A Welfare Analysis of Norway's Export Promotion Program for Whitefish*

Henry W. Kinnucan

Abhipsita Das

Ingrid Kristine Pettersen**

---

*Second revision submitted to the *European Review of Agricultural Economics* 9 September 2021. Appreciation is expressed to Oral Capps, Jr. and Gary Williams for providing data and to three anonymous journal reviewers for helpful comments on earlier versions of this paper. Any errors of fact, logic, or judgment are the authors' alone. This research was supported by the Alabama Agricultural Experiment Station and contributes to Hatch Project S-1062 ''The Importance of US Food and Agricultural Trade Policy in the New Global Market Environment.''

**Kinnucan (corresponding author kinnuwh@auburn.edu) is an emeritus professor and Das is a graduate research assistant in the Department of Agricultural Economics and Rural Sociology, Auburn University, Auburn, Alabama, USA; Pettersen is an associate professor in the Norwegian College of Fishery Science, UiT - The Artic University of Norway.

Abstract

Norway recently increased the effective levy used to fund its export promotion program for whitefish by 21%. Study results suggest the intensified program is welfare increasing. The net social gain, defined as the difference between the increase in economic surplus associated with the increased advertising and the decrease in economic surplus associated with the increased effective levy, is estimated at between $20 million and $136 million per year, for a best-bet estimate $60 million. The associated benefit-cost ratio (BCR), defined as the ratio of the aforementioned changes in economic surplus, is estimated at between 11 and 71, for a best-bet estimate of 32. The BCR is invariant to the supply elasticity. The invariance property is useful as it implies the BCR can be estimated using strictly demand-side information; there is no need to estimate the supply side of the market. The current levy of 0.75% appears to be well below the levy that would maximize producer welfare.

Keywords: benefit-cost analysis, export promotion, generic advertising, welfare effects

JEL Classification: D61, F14, Q11, Q22

A Welfare Analysis of Norway's Export Promotion Program for Whitefish

1. Introduction

Farm groups have a long history of supporting generic advertising and other activities designed to strengthen the demand for their products in domestic and foreign markets (Forker and Ward, 1993). A large empirical literature has developed on the costs and benefits of these programs (e.g., see Piggott et al., 1995; the case studies in Kaiser et al., 2005; and Kinnucan and Cai, 2011; for a review, see Williams et al., 2018). This paper fills two gaps in the literature. First, using Norway's export promotion program for whitefish as a case study it shows that the benefit-cost ratio (BCR) of a levy-funded generic advertising campaign can be approximated using strictly demand-side information. If the goal is to obtain an estimate of the producer benefits of the advertising in relation to producer costs, estimates of the own-price and advertising elasticities of demand suffice; there is no need to estimate (or simulate) the supply side of the market. Second, it provides an estimate of consumer benefits and costs of the program and the optimal levy. Previous research estimates the producer impact of Norwegian export promotion of whitefish (Williams and Capps, 2020), but does not address the levy rate that would maximize producer gains, or the impact of the program on consumers. The consumer impact is of interest because it provides a more complete picture of the promotion program from a social welfare perspective (Wohlgenant, 1993; Zhao et al., 2003). The consumer impact in export markets is of particular interest because foreign consumers share in the cost of the advertising through levy-shifting and thus have a stake in the program.

That the supply side of the market can be ignored when estimating the producer BCR stems from the twin effects of incidence shifting of the levy and rent-dissipation of the advertising. As the supply curve for a commodity flattens the price increase and thus the gain in producer surplus associated with a given advertising-induced shift in the demand curve decreases. This is the "rent-dissipation effect" first described by Nerlove and Waugh (1961) in their classic study of the advertising of oranges and analyzed in some detail by Kinnucan et al. (1995) in their study of the advertising of catfish. A flattening of the supply curve, however, also decreases the cost of the advertising program to producers. As supply becomes more elastic in relation to demand a larger portion of the levy used to fund the advertising is shifted to consumers. This is the "levy-shifting effect" first described by Chang and Kinnucan (1991) and elaborated by Alston et al. (2000). The two effects (levy shifting and rent dissipation) are offsetting, rendering the supply elasticity moot as a determinant of the optimal advertising levy (Kinnucan and Myrland, 2000) and, as demonstrated in empirical studies by Alston et al. (1998, 2005), the BCR.

Norway's export promotion program for whitefish provides a useful case study for several reasons. Norway's production of whitefish is constrained by a total allowable catch (TAC) quota on the most important whitefish species such as cod, haddock and saithe (Hersoug, 2005; Guttormsen and Roll, 2011; Standal et al., 2016). This provides a natural setting to discuss the role of levy shifting in the distribution, or incidence, of the cost and benefits of generic advertising programs. Some 95% of Norway's whitefish on average is exported (Williams and Capps, 2020). Thus, the domestic market can be safely ignored, which simplifies the analysis. The parameters needed for welfare analysis have been estimated in a recent study by Williams and Capps (2020). This obviates the need for econometric analysis, though some is done to provide a basis for sensitivity analysis. The promotion program is funded by separate levies on cured and "natural" whitefish. Between 2009 and 2011 Norway increased the levy on natural whitefish from 0.30% to 0.75% to make it equal to the levy on cured whitefish. Consequently, there is some interest in knowing whether the increased levy *cum* advertising is remunerative from the producer perspective. In addition to considering explicitly the effect of the increased levy on producer welfare, this study differs from the analysis of Williams and Capps (2020) by *i*) considering the effect of the intensified program on consumer welfare; *ii*) taking into account the effect of levy shifting on the estimated BCR; *iii*) comparing the current levy of 0.75% to the optimal levy as developed by Kinnucan and Myrland (2000); and *iv*) showing that the BCR can be approximated using strictly demand-side information.

Studies of export promotion of farm products include Kinnucan et al. (2000), Kinnucan and Myrland (2002, 2008), Kaiser et al. (2005), Rusmevichientong and Kaiser (2009), Xie et al. (2009) and Kinnucan and Cai (2011). These studies have generally found the programs to be welfare increasing from the producer perspective. No study other than Williams and Capps (2020), however, has been conducted for Norway's export promotion program for whitefish. And no study other than Kinnucan and Cai (2011) has looked at the effects of the programs on consumer welfare.

2. Background Information

Norway is the world's second largest seafood exporter (FAO, 2020). Since the beginning of the 10^{th} century exports of fish, in particular dried cod, has connected Norwegians to an international market where fish was traded for other commodities (Hannesson et al., 2010; Amilien et al., 2019). But while dried cod was the most valuable export product from Norway in the 10th century (Amilien et al., 2019), in 2017 farmed Atlantic salmon was the most important species in Norwegian seafood exports accounting for nearly 70% and whitefish only about 16% of the total seafood export value (Norwegian Seafood Council, 2017).

According to data provided by the Norwegian Seafood Council (hereafter "NSC") the whitefish category consists of over 20 species, with cod, saithe and haddock accounting for about 85% of the total Norwegian whitefish export value. Norwegian whitefish is exported in several different product forms, varying from traditional products and supply chains such as dried and dried and salted to fresh and frozen products (Asche et al., 2018). The dried and dried and salted are classified as cured products and the fresh and frozen products as natural whitefish. The natural category consists of a mixture of whole fish and fillets. The market for whitefish is global, with a common price determination process (Gordon and Hannesson, 1996; Asche et al., 2004; Bronnmann et al., 2016; Pettersen and Myrland, 2016; Pettersen et al., 2018).

There has been substantial growth in both value and quantity of Norwegian whitefish exports from 2003 to 2017 (Table 1). Both cured and natural whitefish increased in terms of value in the beginning of the study period, but while the value of natural whitefish has continued to increase, the value of cured whitefish has decreased since 2010 (Figure 1). The reason is quite stable export volumes of cured whitefish and a steady increase in export volumes for whitefish. Thus, the relative importance of natural whitefish in Norwegian whitefish exports has increased steadily over the years following increases in catch and quotas, in particular for cod (Sogn-Grundvåg et al., 2021).

The promotion program is managed by the NSC. The NSC was established in 1991 by the Ministry of Fisheries with the aim of increasing the value of Norwegian seafood through increased demand and knowledge. The head office is in Tromsø, Norway with 13 country representatives globally. The NSC is funded by a statutory levy on all seafood exports from Norway and the majority of the funds are spent on promoting Norwegian seafood through marketing campaigns globally (NSC, 2021). Natural whitefish are promoted primarily in Europe and, to a lesser extent, the United States and Asia. The cured products are also promoted in Europe but there is also substantial activity overseas, like in Brazil and the Dominican Republic. Examples of export promotion activities include campaigns in various media, cooking competitions, press trips and many more. The statutory levy used to fund the promotion remained constant over 2003-2017 study period at 0.75% for cured whitefish, while the levy on natural whitefish increased between 2009 and 2011 from 0.30% to 0.75% where it has remained (Table 1). The effective levy for cured and natural whitefish combined, computed by dividing export promotion expenditures by export value, between the subperiods 2003-2010 and 2011-2017 increased from 0.63% to 0.76% for an overall increase of 21% (Table 1). This increase serves as the basis for the analysis to follow.

3. Graphical analysis

Figure 2 presents a graphical illustration of the scenarios investigated in this study. In this figure there are three demand curves. D is the level of export demand without the levy; D_T is the level of export demand with the levy but without advertising; and D_A is the level of export demand with the levy and advertising. $D_A = D$ under the simplifying assumption that the advertising restores demand to its original (pre-levy) level.[1] With this assumption two scenarios are considered: fixed export supply depicted by curve S, and upward-sloping export supply depicted by curve S'. Focusing first on the fixed-supply scenario, the cost to domestic producers of a levy that shifts the demand curve by the vertical distance *ab* is given by rectangle $PabP_S$ where P is foreign consumer price and P_S is domestic producer price net of the levy. Advertising that restores demand to its original level, i.e., shifts the demand curve up by the vertical distance *ab*, increases producer surplus by rectangle $PabP_S$. The gain in domestic producer surplus associated with the advertising matches the loss in domestic producer surplus associated with the levy. The BCR is 1 and the program is break even.

Turning to the upward-sloping supply scenario, the cost to domestic producers of the same levy-induced shift in the demand curve is given by trapezoid $PadP_S'$, which is smaller than rectangle $PabP_S$. The difference between $PabP_S$ and $PadP_S'$ is the levy-shifting effect alluded to earlier. Unlike the fixed-supply scenario where all the levy revenue comes from producers, with upward-sloping supply a part of the revenue comes from consumers. Specifically, under S' the levy generates revenue equal to rectangle $P'cdP_S'$, of which domestic producers provide rectangle $PedP_S'$ and foreign consumers provide rectangle $P'ceP$. The consumer share increases as the supply curve flattens. The reason is that as the supply curve flattens, more of

[1] The effect of a levy in a competitive market can be analyzed either as a supply shift or a demand shift (Hirshleifer, 1976, pp. 22-38). In the present study, we choose to analyze the effect as a demand shift.

the levy is passed onto consumers in the form of a higher consumer price and consequently the levy has a smaller depressing effect on producer price ($P' > P \implies P_S' > P_S$).

Although the cost of the advertising program to producers declines as the supply curve flattens, this does not mean the BCR is higher. The reason is that the gain to producers also declines. Under S', advertising that restores demand to its original level increases producer surplus by trapezoid $PadP_S'$, which is smaller than rectangle $PabP_S$, which is the producer gain when supply is fixed. The difference between $PabP_S$ and $PadP_S'$ is the rent-dissipation effect alluded to earlier. As we show later, the producer loss from rent dissipation offsets the producer gain from tax shifting, rendering the BCR invariant to the supply elasticity. The BCR is 1 irrespective of whether supply is fixed or upward sloping.

If producers kept the money raised from the levy rather than spending it on advertising they would experience a welfare gain equal to rectangle $P'ceP$ (the revenue extracted from foreign consumers) minus triangle ead (the efficiency loss associated with the reduced volume of trade). This gain could be viewed as the opportunity cost of the promotion program. The gain vanishes under the fixed-supply scenario as then the monies raised by the levy (rectangle $PabP_S$) come strictly from domestic producers (as a transfer to the promotion authority); foreign consumers escape the program's cost.

The foregoing analysis pertains to welfare effects from the domestic producer perspective. As we show in the simulations presented later, under fairly general conditions the same principles apply to welfare effects from the foreign consumer perspective.[2]

4. Structural model

The structural model used to measure the welfare effects depicted in Figure 2 consists of four equations

(1) $Q_d = D(P, \bar{A})$

(2) $Q_s = S(P_s)$

(3) $P_s = P - \bar{T}$

(4) $Q_s = Q_d = Q$

where Q_d and Q_s are the quantities demanded in and supplied to the export market; P and P_s are the levy inclusive and exclusive prices, respectively, of the exported product; $\bar{A}$ is advertising expenditure; $\bar{T}$ is the wedge between the foreign consumer and domestic producer prices associated with the levy. Foreign consumers respond to the levy-inclusive price P, which is higher than the levy-exclusive price that domestic producers respond to, namely P_s. The model consists of three endogenous variables (Q, P, P_s) and two exogenous variables ($\bar{A}$, $\bar{T}$).[3] Other variables that shift the supply and demand curves are suppressed.

---

[2] To the extent export promotion increases the domestic price domestic consumers will experience a welfare loss (Kinnucan and Cai, 2011). Since virtually all of Norway's production of whitefish is exported this welfare loss is apt to be unimportant and thus is ignored.

[3] In our initial specification of the structural model we included the equation $T = A/Q$ to permit the levy and, alternatively, promotion expenditures to be endogenous (Just and Pope, 2016). Simulations of the model that included this equation provided welfare measures that were within 1% of the welfare measures that excluded the equation. Treating A or T as endogenous complicates the comparative statics of the model without providing any

Equations (1) – (4) can be converted to an equilibrium displacement model (Piggott, 1992; Wohlgenant, 2011) by taking the total differential of each equation and converting absolute changes in the variables to relative changes to yield:

(5) $Q_d^* = \eta_P P^* + \eta_A \bar{A}^*$

(6) $Q_S^* = \varepsilon_P P_S^*$

(7) $P^* = (1-\phi)P_S^* + \phi \bar{T}^*$

(8) $Q_d^* = Q_S^* = Q^*$

where $Z^* = dZ/Z$ is the relative change in variable Z; $\eta_P (< 0)$ and η_A (> 0) are elasticities of export demand with respect to price and advertising, respectively; $\varepsilon_P (\geq 0)$ is the price elasticity of export supply; and $\phi = \bar{T}/P = \bar{A}/PQ < 1$ is advertising intensity in the initial equilibrium, i.e., before the demand shift. The demand curve is downward sloping; the supply curve is upward sloping (or vertical); and an increase in advertising shifts the demand curve to the right.

4.1 Reduced form

The model's reduced form is obtained by solving equations (5) – (8) simultaneously for the endogenous variables in terms of $\bar{A}^*$ and T^* to yield:

(9) $P^* = \frac{(1-\phi)\eta_A}{\varepsilon_P - (1-\phi)\eta_P} \bar{A}^* + \frac{\phi \varepsilon_P}{\varepsilon_P - (1-\phi)\eta_P} \bar{T}^*$

(10) $P_S^* = \frac{\eta_A}{\varepsilon_P - (1-\phi)\eta_P} \bar{A}^* + \frac{\phi \eta_P}{\varepsilon_P - (1-\phi)\eta_P} \bar{T}^*$

benefit in terms of improved precision in the welfare measures. Consequently, we treat both variables as exogenous.

(11) $Q^* = \frac{\varepsilon_P \eta_A}{\varepsilon_P - (1-\phi)\eta_P} \bar{A}^* + \frac{\varepsilon_P \phi \eta_P}{\varepsilon_P - (1-\phi)\eta_P} \bar{T}^*.$

An isolated increase in advertising increases the consumer price, the producer price, and exports. An isolated increase in the levy increases consumer price, decreases producer price, and decreases exports. If export supply is fixed the reduced form simplifies to:

(9') $P^* = \frac{\eta_A}{-\eta_P} \bar{A}^*$

(10') $P_S^* = \frac{\eta_A}{-(1-\phi)\eta_P} \bar{A}^* - \frac{\phi}{(1-\phi)} \bar{T}^*$

(11') $Q^* = 0.$

In this instance, an isolated increase in advertising has no effect on exports and an isolated increase in the levy has no effect on either exports or the consumer price. The entire burden of the levy falls on domestic producers. Whether a combined increase in the advertising and the levy increases producer price depends on the relative sensitivity of consumer demand to advertising and price, i.e., on the relative magnitudes of η_A and $\phi\eta_P$.

4.2 Welfare formulas

Assuming parallel shifts the welfare effects of an increase in advertising can be approximated using the following formulas (Wohlgenant, 1993; Kinnucan and Gong, 2014):

(12a) $\Delta \mathrm{CS}_A = PQ(V_A - P^*)(1 + 0.5Q^*)$

(12b) $\Delta \mathrm{PS}_A = PQ \cdot P_S^*(1 + 0.5Q^*)$

(12c) $\Delta \mathrm{TS}_A = \Delta \mathrm{CS}_A + \Delta \mathrm{PS}_A$

where $\Delta \mathrm{CS}_A$, $\Delta \mathrm{PS}_A$ and $\Delta \mathrm{TS}_A$ are changes in foreign consumer, domestic producer, and total surplus, respectively; PQ is the value of exports in the initial equilibrium; $V_A = \frac{\eta_A}{-\eta_P} A^*$ is the proportional *vertical* shift in the demand curve due to the increased advertising, i.e., the shift in the price direction from the initial equilibrium point with quantity held constant (see equation (9')); and P^*, P_S^* and Q^* are the relative changes in consumer price, producer price, and quantity for a given value of $\bar{A}^*$. The consumer benefit, the shaded area above the price line P in Figure 2, implicitly assumes consumers get utility from the advertising. The assumption may be questioned (e.g., Tremblay and Tremblay, 1995). However, we adopt the viewpoint of Zhao et al. (2003, p. 198, fn. 11), to wit "There seems to be a consensus that consumers gain welfare from advertising…[either] because their knowledge about the product has changed (thus, product characteristics have changed that are objects in their decision functions) or their taste ordering has changed (thus, parameters in the decision functions have changed)." They cite Dixit and Norman (1979) to support this viewpoint.

The corresponding formulas for the welfare effects of an increase in the levy are:

(13a) $$\Delta \mathrm{CS}_T = -PQP^*(1 + 0.5Q^*)$$

(13b) $$\Delta \mathrm{PS}_T = PQP_S^*(1 + 0.5Q^*)$$

(13c) $$\Delta \mathrm{TS}_T = \Delta \mathrm{CS}_T + \Delta \mathrm{PS}_T$$

where P^*, P_S^* and Q^* are the relative changes in consumer price, producer price, and quantity for a given value of $\bar{T}^*$.

The values for P^*, P_S^* and Q^* in equation sets (12) and (13) are obtained by simulating equations (5) – (8). Benefit-cost ratios are computed using the formulas:

(14a) $$\mathrm{BCR_C} = \frac{\Delta CS_A}{-\Delta CS_T}$$

(14b) $$\mathrm{BCR_P} = \frac{\Delta \mathrm{PS}_A}{-\Delta PS_T}$$

where $\mathrm{BCR_C}$ and $\mathrm{BCR_P}$ are BCRs from the consumer and producer perspectives.[4]

5. Model calibration

The equilibrium displacement model (equations (5) – (8)) is calibrated using parameter estimates from Williams and Capps (2020). In that study a demand equation for exports of whitefish from Norway is estimated using monthly data for 2003-2017. The advertising variable is specified as an Almon lag of length 2. A lagged dependent variable is included in the equation to account for inertia; 11 monthly dummy variables are included to account for seasonal shifts in demand; and five additional dummy variables are included to account for weather-related events and other factors found to affect demand. Suppressing the dummy variables, the equation estimated by OLS is as follows (Williams and Capps, 2020, Table 1; *t*-ratios in parentheses):

$$(15)\quad q_t = \underset{(9.79)}{7.472} + \underset{(4.42)}{0.2628\, q_{t-1}} \underset{(-5.50)}{-0.3070\, p_t} + \underset{(2.66)}{0.1117\, ps_t} + \underset{(3.97)}{0.2493\, y_t}$$

$$+ \underset{(3.73)}{0.02362\, a_t} + \underset{(3.73)}{0.03149\, a_{t-1}} + \underset{(3.73)}{0.02362\, a_{t-2}} + u_t \qquad \text{Adj } R^2 = 0.832, \ \text{DW} = 1.75$$

where q_t, p_t, ps_t, y_t, and a_t are, respectively, exported quantity, own-price, substitute price, income, and advertising expenditures. All variables are expressed in logarithms. The substitute price is for salmon. The interested reader is referred to the original paper for a precise definition of the variables. Equation (15) is an autoregressive distributive lag (ARDL) model of order (1,0,0,0,2). It is properly interpreted as the short-run demand relation. The parameters

[4] Some studies define producer benefit as the increase in industry revenue associated with the increased advertising (e.g., Williams et al., 2010; Williams and Capps, 2020). Here, we follow the tradition established by Nerlove and Waugh (1961) and define producer benefit as the increase in producer surplus associated with the increased advertising. For a good discussion of the surplus measures, see Johnson (1992).

of interest are the long-run values for η_A and η_P. These may be obtained by setting $q_t = q_{t-1} = \tilde{q}_t$ and $a_t = a_{t-1} = a_{t-2} = \tilde{a}_t$ to yield the long-run demand relation:

(16) $$\tilde{q}_t = 10.136 - 0.4164\, p_t + 0.1515\, ps_t + 0.3382\, y_t + 0.1068\, \tilde{a}_t + \; u_t.$$

The point estimates of the long-run values for η_A and η_P are 0.1068 and -0.4164. The estimated long-run price elasticity falls within the range of estimates for whitefish in the literature reported by Williams and Capps (2020, p. 562). However, as noted by Williams and Capps (2020, p. 575), the estimated long-run advertising elasticity is higher than comparable estimates in the literature for Norwegian salmon, which range from 0.0133 to 0.059. (No previous estimates of η_A exist for whitefish.)

To assess the extent to which parameter uncertainty affects welfare measurement we constructed 95% confidence intervals for $\hat{\eta}_A$ and $\hat{\eta}_P$ to serve as the basis for sensitivity analysis. The confidence intervals were constructed by re-estimating Williams and Capps' (2020) model in error correction form. An advantage of the error-correction form of an ARDL model is that it provides direct estimates of the long-run parameters and their standard errors (Cuddington and Dahger, 2015). The equation estimated is identical to the equation estimated by Williams and Capps (2020) except that we did not impose the Almon restrictions. Following Williams and Capps (2020) the model was estimated by OLS. For brevity we report in equation (17) only the results relating to the long-run demand relation *sans* intercept and dummy variables; the complete set of results are provided Appendix A.

(17)	$\hat{q}_t =$	-0.4174 p_t	+ 0.2054 ps_t	+ 0.2814 y_t	+ 0.0996 a_t
	s.e.	(0.0634)	(0.0584)	(0.0801)	(0.0276)
	95% CI	[-0.541, -0.293]	[0.091, 0.310]	[0.125, 0.438]	[0.0457, 0.1538]

The estimated long-run elasticities have the correct signs and are significant in the sense that none of their 95% confidence intervals goes through zero. The advertising elasticities in equations (16) and (17), namely 0.1068 and 0.0996, are nearly identical, which suggests the failure to impose the Almon restrictions is innocuous. The 95% confidence limits for the advertising elasticity, namely 0.0457 and 0.1538, are within the range of estimated export promotion elasticities for farm products summarized by Rusmevichientong and Kaiser (2009). Based on these estimates three scenarios are considered:

Scenario A: $\hat{\eta}_A = 0.0996; \hat{\eta}_P = -0.417$ (''best-bet'')

Scenario B: $\hat{\eta}_A = 0.0457; \hat{\eta}_P = -0.541$ (''pessimistic'')

Scenario C: $\hat{\eta}_A = 0.1538; \hat{\eta}_P = -0.293$ (''optimistic'')

Scenario A is based on the point estimates of the parameters; scenarios B and C are based on the 95% confidence limits of the parameters. The values for η_P assigned to scenarios B and C reflect the principle ''it is always more profitable to shift a less elastic demand curve'' (Kinnucan and Gong, 2014, p. 76). The supply elasticity is set to alternative values on the closed interval $\varepsilon_P \in [0, 2.00]$, the same range considered by Williams and Capps (2020). The average annual expenditure on export promotion in the pre-levy increase period 2003-10 was \$9.29 million against an average annual export value of \$1,472 million. Based on these values the promotion intensity parameter is set to $\phi = A/PQ = 0.0063$. Welfare effects are computed by setting $\bar{T}^*$ to 0.210 and $\bar{A}^*$ to 0.176. The effective levy between the pre- and post-levy increase periods increased by 21.0% (Table 1); the associated increase in real advertising expenditures based on data used in Williams and Capps's (2020) analysis is 17.6%. The parameter values used in the simulations are summarized in Table 2.

6. Results

6.1 Welfare effects

The effects of the increased levy *cum* promotion on producer and consumer welfare for alternative values of the supply and demand elasticities are shown in Table 3. Focusing first on Scenario A where the demand elasticities are set to their best-bet values $\eta_A = 0.0996$ and $\eta_P = -0.417$, the 17.6% increase in promotion expenditures generates a gross welfare gain to consumers and producers equal to $62 million per year. The gross gain is not affected by the supply elasticity. Its distribution between consumers and producers, however, is affected. As the supply elasticity increases from 0 to 2.0 the gross gain to consumers rises from $0 to $52 million and the gross gain to producers falls from $62 million to $11 million. When supply is fixed producers enjoy the entire welfare gain associated with the increased advertising; as the supply curve flattens (implying a reduced price effect) the gross welfare gain is increasingly shared with consumers. The decline in producer welfare from $62 million to $11 million as ε_P increases from 0 to 2.0 quantifies the rent-dissipation effect.

A similar principle applies to the levy. The 21.0% increase in the levy generates a gross welfare loss to consumers and producers equal to $1.96 million per year. The gross welfare loss is not affected by the supply elasticity. Its distribution between consumers and producers, however, is affected. As the supply elasticity increases from 0 to 2.0 the gross loss to consumers rises from $0 to $1.61 million and the gross loss to producers falls from $1.96

million to \$0.34 million. When supply is fixed producers suffer the entire welfare loss associated with the increased levy; as the supply curve flattens (implying a larger effect of the increased levy on *consumer* price and a smaller effect on *producer* price -- see Figure 2) the gross welfare loss is shared increasingly with consumers. The decline in producer loss from \$1.96 million to \$0.34 million as ε_P increases from 0 to 2.0 quantifies the levy-shifting effect.

Altering η_A and η_P changes the welfare gains and losses in expected ways. Under the pessimistic scenario where $\eta_A = 0.0457$ and $\eta_P = -0.541$ the gross welfare gain from the increased advertising declines from \$62 million of \$22 million per year (Table 3, Scenario A vs. B). Under the optimistic scenario where $\eta_A = 0.1538$ and $\eta_P = -0.293$ the gross welfare gain from the increased advertising rises from \$62 million to \$138 million per year (Table 3, Scenario A vs. C). Across all three scenarios the gross welfare loss from the increased levy is \$1.96 million per year.[5] The principles of rent-dissipation and levy shifting apply irrespective of the magnitudes of η_A and η_P. Specifically, as the supply curve flattens the producer gain from the increased advertising declines, but so does the producer cost of the increased levy (Table 3, compare columns ΔPS_A and ΔPS_T). This suggests the BCR is invariant to the supply elasticity.

6.2 Benefit-cost ratios

To test whether the BCR is indeed invariant to the supply elasticity the welfare gains in Table 3 were divided by the welfare losses as shown in Table 4. Results affirm the invariance property. The BCR under Scenario A is 32, decreases to 11 under Scenario B, and increases to 71 under

[5] That the gross welfare loss from the levy is invariant to η_A and η_P can understood by solving equations (5) and (7) for the inverse demand function $P_s^* = \frac{1}{(1-\phi)\eta_P} Q_d^* - \frac{\phi}{(1-\phi)} \bar{T}^* - \frac{\eta_A}{(1-\phi)\eta_P} \bar{A}^*$. The effect of a change in the levy on producer price involves neither η_A or η_P. Since the price effect of the levy is invariant to η_A and η_P the welfare effect must be invariant as well (see equations (13a) and (13b)).

Scenario C. But in all instances the BCR does not change as ε_P is increased from 0 to 2.0. The producer BCR is invariant to the supply elasticity because the reduced producer gain from the advertising associated with a flattening of the supply curve is matched by the reduced producer cost of the advertising as more of the levy is shifted to consumers. The consumer BCR is invariant because the increased consumer gain from the advertising associated with a flattening of the supply curve is matched by the increased consumer cost of the advertising as more of the levy is borne by consumers.

The invariance property holds for both the producer and the consumer BCR, which are equal. The only instance in which the equality does not hold is when supply is fixed, in which case the consumer BCR is undefined (Table 4, last column). When supply is fixed consumers bear none of the cost of the advertising, but neither do they enjoy any of the benefit. The reason is that in this instance price rises by the full amount of the increased per-unit willingness to pay induced by the advertising.

The large BCRs should not be construed to mean the price or quantity effects of the intensified program are large. The reason is that the reduced-form elasticities for the advertising and the levy are very small (Table 5). The short-run elasticities in Table 5 correspond to $\varepsilon_P = 0.50$ and the long-run elasticities to $\varepsilon_P = 2.00$. With the maintained hypothesis that the true demand elasticities are bounded between the values specified under scenarios B and C, the short-run reduced-form elasticity of exported quantity with respect to advertising is $\frac{Q^*}{\bar{A}^*} \in [0.0220, 0.0974]$ and the long-run elasticity is $\frac{Q^*}{\bar{A}^*} \in [0.0360, 0.1344]$. Based on these estimates an isolated 17.6% increase in advertising can be expected to increase exports in the short run by *at most* 1.71% and in the long run by *at most* 2.36%. As for price effects, the reduced-form elasticities for the producer price are $\frac{P_S^*}{\bar{A}^*} \in [0.0440,\ 0.1949]$ in the short run and $\frac{P_S^*}{\bar{A}^*} \in [0.0180,\ 0.0672]$ in the long run. An isolated 20% increase in advertising increases the producer price in the short run by *at most* 3.43% and in the long run by *at most* 1.18%. The foregoing increases are even smaller when the levy effects are included, but the attenuation is modest. For the combined short- and long-run estimates $\frac{Q^*}{\bar{T}^*} \in [-0.0011, -0.0026]$ and $\frac{P_S^*}{\bar{T}^*} \in [-0.0008, -0.0032]$. An isolated 20% increase in the levy decreases exports by *at most* 0.052% and decreases producer price by *at most* 0.064%.

Small price and quantity effects can co-exist with large BCRs. This is important as large increases in advertising can create unrealistic expectations about their ability to increase quantity, revenue, or both. When such outcomes are not forthcoming large BCRs may lack credibility. But when advertising intensity is low, as is the case for Norway's export promotion program for whitefish, it does not take much of a shift in the demand curve to generate a large gain. In 2017 Norway spent $14.9 million on export promotion of whitefish. Although the expenditure is large, it is miniscule against an export value in 2017 of $1.81 billion (Table 1). Therein lies the reason for why small volume or value effects of advertising and large BCRs are not necessarily incompatible.

Although the *ratio* of benefits and costs is not affected by the supply elasticity, the *size* of the net welfare gain is affected. For example, referring to Scenario A in Table 4, as ε_P increases from 0 to 2 the net gain to domestic producers from the expanded promotion program dwindles from $60.0 million to $10.7 million and the net gain to foreign consumers rises from $0 to $50.4 million. Supply response matters for the *net* gain in welfare that producers and consumers realize from a given advertising/levy-induced shift in the demand curve. It does not matter, however, for the *ratio* of the gain to the loss.

6.3 Optimal levy

The large benefit-cost ratios suggest the industry is underinvesting in export promotion. This hypothesis may be verified by comparing the current levy rate of 0.75% with the levy rate that would maximize producer welfare. When the levy is against exports (as opposed to industry output), as is the case for Norway's whitefish program, the relevant optimality condition is (Kinnucan and Myrland, 2000, p. 43, equation (8b)):

(18) $$\tau_x^o = \frac{k_x\eta_A^x + (1-k_x)\eta_A^d}{-\eta_P^x\left(k_x + (1-k_x)\eta_A^d\right)}$$

where k_x is the export quantity share; η_A^x and η_P^x are export demand elasticities with respect to advertising and price; and η_A^d is the advertising elasticity corresponding to domestic market promotion. Equation (18) gives the levy rate that maximizes *net* producer surplus where net surplus is the difference between the gain in producer surplus associated with increased advertising and the loss in producer surplus associated with the increased levy used to finance the increased advertising. If none of the funds is spent on domestic market promotion equation (18) reduces to the Dorfman-Steiner (1954) rule $\tau_x = \eta_A^x / -\eta_P^x$. Using this rule and substituting the best-bet values $\eta_A^x = 0.0996$ and $\eta_P^x = -0.417$ yields $\tau_x^{'} = 0.2397$; redoing the calculation with the pessimistic values $\eta_A^x = 0.0457$ and $\eta_P^x = -0.541$ yields $\tau_x^{'} = 0.0845$. Based on these parameter estimates the optimal levy is between 8.4% and 24.0%. These rates represent upper bounds as they do not take into account opportunity cost. Also, as noted by Nerlove and Waugh (1961), when the levy must be approved by producers the rate must be kept low enough to attract majority support. Consequently, ''Any purely economic theory of cooperative advertising can thus only set an upper bound to optimal expenditures'' (Nerlove and Waugh, 1961, p. 70). Notwithstanding these caveats, given the gap between the actual and computed optimal levy it seems safe to conclude the industry is indeed underinvesting in export promotion.

7. Implications for BCR estimation

Levy shifting renders benefit-cost ratios invariant to the supply elasticity. An important consequence of the invariance property is that the BCR can be approximated using strictly demand-side information. To see this, consider the inverse demand function obtained by substituting equation (7) into (5) and solving for P_S^*

(19) $$P_S^* = \frac{1}{(1-\phi)\eta_P} Q_d^* - \frac{\phi}{(1-\phi)} \bar{T}^* - \frac{\eta_A}{(1-\phi)\eta_P} \bar{A}^*.$$

In this equation $V_T = -\frac{\phi}{(1-\phi)} \bar{T}^*$ is the proportional vertical downward shift in the (tax-burdened) demand curve due to an increase in the levy and $V_A = -\frac{\eta_A}{(1-\phi)\eta_P} \bar{A}^*$ is the proportional vertical upward shift in the curve due to an increase in advertising. The BCR can be approximated by dividing the vertical shift in the curve due to advertising by the vertical shift in the curve due to the levy. Specifically, $\mathrm{BCR} \approx \frac{V_A}{|V_T|} = \frac{\eta_A \bar{A}^*/-(1-\phi)\eta_P}{\phi \bar{T}^*/(1-\phi)} = \frac{\eta_A}{-\eta_P \phi} \frac{A^*}{\bar{T}^*}$.

Substituting parameter values for Scenario A into the formula, namely $\eta_A = 0.0996$ and $\eta_P = -0.417$, and setting $\phi = 0.0063$, $\bar{A}^* = 0.176$ and $\bar{T}^* = 0.210$, yields $BCR \approx 31.8$. This estimate is nearly identical to the BCRs in Table 4 for Scenario A. Repeating the calculation with $\eta_A = 0.0457$ and $\eta_P = -0.541$ (Scenario B) and $\eta_A = 0.1538$ and $\eta_P = -0.293$ (Scenario C) yields 11.2 and 70.3, respectively. These estimates are identical, or nearly so, to those in Table 4 for scenarios B and C. When $\eta_A = 0.0996$, $\eta_P = -0.417$ and $\phi = 0.0063$, the proportional vertical upward shift in the demand curve due to the increased advertising is 32 times larger than the proportional vertical downward shift in the demand curve due to the increased effective levy. A similar interpretation follows for Scenario B and C elasticities. The BCR may be thought of as the ratio of the vertical shift in the demand curve due to promotion to the vertical shift in the demand curve due to the levy. That demand-side information suffices to estimate the BCR is a powerful result that has gone unrecognized in the commodity promotion literature.

8. Conclusion

Between 2009 and 2011 Norway increased its levy on natural whitefish from 0.30% to 0.75%, resulting in an overall increase in the effective levy used to fund its export promotion for natural and cured whitefish by 21%. Study results suggest the increased effective levy generated an annual welfare loss equal to $1.95 million. The annual welfare gain from the associated increase in advertising, however, was more than sufficient to cover the loss, resulting in a net annual gain to society of between $20 million and $136 million, for a best-bet estimate of $60 million. The program's BCR, defined as the increase in economic surplus associated with the increased advertising divided by the decrease in economic surplus associated with the increased levy, is estimated at between 11 and 71, for a best-bet estimate of 32. These benefit-cost ratios apply to Norway's producers and foreign consumers alike. Consequently, it would appear the intensified program is highly remunerative for both groups.

Benefit-cost ratios for levy-funded advertising are invariant to the supply elasticity. An important implication of the invariance property is that BCRs can be estimated using strictly demand-side information; there is no need to estimate (or simulate) the supply side of the market. The reason is that while the welfare gain to producers from increased advertising declines as the supply curve flattens, so too does the welfare loss to producers associated with the increased levy. The offset, at least for sufficiently small shifts in the demand curve, is exact, rendering the supply elasticity moot. A similar result applies to the BCR from the consumer perspective. These results are especially useful from a measurement perspective, as they mean that if the goal is to estimate a BCR research efforts can be concentrated on obtaining robust estimates of the demand response to price and advertising. This can be challenging, as studies suggest estimated advertising elasticities are fragile, sensitive to model specification, estimation procedure, and/or sample updating (Kinnucan et al., 1997; Tomek, 1998; Coulibaly and Brorsen, 1999; Tomek and Kaiser, 1999; Kinnucan and Gong, 2014). Allotting research time to demand estimation that ordinarily would be spent on supply estimation (or simulation) might improve the quality of the results.

The Dorfman-Steiner rule indicates the optimal levy, i.e., the levy that maximizes the net welfare of Norway's whitefish producers, is between 8.4% and 24.0% depending on which elasticity values used in the calculation more nearly represent actual market responses to advertising and price. These rates do not take into account opportunity cost or the effect of the levy rate on producer support for the program, and thus are properly interpreted as upper bound estimates. Still, given the gap between the computed optima and the actual levy of 0.75%, it appears safe to say Norway's whitefish industry is underinvesting in export promotion.

A limitation of the present study is that spillover effects of the promotion program are not considered. Norway exports significant quantities of salmon, which Williams and Capps'

(2020) model suggests substitute for whitefish in the international market (Appendix). This raises the specter of ''beggar-thy-neighbor'' effects (Alston et al., 2001). To the extent the increased demand for whitefish caused by the advertising came at the expense of decreased demand for salmon, the BCRs reported in this study might be overstated (Kinnucan, 1996; Kinnucan and Miao, 2000). A test of this hypothesis requires estimates of the own- and cross-price elasticities of demand for salmon with respect to whitefish and the cross-advertising elasticity, which are not available. Then, too, the analysis ignores the effects of potential changes in consumer tastes and preferences (due to carbon consciousness, animal welfare, dietary concerns, etc.) on advertising effectiveness. The whitefish industry would do well to study the extent to which such changes are taking place in different markets, and the implications for the optimal levy. Notwithstanding these caveats, given the size of the BCRs estimated in this study it seems safe to conclude that the intensified program is welfare increasing, and that the current levy of 0.75% is below the level that would maximize producer returns.

Table 1. Marketing levies for Norwegian whitefish, export quantity, export value, and nominal promotion expenditures, 2003-2017

Year	Statutory Levy[a]		Export	Export	Promotion	Effective
	Natural Whitefish (%)	Cured Whitefish (%)	Quantity[b] (Metric Tons)	Value[b] (mil USD)	Expenditures[b] (mil USD)	Levy[c] (%)
2003	0.30	0.75	303,090	1,035	6.02	0.5819
2004	0.30	0.75	309,618	1,191	4.99	0.4191
2005	0.30	0.75	313,473	1,314	6.97	0.5306
2006	0.30	0.75	334,376	1,514	8.64	0.5710
2007	0.30	0.75	323,568	1,767	8.14	0.4609
2008	0.30	0.75	317,983	1,723	10.52	0.6109
2009	0.30	0.75	351,801	1,488	18.12	1.2178
2010	0.50	0.75	394,006	1,746	10.78	0.6176
2011	0.75	0.75	408,086	2,001	15.48	0.7733
2012	0.75	0.75	389,168	1,770	15.26	0.8621
2013	0.75	0.75	433,760	1,728	17.77	1.0281
2014	0.75	0.75	451,482	1,931	12.09	0.6260
2015	0.75	0.75	395,863	1,636	10.18	0.6221
2016	0.75	0.75	420,230	1,652	9.41	0.5700
2017	0.75	0.75	449,901	1,812	14.87	0.8204
Average 2003-10	0.33	0.75	330,989	1,472	9.28	0.6262
Average 2011-17	0.75	0.75	421,213	1,790	13.58	0.7574
Percent change	130.8	0	27.3	21.6	46.4	21.0

[a]Source: Table 1 in Williams and Capps (2018).
[b]Source: Norwegian Seafood Council provided to us by Williams and Capps, personal communication.
[c]Effective levy = export promotion expenditures on whitefish divided by export value of whitefish.

Table 2. Baseline data and parameter values used in model simulations

Parameter	Definition	Value
A	Average annual expenditures on export promotion in the pre-levy increase period (mil US $)	9.28[a]
PQ	Average annual export value in the pre-levy period increase period (mil US $)	1,472[a]
ϕ	Average advertising intensity in the pre-levy increase period (A/PQ)	0.0063
η_A	Export promotion elasticity for Norway's whitefish	0.0457, 0.0996 or 0.1538
η_P	Export demand elasticity for Norway's whitefish	-0.293, -0.417 or -0.541
ε_P	Export supply elasticity for Norway's whitefish	0, 0.5, 1.5, 1.0 or 2.0
$\bar{T}^*$x 100	Percent increase in the effective levy	21.0[a]
$\bar{A}^*$ x 100	Percent increase in real promotion expenditures	17.6[b]

[a]Source: Table 1.
[b]Source: Data from Williams and Capps (2020) used to estimate text equation (17).

Table 3. Welfare effects of a 21.0% increase in the promotion levy and a 17.6% increase in promotion expenditures for alternative values of the export supply (ε_P), export demand (η_P), and export promotion (η_A) elasticities

Supply	Promotion effect (mil $)			Levy effect (mil $)		
Elasticity (ε_P)	ΔCS_A	ΔPS_A	ΔTS_A	ΔCS_T	ΔPS_T	ΔTS_T
	------------------- Scenario A: $\eta_A = 0.0996; \eta_P = -0.417$ ---------------------					
0	0	62	62	0.00	-1.96	-1.96
0.5	34	28	62	-1.07	-0.89	-1.95
1.0	44	18	62	-1.38	-0.57	-1.95
1.5	49	13	62	-1.53	-0.42	-1.95
2.0	52	11	62	-1.61	-0.34	-1.95
	------------------- Scenario B: $\eta_A = 0.0457; \eta_P = -0.541$ ---------------------					
0	0	22	22	0.00	-1.96	-1.96
0.5	11	11	22	-0.94	-1.02	-1.95
1.0	14	8	22	-1.27	-0.69	-1.95
1.5	16	6	22	-1.43	-0.52	-1.95
2.0	17	5	22	-1.54	-0.42	-1.95
	------------------- Scenario C: $\eta_A = 0.1538; \eta_P = -0.293$ ---------------------					
0	0	137	137	0.00	-1.96	-1.96
0.5	87	51	138	-1.23	-0.72	-1.95
1.0	107	31	138	-1.51	-0.44	-1.95
1.5	116	22	138	-1.63	-0.32	-1.95
2.0	121	18	139	-1.70	-0.25	-1.95

Note: Results are based on an annual export value of $1,472 million and a promotion intensity of 0.63%. See text for details.

Table 4. Benefit-cost ratios associated with Norway's expanded promotion program for whitefish

Supply Elasticity	Domestic Producer			Foreign Consumer		
	ΔPS_A	$-\Delta PS_T$	BCR	ΔCS_A	$-\Delta CS_T$	BCR
	------------------ Scenario A: $\eta_A = 0.0996; \eta_P = -0.417$ ---------------------					
0	62	1.96	31.6	0	0	Undefined
0.5	28	0.89	31.7	34	1.07	31.9
1.0	18	0.57	31.8	44	1.38	32.0
1.5	13	0.42	31.8	49	1.53	32.0
2.0	11	0.34	31.8	52	1.61	32.0
	------------------ Scenario B: $\eta_A = 0.0457; \eta_P = -0.541$ ---------------------					
0	22	1.96	11.2	0	0	Undefined
0.5	11	1.02	11.2	11	0.94	11.3
1.0	8	0.69	11.2	14	1.27	11.3
1.5	6	0.52	11.2	16	1.43	11.3
2.0	5	0.42	11.2	17	1.54	11.3
	------------------ Scenario C: $\eta_A = 0.1538; \eta_P = -0.293$ ---------------------					
0	137	1.96	69.8	0	0	Undefined
0.5	51	0.72	70.4	87	1.23	70.9
1.0	31	0.44	70.6	107	1.51	71.0
1.5	22	0.32	70.6	116	1.63	71.1
2.0	18	0.25	70.7	121	1.70	71.1

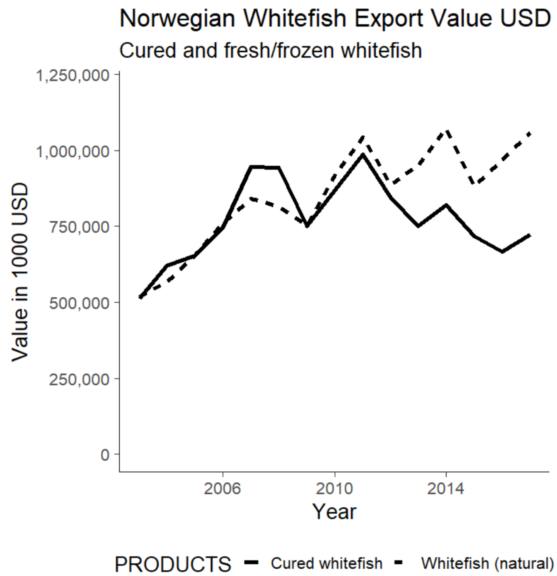
Note: The BCRs are computed from the welfare measures in Table 3. See text for details.

Table 5. Reduced-form elasticities for exports and prices associated with Norway's export promotion program for whitefish

Elasticity	Short run ($\varepsilon_P = 0.50$)		Long run ($\varepsilon_P = 2.00$)	
	Scenario B	Scenario C	Scenario B	Scenario C
$\frac{Q^*}{\bar{A}^*}$	0.0220	0.0974	0.0360	0.1344
$\frac{P^*}{\bar{A}^*}$	0.0438	0.1937	0.0179	0.0668
$\frac{P_S^*}{\bar{A}^*}$	0.0440	0.1949	0.0180	0.0672
$\frac{Q^*}{\bar{T}^*}$	-0.0016	-0.0011	-0.0026	-0.0015
$\frac{P^*}{\bar{T}^*}$	0.0029	0.0039	0.0048	0.0053
$\frac{P_S^*}{\bar{T}^*}$	-0.0032	-0.0022	-0.0013	-0.0008

Note: Under Scenario B $\eta_A = 0.0457$ and $\eta_P - 0.541$; under Scenario C $\eta_A = 0.1538$ and $\eta_P - 0.293$

Figure 1. Norwegian Whitefish Export Value and Quantity, 2003-2017. Source: Norwegian Seafood Council/Statistics Norway



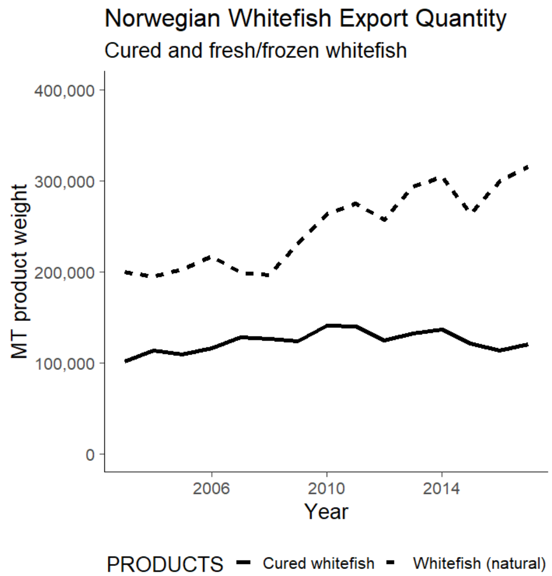
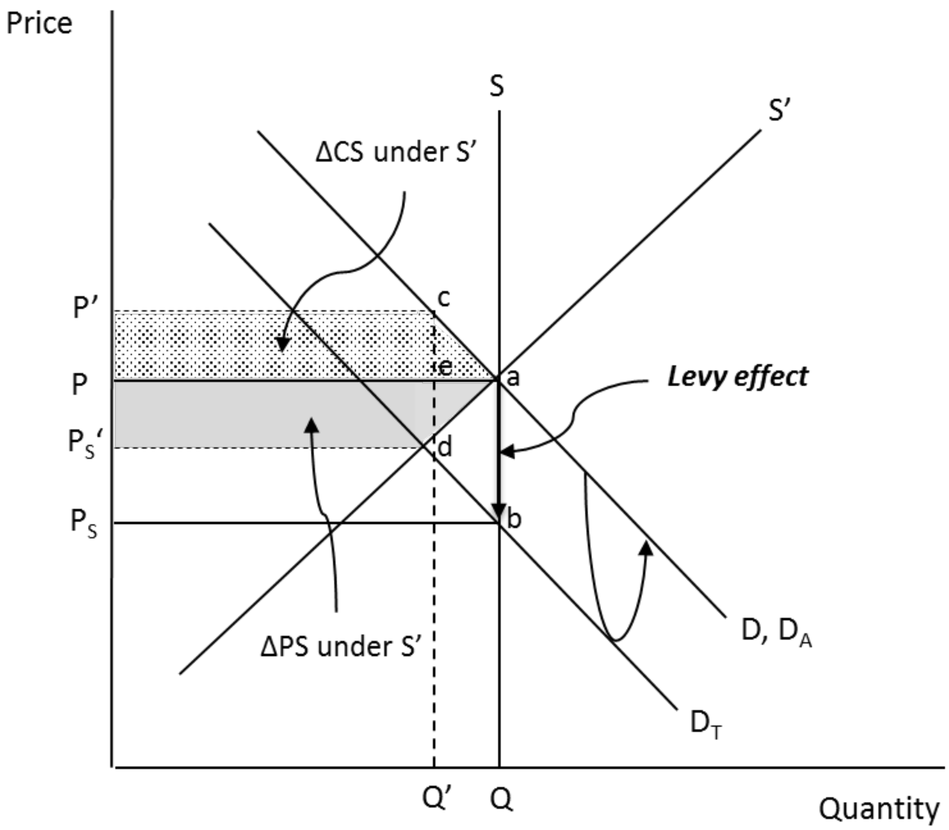


Figure 2. Welfare Effects of Export Promotion Funded by a Levy on Exports



Appendix: Error correction estimates of demand parameters

Suppressing the dummy variables, let the long-run export demand relation estimated by Williams and Capps (2020) be written as follows:

(A1) $q_t = c + \eta_P p_t + \eta_S ps_t + \eta_Y y_t + \eta_A a_t + \epsilon_t$

where q_t, p_t, ps_t, y_t, and a_t are the logarithmic values of exported quantity, own price, substitute price, income, and advertising, respectively, in month t; the eta's are long-run elasticities; and ϵ_t is a random disturbance term. The corresponding short-run demand relation expressed as an ARDL(1, 0, 0, 0, 2) model is:

(A2) $\varphi(L)q_t = c' + \alpha_0\, p_t + \beta_0\, ps_t + \gamma_0\, y_t + \delta(L)a_t + v_t$

where the lag operators defined as follows:

(A3a) $\varphi(L) = 1 - \varphi_1 L \Longrightarrow \varphi(1) = 1 - \varphi_1$

(A3b) $\delta(L) = \delta_0 + \delta_1 L + \delta_2 L^2 \Longrightarrow \delta(1) = \delta_0 + \delta_1 + \delta_2$.

Equations (A1) and (A2) are linked through their coefficients:

(A4a) $\eta_P = \frac{\alpha_0}{\varphi(1)}$ (long run own-price elasticity)

(A4b) $\eta_S = \frac{\beta_0}{\varphi(1)}$ (long run cross-cross price elasticity)

(A4c) $\eta_Y = \frac{\gamma_0}{\varphi(1)}$ (long run income elasticity)

(A4d) $\eta_A = \frac{\delta(1)}{\varphi(1)}$. (long run advertising elasticity).

Estimation of the long-run elasticities and their standard errors is facilitated by reparameterizing the ARDL model as an error-correction model (ECM) (Cuddington and Dagher 2015). The ECM corresponding to equation (A2) inclusive of the dummy variables is

(A5) $$\Delta q_t = c + \lambda[q_{t-1} - \eta_P p_{t-1} - \eta_S ps_{t-1} - \eta_Y y_{t-1} - \eta_A a_{t-1}] + \delta_0 \Delta a_t - \delta_1 \Delta a_{t-1} + \sum_{i=1}^{5} \theta_i D_i + \sum_{i=1}^{11} \mu_i M_i + v_t$$

where $\Delta = 1 - L$ is the difference operator; $\lambda = -\varphi(1)$ is the speed-of-adjustment parameter; the expression in brackets is the error-correction term (ECT); and the D_i and M_i are dummy variables specified by Williams and Capps (2020) to account for seasonality and other factors hypothesized to affect export demand. If ECT > 0 the observed quantity demanded in the preceding month exceeds its long-run (steady-state) equilibrium quantity, which implies quantity demanded in the current month must fall for equilibrium to be restored, i.e., $\Delta q_t < 0$. The opposite is true if ECT < 0. Consequently, λ is expected to be negative in sign. Because the variables are expressed in log form the speed-of-adjustment parameter indicates adjustment in percentage terms. Thus, e.g., if $\hat{\lambda} = -1$ this means 100% of any disequilibrium in the previous month (caused by a random shock to long-run demand in that month) is ''corrected'' in the current month.

OLS estimates of equation (A5) obtained using the econometric software package EViews 11 (2020) are reported in Table A1. The estimated long-run elasticities have the correct signs and are statistically significant. The same is true for the estimated adjustment parameter. Specifically, $\hat{\lambda} = -0.753$ (*t*-value = -12.3), which means 75.3% of the excess demand caused by a random shock is eliminated in one month. The only substantive difference between the estimates in Table A1 and those reported by Williams and Capps (2020, p. 573, Table 1) is that estimates in Table A1 provide the standard errors associated with the estimated long-run elasticities.

Table A1. OLS estimates of the parameters of the error-correction model

Parameter	Estimate	Standard error	t-value	Probability
c	7.5530	0.7747	9.75	0.0000
λ	-0.7526	0.0612	-12.29	0.0000
η_P	-0.4174	0.0634	-6.59	0.0000
η_S	0.2054	0.0584	3.51	0.0006
η_Y	0.2814	0.0801	3.51	0.0006
η_A	0.0996	0.0276	3.60	0.0004
δ_0	0.0199	0.0185	1.07	0.2856
δ_1	-0.0252	0.0186	-1.35	0.1787
θ_1	-0.1675	0.0642	-2.61	0.0100
θ_2	0.1860	0.0470	3.96	0.0001
θ_3	0.1450	0.0650	2.23	0.0270
θ_4	-0.1210	0.0624	-1.94	0.0544
θ_5	-0.2590	0.0497	-5.21	0.0000
μ_1	0.1555	0.0323	4.81	0.0000
μ_2	0.2533	0.0312	8.13	0.0000

μ_3	0.3013	0.0317	9.51	0.0000
μ_4	0.1002	0.0322	3.12	0.0022
μ_5	0.0842	0.0306	2.75	0.0067
μ_6	0.0190	0.0306	0.62	0.5350
μ_7	-0.0099	0.0325	-0.30	0.7619
μ_8	0.0177	0.0322	0.55	0.5834
μ_9	0.2246	0.0309	7.26	0.0000
μ_{10}	0.2596	0.0310	8.38	0.0000
μ_{11}	0.1367	0.0319	4.28	0.0000
Adjusted R^2	0.8562			
D.W.	1.768			
Sample	January 2003 – December 2017 (included observations = 178)			

References

Alston, J.M., Carman, H.F., Chalfant, J.A., Crespi, J.M., Sexton, R.J., and Venner, R.J. 1998. *The California Prune Board's Promotion Program: An Evaluation.* Giannini Foundation Research Report Series no. 344, Giannini Foundation of Agricultural Economics, Oakland CA.

Alston, J.M., Chalfant, J.A., Christian, J.E., Meng, E., and Piggott, N.E. 2005. The Benefits and Costs of Promotion Programs for California Table Grapes. In *The Economics of Commodity Promotion Programs: Lessons from California*, Ed. H.M. Kaiser, J.M Alston, J.M. Crespi, and R.J. Sexton, pp. 71-94. New York: Peter Lang Publishing, Inc.

Alston, J.M., Chalfant, J.A., and Piggott, N.E. 2000. The Incidence of the Costs and Benefits of Generic Advertising. *American Journal of Agricultural Economics* 82: 665-671.

Alston, J.M., Freebairn, J.W. and James, J.S. 2001. Beggar-Thy-Neighbor Advertising: Theory and Application to Commodity Promotion Programs. *American Journal of Agricultural Economics* 83(4): 888-902.

Amilien, V., Vittersø, G., and Tangeland, T. 2019. PGI lofoten Stockfish in Norway. In *Sustainability of European Food Quality Schemes*. Ed. F, Arfini and V. Bellassen, pp. 507–527. Switzerland: Springer.

Asche, F., Cojocaru, A. L., Gaasland, I., and Straume, H.-M. 2018. Cod Stories: Trade Dynamics and Duration for Norwegian Cod Exports. *Journal of Commodity Markets* 12: 71-79.

Asche, F., Gordon, D. V, and Hannesson, R. 2004. Tests For Market Integration and the Law of One Price: The Market for Whitefish in France. *Marine Resource Economics*, 19(2): 195–210.

Bronnmann, J., Yeboah, I. A., and Nielsen, M. 2016. Market Integration between Farmed and Wild fish: Evidence from the Whitefish market in Germany. *Marine Resource Economics*, 31(4): 421-432.

Chang, H.S. and Kinnucan, H.W. 1991. Economic Effects of an Advertising Excise Tax. *Agribusiness: An International Journal* 7(2): 165-173.

Coulibaly, N. and Brorsen, B.W. 1999. Explaining the Differences between Two Previous Meat Generic Advertising Studies. *Agribusiness: An International Journal* 15(4): 501-515.

Cuddington, J. T. and Dagher, L. 2015. Estimating Short and Long-Run Demand Elasticities: A Primer with Energy-Sector Applications. *The Energy Journal* 36(1): 185-209.

Dixit, A. and Norman, V.D. 1979. Advertising and Welfare: Reply. *Bell Journal of Economics* 10: 728-729.

Dorfman, R. and Steiner, P.O. 1954. Optimal Advertising and Optimal Quality. *American Economic Review* 44: 826-836.

EViews 11. 2020. Econometrics Software. IHS Markit. London: United Kingdom.

FAO. 2020. *The State of World Fisheries and Aquaculture 2020. Sustainability in Action.* Rome: https://doi.org/10.4060/ca9229en.

Forker, O.D. and Ward, R.W. 1993. *Commodity Advertising: The Economics and Measurement of Generic Programs*. New York: Lexington Books.

Gordon, D. V, and Hannesson, R. 1996. On Prices of Fresh and Frozen Cod Fish in European and U . S . Markets. *Marine Resource Economics*, 11(4): 223–238.

Guttormsen, A. G., and Roll, K. H. 2011. Technical Efficiency in a Heterogeneous Fishery: The Case of Norwegian Groundfish Fisheries. *Marine Resource Economics*, *26*(4): 293–307.

Hannesson, R., Salvanes, K. G., and Squires, D. 2010. Technological Change and the Tragedy of the Commons: The Lofoten Fishery over 130 Years. *Land Economics* 86: 746–765.

Hersoug, B. 2005. *Closing the Commons. Norwegian Fisheries from Open Access to Private Property*. The Netherlands: Eburon Academic Publishers.

Hirshleifer, J. 1976. *Price Theory and Applications*. New Jersey: Prentice-Hall, Inc.

Johnson, S.R. 1992. Future Directions for Advertising Research: A Researcher's Perspective. In *Commodity Advertising and Promotion*, Ed. H.W. Kinnucan, S.R. Thompson, and H.-S. Chang, pp. 363-369. Ames: Iowa State University Press.

Just, R.E. and Pope, R.D. 2016. Comparison of Generic Advertising for a Competitive Industry to a Monopolist. *Journal of Business and Economics* 85: 73-83.

Kaiser, H.M., Alston, J.M., Crespi, J.M., and Sexton, R.J. (editors). 2005. *The Economics of Commodity Promotion Programs: Lessons from California*. New York: Peter Lang Publishing, Inc.

Kaiser, H.M. Liu, D.J. and Consignado, T. 2005. An Economic Analysis of California Raisin Export Promotion. In *The Economics of Commodity Promotion Programs: Lessons from California*, Ed. H.M. Kaiser, J.M Alston, J.M. Crespi, and R.J. Sexton, pp. 209-224. New York: Peter Lang Publishing, Inc.

Kinnucan, H. W. 1996. A Note on Measuring Returns to Generic Advertising in Interrelated Markets. *Journal of Agricultural Economics* 47: 261-267.

Kinnucan, H. W. and Cai, H. 2011. A Benefit-Cost Analysis of U.S. Agricultural Trade Promotion. *American Journal of Agricultural Economics* 93(1): 194-208.

Kinnucan, H. W. and Gong, L. 2014. Goodwill and Export Promotion Dynamics. *Journal of Agricultural and Applied Economics* 46: 73–89.

Kinnucan, H.W. and Miao, Y. 2000. Distributional Impacts of Generic Advertising on Related Commodity Markets. *American Journal of Agricultural Economics* 82(3): 672-678.

Kinnucan, H. W., and Myrland, Ø. 2008. On Generic versus Brand Promotion of Farm Products in Foreign Markets. *Applied Economics*. 40: 673-84

Kinnucan, H.W. and Myrland, Ø. 2000. Optimal Advertising Levies with Application to the Norway-EU Salmon Agreement. *European Review of Agricultural Economics* 27: 39–57.

Kinnucan, H. W. and Myrland, Ø. 2002. Relative Impacts of the Norway-EU Salmon Agreement. *Journal of Agricultural Economics.* 53: 195-219.

Kinnucan, H.W., Nelson, R.G. and Xiao, H. 1995. Cooperative Advertising Rent Dissipation. *Marine Resource Economics* 10: 373-384.

Kinnucan, H. W., Xiao, H. and Yu, S. 2000. Relative Effectiveness of USDA's Nonprice Export Promotion Instruments. *Journal of Agricultural and Resource Economics.* 25: 559-77.

Kinnucan, H.W., Xiao, H., Hsia, C.-J. and Jackson, J.D. 1997. Effects of Health Information and Generic Advertising on U.S. Meat Demand. *American Journal of Agricultural Economics* 79(1): 13-23.

Nerlove, M. and Waugh, F.V. 1961. Advertising Without Supply Control: Some Implications of a Study of the Advertising of Oranges. *Journal of Farm Economics* 43: 813–837.

Norwegian Seafood Council. 2017. *Seafood Exports Worth Record-High NOK 94.5 Billion in 2017*. https://en.seafood.no/news-and-media/news-archive/seafood-exports-worth-record-high-nok-94.5-billion-in-2017/ (Accessed 10 June 2021).

Norwegian Seafood Council. (2021). *About Us*. https://en.seafood.no/about-norwegian-seafood-council/about-us/ (Accesed 10 June 2021).

Pettersen, I. K., Brækkan, E. H., and Myrland, Ø. 2018. Are Norwegian Fishermen Selling in the Same Market? *Journal of Commodity Markets*, 12: 9–18.

Pettersen, I. K., and Myrland, Ø. 2016. A Cod is a Cod, But is it a Commodity? *Journal of*

Commodity Markets, 3(1): 70–75.

Piggott, R.R. 1992. Some Old Truths Revisited. *Australian Journal of Agricultural Economics* 36(2): 117-140.

Piggott, R.R., Piggott, N.E. and Wright, V.E. 1995. Approximating Farm-Level Returns to Incremental Advertising Expenditure: Methods and an Application to the Australian Meat Industry. *American Journal of Agricultural Economics* 77: 497-511.

Rusmevichientong, P. and Kaiser, H.M. 2009. Measuring the Effectiveness of U.S. Rice Export Promotion Programs. *Agribusiness: An International Journal* 25(2): 215-230.

Sogn-Grundvåg, G., Zhang, D., Henriksen, E., Joensen, S., Bendiksen, B. I., and Hermansen, Ø. 2021. Fish Quality and Market Performance: The Case of the Coastal Fishery for Atlantic Cod in Norway. *Marine Policy*, 127: 104449.

Standal, D., Sønvisen, S. A., and Asche, F. 2016. Fishing in Deep Waters: The Development of a Deep-Sea Coastal Fleet in Norway. *Marine Policy*, *63*(1): 1–7.

Tomek, W.G. 1998. Structural Econometric Models: Past and Future (with Special Reference to Agricultural Economics Applications). *Proceedings of the NCR-134 Conference on Applied Commodity Price Analysis, Forecasting, and Market Risk Management*. Chicago, IL.

Tomek, W.G. and Kaiser, H.M. 1999. On Improving Econometric Analyses of Generic Advertising Impacts. *Agribusiness: An International Journal* 15(4): 485-500.

Tremblay, C.H and Tremblay, V.J. 1995. The Impact of Cigarette Advertising on Consumer Surplus, Profit, and Social Welfare. *Contemporary Economic Policy* 13: 113-124.

Williams, G.W. and Capps, O., Jr. 2020. Advertising with Supply Control: Some Implications of Norwegian Whitefish Export Promotion. *Agricultural and Resource Economics Review* 49(3): 558-585.

Williams, G.W., Capps, O., Jr., and Dang, T. 2010. Does Lamb Promotion Work? *Agribusiness: An International Journal* 26(4): 536-556.

Williams, G.W. and Capps, O., Jr. 2018. *How Effectively Does the Norwegian Seafood Council Promote Norwegian Seafood Exports?* Forecasting and Business Analytics, LLC. College Station, TX.

Williams, G.W., Capps, O., Jr., and Hanselka, D. 2018. U.S. National Economic Contributions to Generic Food and Agricultural Product Advertising. *Journal of International Food and Agribusiness Marketing* 30(2): 181–210.

Wohlgenant, M.K. 2011. Consumer Demand and Welfare in Equilibrium Displacement Models. In *The Oxford Handbook of the Economics of Food Consumption and Policy*, Ed. J.L. Lusk, J. Roosen, and J. Shogren, pp. 292-320. Cambridge: Oxford University Press.

Wohlgenant, M. K. 1993. Distribution of Gains from Research and Promotion in Multistage Production Systems: The Case of the U.S. Beef and Pork industries. *American Journal of Agricultural Economics*. 75(3), 642-651.

Xie, J., Kinnucan, H.W., and Myrland, Ø. 2009. Demand Elasticities for Farmed Salmon in World Trade. *European Journal of Agricultural Economics* 36(3): 425-445.

Zhao, X., Anderson, K., and Wittwer, G. 2003. Who Gains from Generic Wine Promotion and R&D? *Australian Journal of Agricultural and Resource Economics* 47: 181-209.