The Implications of Marketing-Order Quality Regulations in a Free-Trade Environment

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Tina L. Saitone
Agricultural and Resource Economics Department
University of California, Davis
saitone@primal.ucdavis.edu

and

Richard J. Sexton
Agricultural and Resource Economics Department
University of California, Davis
rich@primal.ucdavis.edu

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In an attempt to stabilize farm incomes and mitigate the adverse price movements common to agricultural commodities, often known as the “farm problem”, the Agriculture Adjustment Act (AAA) of 1933 authorized the formation of federal marketing orders. When portions of the AAA were invalidated, marketing orders were re-authorized under the Agriculture Marketing Agreement Act (AMAA) of 1937. Under the authorizing legislation, marketing orders could perform production and processing research, impose quality regulations and inspections, control the volume of product brought to market and/or conduct other supply-management practices. In 1954, the AMAA was amended to include section 8e, which specifies that imports are subject to the same quality standards, regulations, and other provisions as are imposed upon domestic production by a marketing order.

The various functions which can be performed under the auspices of marketing orders have attracted considerable research interest in the years since marketing orders were implemented. The volume-control provisions have always been widely controversial and attracted the interest of researchers since the inception of the AAA (e.g., Stokdyk, 1933; Wellman, 1935). Despite the considerable amount of research surrounding the use of direct volume control provisions to manage supply (e.g., Jesse, 1979; Dunn and Heien, 1982; Lenard and Mazur, 1985), relatively few marketing orders have authorized this provision and even fewer still utilize it (Lee et al., 1996). The generic promotion provision of marketing orders has also been studied extensively (e.g., Alston, Freebairn, and James, 2001; Kaiser et al. 2005), especially in the light of recent Supreme Court decisions surrounding the legality of these programs (Crespi, 2003).

Since Wellman (1935) it has been recognized that minimum quality provisions enacted through marketing orders can act as a subtle form of volume control. Yet, the implications of minimum quality standards (MQS) imposed through a marketing order have received comparatively little attention despite the relative frequency of their authorization and utilization. Of the 33 marketing orders currently operating under the federal statutes, 31 have some combination of grade, size, or maturity provisions authorized or in effect (USDA, 2007).[1] Among this group, 16 have altered these requirements at least once over the previous 10 years (AMS, 2006).

A common justification for MQS is that they help to maintain or enhance market demand for a commodity by ensuring that poor quality product doesn't reach consumers (e.g., Alston and Carmen, 2005). This argument relies, at least implicitly, upon asymmetries in information—grading and inspection of product will increase the information available to consumers and mitigate or eliminate adverse selection problems. However, quality (e.g., size, color, blemishes) is often observable (Bockstael, 1984), in which case the arguments in support of imposing MQS to mitigate information asymmetries are substantially weakened.

As efforts to liberalize trade continue apace, the degree to which a MQS can be used in conjunction with section 8e as a nontariff trade barrier becomes a subject of increasing importance. The high incidence of utilization of the section 8e provision, coupled with a relatively high degree of variability of standards over time, serves to motivate further research on how MQS imposed through marketing orders can affect producer profits, consumer welfare and influence trade patterns.

The model developed in this paper is intended to investigate specifically the strategic role of a MQS imposed by a domestic agricultural industry under the auspices of marketing order

[1] 25 of the federal marketing orders have minimum grade standards in place while 22 have size regulations in effect. The commodities for which imports must comply with the grade, size, maturity, and quality requirements include: avocados, dates, filberts, grapefruit, table grapes, kiwi fruit, black olives, onions, oranges, Irish potatoes, plums, dried prunes, raisins, tomatoes, and walnuts (USDA, 2005).

legislation in both a closed- and open-economy setting. Both because the role of MQS in asymmetric information settings is relatively well understood and because we ascribe to Bockstael's (1984) and Chambers and Pick's (1994) views that in many agricultural-product settings, quality information between buyers and sellers is assumed to be symmetric. Production in the model is vertically differentiated and for simplicity divided into two quality categories, high and low, where the total production and the ex ante shares of production in these categories are exogenous (e.g., determined by weather conditions and ex ante planting decisions). Producers are able to undertake activities using a convex technology to transform low-quality product into high-quality product, for example through applying pesticides to reduce damage from insects or worms, thinning fruit to increase size, and delaying harvest to increase ripeness.

The model allows domestic producers to act collectively, as permitted under marketing-order provisions, and to choose whether or not to impose a MQS. Accordingly, the domestic industry will impose such a standard if its profit under the MQS is higher than its profit under no regulation. The imposition of a binding MQS by domestic producers in this model implies eliminating the low-quality product from the market, effectively making it worthless. Although inability to sell the low-quality product under a MQS diminishes producer profits ceteris paribus, we show that for various market conditions elimination of the self-selection constraint caused by the presence of the low-quality product enables the high-quality product to sell at a sufficiently higher price to make imposing the MQS an optimal strategy for the industry. In the open-economy model, a "raising-rivals-cost" aspect to MQS can emerge due to asymmetric costs between domestic and foreign sellers associated with quality enhancement or through differences between countries in the ex ante shares of low-quality product.

A key result from the model is that when the product is sold competitively, any market condition that causes the domestic industry to impose an MQS insures that all consumers of the product are harmed by the MQS. An open-economy setting expands the range of model parameterizations when a domestic industry will implement an MQS because it can often direct the costs imposed by the MQS primarily to importers, while capturing the majority of the benefits conferred by the MQS. However, in a model of duopoly competition between a domestic industry and an exporter, we show that a MQS can eliminate the incentives of the duopolists to under provide quality enhancement, potentially leading to situations where MQS can be socially beneficial.

Relevant Literature

The general literature on MQS usually assumes a duopoly market structure with vertically differentiated products and where the demand side of the market is characterized by Mussa-Rosen (1978) type preferences (e.g., Ronnen, 1991; Crampes and Hollander, 1995; Maxwell, 1998). Within a two-stage modeling framework, firms first choose a single quality level to produce, which can be enhanced by incurring additional costs, and then choose price. The costs associated with quality enhancement are assumed to be symmetric across firms.

Results from this basic framework demonstrate that the effects of MQS are highly dependent on the specification of the quality cost function. Ronnen (1991) assumes that fixed costs are an increasing function of the level of quality of the product, and finds that imposition of a MQS reduces the range of product quality variations available to producers, intensifies price competition, increases quality, and improves consumer welfare. Alternatively, when quality costs are assumed to be variable and independent of quantity and the MQS is imposed exogenously (Crampes and Hollander, 1995), the effect on consumer welfare depends upon the degree to which the high-quality firm responds to the MQS by increasing quality. If it significantly increases the quality that it produces, consumer welfare declines.[2]

Ecchia and Lambertini (1997) incorporated a MQS chosen to maximize social welfare into the conventional vertically differentiated duopoly framework. They showed that when quality costs are variable, quality dependent, and quadratic in nature and the MQS is set to maximize social welfare, the results regarding quality level produced, price, and consumer welfare are qualitatively the same as when quality costs are fixed as posited by Ronnen (1991).

Unfortunately, these general analyses of the effects of MQS may have little relevance to the types of regulations that U.S. agricultural industries can impose under the auspices of federal marketing orders. A key distinction is the fact that, subject to government approval, industries can choose whether to set an MQS and which dimensions of product quality to regulate, and make this decision presumably to maximize industry profits. Within the general MQS literature, the standard is usually exogenous, or, if endogenous, chosen by a planner to maximize social welfare.

Further, in an open-economy context the assumption of symmetric cost functions (e.g., Ronnen, 1991; Crampes and Hollander, 1995; Ecchia and Lambertini, 1997) ignores the likelihood that a MQS could be more difficult for some producers or countries to meet due to heterogeneous growing conditions and differential access to production and quality-enhancing technologies and skilled labor. Marketing boards, thus, can choose strategically to regulate product characteristics where domestic producers have advantages in production.

In an agricultural context it is also unrealistic to assume that producers select a single level of product quality to produce. In most cases quality variation will exist within any harvest due to differences among producers in weather conditions, land quality, or application of inputs such as fertilizers and pesticides. Additionally, production of high- and low-quality products almost always

[2] The quality response of the high-quality firm determines the impact that the MQS has on consumer welfare. If the response to the MQS by the high-quality firm is relatively small, the disparity between the quality of the two products narrows and causes price competition to increase which benefits consumers. If instead the high-quality firm responds to the MQS significantly the disparity between high- and low-quality rises which cause price competition to be less intense and consumers to be worse off.

occurs simultaneously. For example, a given harvest will yield both large and small fruit and some, but not all, product will be blemished, suffer from pest damage, etc. The decision in these contexts is, thus, not the choice of a quality level to produce but, rather, is one of expenditures to make to improve upon the exogenous quality distribution offered by nature.

Agricultural Marketing Orders and MQS

Early works on the effects of the imposition of MQS (e.g., Shafer, 1968; Jesse, 1979) ignored the endogeneity of the quality decision of both consumers and producers and assumed that a MQS simply served to increase the average quality of the product available in the market and thereby increase demand. The effects of imposing an MQS when quality changes are exogenous and supply and demand are assumed to be linear depend upon the elasticities of supply and demand and the relative sizes of the shifts of those curves caused by imposing an MQS. Thus, models treating MQS as shifts in demand and supply yielded ambiguous and varied results (Shafer, 1968; Jesse, 1979; Powers, 1990).

Bockstael (1984) showed that when consumers have perfect information about product quality, the imposition of MQS reduces net social benefits when low-quality product is diverted to alternative markets or eliminated completely. Unlike prior investigators, Bockstael assumed that quality is endogenous to consumers and captured the effects of the presence of varying quality levels by utilizing different but interrelated compensated demand functions to model distinct quality levels as different but interdependent goods. Producers were assumed to be able to increase the quality of their production by incurring additional costs yet the technological representation of such transformation was not specified explicitly. Bockstael found that societal welfare will change when product not meeting the MQS can be diverted into a secondary market, a common option and occurrence in agricultural product markets, based upon consumers' valuation of quality. If consumers are indifferent to product quality then the presence of a secondary market is only a form of price discrimination and consumers and society incur losses from its existence. If consumers do perceive differences in quality and product not meeting MQS is diverted to secondary markets, then consumer and societal welfare will also unambiguously decline because consumers are unable to access the low-quality product.

Chambers and Pick (1994) were the first to consider explicitly the trade impacts of MQS imposed under section 8e. They assumed that different qualities of the same product are treated as distinctly different goods with different prices, two countries engaged in active trade, and that both of the countries possess the same technology with constant returns to scale. Employing a multi-product general equilibrium modeling framework, they found that, in a free-trade situation with symmetric information, the imposition of an MQS by one country can act as a non-tariff trade barrier and reduce the net social welfare of at least one of the countries trading, if not both. They show that in these situations, net social welfare must decline with the imposition of MQS. By introducing international trade into Bockstael's model, Chambers and Pick (1994) allow net social welfare of one of the trading partners to increase as a consequence of the diversion of product not meeting MQS to alternative markets. Ultimately, the authors show that, while social welfare for one of the trading partners could potentially increase, it is not possible for the social welfare in both of the trading countries to increase.

Relative to the antecedent literature, our model makes several extensions. First, we adopt the Mussa-Rosen specification of consumer preferences utilized in the general literature on MQS to allow a precise representation of the interaction of different quality levels in the market place. Second, we adopt a technological specification that is consistent with a prototype agricultural product, with exogenous total production and ex ante distributions of high- and low-quality product, but we allow the distribution of high-quality product to be enhanced through a convex transformation function. Third, we allow the domestic industry to choose strategically whether to impose a MQS or not based upon profit maximization.

Finally, we investigate the trade-distorting potential of MQS through the section 8e provision and consider two generalizations relative to the prior literature. First, we allow asymmetries between domestic and foreign producers in terms of the distribution of high- and low-quality product and the costs of quality enhancement. Second, we consider both perfect competition (the norm in analyses of MQS imposed through marketing orders) and Cournot duopoly competition as equilibrium concepts in the trade scenario. Our use of the Cournot framework is motivated by the facts that marketing orders allow domestic producers to act collectively and many commodities are exported through a state trading agency that acts as a single-desk seller (Sexton and Lavoie, 2001).

The Model

We consider a vertically differentiated commodity which can either be high-quality (H) or low-quality (L), where consumers always prefer H over L. Total output, X, is exogenous (e.g., it is based upon prior planting decisions). The ex ante share of total output that is low-quality is denoted as γ, where $0<\gamma<1$. Thus, the ex ante amount of high-quality product is $(1-\gamma)X$. Costs of producing output are sunk and do not enter into the analysis.

Although total output is exogenous, producers are often able to undertake activities to increase the proportion of H product. Following Chalfant and Sexton (2002), we assume that product that would be L in the absence of quality-enhancing activities can be transformed into H product through a convex "transformation cost function", which for simplicity we model in quadratic form,

$$C(T)=0.5\beta T^2, \tag{1}$$

where $T\in[0,\gamma X]$ is the amount of L product transformed to H, and β is a parameter that calibrates the marginal cost of quality enhancement. For example, β would depend upon availability and cost of quality-enhancing inputs, such as herbicides and pesticides, and other inputs, such as labor.

Although suppliers, through quality enhancement, can choose the proportions of H and L products that they produce, they cannot choose the magnitude of the quality of either the H or L product. Consequently, the quality level of the H product, q_H, is normalized to 1.0, the quality of the L product is $q_L = \alpha$, where $\alpha < 1$, and, hence, $1-\alpha$ is the quantitative difference in quality between the H and L products.[3]

Following Mussa and Rosen (1978), it is assumed that there is a continuum of consumers in the market indexed by a taste parameter for quality, θ, uniformly distributed on [0, 1] who derive utility from only the first unit of the commodity that they purchase. A consumer with taste parameter θ has utility $U(\theta, q) = \theta q$ and surplus $CS(\theta, q, P_q) = \theta q - P_q$ from consuming a unit of the commodity, where P_q represents the price of the commodity of quality level $q = H, L$. The consumer who is indifferent between consuming the H product and the L product is represented by taste parameter $\theta_H = \dfrac{P_H - P_L}{q_H - q_L} = \dfrac{P_H - P_L}{1-\alpha}$, while the consumer who is indifferent between consuming the L product and not consuming the product at all, and accordingly obtaining CS = 0, is represented by $\theta_L = \dfrac{P_L}{q_L} = \dfrac{P_L}{\alpha}$. Therefore, respective demands for the H and L products are:

(2) $$Q_H = 1 - \theta_1 = 1 - \frac{P_H - P_L}{1-\alpha}$$

(3) $$Q_L = \theta_1 - \theta_0 = \frac{P_H - P_L}{1-\alpha} - \frac{P_L}{\alpha}.$$

Inverting the system of equations comprised of (2) and (3) results in the indirect demand functions:

(2') $$P_H = 1 - Q_H - \alpha Q_L,$$

[3] This assumption is a simplification for modeling purposes, but may hold literally in real-world instances when quality designations are based upon standards set by government, and consumers utilize those standards as proxies for true quality.

(3’) $$P_L = (1 - Q_H - Q_L)\alpha \ .$$

It is assumed throughout that the potential demand for the commodity exceeds the sum of the exogenous output, which implies $X < 1$.

Symmetric Competitive Markets

We first consider the simplest case, where the exogenous distribution of H and L quality is immutable and cannot be cannot be altered by production practices. Although this case is not necessarily realistic, it is useful for expository purposes and as a benchmark case to which others can be compared. Given the total output, *X*, and low-quality share γ, substitute these parameters into (2’) and (3’) to obtain the prices of the H and L products: $P_H^0 = 1 - X[1 - \gamma(1-\alpha)]$, and $P_L = (1 - X)\alpha$. The price of the L product is determined by the market-clearing or individual-rationality condition such that the marginal consumer is just willing to consume the L product. The price of the H product is determined by a self-selection condition such that the marginal consumer of H product is just indifferent between consuming the H product at price P_H^0 and consuming the L product at price $P_L^0 = (1 - X)\alpha$. This “competition” between the H and L product constrains sellers’ pricing of the H product and creates a possible incentive for the industry to impose a MQS.

The implementation of a binding MQS in this context eliminates L product from the market, making it worthless.[4] In the presence of a MQS the price of the H product is no longer determined by a self-selection condition but, rather, by the market-clearing or individual-rationality condition that the marginal consumer is just willing to consume the H product: $P_H^1 = 1 - (1 - \gamma)X$. The total revenue (equivalent to total variable profit for the sunk-costs case) for producers when the MQS is

[4] MQS prohibit products that don’t meet the standard from being sold for human consumption. Thus, it is reasonable to assume that low-quality product will be disposed of. However, the qualitative conclusions of the model are unaffected if the low-quality product can be resold, e.g., as animal feed, at a constant price less than $\mathrm{P}_{\mathrm{L}}^0$.

not imposed is $\pi_i^0 = P_H^0 X(1-\gamma) + P_L^0(\gamma X)$, while with the imposition of a MQS revenue is $\pi_i^1 = P_H^1 X(1-\gamma)$.

Figure 1 illustrates the exogenous-quality scenario. The market's willingness to pay for the H and L products over the interval $[0, X]$ (based upon individual rationality) is denoted by the line segments *1m* and αa, respectively. Price for the L product, P_L^0, is determined by the individual rationality condition at the intersection of output *X* with the low-quality willingness-to-pay curve. In the absence of a MQS, the price for the high-quality product is determined by the self-selection condition, which is illustrated in figure 1 by the segment with endpoints $1-(\alpha - P_L^0)$ and *m*. For example, denote $\tilde{\theta}$ as the taste parameter of the consumer located at $(1-\gamma)X$, the level of H product available on the market. This consumer receives surplus *fo* if he consumes the L product. Therefore a price that satisfies this consumer's self-selection constraint, must also give him at least surplus *fo*. The price that satisfies the constraint at equality is denoted as point $\tilde{\theta}n = P_H^0$ in figure 1, where *n* is chosen to satisfy the condition *nk = fo*.

The revenue generated from the sale of the H and L products in the no-MQS case is represented in figure 1 by the areas $(1-\gamma)XnP_H^0e$ and $Xaf(1-\gamma)X$, respectively. The revenue and variable profit in the no-MQS case is the sum of these revenues.

Imposition of a MQS alters the market in a fundamental way. As a consequence of preventing sale of the L product, consumers are no longer able to substitute between the L and H products, eliminating the self-selection constraint on the market. Instead the condition that determines the equilibrium price for the high-quality product is the market-clearing or willingness-to-pay constraint. In the presence of a MQS, the marginal consumer with taste parameter $\tilde{\theta}$ is willing to pay a price equal to $\tilde{\theta}k = P_H^1$. The revenue generated from the sale of the H product in the presence of a MQS is represented by the area $(1-\gamma)XkP_H^1e$ in figure 1.

In the exogenous-quality scenario, the change in industry variable profits from imposing a MQS depends upon two offsetting effects: (i) a *price effect*, which is the change in revenue as a result of the MQS-induced price increase for H product (i.e., $(P_H^1 - P_H^0)[(1-\gamma)X]$), and (ii) a *regulation effect,* which is the revenue, $P_L^0(\gamma X)$, lost from being unable to sell the L product under a MQS. The regulation effect is increasing in α and γ and decreasing in *X*. The price effect in this scenario is due solely to what we term the *self-selection effect*—the MQS removes the self-selection constraint on price for the H product, thus, $P_H^1 > P_H^0$, and the price effect is always positive in this model.[5] The magnitude of the self-selection effect is increasing in the quality of the L product, α, the size of the market relative to total potential demand, *X*, and the proportion, γ, of production that is L.

In the model with exogenous quality, consumers are necessarily harmed by the imposition of a MQS. Price of the H product unambiguously increases, causing surplus of H consumers to decrease by the amount $nkP_H^1P_H^0$. Individuals who consumed L product in the no-MQS equilibrium do not consume it in the MQS equilibrium, resulting in surplus loss of area *aof* in figure 1.

The dead weight loss associated with the imposition of the MQS in the symmetric competitive market scenario is equal to the sum of the loss of revenue associated with elimination of the sale of the L product, area $Xaf(1-\gamma)X$, and the loss of consumer surplus that was derived by the consumers who purchased the L product in the absence of the MQS, area *aof*.

[5] When we subsequently consider quality-enhancement activities, we will introduce a *supply effect,* which results from increased transformation of L product to H after the MQS is imposed.

The market in this simplest scenario is characterized by three parameters: X, the size of the market relative to potential demand, γ, the share of production that is low quality, and α, the relative quality level of the L product. In considering market conditions when it is in the interests of the industry to impose a MQS, it is noteworthy that the magnitude of α does not matter. Higher α increases the value of the L product for any values of X and γ, making the impact due to the regulation effect greater, but it also "tightens" the self-selection constraint because L product competes more closely with H the higher is α, reducing P_H^0 in the no-MQS scenario, and thereby making the price effect from eliminating the constraint greater. In the exogenous-quality model these two effects exactly cancel.

The industry's decision regarding imposition of a MQS thus hinges solely on X and γ in this benchmark case. The isoprofit line in figure 2 identifies (X, γ) combinations that equalize producer revenues in the MQS and no-MQS scenarios. For (X, γ) combinations below the line, it is optimal for producers to impose a MQS, whereas for parameter combinations above the contour a MQS is not optimal from the industry's perspective.

MQS with Endogenous Quality Enhancement

We now extend the model to the case where the ex ante distribution of L and H product can be altered according to the transformation function given in equation (1). The difference in value or premium, P, between high- and low-quality product given the ex ante distribution represents the market's inverse demand for quality enhancement:

(4) $$P = P_H - P_L = 1 - \alpha - Q_H + \alpha Q_H = (1-\alpha)(1-Q_H)$$

Replacing the quantities demanded in (4) with the ex ante quality distribution yields

(5) $$P(T \mid \alpha, \gamma, X) = (1-\alpha)[1-(1-\gamma)X - T],$$

where T represents the total amount of low-quality product transformed to high quality.

To derive the supply function for quality enhancement, differentiate the cost function to obtain marginal cost, $MC(T) = \beta T$, set $P = \beta T$ and solve for $T = P/\beta$. Transformation of L product to H is limited by the ex ante availability, γX, of L product. To find the level of P where the total available quantity of L product is transformed, solve $\gamma X = P/\beta$ for $P = \gamma\beta X$. Then we write market supply of quality enhancement as

(6) $$T = \begin{cases} P/\beta & if \quad P < \gamma\beta X \\ \lambda X & if \quad P \geq \gamma\beta X \end{cases}.$$

Equating the demand (5) and supply (6) for quality enhancement yields the total amount of L product transformed to H in competitive equilibrium. If (5) intersects (6) in its vertical portion, then the entire amount of ex ante L production is converted to H. The case of interest is the "interior solution" where only a portion of the L product is transformed to H in the absence of a MQS. Imposition of a MQS is irrelevant if the entirety of the low-quality product is converted to high-quality product without the intervention of a MQS.

Limiting attention to this case, we find that the equilibrium volume of transformation under perfect competition in the no-MQS case (denoted with a "0" superscript) is:

$$T^0 = \frac{(1-\alpha)(1-X+\gamma X)}{\alpha-\beta-1} < \gamma X .$$

Prices for the H and L products in the no-MQS competitive equilibrium are

$$\begin{aligned} P_H^0 &= 1 - Q_H - \alpha Q_L = 1 - X[1-\gamma(1-\alpha)] - T^0(1-\alpha) \\ &= \frac{(X + \alpha\gamma X - \gamma X - 1)\beta + \alpha(1-\alpha)(X-1)}{\alpha-\beta-1} \end{aligned}$$

$$P_L^0 = (1 - X)\alpha \ .$$

The location of the consumer who is indifferent between consuming H product and L product is

$$\theta_H^0 = \frac{\beta(1 - X + \gamma X)}{\beta - \alpha + 1}$$

and the location of the consumer who is indifferent between consuming the L product and nothing is

$$\theta_L^0 = 1 - X \ .$$

Figure 3 illustrates this model. The market demand for H product, the market demand for L product, and the maximum willingness to pay for the high-quality product for each consumer who purchases the L product are defined and constructed as described in reference to figure 1. In the absence of a MQS producers incur two costs in transforming L product to H: the actual costs of quality enhancement, represented in aggregate by the industry marginal transformation cost function MC(T) = βT, and the opportunity cost of transformation, namely the price $\mathrm{P}_0^{\mathrm{L}}$ that could be received for selling the product as low quality. The competitive equilibrium in the absence of a MQS thus occurs where the market demand for quality enhancement, segment nm, intersects the "full" marginal transformation cost curve, $\beta T + P_L^0$, at quantity of transformation T^0, and high-quality price $\mathrm{P}_{\mathrm{H}}^0$.

The revenue generated from the sale of the H and L products is represented by the areas $cd\,P_H^0\,e$ and *Xabc*, respectively. The direct costs associated with the transformation are depicted by the triangle *bdf*. Therefore, the variable profit to industry producers in the no-MQS scenario as depicted in figure 3 is $\pi^0 = Xabc + cd\,P_H^0\,e - bdf$.

Now consider the imposition of a MQS. Consumers are no longer able to substitute between the L and H products, eliminating the self-selection constraint on the market. Instead the equilibrium price for the high-quality product is determined by the market-clearing condition or individual-rationality constraint that consumers are willing to purchase all H product that is produced, either ex ante or through transformation. Thus, with the MQS, the market's demand to transform L product to H is the residual H demand determined by the willingness to pay for H product of those consumers who would not purchase H product in the absence of transformation. In reference to figure 3, the consumer with taste parameter $\tilde{\theta}$ is willing to pay a price equal to $k\tilde{\theta}$, while the "last" potential consumer is willing to pay price mX. The market demand for quality enhancement in the MQS case is therefore the residual willingness to pay for H, given ex ante H production $(1-\gamma)X$ --the segment km in figure 3.

Mathematically, we derive this residual demand by finding the taste parameter, θ_H, of the consumer who is indifferent between consuming the H product and nothing: $\theta_H = \frac{P_H}{q_H} = P_H$. The direct demand for the H product under the MQS is then $Q_H = 1-\theta_H = 1-P_H$. Thus, the indirect residual demand function for quality enhancement, given ex ante high quality production $(1-\gamma)X$, is

(7) $$P_H(T|\gamma, X) = 1-Q_H = 1-(1-\gamma)X - T.$$

The market's supply of quality enhancement is also altered by the MQS because transformation of L product to H no longer involves the opportunity cost of selling the product as L. Therefore, the market's inverse supply curve for transforming L product to H is simply the marginal cost curve, P_H = MC(T) = βT. In the presence of a MQS, the equilibrium price for H product, P_H^1, and amount of L product transformed, T^1, is found where MC(T) intersects the inverse residual demand curve for quality enhancement (7).

Continuing to focus on the case of an interior solution for T, we have:

(8) $$T^1 = \frac{1-X+\gamma X}{\beta+1},$$

where the superscript "1" denotes equilibrium conditions in the presence of a MQS. Substituting (8) into (7) yields the equilibrium price for the H product when a MQS is imposed:

$$P_H^1 = 1 - Q_H = 1 - [(1-\gamma)X + T^1] = \frac{\beta(1 - X + \gamma X)}{\beta + 1}$$

The difference in the amount of product transformed in equilibrium is

$$T^1 - T^0 = \frac{\alpha\beta(1 - X + \gamma X)}{(\beta+1)(\beta-\alpha+1)}.$$

Given X<1, it follows that $1 - X + \gamma X > 0$. Therefore, if $\beta \geq \alpha$, $T^1 - T^0 > 0$.

The consumer who is indifferent between consuming the H product and nothing is located at

$$\theta_H^1 = P_H^1 = \frac{\beta(1 - X + \gamma X)}{\beta + 1} < \theta_H^0.$$

In figure 3 the equilibrium is depicted by the intersection of segment *km* and βT .Consequently, the revenue associated with the production of the H product is the area $gh\,P_1^H$ *e*. The cost incurred from transforming T^1 is the area of the triangle $gh(1-\gamma)X$, so $\pi^1 =$ $gh\,P_1^H$ *e* - $gh(1-\gamma)X$.

Mathematically, the variable profits for producers in the no-MQS and MQS equilibria are

(9) $$\pi^0 = P_H^0(X - \gamma X + T^0) + P_L^0(\gamma X - T^0) - 0.5\beta(T^0)^2,$$

(10) $$\pi^1 = P_H^1(X - \gamma X + T^1) - 0.5\beta(T^1)^2.$$

In determining conditions when it is in the industry's interest to impose a MQS when quality enhancement is possible, it is once again helpful to breakdown the overall impact into component effects. The price effect and regulation effect are largely as discussed for the exogenous-quality case.

The price effect in this and subsequent scenarios where quality-enhancement is possible is the change in revenue as a result of the MQS-induced change in P_H for H product that would have been produced and sold in the absence of the MQS, either through ex ante production or transformation: $(P_H^1 - P_H^0)[(1-\gamma)X + T^0]$. The regulation effect is the revenue lost from L product that is not transformed and consequently is wasted under the MQS: $P_L^0(\gamma X - T^1)$. A third effect, which we term the *quality-enhancement effect*, exists when quality enhancement is possible. It is the change in revenue generated from the sale of the incremental H product created by the additional transformation under the MQS: $(P_H^1 - P_L^0)(T^1 - T^0) - 0.5\beta[(T^1)^2 - (T^0)^2]$. The profitability of the implementation of the MQS depends upon the sign of the sum of the three effects.

The price effect itself can usefully be decomposed into two effects when there is quality enhancement. As before, the self-selection component of the price effect is due to elimination of the self-selection constraint with imposition of a MQS and its replacement for pricing purposes by the willingness-to-pay or individual-rationality condition. A *supply effect* also occurs in the quality-enhancement case as a result of movement along the high-quality residual demand function due to the additional product transformed from L to H caused by the MQS.

Define P_H^* as the price that would result under the MQS regime, given the equilibrium amount of H product sold in the no-MQS regime: $P_H^* = 1 - Q_H^0 = 1 - [(1-\gamma)X + T^0]$. The total change in price, $P_H^1 - P_H^0$, can then be written as follows:

$$P_H^1 - P_H^0 = (P_H^1 - P_H^*) + (P_H^* - P_H^0).$$

The self-selection effect is $P_H^* - P_H^0 = \alpha Q_L = \alpha(\gamma X - T^0)$, and it is always positive. The magnitude of the self-selection effect is increasing in α, γ, and the cost of transformation, β. Graphically, this effect is represented by the movement from point *d* on the no-MQS demand curve, *nm,* to the point *s* on the MQS demand curve, *km* in figure 3. The supply effect is $P_H^1 - P_H^* = T^0 - T^1 < 0$, because $T^1 > T^0$. Graphically, it is the movement along the no-MQS demand curve, k*m,* from point *s* to point *h* in figure 3. Because the self-selection and supply components of the price effect offset, the overall sign of the price effect is in general ambiguous for the case of an MQS with quality enhancement.

In general, the sign of the quality-enhancement effect is also ambiguous. A necessary but not sufficient condition for the effect to be positive is that $P_H^1 > P_H^0$. Because T^0 represents the level of quality enhancement that maximizes producer profits, given P_H^0, the incremental product transformed, $T^1 - T^0$, cannot increase industry profits unless $P_H^1 > P_H^0$.

The overall impact on producers' variable profits from imposing a MQS now depends upon four parameters: $X, \alpha, \gamma,$ and β. The regulation effect from imposing a MQS is always negative because some valuable L product cannot be sold. However, the price effect and quality-enhancement effect can be either positive or negative and, if positive, can be of a sufficient magnitude to dominate the regulation effect and make imposing a MQS desirable from the industry's perspective. One useful benchmark case to consider is whether $P_H^1 > P_H^0$. Unless this condition holds, a MQS can never be desirable from producers' perspective because all three effects are nonpositive when $P_H^1 \leq P_H^0$. Thus, an increase in the price of the H product is a necessary but not sufficient condition for the industry to impose a MQS.

Consider now the effect of a MQS on consumers when quality enhancement is possible. Utilizing figure 3 it is possible to identify three specific groups of consumers: (i) consumers who purchase the H product both before and after the imposition of a MQS—those with taste parameters

$\theta \in [\theta_H^0, 1]$, (ii) consumers who buy the L product in the absence of a MQS and buy the H produce in the presence of a MQS—those with taste parameters $\theta \in [\theta_H^1, \theta_H^0)$, and (iii) consumers who buy the L product in the absence of a MQS and buy nothing in the presence of a MQS—those with taste parameters $\theta \in [\theta_L^0, \theta_H^1)$.

Consumers in group (iii) are unambiguously harmed by a MQS while consumers in group (i) benefit from a MQS if P_H falls and are harmed if P_H rises. The welfare effect on group (ii) consumers is more complicated because their higher utility from consuming the H product is offset by the higher price they pay, $P_H^1 > P_L^0$. However, because consumers in this group could have purchased the H product at price P_H^0 in the no-MQS scenario and did not, we know that they cannot benefit from a MQS unless $P_H^1 < P_H^0$.

Because a necessary condition for producers to implement a MQS is that the high-quality price rises $(P_H^1 > P_L^0)$, we can conclude that *all* consumers in the market who would purchase the product in a no-MQS competitive equilibrium lose from an industry-implemented MQS.

MQS in a Free-Trade Environment

As noted, an important dimension of minimum quality standards imposed by U.S. marketing orders is the opportunity through section 8e to impose the same regulations on importers. We now extend the model to consider MQS in a free-trade environment. We consider a case where the domestic industry (D) faces competition from an importing country (F). For simplicity, both countries have equal shares of the total production, *X*.

MQS with Asymmetric Exogenous Quality, Perfectly Competitive Markets, and Trade

Heterogeneity in land quality and weather conditions may cause countries to produce different distributions of H and L products, so in this scenario we allow D and F to have different proportions, γ^D and γ^F of L product.

When the ex ante quality distribution cannot be altered and the proportions of L product produced by D and F are asymmetric, the profits for producers in country *i* when the MQS is not imposed are $\pi_i^0 = 0.5[P_H^0(X - \gamma^i X) + P_L^0(\gamma^i X)]$ for $i = D, F$. Whereas, after the imposition of the MQS, the profits for producers in country *i* are $\pi_i^1 = 0.5[P_H^1(X - \gamma^i X)]$ for $i = D, F$. Because increases in either country's proportion of L product increases the price of the H product for a given *X*, with or without a MQS, increases in the proportion of L product produced by F cause the profit of D to increase, and vice versa, in both the presence and the absence of a MQS.

The price of the H product in the absence of a MQS is $P_H^0 = 1 - 0.5X[2 - (\gamma^D + \gamma^F)(1-\alpha)]$, while P_L remains unchanged from the symmetric scenario. The price of the H product after the imposition of a MQS is $P_H^1 = 1 - 0.5X[2 - \gamma^D - \gamma^F]$. As in the symmetric exogenous quality level scenario, the price effect of the MQS is always positive, while the regulation effect always causes producer profits to decline. Thus, profits for D and F are still determined by the sign of the difference between the price effect and the regulation effect, but these profit levels are no longer symmetric.

Figure 4 depicts isoprofit contours, constructed by equating domestic producer profits with and without a MQS, given alternative proportions of L product produced by F. In the parameter space that lies above an isoprofit contour a MQS reduces domestic profits, while in the parameter space below an isoprofit line a MQS increases domestic profits. The figure makes clear that in a free-trade scenario, an advantage for the D country in producing high quality relative to F enlarges the parameter space when the D country wishes to impose a MQS because more of the costs of the MQS in terms of foregone sales of L product are borne by the F country, while the D country is able to capture a larger share of the advantage of removing the self-selection constraint due to its greater share of H product.

MQS with Symmetric Endogenous Quality Enhancement, Perfectly Competitive Markets, and Trade

In this scenario we consider the imposition of a MQS in a model where D and F interact in a perfectly competitive market setting. To simplify this case we assume symmetry between the D and F producers: (i) each country has half of the total exogenous output ($X^D = X^F = X/2$), (ii) the shares of L product available to each country are the same ($\gamma^D = \gamma^F = \gamma$), and (iii) each is equally efficient at transforming L product to H ($\beta_D = \beta_F = \beta$).

Equating the supply function for quality enhancement and the demand for quality enhancement yields the total amount of L product transformed to H product collectively by D and F in competitive equilibrium (denoted with a superscript "0" to indicate the level of transformation before the imposition of the MQS and with a subscript "C" to indicate the perfectly competitive market structure) is

$$T_C^0 = \frac{2(1-\alpha)[X - 1 - \gamma X]}{2\alpha - \beta - 2}.$$

Because D and F have symmetric costs, each transforms the same amount of product: $T_C^0/2$. T_C^0 is the socially optimal level of transformation. The prices for the H and L products in the competitive equilibrium with no MQS are

$$P_H^0 = 1 - X[1-\gamma(1-\alpha)] - T_C^0(1-\alpha)$$
$$= \frac{[X + \alpha\gamma X - \gamma X - 1]\beta + 2\alpha(1-\alpha)(X-1)}{2\alpha - \beta - 2} \text{ and}$$

$$P_L^0 = (1-X)\alpha ,$$

respectively. To complete the characterization of the equilibrium in the absence of the MQS, the location of the consumer who is indifferent between consuming H product and L product is

$$\theta_h^0 = \frac{\beta(1 - X + \gamma X)}{2 + \beta - 2\alpha}$$

whereas the location of the consumer who is indifferent between consuming the L product and nothing is

$$\theta_l^0 = 1 - X .$$

Eliminating the L product from the market by imposing a MQS and equating the supply function for quality enhancement and the demand for quality enhancement yields the total amount of L product transformed to H product collectively by D and F in the competitive equilibrium in the presence of an MQS:

$$T_C^1 = \frac{2[1 - X + \gamma X]}{\beta + 2} .$$

Each country transforms half of this total, given their symmetry: $T_C^1 / 2$.

The prices for the H and L products after the MQS is imposed are

$$P_H^1 = 1 - Q_H = 1 - [(1-\gamma)X + T^1]$$
$$= \frac{\beta[1 - X + \gamma X]}{\beta + 2}$$

and $P_L^1 = 0$, respectively. The consumer who is indifferent between consuming the H product and nothing is located where

$$\theta_H^1 = P_H^1 = \frac{\beta(1 - X + \gamma X)}{\beta + 2}.$$

The elimination of the L market with the imposition of the MQS causes the demand for the H product to increase such that $\theta_H^1 < \theta_H^0$.

The difference in the amount of product transformed in equilibrium is

$$T_C^1 - T_C^0 = \frac{2\alpha\beta[X - 1 - \gamma X]}{(\beta + 2)(2\alpha - \beta - 2)}.$$

Given $\alpha < 1$ and $\beta > 0$ by assumption, it follows that $2\alpha - \beta - 2 < 0$. Similarly, given that X<1 and the remaining terms in the square brackets in the numerator are negative, it follows that $X - 1 - \gamma X < 0$. Therefore, $T_C^1 - T_C^0 > 0$ and, thus, countries transform more of the L product to H when a MQS is imposed. The MQS in the competitive market case with trade thus creates two sources of deadweight loss. One is due to the excessive quality enhancement that occurs as a result of the imposition of the standard and the other is due to inability to sell the L product.

The profits for producers in country *i* in the no-MQS and MQS equilibria are

$$\pi_i^0 = 0.5[P_H^0(X - \gamma X + T^0) + P_L^0(\gamma X - T^0) - 0.25\beta(T^0)^2] \text{ for } i = D, F$$

$$\pi_i^1 = 0.5[P_H^1(X - \gamma X + T^1) - 0.25\beta(T^1)^2] \text{ for } i = D, F.$$

As in the previous scenarios the impact of the MQS on the profits of D and F can be decomposed into three effects. The interpretation of these effects is the same but the formulation changes as a result of the incorporation of trade in the symmetric case. The price, quality-enhancement, and regulation effects in the symmetric monopolistic markets case are, respectively,

$$0.5(P_H^1 - P_H^0)[(1 - \gamma)X + T_C^0],$$

$$0.5(P_H^1 - P_L^0)(T_C^1 - T_C^0) - 0.125\beta(T_C^{1^2} - T_C^{0^2}), \text{ and}$$

$$0.5P_L^0(\gamma X - T_C^1).$$

MQS with Symmetric Endogenous Quality Enhancement, Duopoly Competition, and Trade

We now consider the imposition of a MQS in model setting where both D and F are monopoly sellers of their country's production. Thus, the two countries compete as duopolists for sales in the D market.[6] Given the exogeneity of total production, the countries' strategic variable is the amount of L product to transform to H. We seek a Cournot-Nash equilibrium for the volumes of L which each country will transform. We retain the symmetry assumptions from the prior subsection to simplify the analysis: $X^D = X^F = X/2$, $\gamma^D = \gamma^F = \gamma$, and $\beta_D = \beta_F = \beta$. The profit function for country *i* = *D*, *F* in the absence of a MQS is

$$\pi_0^i = 0.5[P_H^0(X - \gamma X + 2T_i) + P_L^0(\gamma X - 2T_i) - \beta T_i^2],$$

where the prices in the absence of a MQS are

$$P_H^0 = 1 - X + (1-\alpha)[\gamma X - T_D - T_F]$$

$$P_L^0 = (1 - X)\alpha,$$

Solving the first-order conditions of the two countries' profit maximization problem (i.e., $\frac{\partial \pi_i^0}{\partial T_i} = 0$ for i = D, F) simultaneously yields the optimal level of transformation in the no-MQS case:

$$T_D^0 = T_F^0 = \frac{(1-\alpha)(2 + 3\gamma X - 3X)}{2(\beta - 3\alpha + 3)}.$$

Collectively, D and F transform

$$T_O^0 = \frac{(1-\alpha)(2 + 3\gamma X - 3X)}{\beta - 3\alpha + 3}$$

[6] Modeling imports to the domestic market as emanating from a single seller reflects the fact that many agricultural commodities are exported through state trading agencies or exportation is dominated by a single firm. Modeling the domestic industry as a single seller is consistent with marketing orders allowing producers to act collectively in marketing.

where subscript "O" is used to denote values in the duopoly equilibrium. The difference between the socially optimal level of quality enhancement, found at the competitive equilibrium, and the level of quality enhancement in the duopoly case is

$$T_C^0 - T_O^0 = \frac{(\alpha-1)[2(\alpha-1) + X\beta(\gamma-1)]}{(\beta-3\alpha+3)(\beta-2\alpha+2)} .$$

Given that $\alpha < 1$, the terms $\alpha - 1$ and $2(\alpha-1)$ are negative. Additionally, since $0 < \gamma < 1$, the term $X\beta(\gamma-1) < 0$. Consequently, the numerator is positive. Expanding the denominator of the quotient yields $\beta^2 + 5(1-\alpha) + 3(1-\alpha)2(1-\alpha)$ which is always positive. Therefore, $T_C^0 - T_O^0 > 0$.

Thus, when sellers have market power in the no-MQS equilibrium, they provide less than the socially optimal amount of quality enhancement. This result is consistent with the conventional intuition that entities with market power will restrict the amount of product on the market to raise price and profit. Throughout all of the scenarios considered (5) is the demand for transformation in the absence of a MQS. Any entity with market power will thereby perceive a marginal revenue curve that is steeper (i.e., that lies below the demand for transformation) than the demand for transformation. Therefore, for a given autarkic or trade scenario any market structure where market participants have market power will yield a level of transformation that is less than the socially optimal level.

The prices for the H and L products in the duopoly equilibrium with no MQS are

$$P_H^0 = 1 - Q_H - \alpha Q_L = 1 - X[1-\gamma(1-\alpha)] - (T_D^0 + T_F^0)(1-\alpha)$$
$$= \frac{(\gamma X - \alpha\gamma X - X + 1)\beta - (3X-2)\alpha^2 - (3X+1)\alpha - 1}{\beta - 3\alpha + 3} \quad \text{and}$$

$$P_L^0 = (1-X)\alpha .$$

To complete the characterization of the no-MQS equilibrium, the location of the consumer who is indifferent between consuming the H product and the L product is

$$\theta_H^0 = \frac{1-\alpha+\beta(1-X+\gamma X)}{\beta-3\alpha+3}$$

while the consumer who is indifferent between consuming the L product and not consuming the product at all is represented by

$$\theta_L^0 = 1-X \ .$$

The implementation of a MQS eliminates L product from the market. Adjusting the indirect demand function for the H product and thereby each country's demand for transformation results in the profit function for country *i = D, F* under the MQS:

$$\pi_1^i = 0.5[P_H^1(X-\gamma X+2T_i)-\beta(T_i)^2]$$

Again solving the first-order conditions of the two countries' profit functions simultaneously yields the optimal level of transformation after the imposition of the MQS:

$$T_D^1 = T_F^1 = \frac{2+3\gamma X-3X}{2(\beta+3)} \ .$$

Therefore, the aggregate amount of transformation that occurs after the imposition of a MQS is

$$T_O^1 = \frac{2-3X(1-\gamma)}{\beta+3} \ .$$

The price of the H product after the imposition of the MQS is

$$\begin{aligned} P_H^1 &= 1-Q_H = 1-(X-\gamma X+T_D+T_F) \\ &= \frac{1+\beta(1-X+\gamma X)}{\beta+3} \end{aligned} \ .$$

The consumer who is indifferent between consuming the H product and not consuming the product at all is located where $\theta_H^1 = P_H^1$.

In the symmetric duopoly market case, it is not always true that more L product is transformed after the MQS is imposed. The difference in transformation is

$$T_O^1 - T_O^0 = \frac{\alpha\beta(2-3X(1-\gamma))}{(\beta+3)(\beta-3\alpha+3)}.$$

The denominator of the difference in transformation in this scenario is greater than zero assuming there is some positive cost associated with transforming product. Because both α and β are assumed to be positive, the sign of the numerator depends on the term $2-3X(1-\gamma)$. For the imposition of a MQS to increase the amount of transformation it must be that $X(1-\gamma) < 2/3$. Figure 5 shows that for the preponderance of the feasible parameter space this condition holds. The parameter combinations (X,γ) that lie above the curve in figure 5 represent situations where the duopoly sellers collectively transform more under a MQS. Consequently, for all of the parameter combinations, (X,γ), where $X(1-\gamma) < 2/3$ the imposition of a MQS induces the duopoly sellers to move closer to the socially optimal level of transformation.

Mathematically, the variable profits earned by producers in the absence of a MQS and in the presence of a MQS are

$$\pi_i^0 = 0.5[P_H^0(X-\gamma X+2T_i^0)+P_L^0(\gamma X-2T_i^0)-\beta(T_i^0)^2],\ \ i = D, F \text{ and}$$

$$\pi_i^1 = 0.5[P_H^1(X-\gamma X+2T_i^1)-\beta(T_i^1)^2],\ \ i = D, F.$$

As in the previous scenarios the impact of the MQS on the profits of D and F can be decomposed into three effects. The interpretation of these effects is the same but the formulation changes as a result of the duopoly assumption. The price, quality-enhancement, and regulation effects in the symmetric monopolistic markets case are

$$0.5(P_H^1-P_H^0)[X-\gamma X+2T_i^0],$$

$$(P_H^1-P_L^0)(T_i^1-T_i^0)-0.5\beta((T_i^1)^2-(T_i^0)^2), \text{ and}$$

$$0.5P_L^0(\gamma X - 2T_i^1)$$

respectively, for i=D, F.

Conclusion

This paper has explored the economic impact of a MQS imposed by a domestic agricultural industry under the auspices of marketing order legislation in both a closed- and open-economy setting. We developed a simple model, but yet one that reflects core realities of agricultural production and the operation of U.S. agricultural marketing orders--features that have been absent in part or in total from prior analyses of MQS.

Initially, we posited as a benchmark the autarkic, the exogenous-quality scenario and derived the set of market conditions, expressed in terms of the size of production relative to the total market and the proportion of production that is low quality, when it was profit enhancing for the industry to impose a MQS. We showed that any MQS that is desirable from the domestic industry's perspective necessarily causes consumer welfare to decline in aggregate and also for each individual who would consume the product in a no-MQS equilibrium. The deadweight loss from inability to sell and consume the low-quality product insures that aggregate welfare decreases due to imposing the MQS in this setting.

In extending the model to make quality endogenous through transformation of low-quality (L) product to high quality (H), we established that a necessary condition for producers to implement a MQS was for the price of the high-quality product, P_H, to rise as a consequence of the MQS. Whereas P_H rising followed with certainty in the baseline case, P_H may not rise when quality can be enhanced because sellers necessarily transform more L product to H under a MQS, thereby introducing a supply effect, which works opposite the impact on P_H from removing "competition" from the L product (what we termed the self-selection effect). Thus, whenever imposing a MQS is desirable from producers' perspective, it follows once again that *all* consumers in the market who would purchase the product in a no-MQS competitive equilibrium lose from an industry-implemented MQS. An additional feature of note from this scenario is that the increase in quality enhancement that occurs due to the MQS represents a second source of deadweight loss. Because the competitive level of quality enhancement is optimal in the no-MQS case, imposition of the MQS causes excessive production of high-quality product from a societal perspective.

The section 8e provision applying domestic MQS to imports is an important dimension of MQS enacted through U.S. marketing orders, because it presents the possibility that MQS can be used to raise the costs of exporting countries when there is asymmetry between domestic and foreign producers in terms of ex ante ability to produce high-quality production and/or transform L product to H. Our investigation of MQS in a free-trade context focused on three specific scenarios: (i) asymmetric exogenous quality, (ii) symmetric endogenous quality enhancement and perfect competition, and (iii) symmetric endogenous quality enhancement and Cournot duopoly. In the asymmetric quality scenario we showed that an advantage for the domestic country in terms of ex ante ability to produce H product expanded the range of market settings when domestic producers would impose a MQS, in essence because the benefit of a MQS in terms of higher price for the H product inures mainly to domestic producers, while the costs in terms of inability to sell the L product are borne mainly by foreign producers.

Although analyzing MQS in free-trade setting with endogenous quality enhancement and perfect competition presents no new results relative to the autarkic case with endogenous quality enhancement, and, hence, is not inherently interesting in its own right, we presented it as a baseline to characterize the socially optimal level of product transformation, which occurs in the no-MQS setting. As in the autarkic case, imposition of a MQS leads to excessive quality enhancement from a societal perspective.

Finally, we considered trade with endogenous quality enhancement in a setting where both the domestic and foreign countries market through single sellers, who engage in duopoly competition in the domestic market. A key result from this analysis was that duopoly competition in the no-MQS equilibrium results in less quality enhancement than is socially optimal. Because the duopolists transform more L product to H in the presence of a MQS for nearly all market settings, imperfect competition in the market raises the interesting possibility that an industry-imposed MQS could, in fact, increase societal welfare. This outcome would occur in settings when the welfare improvement from increased quality enhancement resulting from a MQS exceeded the inevitable deadweight loss caused by inability to sell the low-quality product due to the MQS. Isolating such market settings is the subject of ongoing research.

Figure 1. Impact of a MQS in the Symmetric Competitive Market Scenario.

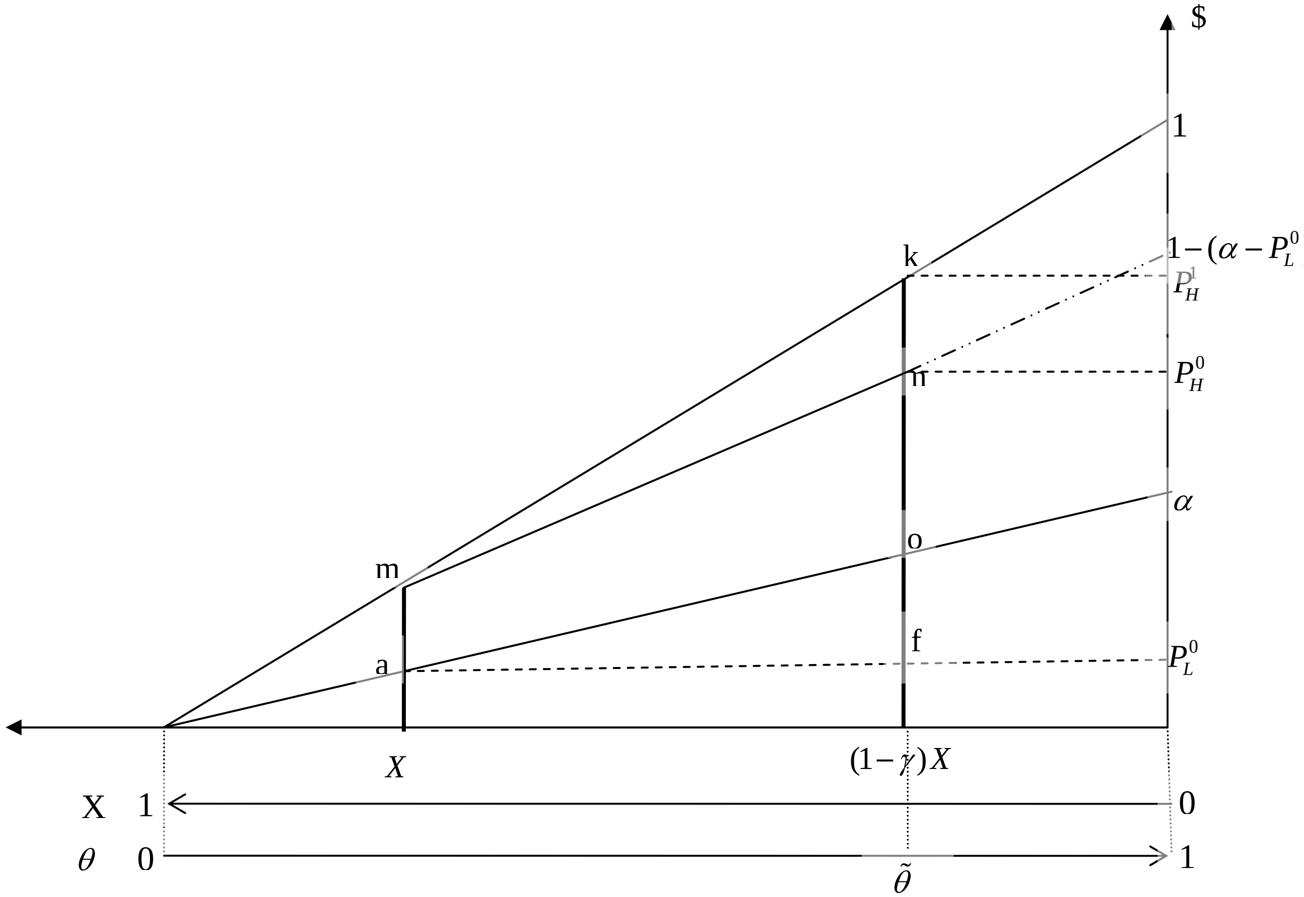


Figure 2. Isoprofit Contour and the Parameter Space where the Imposition of a MQS is Optimal from the Perspective of Producers.

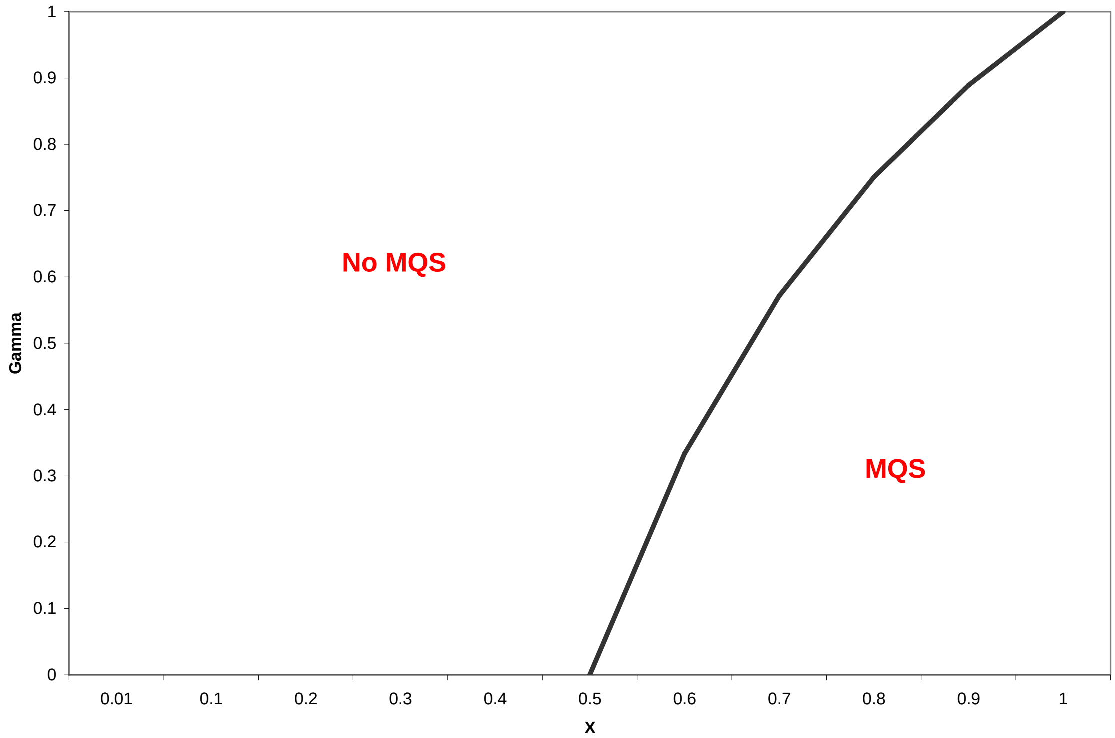


Figure 3. Impact of a MQS in the Endogenous Quality-Enhancement Scenario.

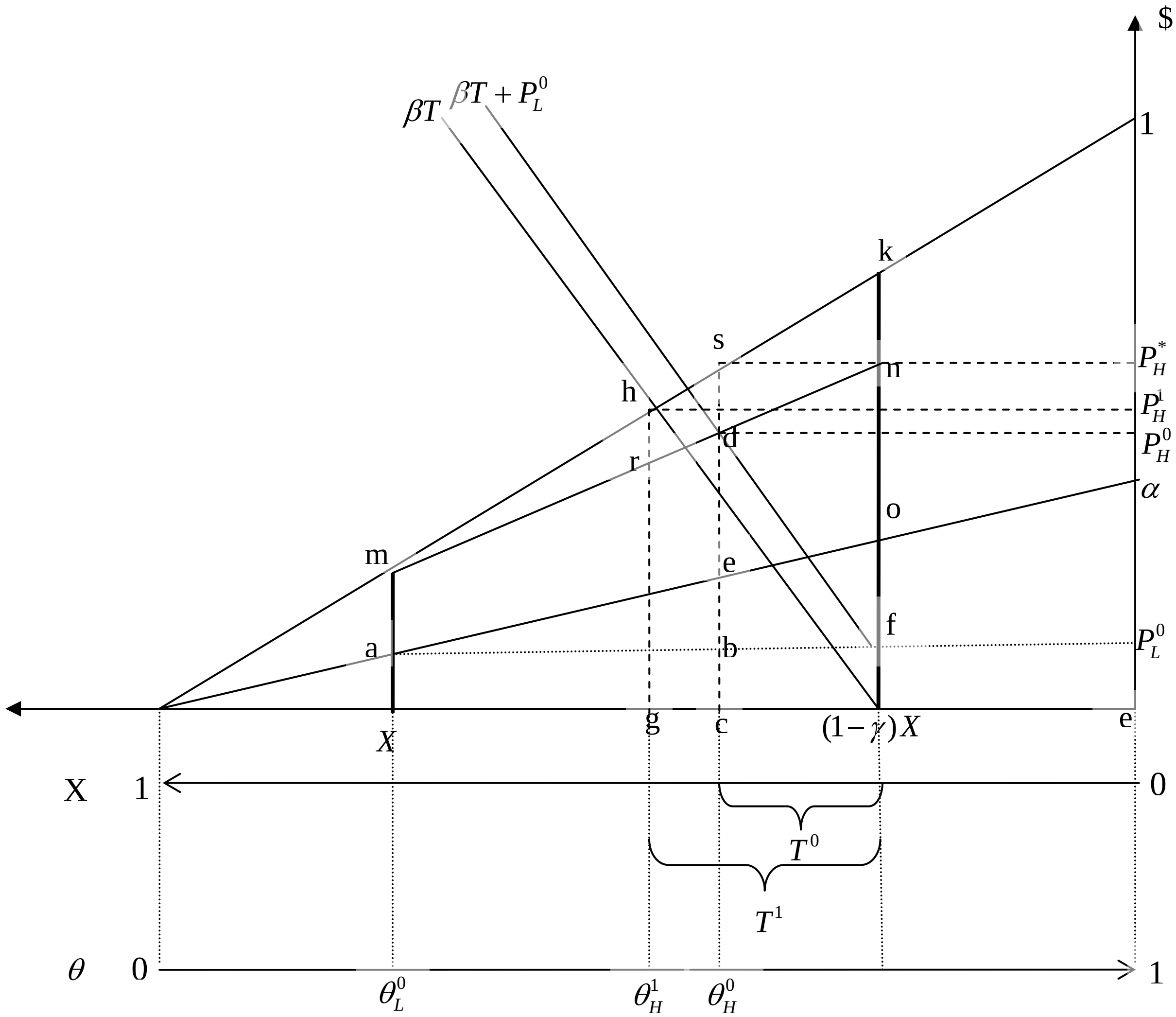


Figure 4. Isoprofit Contours and the Parameter Space where the Imposition of a MQS is Optimal from the Perspective of Producers when Low-Quality Production is Asymmetric.

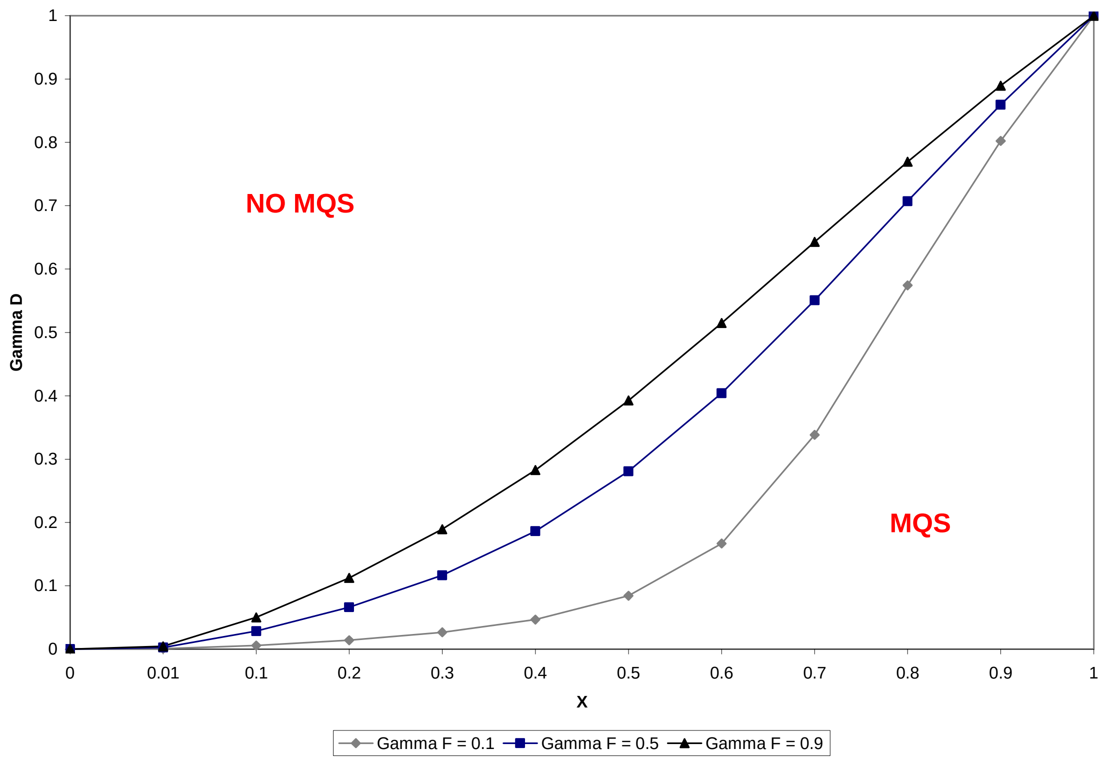
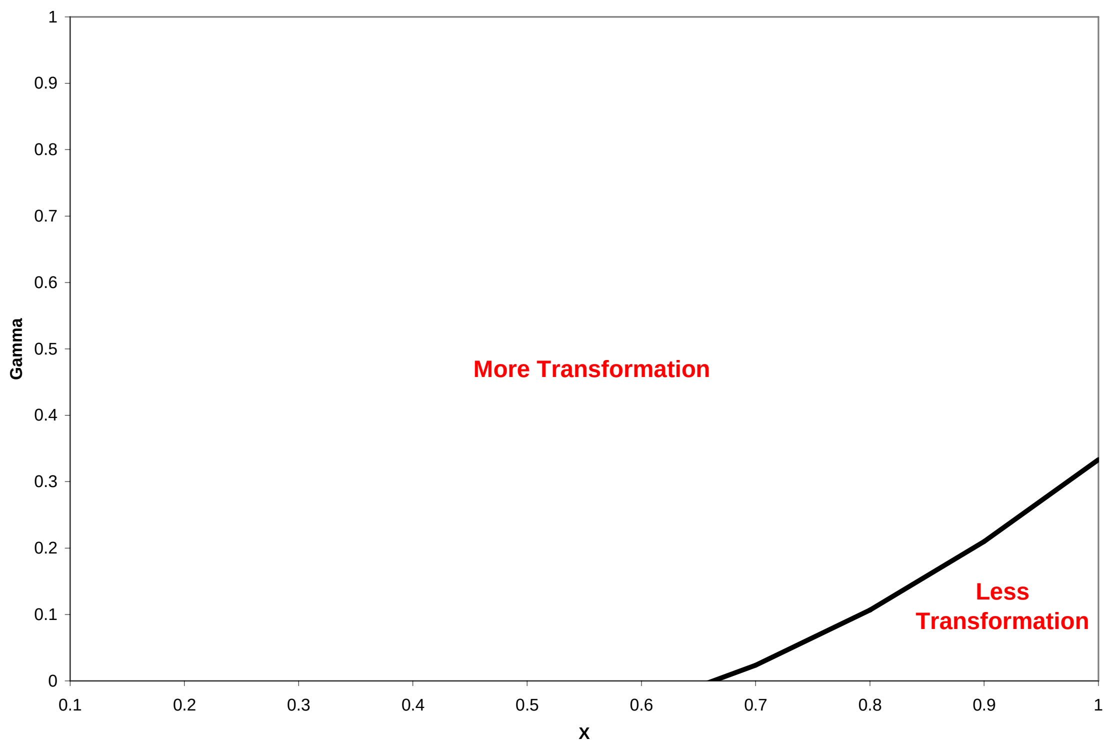


Figure 5. Parameter Space where Duopoly Sellers Transform More Product in the Presence of a MQS.



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