Australian Journal of Agricultural Economics, Vol. 26, No. 3 (December 1982), pp. 233-237

ESTIMATING THE IMPACT OF BEEF IMPORT RESTRICTIONS IN THE US IMPORT MARKET: COMMENT

Will Martin*

Iowa State University, Ames, Iowa 50011

In a recent article, Chambers, Just, Moffitt and Schmitz (1981) (hereinafter CJMS) have proposed disequilibrium econometrics as a procedure to take into account the effects of import restraints on the US beef import market. In their empirical model, CJMS have allowed for the possibility of price disequilibrium but have not incorporated the restraints on quantity. The purpose of this comment is to consider the effects of this divergence between the model used by CJMS and the structure of the market under import restraints.

In the first part of their article, CJMS postulate that the *ex post* supply function is shifted upward by the existence of the quantitative import restraint. Because the restraints are negotiated on an annual basis, the supply function is not merely raised but, rather, becomes completely vertical in an annual model. Their specification is, however, appropriate for a model dealing with sub-periods of a year. When the annual restraint is binding, imports in any sub-period of the year are still price responsive, but entitlement to import is scarce and has a value or shadow price. The marginal cost of importing is increased because importing one unit of meat uses up a valuable unit of entitlement to import. As a result, the supply curve of imports in any sub-period is raised by the value of an entitlement to import.

It does not seem appropriate to term this effect a source of continuing disequilibrium. Before 1 January of each year, the Secretary of Agriculture must publish the quantity which determines the import restraint level for the coming year (Conable 1980, p. 1). Because meat importers are aware of the likely effect of the restraint well in advance, the restraints cause a change in the structure of the market rather than a disequilibrating shock. Thus, the existence of the restraint leads to a new equilibrium price, given by P_t in their Figure 1.

If the shadow price of entitlement to import were observable, as it would be if entitlements were freely traded, the change due to the import restraint could be incorporated in a conventional simultaneous-equation model as a shift in the import supply function. Thus, conventional techniques could, conceptually, yield estimates of both the *ex ante* and the *ex post* curves. Because the shadow price is not generally known, the estimation problem becomes much more difficult, since any change in the

* Will Martin is now at the BAE, Canberra. Jim Longmire and Joe Dewbre of the BAE and Roy Gardiner, Wayne Fuller and Raymond Joe Schatzer of Iowa State University provided valuable comments on earlier drafts of this paper. The author is entirely responsible for any remaining errors.

shadow price is an unobservable change in the structure of the supply equation.

In their discussion of welfare effects (pp. 126-7), CJMS turn to a graphical model (presumably annual) in which the quantity imported is physically restrained (vertical supply curve) rather than the supply curve being raised. They point out the terms of trade effect which conceivably allows an importing country to gain from an import quota if the quota depresses the world price sufficiently and its importers can then buy at a lower price. Whether the importing country pays the higher domestic price, P_I, or the lower foreign price, P_O, in their Figure 2 depends upon whether the entitlement to import is allocated to domestic groups or the import-supplying nations. In this market, the import entitlements are given to the import-supplying nations which then induce their exporters to restrain supplies (Freebairn and Gruen 1977). Since the property rights to scarce import entitlement have been allocated to agents outside the U.S.A., importers in the U.S.A. must pay the higher price, P_I, in equilibrium.

The actual empirical model used by CJMS is a short-side price disequilibrium model (Bowden 1978, p. 80). Deviations from equilibrium in this model occur because prices do not adjust fully from the price in the last period to the current equilibrium price. A current equilibrium point is defined by the intersection of the supply and demand curves in this model, and disequilibrium at any instant is defined in relation to this equilibrium value. The implicit equilibrium in the CJMS model should have been that associated with the import restraints, not the now non-existent free trade or *ex ante* equilibrium. Unfortunately, CJMS specified the free-trade supply function in their empirical model, even though the process generating their observations must correspond to the restrained or *ex post* supply curve. This leads to an omitted-variable problem, because variables to indicate the degree of restrictiveness of the import restraint, for example, the shadow price of entitlement, have been omitted from the supply function. Alternatively, the problem can be thought of as one of structural change, with the position of the supply function changing every time the value of import entitlement changes.

The problem of structural change might not be serious if the import restraints had only a minor effect in the market or if the shadow price of entitlement had been stable. However, the import restraints are a dominant feature of the market and their effect definitely changed during the CJMS sample period. In their sample period (January 1974 through October 1976), the import restraint was non-binding (zero shadow price) in 1974 but binding (positive shadow prices) in 1975 and 1976 (see Conable 1980, p. 5). The value of the shadow price of entitlement may also have varied considerably both between and within 1975 and 1976.

The omitted variable problem seems almost certain to lead to bias in the CJMS maximum likelihood estimates, as it does in the conventional regression case (Dhyrmes 1980, p. 227). The shadow price of entitlement is endogenous and so it will be correlated with the error terms in the model, increasing the likely severity of the bias. At the very least, if the other parameter estimates are unbiased, the *ex ante* supply curve estimate must be biased upwards because the shadow price has a one-sided distribution—the actual import supply function must lie on or above the free trade function.

CJMS chose to estimate their model by a maximum likelihood procedure. Their estimation procedure required maximisation of a nonlinear likelihood function. The various algorithms for nonlinear maximisation (Goldfeld and Quandt 1972, Ch. 1) have differing performance characteristics and require starting values whose selection influences whether the solution will be a global maximum rather than merely a local maximum or a saddle point. Information on the algorithm used, the selection of starting values and tests that they have located a global maximum of the likelihood function would have been useful in evaluating their empirical results.

Another aspect of the CJMS specification which gives rise to concern is the implied timing of responses in their model. In particular, they specify the supply of imports as a function of Australian price and other economic variables in the current month. Because meat generally takes four to six weeks to travel from Australia to the major importing ports on the US east coast, this specification does not appear to be realistic.

The import restraints undoubtedly pose serious problems for estimation in this market. However, once realistic lags are introduced, the supply of imports becomes predetermined in a monthly model. Taking advantage of the fact that imports are predetermined in any month, it becomes possible to re-estimate the import demand function in a theoretically satisfactory manner. Re-estimating the CJMS demand equation in price-dependent equilibrium form over their sample period resulted in the following OLS estimates (with standard errors in parentheses)[1]:

$$\begin{aligned}(1)\qquad \ln (HP/CPI)_t = {} & \underset{(12.0)}{4.99} - \underset{(0.13)}{0.18} \ln QM_t + \underset{(0.25)}{0.042} \ln (PP/CPI)_t \\ & - \underset{(1.38)}{0.44} \ln (M/CPI)_t - \underset{(0.10)}{0.11} \ln PLONF_t \\ & R^2 = 0.16;\ DW = 0.28\end{aligned}$$

Clearly, the equilibrium model specified in equation (1) does not appear to fit the data satisfactorily. None of the estimated coefficients are significant at the 10 per cent level (two-tailed test), the Durbin-Watson statistic indieates positive autocorrelation of the residuals and the R^2 indicates very low explanatory power. This single equation was then re-estimated in a version which allows for price disequilibrium in order to provide a test for the hypothesis of price equilibrium and to obtain an improved estimate of the elasticity of demand for imports. Any price disequilibrium observed in this model could be caused by factors such as slow adjustment of prices or delays in revising price expectations. It would not be caused by the import law, since imports are always assumed predetermined. The model used was:

[1] The variables used follow the descriptions given by Chambers et al., 1981, p. 129 (i.e. monthly data for Jan. 1974 through Oct. 1976):
CPI = US consumer price index, all items 1967 = 100;
HP = retail price of ground beef c/lb;
M = US personal income in millions of dollars;
$PLONF$ = seven-states cattle placed on feed, thousand head;
PP = retail pork price c/lb; and
QM = imports of beef and veal, carcass weight million lb.

$$(2) \qquad (P_t - P_{t-1}) = (1-\mu)\bullet(P_t^* - P_{t-1}) + e_t,$$

where:

$P_t = \ln (HP/CPI)_t$;
P_t^* = the equilibrium price as specified in equation (1);
μ = a coefficient of friction in price adjustment, $0 < \mu < 1$ (Bowden 1978, p. 80); and
e_t = a random error term.

Equation (2) was first estimated by OLS to obtain starting values for the Gauss-Newton nonlinear least squares estimator with analytical derivatives (Statistical Analysis Systems Institute 1979, p. 317). The resulting equation estimate (with asymptotic standard errors given in parentheses) was:

$$(3) \quad (P_t - P_{t-1}) = \underset{(0.055)}{(1-0.88)} \bullet (\underset{(26.8)}{7.42} - \underset{(0.36)}{0.60} \ln QM_t + \underset{(0.68)}{0.82} \ln (PP/CPI)_t$$

$$- \underset{(3.1)}{0.4} \ln (M/CPI)_t - \underset{(0.22)}{0.18} \ln (PLONF_t - P_{t-1})$$

Only the parameter estimates for μ and the own-price flexibility coefficient were significant at the 10 per cent level (one-tailed test) and these are of particular interest. A value of zero for μ implies complete price adjustment in one period (i.e. an equilibrium model) while a value of unity implies a total lack of price responsiveness. Using this model, the equilibrium hypothesis of complete price adjustment ($\mu = 0$), is rejected. This result provides tentative support for the assumption by CJMS that price disequilibrium is more appropriate than price equilibrium for this market. The equation implies a price flexibility of -0.60 which, when inverted, leads to an estimated demand price elasticity of -1.66. This is noticeably more elastic than the estimate of -0.97 obtained by CJMS, although part of the difference might be due to the change from quantity dependent to price dependent form.

The test for $\mu = 0$ described above provides only a tentative test for price disequilibrium, since the estimated value of μ may partially reflect autocorrelation of the residuals. Attempts were made to obtain estimates for a more complex nonlinear model with autoregressive disturbances but it was not possible to obtain satisfactory estimates using this data set. Resolution of this question will probably require further analysis with larger data sets.

While it has been possible to obtain some estimates of the demand function parameters, there does not seem to be any straightforward way to obtain improved estimates of the supply function. Detailed specification of the effects of import restrictions and the export controls used by exporting countries (Reeves, Longmire and Reynolds 1980) and, possibly, use of techniques such as limited dependent variable analysis (Tobin 1958) seem necessary to obtain improved estimates of the underlying supply function.

One final cause for concern is the lack of references to disequilibrium techniques in the CJMS reference list. Fortunately, Ziemer and White (1982) have provided an extensive list of references in a subsequent application of this technique.

CJMS have made a useful contribution through their concise exposition of an interesting type of price disequilibrum econometrics and the suggestion that these procedures may be useful for estimation with monthly data in this market. Unfortunately, they omitted the quantity constraint in their specification of the empirical model and this omission could lead to serious bias in their parameter estimates. Re-estimation of their demand function without this potential source of bias resulted in a somewhat more price-elastic estimate than they obtained. The problems arising from the CJMS specification emphasise the extreme importance of ensuring that the specific disequilibrium model used in any application corresponds very closely to the structure of the market under consideration.

References

Bowden, R. J. (1978), *The Econometrics of Disequilibrium*, Studies in Mathematical and Managerial Economics Vol. 26, North Holland, Amsterdam.

Bureau of Economic Analysis (1975-77), *Survey of Current Business*, US Department of Commerce, Washington, D.C.

Chambers, R. G., Just, R. E., Moffitt, L. J. and Schmitz, A. (1981), 'Estimating the impacts of beef import restrictions in the US import market', *Australian Journal of Agricultural Economics* 25(2), 123-33.

Conable, D. B. (1980), 'Changes in US Meat import law', *Foreign Agriculture, Supplement for July 1980*, US Department of Agriculture, Foreign Agricultural Service, Washington, D.C.

Dhrymes, P. J. (1970), *Econometrics*, Harper and Row, New York.

Freebairn, J. W. and Gruen, F. H. (1977). 'Marketing Australian beef and export diversification schemes', *Australian Journal of Agricultural Economics* 21(1), 26-39.

Goldfeld, S. M. and Quandt, R. E. (1972), *Nonlinear Methods in Econometrics*, North Holland, Amsterdam.

Reeves, G., Longmire, J. and Reynolds, R. (1980) 'Australia's beef export supply for markets other than the United States and Japan' in K. Anderson, and A. George (eds), *Australian Agriculture and Newly Industrialising Asia: Issues for Research*, Australia-Japan Research Centre, Canberra.

Statistical Analysis Systems Institute (1979), *SAS User's Guide*, Cary, North Carolina.

Tobin, J. (1958), 'Estimation of relationships for limited-dependent variables', *Econometrica* 26(1), 273-85.

US Department of Agriculture (various issues), *Livestock and Meat Situation*, US Dept. of Agriculture, Washington, D.C.

Ziemer, R. F. and White, F. C. (1982), 'Disequilibrium market analysis: an application to the US fed beef sector', *American Journal of Agricultural Economics* 64(1), 56-62.