclusions regarding the tests for homogeneity and symmetry hypotheses.

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