

Welfare Effects of GM Crop Restrictions on Trade: Lecture XIX

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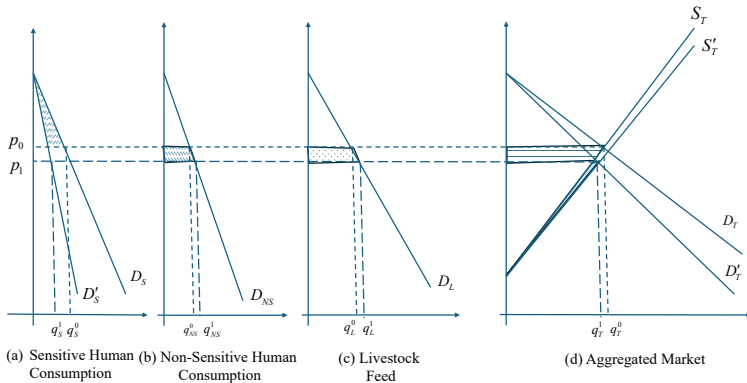
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1 StarLink and Aventis CropScience

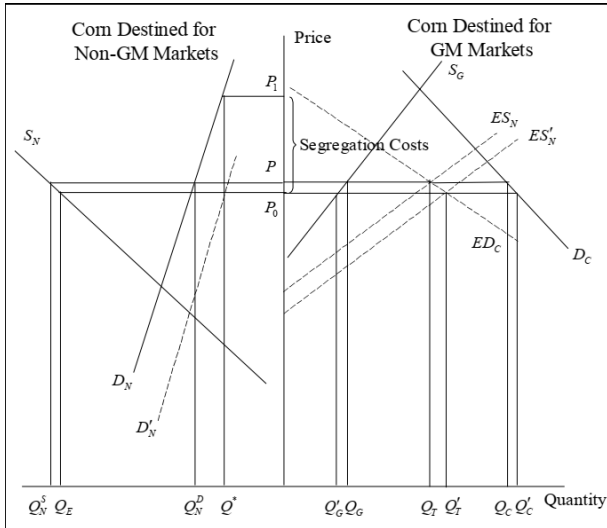
Starlink and Aventis CropScience

- Moss, C.B., Schmitz, T.G & Schmitz, A. (2004) The Brave New World: Imperfect Information, Segregation Costs, and Genetically Modified Organisms *Agrarwirtschaft - German Journal of Agricultural Economics* 53(8), 303-308.
- The “SarLink” controversy arose in late 2000 when several food products were found to contain Genetically Modified Corn – specifically a variety of corn that was produced by Plant Genetic Systems which was purchased by Aventis CropScience.
- This corn contained a gene that was resistant to certain pests (typically the European Corn Borer) (blufosinate and a variant of *Bacillus thuringiensis* – which resulted in a protein Cry9C.
- This “event” had been licensed for use in animal feed, but was not approved for human consumption because it had been implicated in increased incidence of food allergies.

- One September 18, 2000, a *Genetically Engineered Food Alert*” was released because Cry9C had been detected in “Taco Bell Home Originals” brand taco shells purchased in near Washington, D.C.
- The fact that Cry9C had been discovered in human food was violated its release, but a couple of points explain our involvement in this research.
 - First, the corn market is dominated by the demand for livestock feed - relatively little corn is used for direct human consumption.
 - The point of most of the conflict was the imposition of segregation costs so that StarLink corn was used in the feed market.
 - The breakdown of segregation and implications for segregation costs had trade implications.



Effect of Segregation Costs on the Market Price for GM and non-GM Crops



- The market equilibrium, given segregation costs τ and supply shift due to GM technologies ψ can be written as

$$\begin{aligned} D^T(p, \tau) &= D^N(p + \tau) + D^G(p) = \\ S^N(p) + (1 + \psi)^G(p) &= S^T(p) \end{aligned} \quad (1)$$

- In this application, we define the societal welfare from the corn market as

$$\begin{aligned} \int_{p^* + \tau}^{\bar{p}_N} D^N(p) dp + \int_{p^*}^{\bar{p}_G} D^G(p) dp + \int_{\underline{p}_g}^{p^*} S^N(p) dp + \\ (1 + \psi) \int_{\underline{p}_G}^{p^*} S^G(p) dp = W(\tau, \psi) \end{aligned} \quad (2)$$

- $\bar{p}^N$ is the choke price for non-GM consumers;
- $\bar{p}_g$ is the choke price for GM consumers;
- p^* is the equilibrium price defined as the price that clears Equation 1;
- $\underline{p}_N$ is the choke price for GM producers;
- $\underline{p}_G$ is the choke price for non-GM producers; and
- $W(\tau, \psi)$ is the welfare from the production and consumption of corn as a function of the segregation costs and supply shift.

- A simple Leibenz

$$\begin{aligned}
 \frac{\partial}{\partial \tau} \int_{p^* + \tau}^{\bar{p}_N} D^N(p) dp &= \frac{\partial \bar{p}_N}{\partial \tau} D^N(p) dp \\
 - \frac{\partial (p^* + \tau)}{\partial \tau} \int_{p^* + \tau}^{\bar{p}_N} D^N(p) dp + \int_{p^* + \tau}^{\bar{p}_N} \frac{\partial D^N(p)}{\partial \tau} dp & \quad (3) \\
 &= - \int_{p^* + \tau}^{\bar{p}_N} D^N(p) dp
 \end{aligned}$$

- Applying Leibniz's Rule

$$dp^* \left[- \int_{p^* + \tau}^{\bar{p}_N} D^N(p) dp - \int_{p^*}^{\bar{p}_G} D^G(p) dp + \int_{\underline{p}_N}^{p^*} S^N(p) dp + \int_{\underline{p}_G}^{p^*} S^G(p) dp \right] - d\tau \int_{p^* + \tau}^{\bar{p}_N} D^N(p) dp + \psi \int_{\underline{p}_G}^{p^*} S^G(p) dp = dW(\tau, \psi) \quad (4)$$

- As the equilibrium price increases, consumer surplus for both GM and non-GM consumers decline as the producer surplus for both GM producers and non-GM producers increase.
- Note the conditionality of the next state - **if the price increases** the producer surplus for both GM and non-GM producers increases.

- However, as the segregation cost increases (the 'third term' in Equation 4) the increase in segregation costs implies a reduction in the non-GM consumer surplus.
- The shift in supply implies that the producer surplus increases.
- Dividing Equation 4 by $d\tau$

$$\begin{aligned} & \frac{dp^*}{d\tau} \left[- \int_{p^*+\tau}^{\bar{p}_N} D^N(p) dp - \int_{p^*}^{\bar{p}_G} D^G(p) dp \right. \\ & + \left. \int_{\underline{p}_N}^{p^*} S^N(p) dp + \int_{\underline{p}_G}^{p^*} S^G(p) dp \right] - \int_{p^*+\tau}^{\bar{p}_N} D^N(p) dp + \quad (5) \\ & + \frac{d\psi}{d\tau} \int_{\underline{p}_G}^{p^*} S^G(p) dp = \frac{dW(\tau, \psi)}{d\tau} \end{aligned}$$

- Similarly,

$$\begin{aligned} \frac{dp^*}{d\psi} \left[- \int_{p^*+\tau}^{\bar{p}_N} D^N(p) dp - \int_{p^*}^{\bar{p}_G} D^G(p) dp \right. \\ \left. + \int_{\underline{p}_N}^{p^*} S^N(p) dp + \int_{\underline{p}_G}^{p^*} S^G(p) dp \right] \\ - \frac{d\tau}{d\psi} \int_{p^*+\tau}^{\bar{p}_N} D^N(p) dp + \int_{\underline{p}_G}^{p^*} S^G(p) dp = \frac{dW(\tau, \psi)}{d\psi} \end{aligned} \quad (6)$$

- Moving forward we assume that a market equilibrium exists

$$D^N(p^* + \tau) + D^G(p^*) - S^N(p) - (1 - \psi) S^G(p^*) = 0 \quad (7)$$

- Taking a first-order Taylor series expansion around the equilibrium

$$\begin{aligned}
 q^D &= [a_N^D + b_N^D (p^* + \tau)] + [a_G^D + b_G^D p^*] = \\
 &[a_N^S + b_N^S p^*] + (1 + \psi) [a_G^S + b_G^S p^*] = q^S \\
 p^* &= \frac{[a_N^D + a_G^D - a_N^S - (1 + \psi) a_G^S] + b_N^D \tau}{[b_N^D + b_G^D - b_N^S - (1 + \psi) b_G^S]}
 \end{aligned} \tag{8}$$

- Therefore

$$\begin{aligned}
 \frac{dp^*}{d\tau} &= - \frac{b_N^D}{[b_N^D + b_G^D - b_N^S - (1 + \psi) b_G^S]} < 0 \\
 \frac{dp^*}{d\psi} &= \frac{a_G^S}{[b_N^D + b_G^D - b_N^S - (1 + \psi) b_G^S]} \\
 &- \frac{[a_N^D + a_G^D - a_N^S - (1 + \psi) a_G^S] + b_N^D \tau}{[b_N^D + b_G^D - b_N^S - (1 + \psi) b_G^S]} \leq 0
 \end{aligned} \tag{9}$$

Market Solutions with Societal Welfare Constraint

	Segregation costs (\$/bushel)					
	0.00	0.05	0.10	0.15	0.20	0.25
Percent increase in supply	0.000	0.003	0.005	0.008	0.010	0.013
Equilibrium price	2.350	2.347	2.344	2.340	2.337	2.334
Non-GM corn demanded	0.200	0.199	0.198	0.198	0.197	0.196
GM corn demanded	10.000	10.004	10.008	10.012	10.016	10.021
total demand	10.200	10.203	10.207	10.210	10.213	10.217
Non-GM corn supplied	6.120	6.116	6.112	6.107	6.103	6.099
GM corn supplied	4.080	4.088	4.095	4.102	4.110	4.117
total supply	10.200	10.203	10.207	10.210	10.213	10.217
Non-GM consumer surplus	1.175	1.166	1.156	1.147	1.138	1.129
GM consumer surplus	38.907	38.939	38.971	39.003	39.035	39.067
total consumer surplus	40.082	40.105	40.128	40.150	40.173	40.196
Non-GM producer surplus	5.944	5.925	5.905	5.886	5.866	5.847
GM producer surplus	3.963	3.960	3.957	3.953	3.950	3.947
total producer surplus	9.907	9.884	9.862	9.839	9.816	9.793
societal surplus	49.989	49.989	49.989	49.989	49.989	49.989