Global Welfare Impacts of U.S. Meat Promotion Activities

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An equilibrium displacement model of the U.S. meat markets is used to measure the potential impacts of promotion investment, differentiating meats by types and by supply source, taking into account the U.S. participation in global meat markets, and considering imperfect competition in the meat industry. The increase in U.S. producer welfare resulting from a 10 percent increase in promotion ranges from -$1.29 million to $2.60 million for U.S. beef producers and from -$0.96 million to $1.67 million for U.S. pork producers, depending primarily on the advertising elasticity used.

Key Words: equilibrium displacement model, international trade, beef and pork promotion activities

For the past two decades, U.S. beef and pork producers have used checkoff funds as a common marketing tool to increase domestic and foreign demand for their products. Assessments from the beef checkoff totaled approximately $1.31 billion from 1987 through 2002, a large portion of which was allocated towards promotion programs (Ward 2004). Generic advertising expenditures for pork increased from $7.4 million in 1987 to $17.6 million in 2005 (Beach et al. 2007). The U.S. government has also played an important role in developing, maintaining, and expanding markets for U.S. meats by funding export promotion programs. In 2008, the U.S. government allocated $28.56 million for export promotion of red meats and poultry via the Market Access Program (MAP) and the Foreign Market Development Program (FMD) (Table 1).

The U.S. generic commodity promotion programs seek to both inform and change consumer attitudes and perceptions, with the goal of increasing domestic and export sales and market shares for U.S. agricultural commodities. However, there has been a lot of debate in recent years about the continuation of these programs. These arguments have centered around the "… total benefits and costs and the distribution of costs and benefits among producers and handlers of a given commodity covered by a promotion program" (Alston, Freebairn, and James 2001, p. 888). Given the significant amounts of producer and U.S. government funds devoted to the domestic and international promotion of beef and pork, and the ongoing debate over the welfare implications of advertising, it is important to know the economic impacts of meat promotion.

The United States is one of the major players in world meat markets. In 2008, the United States was the largest importer and the third largest exporter of beef and veal, the second largest exporter and the sixth largest importer of pork, and the second largest exporter of broiler meat. Despite having the lion's share of the global meat trade, the United States' global market share has fluctuated during the past decade (USDA-FAS 2008). For instance, imports of beef from the United States were banned by Canada, Mexico, South Korea, and Japan following the outbreak of bovine spongiform

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Table 1. U.S. Industry and Government Funded Meat Export Promotion Expenditures *($ millions)*

Year	FAS Allocations				Matching Industry Contributions		Value of Exports	
	MAP[1]		FMD[2]		Checkoff & Other Industry Contributions[3]			
	USMEF[4]	USAPEEC[5]	USMEF	USAPEEC	USMEF	USAPEEC	Red Meats (beef, pork, lamb)	Poultry
2005	23.94	6.51	2.16	1.77	22.38	8.23	4,015	2,616
2006	--[6]	--[6]	2.04	1.71	1.98[7]	1.74	4,932	2,338
2007	15.77	5.24	2.02	1.70	16.24	8.11	5,788	3,300
2008	18.84	6.02	2.02	1.68	---[7]	---[7]	8,528	4,169

Source: USDA-FAS 2009a, 2009b, 2009c, and USMEF 2009.

Notes:
1 FAS program ceiling for Market Access Program from federal government budget.
2 FAS program ceiling for Foreign Market Development Program from federal government budget.
3 Contributions are those expenditures incurred and paid from checkoff and other industry funds in support of MAP and FMD activities. Other industry contributions are from membership dues, state contributions, and miscellaneous income.
4 U.S. Meat Export Federation. Products covered under USMEF expenditures are beef, pork, and lamb.
5 USA Poultry & Egg Export Council.
6 There was no MAP programming for 2006, as 2005 and 2007 were 18-month years.
7 Final MAP contributions for 2008 were not available at the time of final paper submission.

encephalopathy (BSE) in 2003. Additionally, the markets of major importing countries are differentiated in terms of buyers' attitudes toward meats from various sources (Henneberry and Hwang 2007). In the Asian markets, grain-fed beef imported from the United States has generally been viewed as having a higher quality than grass-fed (nonfed) beef imported from other sources. Therefore, supply source differentiation is important when analyzing global meat markets (Mutondo and Henneberry 2007).

Study Objectives and Contribution to Existing Literature

The objective of this study is to estimate the economic impacts of U.S. government- and industry-funded domestic and export promotion programs for beef and pork on the welfare of producers and marketers of U.S. meats. The meats studied here are beef, pork, and poultry. An equilibrium displacement (EDM) model is used to accomplish the goals of this study.

Equilibrium displacement models have been used in the literature to measure the impacts of various supply and demand shocks on the U.S. meat sector (Wohlgenant 1993, Alston, Freebairn, and James 2001, Brorsen et al. 2002, Kinnucan 2003, Brester, Marsh, and Atwood 2004, Lusk and Anderson 2004). However, none of these studies considered meats as supply source differentiated. Brester, Marsh, and Atwood (2004) and Lusk and Anderson (2004) measured the impacts of country of origin labeling on the U.S. meat industry, without taking into account the welfare impacts in an international trade context and without considering imperfectly competitive markets. Alston, Freebairn, and James (2001) analyzed optimal advertising strategies under various scenarios regarding cooperation of producer groups in determining their advertising budgets. While cross-product effects of generic meat promotion programs were considered in their study, imperfect competition and source differentiation were not. Although Wohlgenant (1993) considered different levels of the marketing channels, he did not differentiate meats by source of origin. Kinnucan (2003) analyzed the effect of market power in determining optimal generic beef advertising for the U.S. beef industry.

Regarding meat promotion effectiveness, Kinnucan, Xiao, and Hsia (1996) analyzed the impacts of beef promotion using a partial equilibrium approach but did not specifically consider exports or other meats. Coulibaly and Brorsen (1999) reestimated the single-equation model in Ward and Lambert (1993) using more recent data, with the objective of evaluating beef advertising effectiveness. These studies only included beef and did not include international markets for U.S. beef. Regarding export promotion of meats, Henneberry and De Brito (1994) estimated the impact of U.S.

beef export promotion programs in Japan, using a Rotterdam model.

Yet no research for any commodities, to our knowledge, has evaluated returns to promotion while including both domestic and global demand for U.S. meats simultaneously and accounting for imperfectly competitive markets. Also, past studies assume a perfectly competitive market structure. Over time, the food industry in the United States has become more concentrated and imperfectly competitive. The four-firm concentration ratio in the U.S. beef packing industry increased from 0.30 in 1978 to 0.86 in 1994, and statistically significant monopoly/monopsony price distortions in slaughter cattle and wholesale beef markets have been reported (Schroeter 1988, Stiegert, Azzam, and Brorsen 1993, Sexton 2000). Hence, the model used here is expanded to estimate welfare effects in the presence of imperfect competition.

Supply source differentiation allows us to consider the interrelationships between U.S.-produced meats and other meats in the U.S. export markets through cross-price relationships. Most of the past partial-equilibrium studies on U.S. meat demand have been limited to aggregate (non-source-differentiated) products. Some have estimated demand for various cuts of meat but have not differentiated meats by supply sources (Brester and Wohlgenant 1991, Eales and Unnevehr 1998). The studies that have used source differentiation have been limited to one market, Japan as an example (Hayes, Wahl, and Williams 1990, Yang and Koo 1994). Ignoring source differentiation may bias elasticity estimates (Mutondo and Henneberry 2007). We use source-differentiated elasticities, which are expected to produce more accurate results.

Thus, the contribution of this study to the existing literature is threefold. Firstly, meats are differentiated by their supply source, and hence buyers' preferences for meats from certain sources are considered. Secondly, by including international trade in the welfare impact model, the effect of export promotion policies and their impact on the United States and its trading partners are included. Thirdly, by incorporating an imperfectly competitive market structure in the modeling framework, this study is a more accurate reflection of global meat markets in which imperfect market structure may prevail.

An Overview of U.S. Meat Demand and Global Market Participation

U.S. meat production has become increasingly dependent on exports, although the trend in per capita consumption varies across meats. Per capita demand for beef in the United States has been on a slow downward trend, declining from 68 pounds in 1999 to 65 pounds in 2008. Domestic consumption accounted for 93 percent of total beef supplies (domestic production, plus imports, plus beginning stocks) in the United States, while exports (1.5 billion pounds) accounted for 5 percent and imports accounted for 10 percent of total beef supplies in 2008. Pork consumption fluctuated around 51 pounds per capita over the past five years, reaching 53 pounds per capita in 2008. Domestic consumption was 83 percent of total pork supplies (domestic production, plus imports, plus beginning stocks) of 25 billion pounds, while exports accounted for 15 percent and imports for 4 percent in 2008. Total poultry demand gradually increased from 94 pounds per capita in 1999 to 106 pounds per capita in 2008, an increase of 12.8 percent over the past decade. In 2008, exports (6.7 billion pounds) accounted for 15 percent and imports for less than 1 percent of total poultry supplies (USDA-ERS 2009).

Although exports account for a small percentage of red meat production, export promotion programs have been significant. In 2008, allocations by the Foreign Agricultural Service (FAS) of the U.S. Department of Agriculture (USDA) to red meat export promotion programs under the Market Access and Foreign Market Development programs were over $20 million (Table 1).

With the rapid globalization of the world meat market, the global meat sector has become increasingly complex. The United States is one of the major importers and exporters of red meats, ranking in 2008 as the third largest importer (accounting for 11 percent of the global trade) and the largest exporter of beef and veal (17 percent), and the sixth largest importer (7 percent) and the second largest (39 percent) exporter of pork. Although its imports of poultry are not significant, the United States in 2008 was the second largest exporter of poultry to the global markets, accounting for 34 percent of global broiler meat trade (USDA-FAS 2008).

U.S. Meat Promotion Programs

Under the beef checkoff program, which became mandatory in a 1988 national referendum, domestic and imported cattle are assessed a fee of $1 per head, paid by the seller, in addition to a comparable assessment on imported beef and beef products (Marsh 2002). Of this assessment, half remains in the state in which it was collected for state promotion programs and the other half is sent to the Cattlemen's Beef Board for national promotion and research. Some state funds may also be transferred to the Board at the national level. Since its inception, about three-fourths of the checkoff expenditures at the national level have been directed towards domestic demand-enhancing efforts, with the lion's share spent on media advertising, including national television advertising. Consumer and producer information programs and foreign market development programs have exhausted the balance of checkoff demand enhancing expenditures (Ward 2004).

The pork checkoff program is funded by a mandatory assessment collected from hog producers and hog and pork importers. The National Pork Board (NPB) collects and manages the checkoff programs, with the primary goal of increasing the profitability of hog and pork producers and importers by expanding the demand for hogs and pork (Beach et al. 2007). Pork producers are mandated to pay 0.40 percent of the gross value of sales from U.S.-produced market hogs. Imported hogs and pork producers are assessed at the same rate. The NPB allocates its checkoff fund expenditures to eleven broad categories, with two-thirds of their budget spent on domestic and foreign market promotions, which include activities such as advertising, foreign market development, and marketing to specific groups (Beach et al. 2007). The share of foreign market development expenditures in the total pork checkoff budget doubled from 1995 to 2006, from 4 percent to 8 percent. Beach et al. (2007) indicate a marginal return of $13.80 for each additional $1 of NPB program expenditures.

The FAS has been involved in export promotion programs through the Foreign Market Development (FMD) Program, created in 1955, and the Targeted Export Assistance (TEA) Program, created in 1985. The Market Access Program (MAP) has replaced TEA. The export market development programs (MAP and FMD) use funds from the USDA's Commodity Credit Corporation (CCC) to aid in the creation, expansion, and maintenance of foreign markets for U.S. agricultural products. Both programs are administered by FAS. MAP and FMD allocations to beef, pork, and poultry, and industry contributions from matching industry (checkoff and other industry) contributions for the past four years, are presented in Table 1. Beef and pork export market promotion is conducted through the U.S. Meat Export Federation (USMEF). In 2007, the USMEF budget for export market promotion through MAP and FMD was $15.77 million and $2.02 million, respectively. Red meat budget allocations from matching industry contributions were $16.24 million in 2007 (Table 1). MAP and FMD allocations to USMEF were increased to $18.84 million and $2.02 million, respectively, in 2008.

An Equilibrium Displacement Model of Global Meat Markets

The global meat market has numerous market segments. An accurate analysis of returns from U.S. meat promotion to the producers and marketers in major meat supplying countries requires a model that appropriately represents this complex industry structure (Mounter et al. 2008). We use an equilibrium displacement model (EDM) to estimate the welfare impacts of beef and pork promotions on the welfare of beef, pork, and poultry producers and marketers in the United States and in other major exporting countries.[1] In the EDM, the meat industry is horizontally disaggregated into beef, pork, and poultry (meat *i*). Each meat is further disaggregated by supply (production) source (source-differentiated meat products *j*). Moreover, U.S. beef is disaggregated into (grain) fed and nonfed (mainly from dairy stock).

We use the partial equilibrium EDM framework to generate linear approximations to long-run

[1] The assumptions of the EDM model include: (a) the linearity of all supply and demand curves; (b) the fact that any shifts in supply and demand curves are parallel. Additional assumptions include: (c) the elasticity of substitution between marketing inputs and farm products is zero (fixed proportion technology); and (d) that substitute and complementary relationships are modeled on the demand side but not on the supply side. The first assumption is generally considered reasonable for small shifts. Chung and Kaiser (1999) have shown that results can be sensitive to the second assumption. While Wohlgenant (1989) does find some econometric support for substitution between marketing inputs and farm products, it is hard to dispute that packers could increase output considerably by adding capital and labor and not cattle and hogs. The last assumption is supported by the high degree of specialization in the meat industry (MacDonald et al. 1996).

changes in quantities and prices of source-differentiated meats arising from U.S. domestic and export promotion programs. More specifically, the global meat industry in this study is represented by a system of demand and supply relationships representing U.S. domestically produced meats and U.S. meat imports from major countries, plus U.S. meat exports to major countries (Figure 1). The demand side of the EDM incorporates the demand systems of major destinations (k) for U.S. produced meats. The demand for U.S. produced meats is divided into five systems, each representing a major market for U.S. produced meats. These destinations (United States, Canada, Japan, Mexico, and South Korea) account for over 90 percent of U.S. produced meat sales. The demand system for each of these five countries includes beef, pork, and poultry, each source-differentiated. The goal is to include meat products that compete with U.S. meats in these k markets.

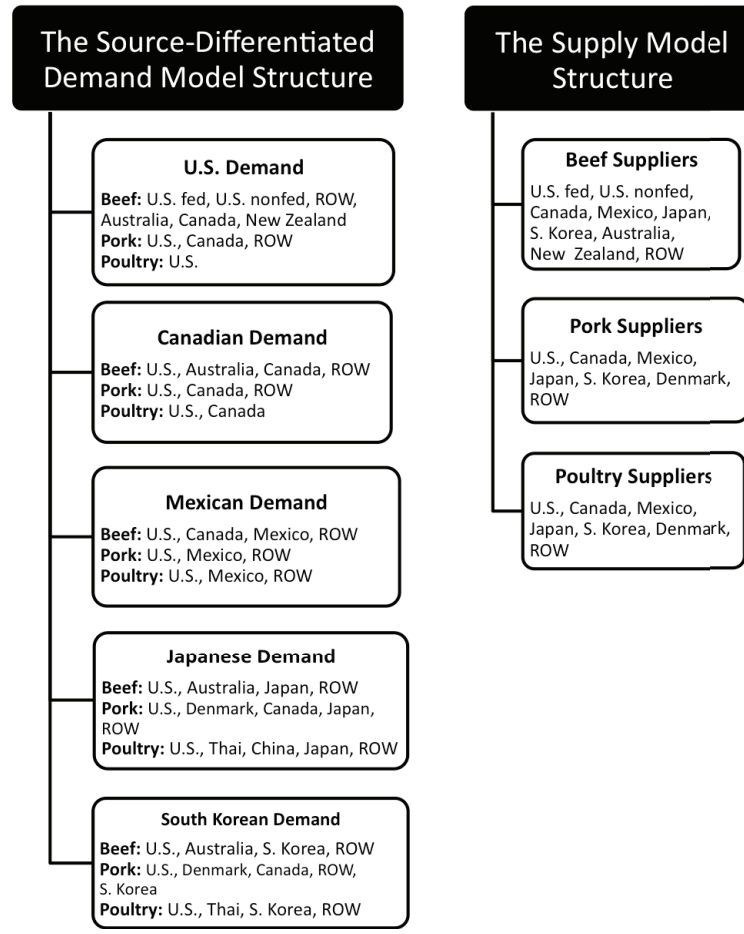

Figure 1. The Demand and Supply Model Structure

On the supply side, the meat suppliers are the United States, Canada, Japan, Mexico, South Korea, Brazil, Australia, New Zealand, Denmark, China, Thailand, and the rest of the world (ROW). A country is identified as a supply source if imports from that source constituted at least 10 percent of the total volume of imports of the selected meat. The suppliers vary for each type of meat in each destination. Additionally, certain suppliers are assumed to be both meat buyers (consume domestically produced meats as well as imported meats) and exporters. These suppliers are the United States and Canada.[2] The other suppliers are assumed to be only meat buyers or meat exporters. Suppliers that are only meat buyers are Japan, Mexico, and South Korea, and those that are only meat exporters are Brazil, Australia, New Zealand, Denmark, China, Thailand, and the ROW (Figure 1). Vertical marketing relationships for domestically produced meats are considered in every country that exports meat. Retail-level supply is the sum of the supply of marketing services and the supply at the farm. The supply of marketing services is assumed to be perfectly elastic, so farm prices are equal to retail prices minus a constant.

[2] Supply and demand forces have made the global meat markets highly segmented. This has caused some countries to export one grade of meat (product) while importing another grade of the same meat type. For example, U.S. beef exports are primarily grain-fed, high-value cuts, while its imports are mainly grass-fed (nonfed), lower-value beef products for processing. For pork, a large portion of the U.S. imports from Denmark are baby back ribs (Leuck, Haley, and Harvey 2004). The U.S. meat promotion expenditures are mainly aimed at increasing demand for U.S.-produced meats. In the EDM model used in this study, demand for fed and nonfed beef in the U.S. market as well as the demand for domestically produced meats versus source-differentiated imported meats is differentiated in the five studied markets. This differentiation of meat products makes it possible to differentiate between the imports and exports of the same meat type.

Average prices and quantities in 2002 are used to define an initial equilibrium (data are from USDA-FAS 2009c). The impact of any exogenous change to the system, such as industry- and government-funded meat promotion programs, is modeled as a shift in demand or supply from that initial equilibrium. From the resulting changes in market prices and quantities, the changes in producer and marketer surpluses are calculated. These are presented as changes in welfare accruing to producers and marketers in the United States and its meat trading partners, as is commonly done in similar studies (Mounter et al. 2008, p. 5).

The meat model specified here includes source-differentiated, retail-level meat demand equations and meat supply [farm-level and excess supply (or retail-level)] equations linked with their respective quantity and price equations. In addition, the model of meat marketers' demand considers relationships (substitute and complementary) between U.S. produced meats and meats from other supply sources in the U.S. domestic and export markets.

In general terms, the structural EDM model is given by the following:

(1) Retail meat demand with exogenous shifter,

$$Q_{ijk}^{d*} = \eta P_{k}^{d*} - \varpi_{ik}$$

(2) Farm supply or excess supply with shifter,[3]

$$Q_{ij}^{s*} = \varepsilon_{ij} P_{ij}^{s*} + \gamma_{ij}$$

(3) Quantity equilibrium conditions:

i. for meat exporters,

$$Q_{ij}^{s*} = \tau_{ijj} Q_{ijj}^{d*} + \sum_{k \neq j}^{K} \lambda_{ijk} Q_{ijk}^{d*}$$

ii. for meat importers,

$$Q_{ijk}^{s*} = Q_{ijk}^{d*}$$

[3] ε_{ij} is the own-price farm supply elasticity for the suppliers that are considered as both meat buyers and exporters and for those that are only considered as meat buyers, while it is the excess supply elasticity for the suppliers that are only meat exporters.

Following Sexton (2000), and Sexton and Zhang (2001), the demand-supply price linkage equations in their EDM form, when allowing for imperfect competition between meat suppliers and marketers (providers of marketing margins), are as specified below [equation (4)].

(4) Price equilibrium conditions (retail-farm price linkages with shifters)

$$P_{ijk}^{d*}(1+\xi/\eta_{ijk}) = P_{ij}^{s*}\delta_{ijk}(1+\theta/\varepsilon_{ij})$$

Definitions of variables are given in Table 2. Superscript (*) represents the percentage change operator, so that

$$Q_{ijk}^{d*} = dQ_{ijk}^{d}/Q_{ijk}^{d} = d\ln(Q_{ijk}^{d}),$$

similarly

$$P_{ijk}^{d*} = dP_{ijk}^{d}/P_{ijk}^{d} = d\ln(P_{ijk}^{d}).$$

The demand and supply equations may be linked with demand-supply price equation (4) to ensure equilibrium across marketing channels. The market conduct parameters (ξ and θ) in equation (4) measure the extent of meat marketers' market power. ξ measures the departure from competition in selling the finished product (upstream market power), with $\xi = 0$ denoting perfect competition (meat marketers do not have market power in selling the finished product); $\xi = 1$ denoting pure monopoly; and $\xi \in [0,1]$ denoting various degrees of meat marketers' oligopoly market power, where high values denote greater departure from competition. θ measures meat marketers' departures from competition in buying the farm product (downstream market power), with $\theta = 0$ denoting perfect competition (meat marketers do not have market power in buying the source differentiated product); $\theta = 1$ denoting pure monopsony; and $\theta \in [0,1]$ denoting various degrees of meat marketers' oligopsony market power, where high values denote greater departure from competition. Fifty-seven price linkage equations and twenty-five quantity linkage equations are included in the EDM in this study.

Table 2. Definitions of Variables for the Equilibrium Displacement Model

Variable	Definition
Q^d_{ijk}	Quantity of meat of type i from country j demanded in country k
Q^d_{ijj}	Quantity of meat i from country j that is demanded in the supplying country j (from its own domestically produced source)
Q^s_{ij}	Quantity of meat of type i, supplied by country j
Q^s_{ijk}	Quantity of meat of type i supplied from country j to the consuming country k
P^d_k	Retail prices for source differentiated meats in country k
P^d_{ijk}	Retail price of meat i from country j in country k
P^s_{ij}	Farm level supply price of meat i from country j, for $j = k$ Export price of meat i from country j, for $j \neq k$
η	Own-price and cross-price demand elasticities
η_{ijk}	Own-price demand elasticity of meat i from country j, demanded in country k
ϖ_{ik}	Demand shifters of meat i demanded in country k – increase in demand resulting from industry and government promotion expenditures
ε_{ij}	Own-price farm supply elasticity of meat i in country j, for $j = k$ Excess supply elasticity of meat i from country j, for $j \neq k$
γ_{ij}	Supply shifter of meat i from country j – increased cost of supplying meats resulting from promotion
$\tau_{ijj} = Q^d_{ijj}/Q^s_{ij}$	Ratio between the quantity of meat i from country j that is demanded in the supplying country j and the total quantity supplied of meat i by country j
$\lambda_{ijk} = Q^d_{ijk}/Q^s_{ij}$	Ratio between the quantity of meat i from country j that is demanded in the importing country k and the total quantity of meat i supplied by country j
$\delta_{ijk} = P^s_{ij}/P^d_{ijk}$	Ratio between the supply price of meat i from country j and the demand price of meat i from country j, demanded in country k
ξ and θ	Market conduct parameters (conjectural elasticities)
Subscripts: i[1]	Meat type (beef, pork, poultry), U.S. beef is segmented into fed and nonfed
j[2]	Country of origin (supply source) of meat type i
k	Consuming countries (U.S., Canada, Japan, Mexico, and S. Korea)

1 U.S. beef marketed in the U.S. is segmented into fed and nonfed.
2 The j suppliers are the U.S., Canada, Japan, Mexico, South Korea, Brazil, Australia, New Zealand, Denmark, China, Thailand, and the ROW.

Simulation Methods and Welfare Measures

Matching industry (checkoff and other contributions) and U.S. government-funded domestic and export promotions are modeled as parallel shifts in the relevant market demand and supply curves. These exogenous shifts initiate changes in market prices and quantities by displacing equilibrium. These initial changes in market prices impact the demand for other meat products through cross-price elasticities. Therefore, although the direct spillover effects of promotion of one product on the others are not assumed (the cross-promotion effects are assumed to be zero), indirect effects of promotion are considered through cross-price effects. The resulting market quantity and price changes induce changes in consumer and producer surpluses in the meat sectors of the studied countries. Once values for the model parameters have been specified, the values of the endogenous variables can be calculated by solving the demand and supply equations and the price and quantity market equilibrium condition equations simultaneously. Subsequently, changes in economic surplus resulting from the exogenous shifts in demand and supply can be estimated from the changes in equi-

librium market prices and quantities within the model (Mounter et al. 2008).

Our EDM model is composed of fifty-seven source-differentiated demands [equation (1)]; twenty-five supplies [equation (2)]; twenty-five quantity linkages [equation (3)]; and fifty-seven price linkages [equation (4)]; which results in a matrix of 164 x 164. The system can be solved for relative changes in endogenous variables caused by relative changes in exogenous supply and demand shifters (promotion induced changes). Once the values of the endogenous variables have been determined by solving the equations, the changes in producer surplus can be calculated. The formulas for calculating the changes in producer surplus at farm and marketing levels in the case of parallel shifts are adapted from Wohlgenant (1993, p. 645, equation 10), and are as follows:

$$\Delta PS_{ij} = P^{s}_{ij} Q^{s}_{ij} (P^{s*}_{ij} + \gamma_{ij}) (1 + 0.5 Q^{s*}_{ij}) \quad (5)$$

(producer surplus at farm level);

$$\Delta PS_{ijk} = P^{d}_{ijk} Q^{d}_{ijk} (P^{d*}_{ijk}) (1 + 0.5 Q^{d*}_{ijk}) \quad (6)$$

(producer surplus at marketing level);

where ΔPS_{ij} is the change in producer surplus of meat i by country j at the farm level; ΔPS_{ijk} is the change in producer surplus at the marketing (retail) level for meat i from country j, demanded in country k; and other variables are as previously defined.

Methods of Simulating Beef and Pork Promotions

The model described above is used to calculate the welfare impact of beef and pork promotions. The model is simulated by simultaneously shifting the supply and demand curves for U.S. beef and pork from the initial equilibrium and assuming either perfect competition in the meat industry or that marketers have market power. The U.S. beef and pork supply curves are shifted to the left to reflect the cost to the producers of financing meat promotions through the beef and pork checkoff programs. To translate these costs into the percentage cost shifts (γ) required in the model, revenues from mandatory assessment under beef and pork checkoff programs are divided by the respective total farm revenues for each industry. In 2002, beef and pork checkoff programs generated $35.7 million and $27.4 million, respectively (USDA-ERS 2009). In the same period, the total farm revenues for cattle and hogs were $17,437 million and $6,860 million, respectively. After dividing the mandatory assessment of each checkoff program by its respective farm revenue, it is shown that in 2002, promotion increased farm production costs by 0.2 percent and 0.4 percent in the beef and pork industries, respectively. Therefore, a 10 percent increase in the mandatory assessment shifts U.S. beef and pork farm supply curves by entering the corresponding shifters ($\gamma = -0.0002$ for beef and $\gamma = -0.0004$ for pork) in the farm supply equation (2). The farm supply shifters are entered as negative numbers to represent added costs to the system. Note that although producers pay the tax (checkoff contributions), the incidence of the tax is distributed within the marketing chain through price changes.

On the demand side, the magnitude of the estimated demand shifter parameters reflecting the impact of U.S. meat industry- and government-funded generic advertising on beef and pork demands are ambiguous in the literature. Some studies find the parameters to be positive and statistically significant (Ward and Lambert 1993), while others find the parameters to be insignificant and fragile (Brester and Schroeder 1995). The few studies that have estimated the welfare impacts of beef and pork promotions have used demand shifter parameters that range from 0.005 percent (Kinnucan 2003) to 5.7 percent (Wohlgenant 1993[4]) for beef; and 4.5 percent (Wohlgenant 1993) for pork. In this study, the simulations are conducted under two scenarios (I and II), each scenario assuming a different value for the promotion induced demand shifter. In Scenario II, a 10 percent increase in promotion is shown by using the demand shifter value (W) of 0.00005 that reflects low advertising elasticity, which is taken from Kinnucan (2003), the most recent study that has measured beef advertising elasticity and has considered imperfectly competitive markets. In Scenario I, a larger elasticity of 0.00287 is also considered based on Kinnucan, Xiao, and Hsia (1996), which translates into a demand shifter of 0.000287. We use the same value to shift the demand for pork as a result of advertising, due to a

[4] Wohlgenant (1993) created hypothetical values for demand shifts to illustrate methods. The study by Wohlgenant (1993) also differs from this study in data period and elasticities, as well as the modeling framework.

lack of comparable studies that have estimated pork advertising elasticities. Note that Henneberry and DeBrito (1994) estimate higher effects of export promotion, so the effects of export promotion considered here could be conservative. These positive shifters are applied to the marketers' (retail) demand for U.S. produced beef and pork in the United States as well as in global markets for U.S. meats (Canada, Mexico, Japan, and South Korea). Farm-level demand shifts as a result of the shifts in retail demand, since farm-level demand is retail demand minus the supply of marketing services, as in Gardner (1975).

Model Parameters and Hypothetical Scenarios

To simulate the model, parameter values need to be assigned. The model parameters include the previously described own-price and cross-price demand elasticities (η); own-price and excess supply elasticities (ε); quantity and price ratios in market clearing equations; and the market conduct parameters (conjectural elasticities ξ and θ). The own-price and cross-price demand elasticities (η) of the demand equation (1) are from Mutondo (2007, pp. 189-194). Mutondo (2007) estimates price elasticities for source-differentiated products in major global U.S. meat markets, using a restricted source-differentiated almost ideal demand system (RSDAIDS).[5] Regarding the own-price farm supply elasticities (ε_{ij}) in equation (2), because the existing literature already contains credible estimates of own-price supply elasticities for the meat-supplying countries examined in this study (Lusk and Anderson 2004, Wohlgenant 1993, and others), this study utilizes those rather than attempting to estimate them. Market equilibrium [equations (3) and (4)] in the selected five U.S. meat destinations is derived from demand and supply equations. The impacts of U.S. industry- and government-funded promotions are modeled as parallel shifts in the relevant demand or supply curves, through the inclusion of exogenous shifters in the demand (ϖ_{ik}) and supply (γ_{ij}) functions.

Two market structures are considered: perfect competition and those in which marketers have both oligopsony and oligopoly market power. Following Sexton (2000), we use the value of 0.03 as meat marketers' oligopsony and oligopoly market power parameters (θ and ξ).[6] The same market power parameters are used in both the U.S. and international markets. The quantity and price ratios in the quantity equilibrium equations (3) and price linkage equations (4) were calculated using the respective 2002 quantities and prices. The welfare effects as measured by producer/marketer surplus at farm- and retail-levels are calculated under each market structure and for each of the two scenarios (I and II), as described above.

Results

The main objective of this study is to measure the welfare impacts of meat promotion expenditures on producers and marketers of U.S. meats, while including both domestic and global demand for U.S. meats simultaneously and accounting for imperfectly competitive markets. The welfare impacts of U.S. beef and pork promotions (domestic and export) on producers and marketers of U.S.-produced beef, pork, and poultry (sold in the United States and in other countries) are measured using an EDM model, containing demand, supply, and market clearing price and quantity equations. The EDM model is simulated under each hypothetical scenario regarding demand elasticities of U.S. fed and nonfed beef and pork and market structure. The welfare effects as measured by producer and marketer surplus at farm- and retail- levels are calculated under each market structure and for each of the two scenarios (I and II), as described above. These results are presented in Table 3.

5 Considering the large volume of source-differentiated demand and supply elasticities used in the EDM model, the baseline elasticities are not presented here to save space. See Mutondo (2007, pp. 189-194) for a detailed report of demand and supply elasticity figures used in this study. The matrices of elasticities show that, although there are some complementary relationships in demand, most cross-price effects are positive, indicating substitutability. This is normal, as the parameters of the RSAIDS model in Mutondo (2007) were not restricted to show substitutability. Demand elasticities that are used in this study for simulations and welfare impact analysis are unconditional. For the explanation of the restricted source-differentiated AIDS (RSDAIDS), see Henneberry and Hwang (2007).

6 There is more evidence in the past literature pointing to downstream market power (oligopsony) than upstream market power (oligopoly) in food processing and retailing, and the deviation from perfect competition has been found to be small (Sexton and Zhang 2001, Schroeter 1988). Others have found symmetric patterns of the impact of industrial concentration in the U.S. food industries (Lopez et al. 2002), while Chung and Tostão (2009) find downstream market power and not upstream market power for U.S. beef processors. Following the findings of Lopez, Azzam, and Liron-Espana (2002), we assume symmetric market power both upstream and downstream.

In this study, we disaggregated meats by source of supply. Source-differentiation has enabled us to incorporate the impact of promotion-induced demand and supply shifts on U.S. meat producers and marketers, after markets have fully adjusted. In other words, we have taken into account the relationships (through cross-price effects) between U.S.-produced meats and meats from other supplying countries, within the United States and U.S. major meat destinations. Additionally, by differentiating meats by their supply source, we have taken into account buyers' preferences for source-differentiated meats. Also, in addition to perfectly competitive markets, we have considered market

Table 3. Results of Welfare Impacts of Beef and Pork Promotions on Producers and Marketers of U.S.-Produced Meats *($ millions)*

Description	Beef	Pork	Poultry	Meat Industry
***Scenario I* (advertising elasticities =0.00287)**				
Perfectly competitive market				
Change in farm-level producer surplus in the U.S.	2.60	1.67	-0.79	3.48
Change in retail-level marketer surplus in the U.S.	5.52	4.07	-0.67	8.92
Change in retail-level marketer surplus in Canada	0.04	0.03	-0.01	0.06
Change in retail-level marketer surplus l in Japan	0.12	0.13	0.00	0.24
Change in retail-level marketer surplus in Mexico	0.15	0.10	-0.02	0.23
Change in retail-level marketer surplus in South Korea	0.10	0.01	0.00	0.11
Total	8.53	6.01	-1.49	13.05
Market Power (θ=0.03, ξ=0.03)				
Change in farm-level producer surplus in the U.S.	1.94	1.46	-0.90	2.50
Change in retail-level marketer surplus in the U.S.	5.27	4.27	0.16	9.70
Change in retail-level marketer surplus in Canada	0.04	0.03	-0.01	0.06
Change in retail-level marketer surplus in Japan	0.12	0.14	0.00	0.26
Change in retail-level marketer surplus in Mexico	0.14	0.34	-0.03	0.45
Change in retail-level marketer surplus in South Korea	0.12	0.01	0.00	0.13
Total	7.63	6.25	-0.78	13.09
***Scenario II* (advertising elasticities=0.0005)**				
Perfectly competitive market				
Change in farm-level producer surplus in the U.S.	-1.04	-0.88	0.03	-1.88
Change in retail-level marketer surplus in the U.S.	2.23	1.72	0.03	3.98
Change in retail-level marketer surplus in Canada	0.01	0.01	0.00	0.03
Change in retail-level marketer surplus in Japan	0.05	0.05	0.00	0.10
Change in retail-level marketer surplus in Mexico	0.06	0.04	0.00	0.10
Change in retail-level marketer surplus in South Korea	0.04	0.00	0.00	0.04
Total	1.35	0.96	0.06	2.37
Market Power (θ=0.03, ξ=0.03)				
Change in farm-level producer surplus in the U.S.	-1.29	-0.96	-0.02	-2.28
Change in retail-level marketer surplus in the U.S.	2.13	1.81	0.00	3.95
Change in retail-level marketer surplus in Canada	0.01	0.01	0.00	0.03
Change in retail-level marketer surplus in Japan	0.05	0.06	0.00	0.11
Change in retail-level marketer surplus in Mexico	0.06	0.14	0.00	0.20
Change in retail-level marketer surplus in South Korea	0.05	0.00	0.00	0.05
Total	1.01	1.06	-0.02	2.05

power in the meat industry. Although, some studies have pointed to market power in the U.S. meat industry (Sexton 2000, Schroeter 1988), the degree of market power in overseas markets is unknown. Nevertheless, assuming perfectly competitive markets might be an inaccurate assumption if markets are not perfectly competitive. Therefore, this study contributes to the existing literature by allowing an imperfectly competitive marketing scenario in addition to perfect competition.

The relative welfare impacts of U.S. meat promotion vary according to the model assumptions and parameters. With perfect competition and the higher advertising elasticities (Scenario I), the change in U.S. producer welfare resulting from a 10 percent increase in promotion ranges from $2.60 million for beef producers and $1.67 million for pork producers. The lower advertising elasticities used in Scenario II, however, show that the benefits for U.S. producers of an increase in advertising would be less than the increased costs.

Adding market power reduces producers' surplus at the farm level, while it increases marketers' surplus at the retail level for pork under both scenarios. The changes in surplus measures from adding market power are modest relative to the substantial changes resulting from changing the elasticity of advertising.

Beef and pork promotions have a negative cross-effect on the welfare of poultry producers and marketers in the United States and globally. This reduction in welfare occurs through cross-price effects (e.g., as beef prices change from beef advertising, this would affect the demand for poultry) and not from cross-advertising effects (i.e., direct effects are assumed to be zero). We use estimated demand elasticities that show both gross complements and gross substitutes. Cross-price elasticities from Mutondo (2007, pp. 191-193), which are used in this study, show complementary relationships between U.S. beef and poultry in Japan and South Korea. In addition, pork and poultry are gross complements in U.S. demand. These complementary relationships might be due to a substantial income effect that more than offsets the price effect. The reduction in the welfare of U.S. poultry producers is not large enough to offset the welfare increase of red meat producers and marketers, and therefore a net gain to the meat industry occurs due to beef and pork promotions in Scenario I.

The U.S. promotion-induced demand and supply shifts impact the welfare of producers, marketers, and consumers in U.S. trading partners (Figure 1). As was mentioned earlier, any impacts on non-U.S. meat producers and marketers are measured through cross-price effects [and not as a result of cross-promotion (direct) effects]. Because of the large number of countries included in this study and space limitations, these welfare impacts are not shown here. In Scenario I, the two largest effects are $.067 million for Mexican beef and $.053 million for Australian beef. The small welfare effects are due both to small quantities of imports and the lower cross-price elasticities in the source-differentiated model.

Summary and Conclusions

The global meat industry is a highly segmented market, affected by cross-product relationships resulting from supply source preferences. Additionally, the meat industry in the United States has become more concentrated and imperfectly competitive. Economic evaluations of promotion investments should account for these cross-product effects as well as for the industry's market power. However, promotion effectiveness studies have largely not considered supply-source differentiation and imperfectly competitive industry market power. U.S. beef and pork producers make significant contributions to research and promotion via mandatory checkoff funds. The U.S. government also contributes significant funds to meat export promotion activities. Ignoring cross-product effects and market power in the meat industry may have important policy implications for the allocation of promotion investment funds.

In a departure from past studies, this study analyzes the potential impacts of promotion investment, differentiating meats not only by types but also by supply source and by taking into account the U.S. participation in the global meat markets (U.S. imports and exports). In this study an equilibrium displacement model is designed, which includes U.S. produced meats, U.S. meat imports from major trading partners, and U.S. meat exports to major trading partners, with meats differentiated by source of origin. Moreover, the model developed in this study has the flexibility to simulate welfare impacts of promotion-driven

supply and demand shocks, assuming both perfect competition and marketers' oligopsony market power.

The results indicate that the impacts of meat promotion vary according to the model parameters and the scenarios considered. The key parameter is the advertising elasticity. A high advertising elasticity showed a gain from increased advertising, whereas a low elasticity showed that producers would lose from increased advertising. The effects of adding imperfect competition were modest compared to the results from changing the advertising elasticity.

A caveat in interpreting our findings is that this study focuses on the welfare impacts at producer and retail levels in the major markets for U.S. meats resulting from meat promotion expenditures. Promotion expenditures affect government budgets and also may impact consumers' welfare. However, in this study only the promotion-induced changes in producer/marketers' surplus are reported. Also, the cross-promotion (direct) effects are ignored in this study. More specifically, in our estimations, the impacts of promotion of U.S. meat products on the suppliers of other meat products are measured only through cross-price (indirect) effects.

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