Chapter 9: Economic Impact Analysis

This chapter presents the economic impacts on the markets of the various vehicle categories affected by the emissions control program. Each category of vehicles is modeled separately. However the structure of the economic model used to estimate impacts is essentially the same. The first section of this chapter provides a summary of the economic impact results for each of the categories of vehicles affected by the rule. Next, we provide a general description of the economic theory used to estimate market impacts. We then discuss the concept of fuel efficiency gains resulting from the emissions control program and how they have been incorporated into the economic analysis. Also addressed is the potential for product attribute changes that may result due to the regulation. This is followed by a description of the methodology used to develop the economic model and the supply and demand elasticity estimates.

The remainder of the chapter takes each vehicle category in turn and describes the baseline market characterization, the per vehicle control costs of the regulation, the future years in which the costs are expected to be incurred, and the economic impact results generated from the model (excluding fuel efficiency gains). We compare the future year streams of engineering costs to the estimated economic welfare losses for each vehicle category for which the standards apply. Economic welfare loss is equal to the sum of the loss in consumer and producer surplus measures, excluding fuel efficiency gains. Last, we calculate a future year stream of social costs/gains by adding fuel cost savings to economic welfare losses and compare this stream to the stream of engineering costs of the rule (including fuel efficiency gains).

For each vehicle market, the economic model relies upon the most current year of data available (either the year 2000 or 2001) and examines the effect of the emissions control program as if the standards took effect in this year. The per engine control costs change over time as different phases of the standard are implemented and the learning curve is applied (see Chapter 5 for details concerning the learning curve). It is important to note that the per engine control costs reflect the variable cost and annual portion of capital cost associated with the regulations. To examine the effect of these cost changes, we calculate estimated impacts using baseline year price and output. This allows us to generate relative changes in prices and market quantities and compute losses in consumer and producer surplus. Price and quantity data from a baseline year are used rather than future year projections of prices and quantities because price projections for the future time stream are not available for the various vehicle markets, though quantity projections are.

As stated above, a future stream of welfare (or surplus) losses (excluding fuel cost savings) is calculated by summing of the losses of consumer and producer surplus. This stream of surplus losses, developed from baseline year price and quantity data, is compared to a hypothetical future stream of engineering costs that are calculated by multiplying the annual regulatory cost per vehicle in each year by the baseline year quantity. We calculate hypothetical engineering costs holding quantity constant so that we can make a valid comparison between the loss in surplus and engineering costs. The purpose of this comparison is to generate a surplus loss stream that accounts for projected changes in quantity.

Through our comparison, we develop an annual ratio of surplus loss to engineering costs, which is used to project the annual loss in surplus without fuel efficiency for the future year time stream (this projection is made by multiplying the annual ratio of surplus loss to engineering costs by the annual engineering costs shown in Chapter 7 for each vehicle category). The future stream of surplus losses differs from baseline estimates due to the projected growth in vehicle sales expected through the year 2030. Last, we calculate the future stream of annual social costs/gains by adding fuel cost savings to the projected loss in surplus and compare this stream of social costs/gains to the engineering costs accounting for fuel efficiency.

9.1 Summary of Economic Impact Results

An economic impact analysis of the emissions control program has been carried out to estimate its effects on the recreational diesel marine vessel, Large SI, snowmobile, ATV, and off-highway motorcycle markets. A summary of the economic impact results is presented in this section to show the relative changes in price and quantity and the future year streams of consumer and producer surplus losses (which exclude fuel cost savings), engineering costs, and social costs/gains (which include fuel cost savings) in each vehicle market. The net present value of the stream of surplus loss, fuel savings, and social costs/gains for each vehicle category is also presented. Discussions of the economic theory, methodology, and full estimation of the economic impacts are presented in the sections that follow. The results presented here for each vehicle category summarizes the full results provided in Section 9.6 through 9.10.

As mentioned above, the relative changes in price and quantity have been estimated for each vehicle category using the per vehicle costs as they change over future years. We calculate these economic impacts assuming baseline market price and quantity is the same as it was in the most current year for which data were available (year 2000 or 2001, depending on the vehicle category).

9.1.1 Summary Results for Marine

The focus of the diesel recreational marine vessel analysis is the market for diesel inboard cruisers. Based on discussions with industry representatives, inboard cruisers are the main type of recreational marine vessel equipped with diesel engines. Using a year 2001 baseline average market price of $341,945 (taken from data provided by the National Marine Manufacturers Association) and market quantity of 8,435 inboard cruisers (taken from EPA projections based on data from the National Marine Manufacturers Association), the future year stream of economic impacts were estimated for the changes in per marine vessel costs. These results are presented in Table 9.1-1.

As the table shows, the price and quantity changes are all less than one-quarter of a percent and by the year 2012, the relative price increase and quantity decrease are less than one-tenth of a percent. These impacts are considered minimal. Projected surplus losses are equal to over 99 percent of engineering costs for the diesel inboard cruiser market. The surplus losses are highest in the year 2010 (approximately $9.6 million), which coincides with the implementation of the second phase of the emissions control program for two of the three engine power classes affected by the rule. They fall to their lowest level (approximately $4.9 million) in the year 2014. They then steadily increase up through the year 2030. This trend of increased surplus losses occurs because a larger population of engines are projected further out into the future, hence a larger number of engines need to be controlled. Note that beyond the year 2010, loss in surplus of the rule for recreational diesel marine vessels are in the $5 to $7 million range. For the recreational diesel marine engine market, no fuel cost savings are projected. Therefore, the annual stream of surplus losses equals the social costs of the regulation for this vehicle category.

Table 9.1-1
Summary Economic Impact Results for the Diesel Inboard Cruiser Market

Year	Cost/unit ($)	Change in Price (%)*	Change in Quantity (%)*	Surplus Losses ($$10^3$)**	Engineering Costs ($$10^3$)	Social Costs ($$10^3$)***
2006	$808	0.12%	-0.18%	$7,795.3	$7,806.0	$7,795.3
2007	$844	0.13%	-0.19%	$8,350.3	$8,365.3	$8,350.3
2008	$844	0.13%	-0.19%	$8,558.2	$8,573.8	$8,558.2
2009	$905	0.14%	-0.20%	$9,398.8	$9,413.5	$9,398.8
2010	$905	0.14%	-0.20%	$9,621.7	$9,637.0	$9,621.7
2011	$478	0.07%	-0.10%	$5,203.9	$5,213.4	$5,203.9
2012	$464	0.07%	-0.10%	$5,165.6	$5,176.7	$5,165.6
2013	$464	0.07%	-0.10%	$5,279.4	$5,290.8	$5,279.4
2014	$426	0.06%	-0.09%	$4,952.0	$4,958.1	$4,952.0
2015	$426	0.06%	-0.09%	$5,056.6	$5,062.7	$5,056.6
2016	$426	0.06%	-0.09%	$5,161.4	$5,167.7	$5,161.4
2017	$426	0.06%	-0.09%	$5,266.2	$5,272.7	$5,266.2
2018	$426	0.06%	-0.09%	$5,371.2	$5,377.6	$5,371.2
2019	$426	0.06%	-0.09%	$5,476.0	$5,482.6	$5,476.0
2020	$426	0.06%	-0.09%	$5,580.8	$5,587.6	$5,580.8
2021	$426	0.06%	-0.09%	$5,685.5	$5,692.5	$5,685.5
2022	$426	0.06%	-0.09%	$5,790.3	$5,797.5	$5,790.3
2023	$426	0.06%	-0.09%	$5,895.3	$5,902.5	$5,895.3
2024	$426	0.06%	-0.09%	$6,000.1	$6,007.4	$6,000.1
2025	$426	0.06%	-0.09%	$6,104.9	$6,112.4	$6,104.9
2026	$426	0.06%	-0.09%	$6,209.7	$6,217.2	$6,209.7
2027	$426	0.06%	-0.09%	$6,314.3	$6,322.0	$6,314.3
2028	$426	0.06%	-0.09%	$6,419.0	$6,426.9	$6,419.0
2029	$426	0.06%	-0.09%	$6,523.6	$6,531.7	$6,523.6
2030	$426	0.06%	-0.09%	$6,628.4	$6,636.5	$6,628.4

*Percent change in price and quantity are based upon baseline market conditions for 2001
** Surplus Loss is equal to the sum of the loss in consumer surplus and producer surplus. This estimate reflects projected growth in vehicles occurring subsequent to the baseline year of 2001.
***Social Costs are equal to the surplus losses net fuel cost savings. For this vehicle category, there are no fuel cost savings; the future stream of surplus losses is therefore equal to the future stream of social costs. Cost estimates are based on 2001 dollars.

9.1.2 Summary Results for Large SI

As explained in Section 9.7, we performed an economic impact analysis for only the forklift segment of the Large SI market. A summary of the estimated changes in price and quantity, and the sum of consumer and producer surplus losses for forklifts is contained in Table 9.1-2. To estimate the total social costs/gains for Large SI, we use the engineering costs to approximate the sum of consumer and producer surplus losses for Large SI engines other than forklifts. This approach slightly overestimates the surplus losses for the category since engineering costs are higher than surplus losses.

The baseline year for the economic analysis of the forklift market is 2000. In this year, the forklift price is taken to be $26,380 (the price of a representative Class 5 forklift equipped with a Large SI engine) and the market output is equal to 65,000 forklifts (taken from the Power Systems Research (PSR) database). Based on these data, the relative changes in market price and output are calculated, as are the annual future year streams of surplus losses, engineering costs, and social costs/gains. Results are presented in Table 9.1-2.

Table 9.1-2
Summary Economic Impact Results for the Forklift Market

Year	Cost/unit ($)	Change in Price (%)*	Change in Quantity (%)*	Surplus Losses ($\$10^3$)**	Engineering Costs ($\$10^3$)	Social Costs/Gains ($\$10^3$)***
2004	$610	0.75%	-1.12%	$43,823.1	$44,403.4	$6,724.8
2005	$610	0.75%	-1.12%	$44,996.9	$45,592.7	($29,708.1)
2006	$493	0.60%	-0.90%	$37,410.6	$37,816.0	($75,354.6)
2007	$537	0.66%	-0.98%	$41,745.3	$42,246.7	($108,221.4)
2008	$537	0.66%	-0.98%	$42,780.3	$43,294.1	($143,423.9)
2009	$418	0.51%	-0.77%	$34,194.5	$34,471.7	($187,187.5)
2010	$418	0.51%	-0.77%	$35,002.2	$35,286.0	($220,411.8)
2011	$418	0.51%	-0.77%	$35,809.9	$36,100.3	($248,987.1)
2012	$390	0.48%	-0.72%	$34,185.7	$34,447,5	($263,690.9)
2013	$390	0.48%	-0.72%	$34,939.8	$35,207.4	($273,632.9)
2014	$390	0.48%	-0.72%	$34,693.9	$35,967.3	($282,531.5)
2015	$390	0.48%	-0.72%	$36,448.0	$36,727.2	($290,434.8)
2016	$390	0.48%	-0.72%	$37,202.1	$37,487.0	($297,344.7)
2017	$390	0.48%	-0.72%	$37,956.2	$38,246.9	($303,835.7)
2018	$390	0.48%	-0.72%	$38,710.3	$39,006.8	($309,915.5)
2019	$390	0.48%	-0.72%	$39,464.3	$39,766.6	($315,594.1)
2020	$390	0.48%	-0.72%	$40,218.4	$40,526.5	($320,692.6)
2021	$390	0.48%	-0.72%	$40,972.5	$41,286.4	($325,792.0)
2022	$390	0.48%	-0.72%	$41,726.6	$42,046.3	($330,892.1)
2023	$390	0.48%	-0.72%	$42,480.7	$42,806.1	($336,421.4)
2024	$390	0.48%	-0.72%	$43,234.8	$43,566.0	($342,011.8)
2025	$390	0.48%	-0.72%	$43,988.9	$44,325.9	($347,604.0)
2026	$390	0.48%	-0.72%	$44,743.0	$45,085.7	($352,536.0)
2027	$390	0.48%	-0.72%	$45,497.1	$45,845.6	($357,472.3)
2028	$390	0.48%	-0.72%	$46,251.2	$46,605.5	($362,412.8)
2029	$390	0.48%	-0.72%	$47,005.3	$47,365.4	($367,356.6)
2030	$390	0.48%	-0.72%	$47,759.4	$48,125.2	($372,304.0)

*Percent change in price and quantity are based upon baseline market conditions for 2000

** Surplus Loss is equal to the sum of the loss in consumer surplus and producer surplus. This estimate reflects projected growth in vehicles occurring subsequent to the baseline year of 2000.
***Social Costs/Gains are equal to the surplus losses net fuel cost savings. ( ) represents a negative cost (social gain). Cost estimates are based upon 2000$.

The relative changes in price and quantity are slightly larger than they were for the inboard diesel cruiser market, but they are still considered minimal. The price and quantity changes resulting from the per forklift costs are less than 1 percent, with the exception of the quantity change during the two years of the rule's implementation. By the year 2014, the relative increase in market price is estimated to equal about one-half of one percent and the reduction in quantity is equal to approximately three-quarters of one percent. As the table shows, the annual surplus losses are approximately equal to 98 to 99 percent of engineering costs. Over the future year time stream presented, surplus losses range from a low of $34.2 million in 2009 to a high of $47.8 million in 2030.

An examination of the social costs/gains shows that the gains continually increase in the future. This growth in social gains arises from the increasing fuel savings over time. The initial growth in fuel savings can be attributed to the gradual turnover to new forklifts in the marketplace. After this turnover, the growth in fuel savings can be credited to an increase in the sales of forklifts. With a larger population of forklifts projected, the fuel savings are expected to be larger. Hence the rule, as it affects the forklift market, is expected to result in larger social gains as new forklifts enter the market and as more forklifts are purchased and operated in the future. In 2030, the social gains of the rule for this vehicle category are just over $370 million. Note that the figures discussed here and presented in the above table are not discounted.

Finally, to estimate the social costs/gains for the Large SI category as a whole, we can use engineering costs as an estimate for the sum of consumer and producer surplus losses. These estimates are contained in Table 9.1-3.

Table 9.1-3
Surplus Losses, Fuel Efficiency Gains,
and Social Gains/Costs for Large SI Engines in 2030[a]

Vehicle Category	Surplus Losses in 2030 ($$10^6$)	Fuel Efficiency Gains in 2030 ($$10^6$)	Social Gains/Costs in 2030[b] ($$10^6$)
Forklifts	$47.8	$420.1	$372.3
Other Large SI	$48.1	$138.4	$90.3
All Large SI	$95.9	$558.5	$462.6

[a] Figures are in 2000 dollars.
[b] Figures in this column exclude estimated social benefits.
[c] Figure is engineering costs; see text for explanation.
[d] Net Present Value is calculated over the 2002 to 2030 time frame using a 3 percent discount rate.

9.1.3 Summary Results for Snowmobiles

The baseline year for the economic analysis of the snowmobile market is 2001. In this year, the average snowmobile price is $6,360 and the market output is 140,629. These data are provided by the International Snowmobile Manufacturing Association (ISMA).[1] Based on these data, the relative changes in market price and output are calculated, as are the annual future year streams of surplus losses, engineering costs, and social costs or gains. Results are presented on Table 9.1-4.

Table 9.1-4
Summary Economic Impact Results for the Snowmobile Market

Year	Cost/unit ($)	Change in Price (%)*	Change in Quantity (%)*	Surplus Losses ($\$10^{3}$)**	Engineering Costs ($\$10^{3}$)	Social Costs/Gains ($\$10^{3}$)***
2006	$35	0.28%	-0.56%	$6,546.9	$6,583.5	$6,155.4
2007	$69	0.56%	-1.11%	$13,397.7	$13,546.4	$12,172.3
2008	$65	0.52%	-1.05%	$13,047.2	$13,183.5	$10,577.4
2009	$65	0.52%	-1.05%	$13,316.0	$13,455.2	$9,568.5
2010	$185	1.49%	-2.98%	$37,787.2	$38,933.1	$28,241.7
2011	$181	1.46%	-2.92%	$37,571.1	$38,685.1	$21,937.4
2012	$239	1.92%	-3.85%	$49,981.9	$51,957.6	$24,916.0
2013	$239	1.92%	-3.85%	$50,697.2	$52,701.2	$15,841.0
2014	$202	1.63%	-3.25%	$43,852.8	$45.309.0	($1,007.1)
2015	$196	1.58%	-3.16%	$43,017.6	$44,402.3	($11,957.9)
2016	$182	1.47%	-2.93%	$40,648.1	$41,860.2	($24,397.9)
2017	$180	1.45%	-2.9%	$40,543.0	$41,738.4	($34,420.2)
2018	$180	1.45%	-2.9%	$41,003.0	$42,211.9	($43,542.9)
2019	$180	1.45%	-2.9%	$41,455.4	$42,677.6	($52,141.8)
2020	$180	1.45%	-2.9%	$41,903.1	$43,138.5	($60,276.2)
2021	$180	1.45%	-2.9%	$41,903.1	$43,138.5	($68,292.1)
2022	$180	1.45%	-2.9%	$41,903.1	$43,138.5	($74,761.8)
2023	$180	1.45%	-2.9%	$41,903.1	$43,138.5	($79,630.7)
2024	$180	1.45%	-2.9%	$41,903.1	$43,138.5	($83,278.1)
2025	$180	1.45%	-2.9%	$41,903.1	$43,138.5	($85,777.8)
2026	$180	1.45%	-2.9%	$41,903.1	$43,138.5	($87,804.8)
2027	$180	1.45%	-2.9%	$41,903.1	$43,138.5	($89,549.9)
2028	$180	1.45%	-2.9%	$41,903.1	$43,138.5	($91,022.3)
2029	$180	1.45%	-2.9%	$41,903.1	$43,138.5	($92,224.9)
2030	$180	1.45%	-2.9%	$41,903.1	$43,138.5	($93,165.9)

*Percent change in price and quantity are based upon baseline market conditions for 2001.
** Surplus Loss is equal to the sum of the loss in consumer surplus and producer surplus. This estimate reflects projected growth in vehicles occurring subsequent to the baseline year of 2001.
***Social Costs/Gains are equal to the surplus losses net fuel cost savings.
( ) represents a negative cost (social gain). Cost estimates are based upon 2001$

The relative increases in price expected to occur due to the rule range from 0.28 percent to 1.92 percent and reach a steady state level of 1.45 percent in 2015. The peak occurs in 2012 when the Phase III standards are implemented and the impacts decline with the recognition of learning curve effects. Estimated quantity changes follow a similar trend ranging from decreases of 0.56 percent to 3.85 percent in 2010 then reaching a steady state of 2.9 percent in 2017. It is important to note that these price quantity changes are based upon baseline 2001 snowmobile market conditions. As the table shows, the annual surplus losses are approximately equal to 96 to 99 percent of engineering costs. Over the future year time stream presented, surplus losses range from a low of $6.5 million in 2006 to a high of $50.7 million in 2012. These surplus losses account for projected growth in snowmobiles sales during the period.

An examination of the social costs and gains of the snowmobile regulation shows losses occur through 2013. Social gains begin in 2014 and continually increase in the future. This growth in social gains arises from the increasing fuel savings over time. The growth in fuel savings can be attributed to the gradual turnover of the snowmobile fleet to new fuel efficient technologies and to projected increases in the sales of snowmobiles. With a larger population of snowmobiles projected, the fuel savings are expected to be larger. Hence the rule, as it affects the snowmobile market, is expected to result in larger social gains as new snowmobiles enter the market and as more snowmobiles are purchased and operated in the future. In 2030, the social gains of the rule for this vehicle category are anticipated to be just over $93.0 million. Note that the figures discussed here and presented in the above table are not discounted and reflect 2001$.

9.1.4 Summary Results for ATVs

The baseline year for the economic analysis of the ATV market is 2001. In this year, the average ATV price is estimated to be $5,123 and the market output is equal to 880,000, this data was provided by MIC. Based on these data, the relative changes in market price and output are calculated, as are the annual future year streams of surplus losses, engineering costs, and social costs/gains. Results are presented in Table 9.1-5.

Table 9.1-5
Summary Economic Impact Results for the ATV Market

Year	Cost/unit ($)	Change in Price (%)*	Change in Quantity (%)*	Surplus Losses ($$10^3$)**	Engineering Costs ($$10^3$)	Social Costs/Gains ($$10^3$)***
2006	$43	0.28%	-0.56%	$42,186.6	$42,463.9	$41,252.7
2007	$82	0.53%	-1.07%	$80,258.8	$80,270.6	$76,563.7
2008	$78	0.51%	-1.02%	$75,611.8	$76,518.0	$68,657.0
2009	$71	0.46%	-0.92%	$69,529.4	$70,287.0	$58,605.5
2010	$66	0.43%	-0.86%	$64,681.3	$65,302.2	$49,541.9
2011	$57	0.37%	-0.74%	$55,891.6	$56,379.5	$36,400.4
2012	$53	0.34%	-0.69%	$52,019.5	$52,441.5	$28,143.4
2013	$53	0.34%	-0.69%	$52,019.5	$52,441.5	$23,830.7
2014	$53	0.34%	-0.69%	$52,019.5	$52,441.5	$19,705.2

2015	$53	0.34%	-0.69%	$52,019.5	$52,441.5	$15,801.2
2016	$51	0.33%	-0.66%	$49,612.0	$49,999.1	$9,780.7
2017	$48	0.31%	-0.62%	$47,210.3	$47,556.8	$4,086.6
2018	$48	0.31%	-0.62%	$47,210.3	$47,556.8	$1,360.2
2019	$48	0.31%	-0.62%	$47,210.3	$47,556.8	($456.0)
2020	$48	0.31%	-0.62%	$47,210.3	$47,556.8	($1,630.4)
2021	$48	0.31%	-0.62%	$47,210.3	$47,556.8	($2,429.8)
2022	$48	0.31%	-0.62%	$47,210.3	$47,556.8	($2,924.0)
2023	$48	0.31%	-0.62%	$47,210.3	$47,556.8	($3,298.2)
2024	$48	0.31%	-0.62%	$47,210.3	$47,556.8	($3,580.7)
2025	$48	0.31%	-0.62%	$47,210.3	$47,556.8	($3,790.0)
2026	$48	0.31%	-0.62%	$47,210.3	$47,556.8	($3,942.6)
2027	$48	0.31%	-0.62%	$47,210.3	$47,556.8	($4,054.2)
2028	$48	0.31%	-0.62%	$47,210.3	$47,556.8	($4,132.9)
2029	$48	0.31%	-0.62%	$47,210.3	$47,556.8	($4,189.3)
2030	$48	0.31%	-0.62%	$47,210.3	$47,556.8	($4,227.9)

*Percent change in price and quantity are based upon baseline market conditions for 2001
** Surplus Loss is equal to the sum of the loss in consumer surplus and producer surplus. This estimate reflects projected growth in vehicles occurring subsequent to the baseline year of 2001.
***Social Costs/Gains are equal to the surplus losses net fuel cost savings. ( ) represents a negative cost (social gain). Cost estimates are based upon 2001$

The relative changes in price and quantity resulting from the ATV regulations are considered minimal. The anticipated price change increases resulting from the per ATV costs are 0.53 percent or less. The quantity change decreases resulting from the engine modification costs are 1 percent or less. As the table shows, the annual surplus losses are approximately equal to 98 to 99 percent of engineering costs. Over the future year time stream presented, surplus losses range from a low of $42.2 million in 2006 to a high of $80.3 million in 2007 and reach a steady state of $47.2 million in 2017.

An examination of the social costs/gains shows that the losses decrease beginning in 2008 and become gains in 2019 with gains continually increasing in the future through 2030. This growth in social gains arises from the increasing fuel savings over time. The initial growth in fuel savings can be attributed to the gradual conversion of ATVs to new fuel saving technologies in the marketplace. After this turnover, the growth in fuel savings can be credited to an increase in the sales of ATVs. With a larger population of ATVs projected, the fuel savings are expected to be larger. Hence the rule, as it affects the ATV market, is expected to result in larger social gains as new ATVs enter the market and as more ATVs are purchased and operated in the future. In 2030, the social gains of the rule for this vehicle category are just over $4.2 million. Note that the figures discussed here and presented in the above table are not discounted and reflect 2001$.

9.1.5 Summary Results for Off-Highway Motorcycles

The baseline year for the economic analysis of the off-highway motorcycle market is 2001. In this year, the average off-highway motorcycle price is estimated to be $2,253 and the market sales are equal to195,250 off-highway motorcycles. These data were provided by MIC. Based on these data, the relative changes in market price and output are calculated, as are the annual future year streams of surplus losses, engineering costs, and social costs/gains. Results are presented in Table 9.1-6.

Table 9.1-6
Summary Economic Impact Results for the Off-Highway Motorcycle Market

Year	Cost/unit ($)	Change in Price (%)*	Change in Quantity (%)*	Surplus Losses (\$$10^3$)**	Engineering Costs (\$$10^3$)	Social Costs/Gains (\$$10^3$)***
2006	$79	1.11%	-2.23%	$15,840.8	$16,269.1	$15,207.4
2007	$155	2.18%	-4.37%	$30,551.2	$32,215.0	$28,489.4
2008	$143	2.01%	-4.03%	$28,424.3	$29,846.5	$24,658.7
2009	$128	1.80%	-3.61%	$25,970.3	$27,127.3	$20,302.3
2010	$117	1.65%	-3.30%	$23,984.8	$24,957.7	$16,332.2
2011	$102	1.44%	-2.87%	$21,328.9	$22,079.4	$11,658.7
2012	$99	1.39%	-2.79%	$20,895.5	$21,630.7	$9,242.8
2013	$99	1.39%	-2.79%	$21,104.4	$21,847.0	$7,551.0
2014	$99	1.39%	-2.79%	$21,315.5	$22,065.4	$5,910.8
2015	$99	1.39%	-2.79%	$21,528.6	$22,508.9	$4,332.7
2016	$99	1.39%	-2.79%	$21,743.9	$22,734.0	$2,893.5
2017	$99	1.39%	-2.79%	$21,961.4	$22,961.4	$1,757.2
2018	$99	1.39%	-2.79%	$22,181.0	$22,961.4	$1,039.5
2019	$99	1.39%	-2.79%	$22,402.8	$23,191.0	$609.1
2020	$99	1.39%	-2.79%	$22,626.8	$23,422.9	$325.0
2021	$99	1.39%	-2.79%	$22,853.1	$23,657.1	$119.2
2022	$99	1.39%	-2.79%	$23,081.6	$23,893.7	($35.0)
2023	$99	1.39%	-2.79%	$23,312.4	$24,132.6	($133.4)
2024	$99	1.39%	-2.79%	$23,545.6	$24,374.0	($195.4)
2025	$99	1.39%	-2.79%	$23,781.6	$24,617.7	($240.6)
2026	$99	1.39%	-2.79%	$24,018.0	$24,863.9	($256.0)
2027	$99	1.39%	-2.79%	$24,259.0	$25,112.2	($252.0)
2028	$99	1.39%	-2.79%	$24,501.6	$25,363.7	($244.9)
2029	$99	1.39%	-2.79%	$24,746.6	$25,617.3	($214.4)
2030	$99	1.39%	-2.79%	$24,994.1	$25,873.5	($170.7)

*Percent change in price and quantity are based upon baseline market conditions for 2001

** Surplus Loss is equal to the sum of the loss in consumer surplus and producer surplus. This estimate reflects projected growth in vehicles occurring subsequent to the baseline year of 2001.

***Social Costs/Gains are equal to the surplus losses net fuel cost savings. ( ) represents a negative cost (social gain). Cost estimates are based upon 2001$

The anticipated price change increases resulting from the engine modification costs range from 1.11 percent to 2.18 percent and reach a steady state of 1.39 percent in 2012. The quantity change decreases resulting from the per off-highway motorcycle costs range from 2.23 percent to

4.37 percent and reach a steady state of 2.79 percent in 2012. As the table shows, the annual surplus losses are approximately equal to 98 to 99 percent of engineering costs. Over the future year time stream presented, surplus losses range from a low of $15.8 million in 2006 to a high of $30.6 million in 2007.

An examination of the social costs/gains shows that the social costs reach a peak in 2007 and diminish annually through 2021. In 2020, annual social gains occur for this rule and annual gains occur through 2030. This diminishing social cost and increasing social gain arise from the increasing fuel savings over time. The initial growth in fuel savings can be attributed to the gradual conversion of off-highway motorcycles new fuel saving technologies in the marketplace. Hence the rule, as it affects the off-highway motorcycle market, is expected to result in larger social gains as new off-highway motorcycles enter the market and as more off-highway motorcycles are purchased and operated in the future. In 2030, the social gains of the rule for this vehicle category are $170,700. Note that the figures discussed here and presented in the above table are not discounted and reflect 2001$.

9.1.6 Net Present Value of Surplus Loss, Fuel Cost Savings, and Social Costs/Gains

For each of the vehicle categories, the net present value of the future streams of surplus losses, fuel savings, and social costs/gains have been calculated. The net present values of these future streams are calculated using a 3 percent discount rate and are calculated over the 2002 to 2030 time frame. We also show this information using a 7 percent discount rate. Table 9.1-7 presents the net present values and the surplus loss, fuel savings, and social costs/gains for the year 2030 for each of the vehicle categories.

Table 9.1-7
Year 2030 and Net Present Values of Surplus Losses, Fuel Cost Savings, and Social Costs/Gains ($million)[A]

Vehicle Category	Surplus Loss in 2030	NPV of Surplus Loss[B]	NPV of Surplus Loss[C]	Fuel Cost Savings in 2030	NPV of Fuel Cost Savings[B]	NPV of Fuel Cost Savings[C]	Social Costs/Gains in 2030[D]	NPV Cost
CI Marine	$6.6	$99.6	$59.0	$0.0	$0.0	$0.0	$6.6	
Forklifts	$47.8	$692.2	$415.8	$420.1	$4,883.4	$2,644.2	($372.3)	($
Other Large SI[E]	$48.1	$698.4	$419.7	$138.4	$1,494.4	$804.8	($90.3)	(
Snowmobiles	$41.9	$553.1	$296.9	$135.0	$999.6	$459.7	($93.1)	(
ATVs	$47.2	$829.2	$491.9	$51.4	$510.5	$253.0	($4.2)	
Off-Highway Motorcycles	$25.0	$358.9	$206.2	$25.2	$242.4	$120.6	($0.2)	
Total	$216.6	$3,231.4	$1,889.5	$770.1	$8,130.3	$4,282.3	($553.5)	($

[A] Figures are in year 2000 and 2001 dollars, depending on the vehicle category. ( ) represents a negative cost (social gain).
[B] Net Present Values are calculated using a discount rate of 3 percent over the 2002 - 2030 time period.
[C] Net Present Values are calculated using a discount rate of 7 percent over the 2002 - 2030 time period.
[D] Figures in this column do not include human health and environmental benefits of the regulations.
[E] Figures in this row are engineering cost estimates. See Section 9.7.6.

9.2 Economic Theory

Economic theory is based on the examination of choice behavior. As market conditions change, producers and consumers alter their production and purchasing decisions. In essence, this approach models the expected reallocation of society's resources in response to a regulation. The behavioral approach explicitly models the changes in market prices and production. These changes can be used to compute other impact variables, such as changes in producer and consumer surplus, changes in employment, and total changes in economic welfare. EPA relies heavily on this approach to develop impacts for the economic analysis. In order to develop a methodological approach to examine the economic impacts of the emissions standards applied to diesel recreational marine vessels, forklifts, and recreational vehicles, certain issues such as the model scope and length of run for the analysis must be considered. These concepts are discussed in detail here and can also be found in the OAQPS Economic Analysis Resource Document[2].

9.2.1 Partial vs. General Equilibrium Model Scope

A partial equilibrium market model examines the effect of a regulatory action on a single market, ignoring all other possible market interactions. Such an approach is justified in cases where a regulation's effect is expected to be concentrated in one market sector (i.e., the effect of the regulation in indirectly affected markets is relatively small). Other times this approach is used because of the difficulties of acquiring data for indirectly affected markets.

A general equilibrium market model tracks the effects of a regulation in all sectors of the economy. In this case, all inter-sectoral linkages are accounted for and examined. It is often difficult to examine every effect of a regulation on every market. Many market models therefore examine the most important linkages between sectors of the economy. These are generally referred to as "general" equilibrium models or multi-market partial equilibrium models.

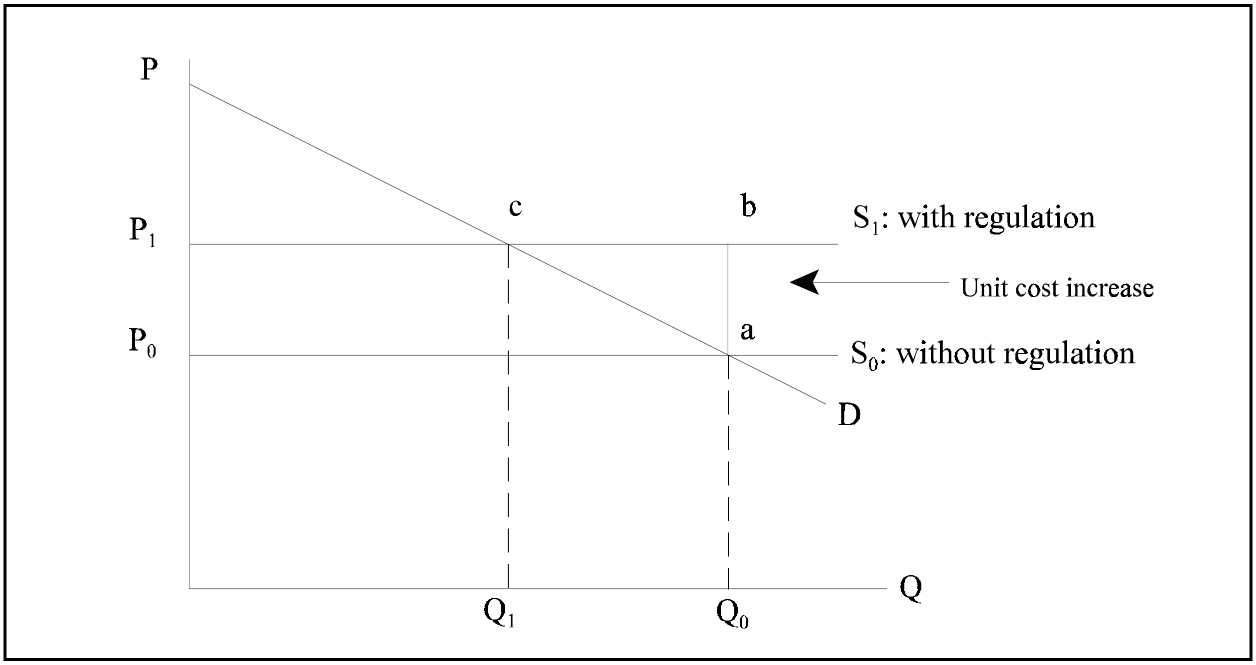
For the analysis of the recreational vehicles emission standards, we rely upon a partial equilibrium market model to examine the economic impacts on the markets of each affected vehicle category. This choice was made because most of the economic impacts are expected to be incurred in the directly affected market and because of data availability issues.

9.2.2 Length-of-Run Considerations

In developing the partial equilibrium model for this analysis, the choices available to producers must be considered. The choices are largely dependent upon the time horizon for which the analysis is performed. Three benchmark time horizons are presented here: the very short run, the long run, and the intermediate run. For this analysis, we focus on the partial quilibrium intermediate run analysis. Though these horizons refer to different lengths of time, they will likely differ depending upon the market in question. What defines these time horizons is the set of options or degree of flexibility producers have to respond to changing market conditions.

In the very short run, all factors of production are assumed to be fixed, thus leaving the

Figure 9.2-1
Full-Cost Pass Through of Regulatory Costs



directly affected entity with no means to respond. Within a short time horizon, regulated producers are unable to adjust inputs or outputs due to contractual, institutional, or other factors. In this scenario, the impacts of the regulation fall entirely on the regulated entities. Producers in this case incur the entire regulatory burden as a one-to-one reduction in their profit. This is often referred to as the “full-cost absorption” scenario.

In the long run, all factors of production are variable and producers can be expected to adjust their production plans in response to changes in cost resulting from a regulation. Entry and exit of firms into the industry is feasible. Figure 9.2-1 illustrates one example of a typical, if somewhat simplified, long-run supply function. In this example, the supply curve is horizontal, indicating that the marginal and average costs of production are constant with respect to output. This horizontal slope reflects the fact that, under long-run constant returns to scale, technology and input prices ultimately determine the market price, not the level of output in the market. Industry long run supply curves may exhibit constant, increasing, or decreasing returns to scale even in perfectly competitive markets. In many industries expansion of production in the long run may bid input prices up leading to increasing returns to scale. Constant returns to scale are assumed for illustrative purposes.

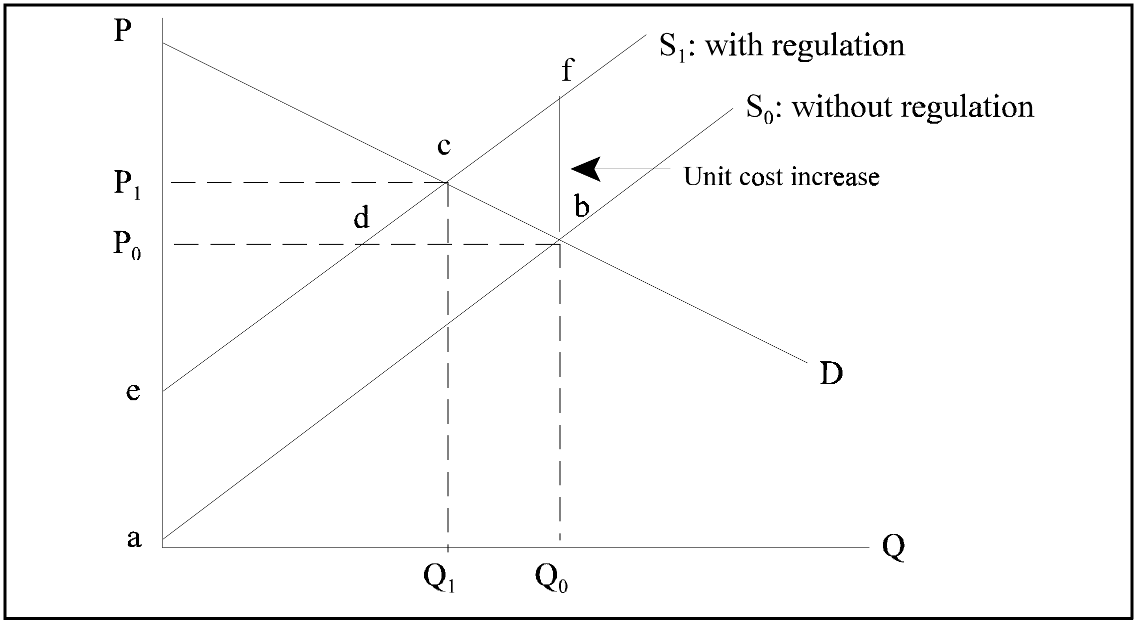
Market demand is represented by the standard downward-sloping curve. A constant cost industry is assumed; equilibrium is determined by the intersection of the supply and demand curves. In this case, the upward parallel shift in the market supply curve represents the regulation's effect on production costs. The shift causes the market price to increase by the full amount of the per-unit control cost (i.e., from P_0 to P_1). With the quantity demanded sensitive to price, the increase in market price leads to a reduction in output in the new with-regulation equilibrium (i.e., Q_0 to Q_1). As a result, consumers incur the entire regulatory burden as represented by the loss in consumer surplus (i.e., the area P_0acP_1). In the nomenclature of EIAs, this long-run scenario is typically referred to as "full-cost pass-through."

The "intermediate" run can best be defined by what it is not. It is not the very short run and it is not the long run. In the intermediate-run, some factors are fixed; some are variable. The existence of fixed production factors generally leads to diminishing returns to those fixed factors. This typically manifests itself in the form of a marginal cost function (which occupies the same locus of points as the supply curve) that rises with the output rate, as shown in Figure 9.2-2.

Again, the regulation causes an inward shift in the supply function due to the increase in production costs. The lack of resource mobility may cause profit (producer surplus) losses for producers in the face of regulation. However, unlike the full-cost absorption scenario, producers are able to pass through the associated costs to consumers to the extent the market will allow. As shown, in this case, the market-clearing process generates an increase in price (from P_0 to P_1) that is less than the per-unit increase in costs (fb), so that the regulatory burden is shared by producers (net reduction in profits) and consumers (rise in price). In this case, the change in consumer surplus is equal to P_0cbP_1. Producer surplus is equal to an increase in revenues on units it had previously sold prior to the cost increase (P_1cdP_0) and a loss due to the costs per unit they now face (area edba). The producer surplus is therefore equal to area edba - P_1cdP_0. The combined consumer and producer surplus loss is equal to P_1cdP_0 - P_1cbP_0 - edba. This is represented by area ecba and is referred to throughout this analysis as the surplus loss.

As mentioned earlier, the economic analysis for each vehicle category focuses on an intermediate run approach. This is justified as the supply curve for each vehicle category shifts inwards by the total annualized cost per vehicle, not simply variable costs. Though this rule goes into effect over a number of years, there is a loss in economic welfare that is distributed across producers and consumers as the rule goes into effect. The analysis presented here chooses to focus on this loss in surplus and how it affects producers and consumers. Even if we were to take a long-run approach, the industry supply curve for each vehicle category may not be horizontal, (and thus represent a constant-cost industry). In fact, in many industries an increasing-cost industry might be the norm as the prices of factors of production are bid upwards as these industries expand.

Figure 9.2-2
Partial-Cost Pass-Through of Regulatory Costs



9.3 Fuel Efficiency Gains

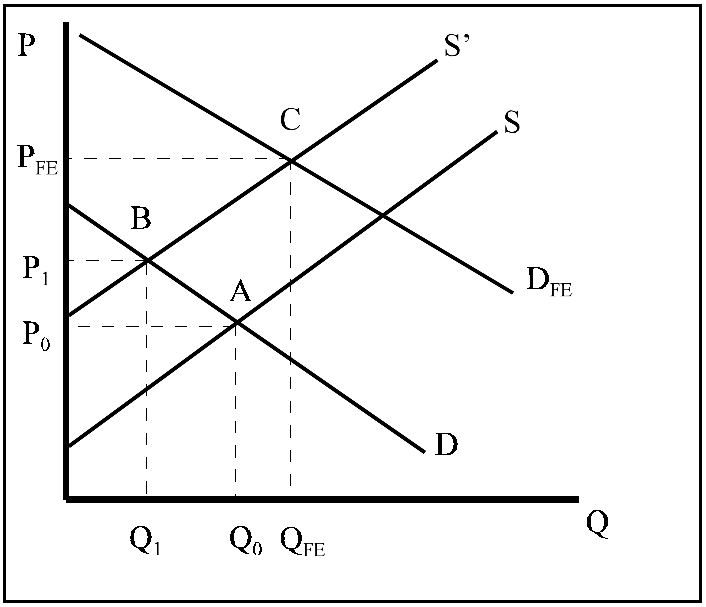
The main purpose of the emissions control program is to reduce emissions. However the changes made to the engines in forklifts, snowmobiles, ATVs, and off-highway motorcycles are also expected to result in fuel cost savings over the lifetime operation of these vehicles. Though the prices of these vehicles are expected to increase due to the regulatory costs imposed, consumers will spend less on fuel to operate the vehicles than they would have had the emissions control program not been implemented. This reduced spending on fuel is a benefit to consumers. This section qualitatively discusses the market impacts and welfare gains that may result from the savings in fuel costs.

When recreational vehicle and large SI engine producers are required to meet the emissions standard, they face an increase in the cost of production. This production cost increase causes an inward shift of the supply curve equal to the regulatory cost per vehicle, shown in Figure 9.2-2. As discussed earlier in Section 9.2.2, this leads to a loss in economic welfare equal to the sum of the loss in producer surplus and consumer surplus. What is not accounted for in Figure 9.2-2, however, is how fuel cost savings might affect the market equilibrium and what surplus gain is reaped from the improved fuel efficiency. Consumers may or may not incorporate the fuel efficiency gains into their valuation of a particular vehicle and the extent to which they do affects the market equilibrium quantity and price, surplus changes, and social costs.

If consumers value the improvement in fuel efficiency of a particular recreational vehicle, their demand curve for this product will shift out. The degree to which demand shifts reflects the magnitude of the potential fuel cost savings, the costs of being informed about the savings, and consumer time preferences. It may be the case that consumers are unaware of the fuel cost savings, that they don't perceive them to be as large as they are, or that they heavily discount their value. In those cases, there may be little or no shift in demand. Larger shifts in demand are expected if consumers face low information costs and/or have a low discount rate for the future savings in fuel costs.

For demonstration purposes, we can examine the hypothetical market for snowmobiles depicted in Figures 9.3-1 through 9.3-3 to see how market equilibrium price and quantity (point A) may change in response to the emissions control program and the fuel cost savings it generates. It is important to note that this discussion applies to all vehicle categories affected by the rule and the snowmobile market is used for explanatory purposes. This entails an examination of the changes in both supply and demand. Looking at Figure 9.3-1, assume that the net present value (NPV) of fuel cost savings per vehicle exceeds the regulatory control costs per snowmobile. As described above, the increase in the costs of producing snowmobiles results in a parallel shift inward of the supply curve. This leads to a higher price (P_1) and lower quantity (Q_1) sold, resulting in a new equilibrium point B. Now however, snowmobiles can operate using less fuel due to the technology advancements that are adopted to reduce emissions. This change in attribute may result in an outwards shift of the demand curve. If consumers fully value the fuel cost savings, demand will shift out to D_{FE}. The new equilibrium price (P_{FE}) and quantity (Q_{FE}) is represented by point C, which exceeds the market equilibrium price (P_0) and quantity (Q_0) before the emissions control program was adopted (point A). If producers were certain that consumers would fully value the fuel efficiency attribute, this change in technology may have occurred without the implementation of the regulation. If consumers and producers view the world in this manner, this scenario appears to be a market failure. What appears to be a win-win situation for consumers and producers does not occur in the market place absent regulation. The risk of producing new technology engines is borne by the producer as it is the producer that incurs the increased production costs. In contrast, fuel efficiency gains are experienced by the consumer to the extent the consumer is willing to pay the higher initial purchase price to gain fuel efficiency over the useful life of the vehicle. Producers offering the new technologies only gain from the new technology investment to the extent consumer's demand increases (demand curve shifts outward) sufficiently to offset the increased cost of production. Thus investment in the new fuel efficient technologies does represent a business risk for the producer and issues such as risk aversion may enter into the decision to introduce these newer, cleaner, and fuel efficient technologies into the marketplace absent regulatory requirements. As is depicted by the next two scenarios, perfect information does not exist regarding consumers preferences for fuel efficiency. Thus absent regulation, producers are making expenditures with uncertain potential for returns.

Figure 9.3-1
New Equilibrium with Full Consumer Valuation of Fuel Efficiency



If consumers do not fully value the fuel cost savings resulting from the regulation, demand may not shift out to D_{FE}, but instead shift to D'. As Figure 9.3-2 shows, market equilibrium is now represented by point D where new equilibrium market price (P_2) exceeds the original market price (P_0). However, the new equilibrium quantity (Q_2) is lower than the original equilibrium quantity (Q_0). In such a scenario, consumers do value the attribute somewhat and are willing to pay an increased price for the fuel efficient vehicles. However the price consumers are willing to pay does not fully compensate the producers for the cost of making the vehicle modification. In this scenario, it is likely that producers will be unwilling to make the engine technology improvements absent regulation.

Another possibility is that demand may not shift at all if consumers do not perceive the fuel cost savings associated with the new technology. In this case, Figure 9.3-3 represents the market outcome. In this final scenario consumers do not value fuel efficiency for these vehicles and, there is no profit motivation for producer to implement the technology changes absent regulation.

Figure 9.3-2
New Equilibrium With Partial Consumer Valuation of Fuel Efficiency

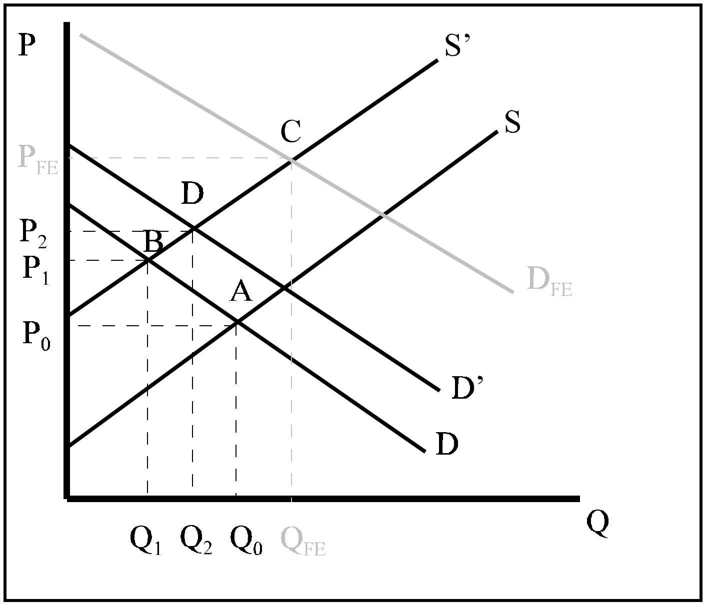
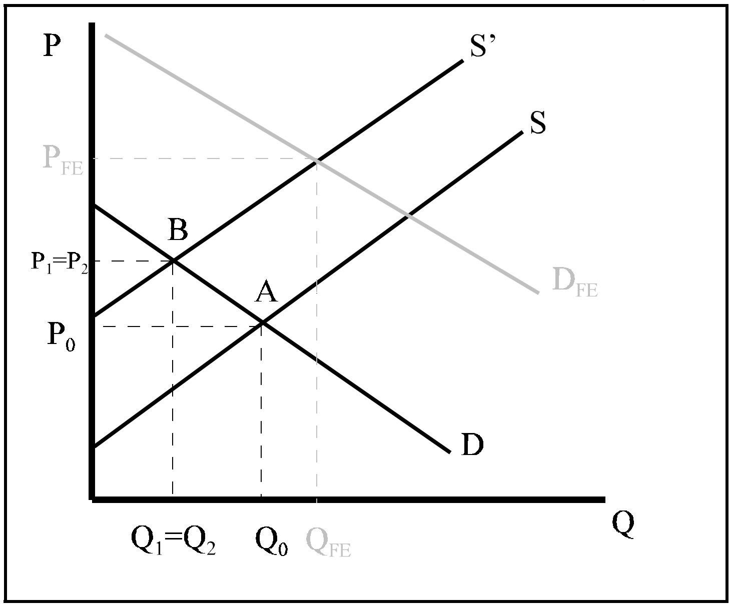


Figure 9.3-3
New Equilibrium with
No Consumer Valuation of Fuel Efficiency



It is important to recognize that the new price and quantity in the market for snowmobiles is determined by both a shift in supply as the cost of producing snowmobiles increases and a shift in demand to account for consumers’ valuation of fuel cost savings. The potential gains to producers from making engine technology changes that increase fuel efficiency are uncertain and provide an explanation as to why these changes have not occurred in some recreational vehicle markets absent regulation.

Another effect not depicted in the graphs above occurs in the fuel or gasoline market where consumers now demand a smaller quantity of fuel to operate the fuel efficient vehicles. Since consumers will now require less fuel to operate snowmobiles than would be required absent the regulation, there is an inward shift in demand for gasoline. This shift in demand will likely be so small as to not affect the price of fuel since consumers of large SI engine equipment and recreational vehicles are a small segment of the total gasoline market. However, consumers experience a gain equal to the NPV of the change in the quantity of fuel consumed multiplied by the price of fuel over the lifetime of the vehicle. This is taken to equal the fuel cost savings for each vehicle category as calculated and presented in Chapter 7. This gain occurs independently of consumer preferences for fuel efficient vehicles. Specifically, if a consumer chooses to purchase a more fuel efficient vehicle, the consumer will experience the gain of increased fuel cost savings while using the product regardless of his or her preference for the fuel efficient attributes of the vehicle.

For this analysis, we are uncertain of the size of the outward shift in demand. We therefore do not project the price and quantity changes that occur taking fuel savings into account. However, we do account for the fuel cost savings by subtracting it from the surplus losses of the rule for each vehicle category over the future year time stream to generate a more accurate assessment of the social costs/gains of the regulation. The annual fuel efficiency gains are projected for each vehicle category in the future as described in Chapter 7 and appropriately consider the fleet of fuel efficient vehicles operating annually through 2030 and expected vehicle usage. The fuel efficiency gains represent the fuel cost savings consumers will experience over the useful life of the more fuel efficient vehicle. We calculate these results for each vehicle category analyzed. Surplus losses without fuel savings and total social costs/gains with fuel savings are presented in the following analysis.

9.4 Potential Product Attribute Changes

It is anticipated that the air emission standards for recreational vehicles will be met by utilizing newer, cleaner, and quieter engine technologies. Anticipated engine technology changes are perhaps most significant for the snowmobile industry. While the ATV and off-highway motorcycle industries have utilized 4-stroke engine technology extensively absent regulation, the snowmobile manufacturers have been slow to introduce this technology. Current models of ATVs are comprised by approximately 80 percent 4-stroke technologies, while the 4-stroke technology represents approximately 55 percent of off-highway motorcycles sales. In contrast, only nine 4-stroke snowmobile models are currently available in the marketplace, and the sales of these vehicles are estimated to account for a small percentage of annual total snowmobile sales. An issue has been raised as to whether the technology changes envisioned to meet the emission standards for recreational vehicles will create attribute changes in vehicles sold. Since the engine technology changes contemplated may be the most significant for snowmobiles, this issue is addressed specifically for this industry in the economic analysis. The relevant question to be addressed from an economic perspective is will snowmobiles post-regulation be perceived from the consumer's perspective as the same product as snowmobiles pre-regulation? Further, will any product attribute changes be adversely or positively viewed by consumers impacting snowmobile demand post-regulation?

Particular product attribute changes alleged to negatively impact snowmobile sales relate specifically to potential performance changes. Modifications to engines may impact the versatility, reliability, or compactness of snowmobiles. Assertions have arisen that consumers of snowmobiles demand high power-to-weight ratio machines and that the new engine technologies contemplated will impair this product attribute. The issue of whether the increased costs per engine will make entry level machines too costly for the entry level or marginal consumer have also been claimed.

Potential product attribute changes are relevant to evaluate the economic impacts of the rule. The economic analysis conducted for this rule postulates that the post-regulation demand for snowmobiles will be identical to the pre-regulation demand for snowmobiles. Consumers will simply respond to the increased cost of an engine and based upon this increased price will likely reduce the quantity of snowmobiles purchased (a movement along a demand curve as opposed to a shift). If however, consumers view these product attribute changes as significant, demand for the product may increase or decrease (demand shift inward or outward). For positive attributes demand may increase (demand shifts outward). Under this scenario, consumers will be willing to pay a higher price for the product because they value the enhanced or new product attribute. If consumers view the product changes negatively, the opposite reaction occurs and demand decreases (demand shifts inward). With decreased demand, consumers will pay a lesser price for the product due to their perceptions that the attribute change negatively affects the value of the product to them. If consumers view the attribute changes positively, the economic analysis overstates market impacts. However, if consumers view the attribute changes negatively, the economic analysis understates the market impacts of the rule. Thus it is important to account for potential product attribute changes in order to provide a reasonable estimation of the potential economic consequences of the rule.

The technology changes envisioned for snowmobiles will enhance the fuel efficiency of snowmobiles. The issue of consumer potential reactions to fuel efficiency gains, a possible positive product attribute change are discussed in Section 9.3. The 4-stroke and direct fuel injection (dfi) technologies also offer the positive attribute of “cleaner and quieter” vehicles. The health and environmental benefits analysis of the rule presented in Chapter 10 assesses the public’s willingness to pay for the human health and environmental benefits of these “cleaner and quieter” technologies. A separate, but somewhat related question is whether snowmobile consumers are willing to pay for these product attributes. It is the latter issue that is relevant for the study of attributes.

The National Park Service (NPS) banned the use of snowmobiles for Yellowstone and Grand Teton National Parks in January 2001. This ban on snowmobile use was based upon the belief that snowmobile usage “adversely affects air quality, wildlife, natural soundscapes, and the enjoyment of other visitors” to the parks.[3] Both the “clean and quiet” aspects of snowmobile attributes are reflected in the NPS ruling. The NPS service is now reviewing their ban and may reverse the ban and allow snowmobiles in the parks with restrictions. It is possible that these actions may impact consumer’s demand for “clean and quiet” engine technologies versus the older technologies. The outcome of the NPS activities on sales of snowmobiles and the mix of technologies consumers will demand is an uncertainty in the economic analysis conducted for this market and the evaluation of consumer’s valuation of product attributes.

The EPA has conducted a product attribute analysis for snowmobiles to address the issue of potential product attribute changes that may occur as a result of this regulation. Specifically, the EPA has looked at the products currently available in the marketplace and those attributes associated with the machines sold. Special emphasis is made to address those attributes that may change with the regulation.

9.4.1 Technology Changes for Snowmobiles

The technology changes anticipated for the snowmobile industry to meet the standards are addressed in Chapter 4 of this report. These standards do not dictate the use of a particular technology, but the engineering analysis evaluates currently available technologies that will meet the emission standards. With the Phase 2 standards for snowmobiles, 50 percent reductions in

HC and CO emissions are mandated. While snowmobile manufacturers may meet these standards in a variety of ways, the EPA estimates 20 percent of the market will use 4-stroke technology, 50 percent direct fuel injection technology, 20 percent modified 2-stroke engines with pulse air, and 10 percent will use unmodified 2-stroke technologies. This technology mix is used to calculate the engineering costs of the rule. It is relevant to note that the standards allow for fleet emissions averaging. Thus particular manufacturers may choose the vehicles most suited to the new technologies to meet the standards. Technologies chosen to meet the standards are also the choice of the manufacturer. This means a manufacturer fearing the loss of consumers for entry level machines may opt not to convert those machines to the newer technologies.

Currently all four manufacturers of snowmobiles produce machines with the 4-stroke technology. In its 2003 product line, Yamaha has introduced a new 4-stroke high performance model.[4] This machine represents a total redesign for the company's highest performance machine. The Yamaha RX-1 is reported to have a horsepower rating of 145 making it one of the most powerful snowmobiles available in the market. The redesigned machine offers a high power-to-weight ratio that compares favorably to high performance 2 stroke competitor models. Yamaha has redesigned the chassis and suspension of its 4-stroke model to achieve the goal of high power to weight performance. Not only is the cleaner and quieter technology compatible with the high performance and maneuverability, this combination has already been introduced into the market with positive reviews.[5] For several snowmobile manufacturers, the 4-stroke technology is offered in more moderately priced, low to middle power range vehicles. For example, the two 4-stroke machines offered for sale by Arctic Cat have estimated horsepower of approximately 53. Thus, different manufacturers within the market place are introducing the newer technologies using dissimilar marketing strategies. A relevant issue from the economic impact perspective is whether snowmobile manufacturers currently in the market are in the same competitive position to introduce these new technologies. This issue is discussed in Section 9.8 of this report.

9.4.2 Statistical Analysis of Snowmobile Product Attributes

In order to address the issue of potential product attribute changes, a statistical analysis of product attributes for all snowmobiles in the 2003 model line is conducted. One technique frequently used to value product attributes is the hedonic model. This model is used extensively in the economic literature to measure consumer's willingness to pay for particular product attributes. The hedonic model assumes that there is a continuous function relating the market price of a good to its constituent attributes. The assumption is made that snowmobile consumers select a snowmobile based upon the marginal value they place on individual snowmobile attributes and the price of those attributes. By analyzing the prices of products currently available in the market, one may gain knowledge of those product attributes consumers value and perhaps gain some insight as to consumer's view of potential changes in those product attributes.

An important limitation of the analysis must be addressed. The hedonic model estimated reflects a market equilibrium relationship between price and product attributes for a single model year. The equilibrium exists because producers of snowmobiles equate the marginal cost of producing attributes to consumer’s willingness to pay for available attributes. The hedonic model adjusts until the marginal cost equals the marginal willingness to pay and equilibrium is achieved. However, the regulations considered will impose a non-marginal change in the product characteristics; therefore one cannot equate the value to consumers directly from this model. Thus the statistical hedonic models estimated cannot be used predictively to evaluate potential market impacts of the regulation (potential shifts in market demand). Additional modeling is required to conduct this type of estimation. Rather, these statistical models provide insight into implicit attribute prices for current product attributes. As stated previously in 9.3, the market model used to assess market impacts for these regulations assumes that no shifts in demand will occur as a result of this regulation.

9.4.2.1 Relevant Product Attributes

An assumption is made that different snowmobiles model prices may be represented by accounting for individual product attributes. Thus, the price of a particular snowmobile model is assumed to be a function of these characteristics. The goal of the hedonic analysis is to determine those product attributes that account for the product price and to analyze those attributes likely to change with regulation.

In order to complete the snowmobile hedonic analysis, an accounting of current product characteristics and those likely to change with regulation is conducted. Product specifications may be separated into the following categories: engine, chassis, dimensions, features, and other attributes. Engine specifications likely to contribute positively to the price of a snowmobile include engine type, engine size (displacement cc), number of cylinders, cooling system, ignition, transmission, breaking system and carburetion. Chassis characteristics involve elements that affect the maneuverability and handling of the vehicle such as suspension and shocks. The length, width, height, weight and fuel capacity are examples of dimension attributes of snowmobiles. Snowmobiles features include a variety of items such as electric start, reverse, seating capacity, color and other enhancements to the vehicles. Finally the brand of snowmobile may have some influence upon product price. Each of the previously listed product attributes potentially influence the price of a vehicle. Those directly measured in the study are chosen based upon the availability of data and the ability to measure these attributes. The characteristics hypothesized to influence price for purpose of this study include engine type, engine displacement cc, the cooling system type, carburetion type, vehicle dimensions (length, width), fuel capacity (impacts the range a vehicle may travel on a tank of gas), seating, electric start, reverse, and color. Color is essentially eliminated as an issue relevant for study by using Manufacturers Suggested Retail Price (MSRP) values for the basic paint vehicles. Other product attributes not evaluated in the study are either unavailable from publicly available sources (snowmobile manufacturers websites), available for a subset of the companies, or difficult to evaluate given the information provided. For example, transmission changes may occur when using new technologies, but transmission types are difficult to measure in a quantitative or qualitative manner as all snowmobiles have automatic transmissions.

Of these attributes, engine type, engine displacement, carburetion, cooling system, and vehicle dimensions (length, width, and fuel tank size) may change with the regulation. Each of these attributes potentially impact the performance of the vehicle. Engine displacement is a measure of the power of the vehicle. In general for 2-stroke engines the greater the engine size the greater the power. In contrast, the relationship between engine displacement and power in the 4-stroke engine is less direct, and this phenomenon may introduce measurement error when looking at a data set that combines 2-stroke and 4-stroke vehicles. While horsepower (hp) may be a better measure of this attribute, hp data are not readily available for all vehicle models. Ideally weight would be the better measure than vehicle length and width to test power-to-weight influence upon price. However, weight data are available for only a subset of snowmobiles offered for sales. Thus width and length proxy for the weight of the vehicle. Consumer's taste and preferences for engine power appear to be changing over time with the demand for greater power machines increasing. According to PSR data, the average engine displacement sized snowmobile produced rose significantly between 1995 and 2000.[6]

The issue of fuel efficiency and consumers willingness to pay for increased fuel efficiency is addressed in part with the fuel tank size variable. Gasoline mileage (miles per gallon) and range (length in hours of a ride with a single tank of gas) information are not available for any snowmobile models on any of the company websites. The absence of any information concerning fuel efficiency is somewhat surprising and may perhaps indicate that snowmobile sellers do not perceive that consumers of snowmobiles have great interest in the relative fuel efficiency of different products. Thus informational problems exist currently for consumers to be able to assess the fuel efficiency of products on the market. However, those products with 4-stroke and dfi technologies are reported to have fuel savings of up to 30% over comparable vehicles with older technologies.[7] Due to the absence of published fuel efficiency data, engine testing data provided by ISMA and from publications are used to construct a statistical relationship between mileage and engine size.[8] All data in the sample are based upon the 2-stroke engine technology. Based upon the sample engine test data, the statistical relationship estimated follows:

Hypothesized relationship: Gallons per hour = f (engine displacement cc)

Fitted Equation: Gallons per hour = -1.56615 + .00920 engine displacement cc

This equation is used to estimate gallons per mile for each of the vehicles in the data set. The gallons per hour are then converted to miles per gallon to estimate mileage for each vehicle type. This information is used along with fuel tank size to estimate the range of each vehicle. The descriptive statistics for data used in the model, parameter estimates, and relevant statistical model information are displayed on Table 9.4-1. The fitted model estimates gallons per hour for 2-stroke vehicles only. It is assumed that 4-stroke vehicles and those equipped with dfi have fuel efficiency gains over comparable 2-stroke vehicles of 25 percent. The mileage and range estimates constructed appear to systematically underestimate the mileage experienced by the typical snowmobile and the range for many of the vehicles appears to be understated suggesting measurement error in these estimates. While these data are used in the analysis, potential measurement errors in the data exist.

As indicated in the fitted equation, mileage is a function of engine size and as the engine size increases fuel consumption increases. The implications of this relationship are quite interesting. If consumers positively value power and power is inversely related to fuel efficiency, product prices may indicate consumers negatively value fuel efficiency. This is an inaccurate conclusion. We assume consumers are rational and value fuel efficiency. A more accurate description of this phenomenon is consumers value power and are willing to pay higher prices for larger engine sizes with greater power. Fuel efficiency declines within 2-stroke models with larger engines.

The prices consumers pay for the attributes of power (measured as engine size displacement) and fuel efficiency (mileage) are jointly determined. The modeling approach taken evaluates the implicit price of the attribute engine size. It is likely that consumers currently have a lower implicit price for engine displacement than would occur if this engine displacement also included greater fuel efficiency. Thus it is important to recognize these attributes are inextricably linked when consumers make purchase choices. The new technologies of dfi and 4-stroke engines do, however, represent the potential to gain fuel efficiencies for a given level of engine power, all other factors held constant.

Table 9.4-1
Statistical Model of Snowmobile Gas Mileage

Data Descriptive Statistics[9]	**Mean**	**Standard Deviation**
Sample Size = 15		
Variable description:		
Engine Size (displacement cc)	540.9	173.2
Gallons per hour	3.41	1.73
Statistical Model Specification: Gallons per hours = f (engine displacement) Gallons per hour = $\beta_1 + \beta_2$ (engine displacement) + ϵ		
Model Results: Gallons per hour = -1.56615 + .00920 engine displacement cc		
Statistical Information	Parameter Estimate	
Variable:		Standard Errors
Intercept	-1.56615	0.60571*
Engine displacement	0.00920	0.00107**
F-Value	73.95	Pr > F < 0.0001
Adjusted R Square	0.839	

* Statistically significant at the 2% significance level.
** Statistically significant at the 1% significance level

9.4.2.2 Data for Hedonic Analysis

The websites of Polaris, Arctic Cat, Bombardier, and Yamaha include listings of the 2003 models available for sale.[10, 11, 12, 13] The specifications for each snowmobile model are listed on these websites and these data are used as the data set for the study. Data are presented for the one hundred and forty four models offered for sale in the 2003 product lines of these manufacturers. Children's snowmobiles are excluded from the study, because the technologies used in this application differ greatly from the typical snowmobile available for sale.

The price of a snowmobile is the dependent variable in the statistical estimation and price must be measured to complete the hedonic analysis. MSRP are used to measure the price of vehicles offered for sale. While the actual price paid for a snowmobile typically is a negotiated price between the buyer and seller, only MSRP are published and readily available for models currently offered for sale. Descriptive Statistics for snowmobile prices and product attributes are shown on Table 9.4-2.

Table 9.4-2
Snowmobile Price and Product Attribute Descriptive Statistics - All Vehicles [14]
(Sample Size = 144)

Product Attributes	Measurement	Mean Value	Standard Deviation
Engine Type	2-stroke versus 4-stroke	Dummy Variable 0 = 2-stroke 1 = 4-stroke (9 4-stroke)	N/A
Engine Size	cubic centimeters	642	144
Cooling System	air cooled or liquid cooled	Dummy Variable 0 = air cooled 1 = liquid cooled (114 liquid cooled)	N/A
Length	inches	116.6	6.7
Width	inches	46.6	1.9
Fuel Tank Size	gallons	11.3	1
Seating Capacity	1 or 2 person vehicle	Dummy Variable 0 = 2 person 1 = 1 person (106 1-person)	N/A
Electric Start	standard equipment or optional	Dummy Variable 0 = option 1 = standard (55 standard)	N/A
Reverse	standard equipment or optional	Dummy Variable 0 = optional 1 = standard (81 standard)	N/A
Electronic Fuel Injection (efi)	Included or not included	Dummy Variable 0 = no efi 1 = efi (27 efi)	N/A
Direct Fuel Injection (dfi)	Included or not included	Dummy Variable 0 = no dfi 1 = dfi (6 dfi)	N/A
Brand Name	Polaris, Arctic Cat, Bombardier, or Yamaha	Dummy Variables 1 = particular brand (12 Yamaha 33 Polaris 68 Bombardier 31 Arctic Cat)	N/A
Mileage	Miles per gallon	6.2	2.7

Range	Miles traveled on a tank of gas	69.3	26.3
Dependent Variable: Snowmobile price	Manufacturers suggested retail price	$7,291	$1,411

Since the 4-stroke engine represents a significant technical departure from the 2-stroke engines, alternative models are estimated for the 2-stroke and 4-stroke models exclusively. The descriptive statistics for those variables subject to quantitative estimates for the 4-stroke and 2-stroke models are shown on Tables 9.4-3 and 9.4-4, respectively. In general, qualitative variables measured by dummy variables are measured as depicted for all vehicles. Some features that are measured using dummy variables are not applicable for the 4-stroke technology. For example, all 4-stroke engines are liquid cooled and have electric start as standard features. Dfi technology is available exclusively on 2-stroke models. Horsepower data are available for all nine 4-stroke models.

Table 9.4-3
Snowmobile Price and Product Attribute Descriptive Statistics[15]
Four-Stroke Models Only (Sample Size =9)

Product Attributes	Measurement	Mean Value	Standard Deviation
Engine Size	cubic centimeters	872	150.7
HP	number	88.6	44
Length	inches	116.6	8.5
Width	inches	47.3	1.4
Fuel Tank Size	gallons	11.1	1.1
Brand Name	Polaris, Arctic Cat, Bombardier, or Yamaha	Dummy Variables 1 = particular brand	N/A
Mileage	Miles per gallon	4.9	1.3
Range	Miles traveled on a tank of gas	55.4	20.7
Dependent Variable: Snowmobile price	Manufacturers suggested retail price	$8,316	$687

Table 9.4-4. Snowmobile Price and Product Attribute Descriptive Statistics[16]
Two-Stroke Models Only (Sample Size = 135)

Product Attributes	Measurement	Mean Value	Standard Deviation
Engine Size	cubic centimeters	626.4	130.7
Length	inches	116.5	6.5
Width	inches	46.6	1.9
Fuel Tank Size	gallons	11.2	0.9
Brand Name	Polaris, Arctic Cat, Bombardier, or Yamaha	Dummy Variables 1 = particular brand	N/A
Mileage	Miles per gallon	6.3	2.8
Range	Miles traveled on a tank of gas	69.9	26.3
Dependent Variable: Snowmobile price	Manufacturers suggested retail price	$7,213	$1,423

9.4.2.3 Statistical Model Results

This section presents the results of statistical estimations including results of statistical tests. The statistical package, SAS 8.2 for Windows was used to generate all statistical results. Various model specifications were estimated including log-log, log-linear and linear models. Generally, the log-log model specification provided the best statistical fit. In this model, all variables are transformed to natural logs except the dummy variables. Numerous model variations were estimated. In nearly all model specifications, the variables electric start, electronic fuel injection, brand name, length, fuel tank size, and electric start are consistently not statistically significant. Since the range and mileage variables are a function of the engine size, these variables are highly correlated. For this reason, model runs were conducted with engine size, range or mileage exclusively. The 4-stroke parameter is correlated with engine size variable. When the model is specified using both of the parameters, the 4-stroke variable appears to have a negative coefficient and to be statistically significant. When the model is estimated with the 4-stroke variable and excludes engine size, the parameter estimates are not significantly different from zero. Thus the fitted model excludes 4-stroke technology from the estimation. It is possible that a dummy variable is not an adequate method of capturing the attributes associated with the technology. Given this results a hedonic models of 2-stroke and 4-stoke models only are estimated. The estimated hedonic function for the full model using engine size follows:

$$\log \text{MSRP} = 8.2419 + 0.5821 \log(\text{ engine displacement cc}) + 0.8561 \log(\text{width}) + 0.2397 \text{ cooling} - 0.0685 \text{ seat} + 0.0495 \text{ reverse} + 0.1066 \text{ dfi.}$$

All parameter estimates are significant at a 1 percent significance level. Relevant statistical model results are shown on Table 9.4-5.

Table 9.4-5
Full Model Statistical Results Using Engine Displacement

Variable	Parameter Estimate	Standard Error*
Intercept	8.2419	0.6987
log (engine displacement cc)	0.5821	0.0362
log (width)	0.8561	0.1713
cool	0.2397	0.0223
seat	-0.0685	0.0159
reverse	0.0495	0.0143
dfi	0.1066	0.0343
F Value	157.28*	
Adjusted R-Square	0.8677	

* All parameter estimates are statistically significant at a 1% significance level.

The model is re-estimated using the same specifications and variables shown in Table 9.4-5, but replacing engine size with a mileage variable and in a subsequent run with the range variable. The models and parameter estimates remain statistically significant. The mileage variable and range variable have negative signs as previously postulated and are statistically significant in each of the runs.

Based upon the statistical results, one may conclude that the relative prices (as measured by MSRP) are higher for vehicles with larger engine sizes, greater width, liquid cooling systems, reverse, and dfi. Alternatively, one-seating capacity machines are priced generally lower than two-seat machines. In the alternative model specifications, the mileage and range variables have negative signs and are statistically significant. This result may be interpreted to mean that consumers value power even when greater power translates into less fuel efficiency.

The full data set is split into a 4-stroke data set and a 2-stroke data set to assess the model differences with these two technologies. The model estimation results for the 2-stroke technology are as follows:

$$\text{Log (MSRP)} = 7.5689 + 0.6461 \text{ log (engine displacement cc)} + 0.7847 \text{ log (width)} \\ + 0.2260 \text{ cool} + 0.0626 \text{ reverse} -0.0722 \text{ reverse} + 0.0906 \text{ dfi}$$

Statistical results are shown in Table 9.4-6. In general, the results of this run differ little from the full model. This is not surprising since 135 observations of the full data set are represented in the 2-stroke model specification. Thus the conclusions for the full model apply to the two-stroke technology.

Table 9.4-6
Two-Stroke Model Statistical Results Using Engine Displacement

Variable	Parameter Estimate	Standard Error*
Intercept	7.5689	0.6984
log (engine displacement cc)	0.6461	0.0386
log (width)	0.7847	0.1683
cool	0.226	0.0218
reverse	0.0626	0.0143
seat	-0.0722	0.0143
dfi	0.0906	0.0333
F Value Adjusted R-Square	165.49* 0.8805	

* All parameter estimates are statistically significant at a 1% significance level.

Only nine 4-stroke models are currently available for sale. Thus the sample size is quite small. In general, only engine size or horsepower are statistically significant. Horsepower provides a stronger statistical relationship to MSRP and the model results are shown below:

$$\log(\text{MSRP}) = 8.3330 + 0.1577 \log(\text{hp})$$

Model results are shown in Table 9.4-7.

Table 9.4-7
Four-Stroke Model Statistical Results Using Engine Horsepower

Variable	Parameter Estimate	Standard Error *
Intercept	8.333	0.1064
log (horsepower)	0.1577	0.0242
F Value Adjusted R-Square	42.53* 0.8941	

* All parameter estimates are statistically significant at a 1% significance level.

The model results tend to provide confirmation that higher powered (greater hp) four-stroke machines are higher priced that than lower powered 4-stroke machines.

In general, the statistical results from all model runs tend to indicate that higher MSRP exist in the current snowmobile market for power (larger engine size or hp), wider machines, liquid cooling, reverse, and dfi product attributes. One-seat machines, all other factors held constant, are lower priced than two-seat machines. The statistical results also indicate prices are higher for vehicles equipped with the dfi technology.

The statistical results indicate that fuel efficiency is inversely related with engine size. Since prices are relatively higher for more powerful machines, this translates to lower fuel efficiency. This phenomenon is related to the two-stroke technology. This does not likely reflect a negative view of fuel efficiency so much as a positive view of greater power. While consumers of 4-stroke models also are willing to pay higher prices for greater power, greater fuel efficiency is an intrinsic attribute of the 4-stroke technology. The model results are not satisfying with regard to the 4-stroke technology. This is likely due to the fact that the dummy variable does not adequately capture the attributes associated with the 4-stroke technology and may also be due to the relatively small number of models with this technology.

9.4.3 Anecdotal Pricing Information For Snowmobiles

The statistical analysis is unsuccessful at identifying product price differentials for the 4-stroke technology versus 2-stroke. For this reason, a model by model comparison is conducted of the 4-stroke snowmobile models that are similar except for engine type. The MSRP differential typically ranges from \$500 to \$600 for the 4-stroke model when compared to the 2-stroke comparable model.[17] The prices consumers actually pay for these comparison vehicles are ultimately dependent upon a negotiated price rather than MSRP.

9.4.4 Uncertainties and Limitations of the Attribute Study

The statistical uncertainties of the attribute study are presented in the discussions of the models estimated. In additional to the statistical uncertainties, other uncertainties exist. The outcome of NPS issues with snowmobile usage in national parks is an uncertainty that cannot be adequately addressed in the analysis. To the extent that NPS actions, spur demand for “cleaner and quieter” snowmobiles, demand for the new technologies may increase. However, the overall impact of a ban on snowmobile usage in the parks is a recognized uncertainty of the economic impact analysis conducted for this rule.

The hedonic model estimated reflects a market equilibrium relationship between price and attributes for a single model year. The equilibrium exists because producers of snowmobiles equate the marginal cost of producing attributes to consumer’s willingness to pay for available attributes. The hedonic model adjusts until the marginal cost equals the marginal willingness to pay and equilibrium is achieved. However, the regulations considered will impose a non-marginal change in the product characteristics; therefore one cannot equate the value to consumers directly from this model. Additional modeling is required to conduct this type of estimation.

9.4.5 Conclusions

Two questions are posed at the beginning of this analysis regarding potential product attribute changes. Those questions are: will snowmobiles post-regulation be perceived from the consumer's perspective as the same product as snowmobiles pre-regulation and will product attribute changes be adversely or positively viewed by consumers impacting snowmobile demand post-regulation? The answer to the first question is that the technology changes envisioned by the rule do alter the attributes of snowmobiles such that the typical consumers of snowmobiles post-regulation will view these products as different from the pre-regulation snowmobile. Two qualifiers to this conclusion exists. The first is that these technologies are already available in the market place. The regulation will simply encourage the proliferation of these new technologies throughout the snowmobile market. The second is a mix of technologies will exist that include older technologies. Thus consumers of the older technology machines will not likely perceive product changes post regulation.

With regard to the second question, consumer demand may change as a result of these altered product attributes. However, quantification of any demand changes is not possible with the data evaluated. The negative aspects of product changes alleged by some involve potential degradation of the power-to-weight ratio for high performance machines. Yamaha's introduction of its new high performance 4-stroke machine is evidence that the "clean and quiet" technologies can coexist with high power-to-weight ratios. Thus consumers will be able to obtain "clean and quiet" high powered snowmobiles. The question then becomes are consumers willing to pay higher prices for the new attributes of cleaner, quieter, greater fuel efficiency, and other performance attributes of snowmobiles equipped with dfi or 4-stroke engines. The statistical analysis provides evidence that MSRP is higher for vehicles equipped with dfi, all other factors held constant. A comparison of the suggested MSRP of comparable 4-stroke and 2-stroke vehicles reflects higher prices for the 4-stroke engine vehicles currently offered in the market of approximately $500 to $600. Thus snowmobile manufacturer's recommend higher prices for the newer technologies. This recommendation reflects the belief that certain consumers will value the bundle of product attributes of the new cleaner quieter machines and be willing to pay a premium for these attributes. The actual price differences paid for new versus old technology vehicles is determined by those prices negotiated in the market. Further, the increased price may reflect an increased cost of production and not necessarily translate into additional profits for the manufacturer.

With regard to the issue of whether entry level consumers will leave the market, fleet emissions averaging will allow producers to use older less costly technologies on entry level machines to avoid sales losses for this segment of the market.

9.5 Methodology

For the economic impact analysis of the effects of the emissions control program, we rely upon a national-level partial equilibrium market model. Inputs to this model include baseline market price, market output (domestic and imported quantities), and estimates of price elasticity of supply and demand. Price elasticities measure the responsiveness of quantity demanded and supplied to changes in price. This section describes the conceptual model used to generate the economic impacts and it provides the methodology and data inputs used to develop estimates of supply and demand price elasticities for each vehicle category.

9.5.1 Conceptual Model

The regulatory compliance costs provide an exogenous shock to the model with the per unit total compliance costs (*c*) resulting in a shift of the domestic supply curve (S_0 to S_1 in Figure 9.2-2 above). This shift, expressed as the cost increase per vehicle, is based on the cost information presented in Chapter 5 (generally, the regulatory cost per engine is taken to equal the cost per vehicle). The model equations that respond to this exogenous shock are described below.

The change in domestic supply (dq^D) due to the imposition of the regulation will depend upon the typical supply response to a price increase and the change in the "net" price of a given vehicle (i.e., $dP - c$) so that

$$dq^D = \xi^D \left[\frac{q^D}{P}\right](dP - c) \qquad \textbf{(Eq. 9-1)}$$

where ξ^D is the domestic supply elasticity. Supply elasticities have been estimated for each of the vehicle categories affected by the emissions standards and a description of the estimation procedure used is provided below.

International trade is included through the specification of an equation to characterize imports to the U.S. Thus, the change in imports from these foreign countries is included through the following equation:

$$dq^I = \xi^I \left[\frac{q^I}{P}\right](dP - c) \qquad \textbf{(Eq. 9-2)}$$

where ξ^I is the import supply elasticity. Data to estimate import supply elasticities for the various vehicle categories were not available. For the economic impact analysis, the value of the import supply elasticity is assumed to equal the value of the domestic supply elasticity.

Next, the change in market supply must equal the change in the quantity of individual suppliers both domestic and foreign, i.e.,

$$dQ = dq^D + dq^I \qquad \textbf{(Eq. 9-3)}$$

where dq^D is the change in domestic supply and dq^I is the change in imports.

Lastly, the market demand condition must hold, i.e.,

$$dQ = \eta\left[\frac{Q}{P}\right]dP \qquad \textbf{(Eq. 9-4)}$$

where η is the market demand elasticity. The economic model relies upon demand elasticities that have been estimated or found in the economics literature for the various vehicle categories. Estimation procedures for demand elasticity are discussed below.

Equations 9-1 through 9-4 form four linear equations with four unknowns (dq^D, dq^I, dQ, and dP) that can be solved using linear algebra, i.e.,

$$\mathbf{b} = \mathbf{A}^{-1}\mathbf{c}'$$

where **b** is the vector containing the four unknowns (dq^D, dq^I, dQ, and dP), $\mathbf{A}^{-1}$ is the inverse of A, a 4x4 matrix, and **c** is the vector (c, c, 0, 0). Using this model, we develop our national-level economic impacts resulting from the rule. The full system of equations (**Ab = c**) is as follows:

$$\begin{bmatrix} -\left(\frac{1}{\varepsilon^d}\right)\left(\frac{P}{q^d}\right) & 0 & 0 & 1 \\ 0 & -\left(\frac{1}{\varepsilon^d}\right)\left(\frac{P}{q^i}\right) & 0 & 1 \\ -1 & -1 & 1 & 0 \\ 0 & 0 & -1 & \eta\frac{Q}{P} \end{bmatrix} \begin{bmatrix} dq^d \\ dq^i \\ dQ \\ dP \end{bmatrix} = \begin{bmatrix} c \\ c \\ 0 \\ 0 \end{bmatrix} \qquad \textbf{(Eq. 9-5)}$$

9.5.2 Price Elasticity Estimation

As discussed above, demand and supply elasticities are crucial components of the partial equilibrium model used to quantify the economic impacts of the emission standards. The price elasticity of demand is a measure of the sensitivity of buyers of a product to a change in price of the product. The price elasticity of demand represents the percentage change in the quantity demanded resulting from each 1 percent change in the price of the product. The price elasticity of supply is a measure of the responsiveness of producers to changes in the price of a product. The price elasticity of supply indicates the percentage change in the quantity supplied of a product resulting from each 1 percent change in the price of the product.

This section presents the analytical approach employed to estimate the demand and supply price elasticities used in the partial equilibrium analysis for each vehicle category. As discussed below, demand and supply elasticity estimates used in the market model are either estimated, assumed, or retrieved from previous studies that have carried out these estimations. In the case of recreational diesel marine vessels, a demand elasticity measure was available from a previous study, but the supply elasticity was estimated. For forklifts, both supply and demand elasticities were estimated. Because of data limitations, EPA's estimates of demand elasticity for the forklift model are not considered robust. Two estimates were generated; one was not significant while the other was significant but not of reasonable size. The economic impact analysis therefore relies upon an assumed price elasticity of demand for forklifts based on the results generated for this vehicle category. A sensitivity analysis is included in an appendix to show the economic impacts of the rule on the forklift market when the large estimate of demand elasticity is used. For the snowmobile, ATV, and OHM markets, attempts were made at econometric estimation of the price elasticity of demand. These attempts were unsuccessful as was a search to find these data in the literature. In lieu of estimates specific to the snowmobile, ATV and the OHM markets, an estimate of the price elasticity of demand for recreational boats obtained from a study are used to estimated market impacts. This value is assumed to be a reasonable estimate of the price elasticity of demand for the snowmobile, ATV and OHM markets. The uncertainties involved in this estimate are acknowledged. A sensitivity analysis is included in the Appendix to Chapter 9 to recognize the uncertainties associated with this estimate. The price elasticity of supply is estimated for the snowmobile and OHM markets. Attempts to estimate this value for the ATV market were unsuccessful. The price elasticity of supply estimate generated for the OHM market is assumed to be a reasonable estimate of this value for the ATV market. Sensitivity analyses are presented in the appendix to this chapter to evaluate the uncertainties involved in these estimates. A summary of the price elasticity of demand and supply used in the study for each vehicle type are summarized in Table 9-5.0 shown below.

Table 9-5.0 Summary of Price Elasticity of Demand and Supply Used in the Market Analyses

Market	Price Elasticity of Demand	Price Elasticity of Supply
Inboard Cruisers	-1.41	1.62
Forklifts	-1.52	0.72
Snowmobiles	-2.03	2.12
ATVs	-2.03	1.04
Off-highway motorcycles	-2.03	0.92

[1] Raboy, David. G. 1987. *Results of an Economic Analysis of Proposed Excise Taxes on Boats*. Washington, D.C: Patton, Boggs, and Blow. Prepared for the National Marine Manufacturing Association. Docket A-2000-01, Document IV-A-129.

[2] Assumed value.

[3] Econometrically estimated.

[4] Assumed value based upon the price elasticity of demand estimate for recreational boats in the Raboy study listed above.

[5] Assumed value based upon the price elasticity of supply estimate for off-highway motorcycles.

9.5.2.1 Price Elasticity Estimation for Marine

Demand Elasticity

The economic model developed for the CI recreational marine vessel market concentrates solely on the inboard cruiser market. This is the segment of the recreational marine vessel market which relies upon diesel engines more than any other. Fortunately, a previously estimated price elasticity of demand for the inboard cruiser market is available[18]. For this reason, demand elasticity was not estimated. The previously estimated value that is used in the economic model is -1.44.

Supply Elasticity

Published sources of the price elasticity of inboard marine cruisers were not readily available. Therefore, an econometric analysis of the price elasticity of supply for boat manufacturing was conducted, assuming that this estimate is representative of the supply elasticity for the inboard cruiser market. The approach used to estimate the supply elasticity makes use of the production function. The methodology of deriving a supply elasticity from an estimated production function will be briefly discussed with the industry production function defined as follows:

$$Q^S = f(L, K, M, t) \qquad \textbf{(Eq. 9-6)}$$

where:

Q^S = output or production

L = the labor input, or number of labor hours,

K = real capital stock,

M = the material inputs, and

t = a time variable to reflect technology changes.

In a competitive market, market forces constrain firms to produce at the cost minimizing output level. Cost minimization allows for the duality mapping of a firm's technology (summarized by the firm's production function) to the firm's economic behavior (summarized by the firm's cost function). The total cost function for a boat producer is as follows:

$$TC = h(C, K, t, Q^S) \qquad \textbf{(Eq. 9-7)}$$

where:

TC = the total cost of production, and

C = the cost of production (including cost of materials and labor).

All other variables have been previously defined.

This methodology assumes that capital stock is fixed, or a sunk cost of production. The assumption of a fixed capital stock may be viewed as a short-run modeling assumption. This assumption is consistent with the objective of modeling the adjustment of supply to price changes after implementation of controls. Firms will make economic decisions that consider those costs of production that are discretionary or avoidable. These avoidable costs include production costs, such as the costs associated with labor and materials. In contrast, costs associated with existing capital are not avoidable or discretionary. Differentiating the total cost function with respect to Q^S derives the following marginal cost function:

$$MC = h'(C, K, t, Q^S) \qquad \textbf{(Eq. 9-8)}$$

where *MC* is the marginal cost of production and all other variables have been previously defined.

Profit maximizing competitive firms will choose to produce the quantity of output that equates market price, *P*, to the marginal cost of production. Setting the price equal to the preceding marginal cost function and solving for Q^S yields the following implied supply function:

$$Q^S = (P, P_L, P_M, K, t) \qquad \textbf{(Eq. 9-9)}$$

where:

P = the price of recreational marine vessels,
P_L = the price of labor, and
P_M = the price of materials input.

All other variables have been previously defined.

An explicit functional form of the production function may be assumed to facilitate estimation of the model. For this analysis, the Cobb-Douglas, or multiplicative form, of the production function is postulated. The Cobb-Douglas production function has the convenient property of yielding constant elasticity measures. The functional form of the production function becomes:

$$Q_t = A K_t^{\alpha_K} t^{\lambda} L_t^{\alpha_L} M_t^{\alpha_M} \qquad \textbf{(Eq. 9-10)}$$

where:

Q_t = output or production in year t,
K_t = the real capital stock in year t,
L_t = the quantity of labor hours used in year t,
M_t = the material inputs in year t, and
A, α_K, α_L, α_M, λ = parameters to be estimated by the model.

This equation can be written in linear form by taking the natural logarithms of both sides of the equation. Linear regression techniques may then be applied. Using the approach described, the implied supply function may be derived as:

$$\ln Q = \beta_0 + \gamma \ln P + \beta_1 \ln K + \beta_2 \ln P_L + \beta_3 \ln P_M + \beta_4 \ln t \qquad \textbf{(Eq. 9-11)}$$

where:

P_L = the factor price of the labor input,
P_M = the factor price of the material input, and
K = fixed real capital.

The β_i and γ coefficients are functions of the α_i, the coefficients of the production function. The supply elasticity, γ, is equal to the following:

$$\gamma = \frac{\alpha_L + \alpha_M}{1 - \alpha_L - \alpha_M} \qquad \textbf{(Eq. 9-12)}$$

It is necessary to place some restrictions on the estimated coefficients of the production function in order to have well-defined supply function coefficients. The sum of the coefficients for labor and materials should be less than one. Coefficient values for α_L and α_M that equal to one result in a price elasticity of supply that is undefined, and values greater than one result in negative supply elasticity measures. For these reasons, the production function is estimated with the restriction that the sum of the coefficients for the inputs equal one. This is analogous to assuming that the boat manufacturing industry exhibits constant returns to scale, or is a long-run constant cost industry. This assumption seems reasonable on an *a priori* basis and is not inconsistent with the data.

The estimated model reflects the production function for boats, using annual time series data for the years from 1958 through 1999. The following model was estimated econometrically, using real values of capital stock, production wages, and material inputs:

$$\ln Q_t = \ln A + \alpha_K \ln K_t + \lambda \ln t + \alpha_L \ln L_t + \alpha_M \ln M_t \qquad \textbf{(Eq. 9-13)}$$

where each of the variables and coefficients have been previously defined.

The data inputs used to estimate the supply elasticity are enumerated in Table 9.5-1. This table contains a list of the variables included in the model and the units of measure. The data for the price elasticity of supply estimation model includes: the value of domestic shipments in millions of dollars; the price index for the value of domestic shipments (the value of domestic shipments deflated by the price index represents the quantity variable which is the dependent variable in the analysis); a technology time variable; production wages in millions of dollars; the implicit GDP deflator (used to deflate production wages), the material inputs in millions of dollars; the price index for value of materials; investment in millions of dollars; the price index for investment; and real net capital stock in millions of dollars.

Table 9.5-1
Data Inputs for the Estimation of Supply Elasticity for the Boat Building Industry[19,2021,22,23,24]

Variable	Unit of Measure
1. Value of Shipments for the Boat Building Industry (SIC 3732)	millions of $
2. Price Index of Shipments for the Boat Building Industry (SIC 3732)	index
3. Time trend	-
4. Production Worker Wages	millions of $
5. Implicit GDP Deflator	index
6. Cost of Material Inputs	millions of $
7. Price Index of Material Inputs	index
8. Investment	millions of $
9. Price Index of Investment	index
10. Real Capital Stock	millions of 1987$

Data to estimate the production function exclusively for inboard cruisers were largely unavailable; therefore, data for SIC code 3732 (Boat Building) is utilized for each of the variables previously enumerated with the exception of the time variable. All data for the supply elasticity estimation were retrieved from the National Bureau of Economic Research-Center for Economic Studies (NBER-CES) Productivity Database and the U.S. Census Bureau's Annual Survey of Manufactures (ASM), with the exception of the technology time trend, the implicit GDP deflator, the price index for investment for SIC 3732 for the years 1997 through 1999, the price indices of shipments and material inputs for SIC 3732 for the years 1998 and 1999, and real capital stock for the years 1998 and 1999 (these data for real capital stock were not available). These variables (except the time trend and real capital stock for 1998 and 1999), were retrieved from the Bureau of Economic Analysis (BEA).

More specifically, the price index of shipments for 1998 and 1999 was retrieved from the BEA's Shipments of Manufacturing Industries. Note that since a price index of material inputs for SIC 3732 was not available beyond 1997, we relied upon a general price index for intermediate materials from BEA's Survey of Current Business. A price index for investment for SIC 3732 was also not available beyond 1996, so a general price index for capital equipment was used for the years 1997 - 1999 from the same source. Last, real capital stock for the years 1998 and 1999 was calculated using the following formula:

$$\text{real cap stock}_i = \text{real cap stock}_{i-1} + \text{real investment}_i - \text{depreciation rate*real cap stock}_{i-1} \qquad \textbf{(Eq. 9-14)}$$

where i = 1998, 1999. The depreciation rate for capital for SIC 3732 was taken as the average depreciation rate over the last 10 years for which investment and capital stock data were available (1987 - 1996).

The capital stock variable was the most difficult variable to quantify for use in the econometric model. Ideally, this variable should represent the economic value of the capital stock actually used by each facility to produce boats for each year of the study. The most reasonable data for this variable would be the number of machine hours actually used to produce boats each year. These data are unavailable. In lieu of machine hours data, the dollar value of net capital stock in constant 1987 prices, or real net capital stock, is used as a proxy for this variable. However, these data are imperfect because they represent accounting valuations of capital stock rather than economic valuations. This aberration is not easily remedied, but is generally considered unavoidable in most studies of this kind.

SAS Release 8.2 for Windows was used to develop econometric estimates of the price elasticity of supply for the boat manufacturing industry. A restricted least squares estimator was used to estimate the coefficients of the production function model. A log-linear specification was estimated with the sum of the α_i restricted to unity. This procedure is consistent with the assumption of constant returns to scale. The model was further adjusted to correct for first-order serial correlation using the Yule-Walker estimation method. The results of the estimated model are presented in Table 9.5-2 with p-values listed in parentheses below each coefficient estimate.

Table 9.5-2
Estimated Supply Model Coefficients for the Boat Building Industry

Variables	Estimated Coefficients
ln(Time) *(t)*	0.3445* (<.0001)
ln(Real Capital Stock) (K_t)	0.3888* (<.0001)
ln(Real Production Wages) (L_t)	0.7604* (<.0001)
ln(Real Material Inputs) (M_t)	-0.1492* (<.0001)

* statistically significant

The coefficients for real capital and real production wages have the anticipated signs and are significant at a high level of confidence. The real material inputs coefficient does not have the anticipated sign but does test significantly different from zero. Using the estimated coefficients and the formula for supply elasticity shown above, the price elasticity of supply for boat manufacturing is derived to be 1.57. The calculation of statistical significance for this elasticity measure is not a straightforward calculation since the estimated function is non-linear. No attempt has been made to assess the statistical significance of the estimated elasticity. The corrections for serial correlation and the restricted model results yield inaccurate standard measures of goodness of fit (R^2). However, the model that is unrestricted and unadjusted for serial correlation has an R^2 of 0.99.

The estimated price elasticity of supply for the boat manufacturing industry reflects that the industry in the United States will increase production of boats by 1.57 percent for every 1.0 percent increase in the price of this product. The preceding methodology does not directly estimate the supply elasticity of inboard cruisers due to a lack of necessary data. The assumption implicit in the use of this estimate of price elasticity of supply is that the supply elasticity of inboard cruisers will not differ significantly from the price elasticity of supply for all products classified under SIC code 3732.

9.5.2.2 Price Elasticity Estimation for Forklifts

Demand Elasticity

Forklifts are used as intermediate products to produce final goods. The demand for large SI engine forklifts is therefore derived from the demand for these final products. Information is provided in Section 2.2 concerning the end uses of forklifts. According to this information, forklifts are used primarily as an input in the manufacturing and wholesale trade sectors. One primary use for forklifts is to lift and transport materials and merchandise in warehouse or retail trade settings. Forklifts are therefore used in the production of a wide variety of goods manufactured by these sectors of the economy.

The assumption was made that firms using forklifts as inputs into their productive processes seek to maximize profits. The profit function for these firms may be written as follows:

$$\underset{Q,I}{MAX}\ \pi = P_{FP} \times f(Q, I) - (P \times Q) - (P_{OI} \times I) \qquad \textbf{(Eq. 9-15)}$$

where:

π = profit,
P_{FP} = the price of the final product or end-use product,
$f(Q, I)$ = the production function of the firm producing the final product,
P = the price of the forklifts,
Q = the quantity input use of forklifts
P_{OI} = a vector of prices of other inputs used to produce the final product, and
I = a vector of other inputs used to produce the final product.

The solution to the profit function maximization results in a system of derived demand equations for forklifts. The derived demand equations are of the following form:

$$Q \bullet g(P, P_{FP}, P_{OI}) \qquad \textbf{(Eq. 9-16)}$$

A multiplicative functional form of the derived demand equations are assumed because of the useful properties associated with this functional form. The functional form of the derived demand function is expressed in the following formula:

$$Q = AP^{\beta} P_{FP}^{\beta_{FP}} \qquad \textbf{(Eq. 9-17)}$$

where:

A = a constant

β = the price elasticity of demand for forklifts, and
β_{FP} = the final product price elasticity with respect to the use of forklifts.

All other variables have been previously defined and β, β_{FP}, and A are parameters to be estimated by the model. In the above equation, β represents the own-price elasticity of demand. The price of other inputs (represented by P_{OI}) has been omitted from the estimated model, because data relevant to these inputs were unavailable. The implication of this omission is that the use of forklifts in production is fixed by technology.

The market price and quantity sold of forklifts are simultaneously determined by the demand and supply equations. For this reason, it is advantageous to apply a systems estimator to obtain unbiased and consistent estimates of the coefficients for the demand equations.[25] Two-stage least squares (2SLS) is the estimation procedure used in this analysis to estimate the demand equation for forklifts. Two-stage least squares uses the information available from the specification of an equation system to obtain a unique estimate for each structural parameter. The first stage of the 2SLS procedure involves regressing the observed price of forklifts against the supply and demand "shifter" variables that are exogenous to the system. These are referred to as instruments. This first stage produces fitted (or predicted) values for the forklift price variable that are, by definition, uncorrelated with the error term by construction and thus do not incur endogeneity bias. These fitted values for price are then used in the second stage equation (see Eq. 9-17). By converting the above equation to natural logarithms, the coefficient on the forklift price variable (β) yields an estimate of constant elasticity of supply.

The exogenous supply-side variables used to estimate the demand function include: the real capital stock variable for SIC code 3537 (the industry that manufactures forklifts), a technology time trend (t), and the price indices for the cost of labor and the cost of materials for SIC code 3537. A price index for the cost of labor was generated by dividing real production worker wages (derived by dividing nominal production worker wages by the implicit GDP deflator) by production worker hours. The demand-side variables include: real GDP and the price indices of manufacturing and wholesale trade. Generally, the price of final products are used as demand-side variables, but because forklifts are used as an input to the production of a wide variety of goods, we rely upon price indices of the manufacturing and wholesale trade sectors.

Data relevant to the econometric modeling of the price elasticity of demand for forklifts are listed in Table 9.5-3. Consistent time series data for the period 1970 through 1999 were obtained. The annual domestic quantity of forklift shipments was retrieved from the Industrial Truck Association Membership Handbook. Price data for forklifts over this time period were not available, so the price index of shipments for SIC code 3537 was retrieved from both the NBER-CES Productivity Database and BEA's Shipments of Manufacturing Industries instead. The following variables were also retrieved from the NBER-CES Productivity Database and the Census Bureau's ASM: production worker wages, production worker hours, real capital stock (except for the years 1998 and 1999), investment, the price index of investment (except for the years 1997 through 1999), and the price indices of shipments and material inputs (except for the years 1998 and 1999).

Other variables, including the price indices for the manufacturing and wholesale trade industries, the implicit GDP deflator, real GDP, the price index of investment for SIC code 3537 for the years 1997 to 1999, and the price indices of shipments and material inputs for the years 1998 and 1999 were retrieved from the Bureau of Economic Analysis. Note that since a price index of material inputs for SIC 3537 was not available beyond 1997, we relied upon a general price index for intermediate materials from BEA's Survey of Current Business. A price index for investment for SIC 3537 was also not available beyond 1996, so a general price index for capital equipment was used for the years 1997 - 1999 from the same source. Real capital stock for the years 1998 and 1999 was derived for SIC 3537 (see Equation 9-13 for the equation used to calculate real capital stock for these years).

Table 9.5-3
Data Inputs for the Estimation of Demand Equations for the Forklift Industry[26,27,28,29,30,31,32]

Variable	Unit of Measure
1. Time Trend	-
2. Price Index of Shipments for the Industrial Truck, Tractor, Trailer, and Stacker Mainery Industry (SIC 3537)	index
3. Quantity of Forklift Shipments	units
4. Price Index for the Manufacturing Industry	index
5. Price Index for the Wholesale Trade Industry	index
6. Price Index of Material Inputs	index
7. Production Worker Wages	millions of $
8. Implicit GDP Deflator	index
9. Production Worker Hours	thousands of worker hours
10. Investment	millions of $
11. Price Index of Investment	index
12. Real Capital Stock	millions of $1987
13. Real Gross Domestic Product	billions of $1987

SAS Release 8.2 for Windows was used to econometrically estimate the price elasticity of demand. Two-stage least squares econometric models were estimated for the forklift industry using the price indices of manufacturing and wholesale trade as the end-use products, respectively. Relying on price indices for entire sectors of the economy to represent specific end-use products is not ideal, but price data on specific products that forklifts are used to manufacture are not readily available. Additionally, forklifts are used in the production of a large variety of goods and it would therefore be difficult to determine which products to focus on for the estimation of demand elasticity. The data limitations are recognized and the demand elasticity estimates generated here are therefore, interpreted with caution.

Overall, the models using price indices for these end products were not successful. This may be due in part to the fact that price indices for entire sectors of the economy are not reliable instruments for the prices of the final products that forklifts are used to produce. The coefficient for the price index of shipments for SIC 3537 was not statistically different from zero in the model which included manufacturing. In the second model, which used the price index of wholesale trade in lieu of price index of manufacturing, the coefficient on the price index of shipments for SIC 3537 was significantly different than zero, but was equal to -5.8, an extremely large estimate of demand elasticity. The model results using the price indices of manufacturing and wholesale trade as the final product prices are reported in Table 9.5-4. with p-values listed below each coefficient estimate. Each of the coefficients reported has the anticipated sign, however not all of the estimates are significantly different from zero.

The price elasticity of demand estimate reflects an elastic demand for forklifts. Regulatory control costs are less likely to be paid by consumers of products with elastic demand when compared to products with inelastic demand, all other things held constant. Price increases for products with elastic price elasticity of demand lead to decreases in revenues for producers, however it does say anything with regard to producer profits.

A degree of uncertainty is associated with this method of demand estimation. The estimation is not robust since the model results vary depending upon the instruments used in the estimation process. For this reason, the above results are used as an indication that the elasticity of demand is elastic and we instead rely upon an assumed measure of -1.5 for the own-price elasticity of demand for forklifts.

Table 9.5-4
Derived Demand Coefficients Equations for the Forklift Industry

Variables	Estimation 1	Estimation 2
Own Price β ln(PI of Shipments for SIC 3537)	-3.03 (0.1113)	-5.76* (<.0001)
End-Use β_{FP} ln(PI of Manufacturing)	0.17 (0.9203)	
End-Use β_{FP} ln(PI of Wholesale Trade)		3.11* (0.0142)
ln(Real GDP)	3.44* (<.0001)	4.23* (<.0001)
F value	24.25* (<.0001)	32.96* (<.0001)
Adjusted R-Square	0.76	0.813

* statistically significant.

Supply Elasticity

Published sources of the price elasticity of forklift supply were not readily available. For this reason, an econometric analysis of the price elasticity of supply for forklifts was conducted using the same approach as the one used to estimate the supply elasticity for boat manufacturing described above.

The estimated model reflects the production function for forklifts, using annual time series data for the years from 1958 through 1999. The data used to estimate supply elasticity are enumerated in Table 9.5-5. The data for the price elasticity of supply estimation model includes: the value of domestic shipments of SIC 3537 in millions of dollars; the price index for value of domestic shipments (the value of domestic shipments deflated by the price index represents the quantity variable which is the dependent variable in the analysis); a technology time variable; production wages in millions of dollars; the implicit GDP deflator (used to deflate production wages), the material inputs in millions of dollars; the price index for value of materials; investment in millions of dollars; the price index of investment; and real net capital stock in millions of dollars.

Data to estimate the production function for the forklifts exclusively were largely unavailable; therefore, data for SIC code 3537 is utilized for each of the variables previously enumerated with the exception of the time variable. All data for the supply elasticity estimation were retrieved from the National Bureau of Economic Research-Center for Economic Studies (NBER-CES) Productivity Database and the U.S. Census Bureau's Annual Survey of Manufactures (ASM), with the exception of the technology time trend, the implicit GDP deflator, the price index for investment for SIC 3537 for the years 1997 through 1999, the price indices of shipments and material inputs for SIC 3537 for the years 1998 and 1999, and real capital stock for the years 1998 and 1999 (these data for real capital stock were not available). These variables (except the time trend and real capital stock for 1998 and 1999), were retrieved from the Bureau of Economic Analysis (BEA).

More specifically, the price index of shipments for SIC 3537 for the years 1998 and 1999 was retrieved from the BEA's Shipments of Manufacturing Industries. Similar to the boat manufacturing industry, a price index of material inputs for SIC 3537 was not available beyond 1997. We therefore relied upon a general price index for intermediate materials from BEA's Survey of Current Business. A price index for investment for SIC 3537 was also not available beyond 1996, so a general price index for capital equipment was used for the years 1997 - 1999 from the same source. Real capital stock for the years 1998 and 1999 was derived for SIC 3537 (see Equation 9-13 for the equation used to calculate real capital stock for these years).

Again, the capital stock variable was the most difficult variable to quantify for use in the econometric model. Ideally, this variable should represent the economic value of the capital stock actually used by each facility to produce forklifts for each year of the study. The most reasonable data for this variable would be the number of machine hours actually used to produce forklifts each year, but we do not possess this information. In lieu of machine hours data, the dollar value of net capital stock in constant 1987 prices, or real net capital stock, is used as a proxy for this variable.

Table 9.5-5
Data Inputs for the Estimation of Supply Elasticity for the Forklift Industry[33,3435,36,37,38]

Variable	Unit of Measure
1. Value of Shipments for the Industrial Truck, Tractor, Trailer, and Stacker Machinery Industry (SIC 3537)	millions of $
2. Price Index of Shipments for the Industrial Truck, Tractor, Trailer, and Stacker Machinery Industry (SIC 3537)	index

3. Time trend	-
4. Production Worker Wages	millions of $
5. Implicit GDP Deflator	index
6. Cost of Material Inputs	millions of $
7. Price Index of Material Inputs	index
8. Investment	millions of $
9. Price Index of Investment	index
8. Real Capital Stock	millions of 1987$

SAS Release 8.2 for Windows was used to estimate econometric estimates of the price elasticity of supply for the forklift manufacturing industry. A restricted least squares estimator was used to estimate the coefficients of the production function model. A log-linear specification was estimated with the sum of the α_i restricted to unity. This procedure is consistent with the assumption of constant returns to scale. The model was further adjusted to correct for first-order serial correlation using the Yule-Walker estimation method. The results of the estimated model are presented in Table 9.5-6 with p-values listed in parentheses below each coefficient estimate.

Table 9.5-6
Estimated Supply Model Coefficients for the Forklift Industry

Variables	Estimated Coefficients
ln(Time) (t)	0.1676 (.2066)
ln(Real Capital Stock) (K_t)	0.5833* (0.0070)
ln(Real Production Wages) (L_t)	1.1632* (<0.0001)
ln(Real Material Inputs) (M_t)	-0.7466* (0.0002)

* statistically significant

The coefficients for real capital and real production wages have the anticipated signs and are significant at a high level of confidence. The real material inputs coefficient does not have the anticipated sign and also tests significantly different from zero. Using the estimated coefficients and the formula for supply elasticity shown above, the price elasticity of supply for forklift manufacturing is derived to be 0.714. The calculation of statistical significance for this elasticity measure is not a straightforward calculation since the estimated function is non-linear. No attempt has been made to assess the statistical significance of the estimated elasticity. The corrections for serial correlation and the restricted model results yield inaccurate standard measures of goodness of fit (R^2). However, the model that is unrestricted and unadjusted for serial correlation has an R^2 of 0.99.

The estimated price elasticity of supply for the forklift manufacturing industry reflects that the industry in the United States will increase production of forklifts by 0.714 percent for every 1.0 percent increase in the price of this product. The preceding methodology does not directly estimate the supply elasticities for forklifts due to a lack of necessary data. The assumption implicit in the use of this price elasticity of supply estimate is that the supply elasticity of forklifts will not differ significantly from the price elasticity of supply for all products classified under SIC code 3537.

9.5.2.3 Price Elasticity Estimation for Snowmobiles

Demand Elasticity

The price elasticity of demand is an important input into the market model, and this information is required to characterize the demand for snowmobiles. Econometric estimation of the price elasticity of demand for snowmobiles was unsuccessful despite numerous model specifications and varied statistical techniques evaluated. A search of the literature did not provide snowmobile price elasticity of demand estimates. A study was conducted for the recreational boat industry in 1987.[39] This study estimates the price elasticity of demand for boats to be -1.78. The price elasticity of demand for a variety of pleasure boat categories were estimated. These estimates range from -1.4 to -2.17. For purposes of this analysis a price elasticity of demand for snowmobiles of -2 is postulated. Since this estimate does not relate specifically to the snowmobile market but to another category of recreational vehicles, and there are uncertainties associated with elasticity estimates, a sensitivity analysis of the impact of this estimate on model results is shown in the Appendix to Chapter 9 of this report.

Supply Elasticity

The price elasticity of supply for snowmobiles is a necessary input into the market model. A literature search did not provide any estimates of this required input. An econometric analysis is conducted and a value for this parameter is estimated. Several approaches were considered including a simultaneous equation approach, a production function approach and a simple supply function specification. Econometric results from the latter approach are presented. With this approach, the quantity of snowmobiles produced is hypothesized to be a function of the price of the product and the price of factors of production including the materials, labor, and capital as follows:

$$Q_t = f\ (P_t,\ P_{M\,t,},\ P_{L\,t,}\ P_{K\,t}) + u_t,$$

Where Q_t is the quantity of snowmobiles produced and sold in period t and $P_{M\,t,}$, $P_{L\,t,}$ $P_{K\,t}$ are the factor prices for inputs of production (materials, labor and capital, respectively) in period t. The data used to estimate the elasticity are enumerated in Table 9.5-7. Consistent time series data for the years 1986 through 2000 are used in the analysis. All price data have been restated into real values using the implicit GDP deflator. Snowmobile price and quantity data are provided by ISMA. The quantity of snowmobiles sold are restated to be values sold on a per household basis. Cost of production data for the snowmobile industry are largely unavailable. In lieu of the cost production data specific to snowmobile production, cost of production data for SIC 3799/NAICS code 336999 Other Transportation Equipment (includes snowmobiles as a product category) are used in the analysis as a proxy for the cost of production data for snowmobiles. The data used for the analysis are listed in Table 9.5-7.

Table 9.5-7
Data Inputs for the Estimation of
Supply Elasticity for the Snowmobile Industry[40,41,42,43,44,45,46,47]

Variable	Unit of Measure
1. Quantity of Snowmobiles Sold	units
2. US Households	number of households
3. Average price of snowmobiles sold	dollars
4. Price Index - Materials (SIC 3799 /NAICS 336999)	price index
5. Price Index - Investment (SIC 3799 /NAICS 336999)	price index
6. Wages per employee (SIC 3799 /NAICS 336999)	dollars
7. Real Implicit Gross Domestic Product Deflator	price index

SAS Release 8.2 for Windows was used to develop econometric estimates of the price elasticity of supply for the snowmobile industry. A log-log specification of the model was estimated. The price of capital was omitted from the model specification due to high correlation with the snowmobile price data. The model was further adjusted to correct for serial correlation using the Yule-Walker estimation method. Alternative lag periods were considered. The results of the estimated model are presented in Table 9.5-8 with related standard errors. Based upon this analysis the price elasticity of supply for the snowmobile industry is estimated to be 2.10.

Table 9.5-8
Estimated Supply Model Coefficients for the Snowmobile Industry

Variables	Estimated Coefficient	Standard Errors
Intercept	-16.4236	1.9094*
log (real price of snowmobiles)	2.1043	0.2441*
log (real wages per employee) (P_{Lt})	-0.2858	0.5479
log (real price of materials)(P_{Mt})	0.1617	0.1322
Total R-Square	0.9771	
Durbin-Watson Statistic	1.9728	

* Statistically significant at the 1% significance level.

The estimated model is statistically significant. The coefficient for real wages per employee has the anticipated signs but is not statistically significant. The coefficient for the materials variable does not have the anticipated sign and is not statistically significant. The coefficient for the price variable has the expected sign and is statistically significant. This value provides an estimate for the price elasticity of supply for snowmobiles. The estimated model is statistically significant. This value of 2.10 represents the price elasticity of supply used in the study. The uncertainty associated with this estimate is acknowledged. A sensitivity analysis of this model input is conducted in the appendix to this chapter.

9.5.2.4 Price Elasticity Estimation for All-Terrain Vehicles

Demand Elasticity

The price elasticity of demand is an important input to the market model, and this information is required to characterize the demand for ATVs. Econometric estimation of the price elasticity of demand for this market was unsuccessful despite numerous model specifications and varied statistical techniques evaluated. A search of the literature did not provide ATV price elasticity of demand estimates. A study was conducted for the recreational boat industry in 1987.[48] This study estimates the price elasticity of demand for boats to be -1.78. The price elasticity of demand for a variety of pleasure boat categories were estimated. These estimates range from -1.4 to -2.17. For purposes of this analysis, a price elasticity of demand for ATVs of -2 is postulated. Since this estimate does not relate specifically to the ATV market but another category of recreational vehicles and there are uncertainties associated with elasticity estimates in general, a sensitivity analysis of the impact of this estimate on model results is shown in the Appendix to Chapter 9 of this report.

Supply Elasticity

The price elasticity of supply is a necessary input in the market model. This estimate is required to characterize the way producers of ATVs respond to a change in the price of the product. A search of the economic literature was conducted without success. Econometric estimation of this variable were undertaken also without success. Numerous model specification and variable combinations were investigated, but the results were not satisfactory from a statistical perspective. The price elasticity of supply for off-highway motorcycles was estimated to be -0.93. Since the productive processes are similar for ATVs and off-highway motorcycles and many of the producers of ATVs also produce off-highway motorcycles, the supply elasticity for off-highway motorcycles appears to be a reasonable proxy for the supply elasticity for ATVs. A discussion of the techniques and data used to econometrically estimate this value follows in Section 9.5.2.5.

9.5.2.5 Price Elasticity Estimation for Off-Highway Motorcycles

Demand Elasticity

The price elasticity of demand is an important component of the market model and this information is required to characterize the demand for off-highway motorcycles. Econometric estimation of the price elasticity of demand for this market was unsuccessful despite numerous model specifications and varied statistical techniques evaluated. A search of the literature did not provide off-highway motorcycle price elasticity of demand estimates. A study was conducted for the recreational boat industry in 1987.[49] This study estimates the price elasticity of demand for boats to be -1.78. The price elasticity of demand for a variety of pleasure boat categories were estimated. These estimates range from -1.4 to -2.17. For purposes of this analysis a price elasticity of demand for off-highway motorcycles of -2 is postulated. Since this estimate does not relate specifically to the off-highway motorcycle market but another category of recreational vehicles and there are uncertainties associated with elasticity estimates in general, a sensitivity analysis of the impact of this estimate on model results is shown in the Appendix to Chapter 9 of this report.

Supply Elasticity

The price elasticity of supply for off-highway motorcycles is econometrically estimated. Data for the study is provided by the MIC and collected from publicly available sources. A description of the data used in the study, the modeling techniques used, and the model results are presented.

Methodology

A partial equilibrium market demand/supply model is specified as a system of interdependent equations in which the price and output of a product are simultaneously determined by the interaction of producers and consumers in the market. In simultaneous equation models, where variables in one equation feed back into variable in other equations, the error terms are correlated with the endogenous variables (price and output). In this case, single-equation ordinary least squares (OLS) estimation of individual equations will lead to biased and inconsistent parameter estimates. Thus, simultaneous estimation of this system to obtain elasticity estimates requires that each equation be identified through the inclusion of exogenous variable to control for shifts in the supply and demand curves over time.

The supply/demand system for OHM over time (t) is defined as follows:

$$Q_t^d = f(P_t, Z_t) + u_t$$

$$Q_t^s = (P_t, W_t) + v_t$$

$$Q_t^d = Q_t^s$$

The first equation above shows quantity demanded in year t as a function of price, P_t and an array of demand factors (e.g., measures of economic activity and substitute prices), and an error term, u_t. The second equation characterizes supply for the OHM market. The quantity supplied, Q_t^s in year t is a function of price and other supply factors, W_t (e.g., input prices) and an error term, v_t. The third equation specifies the equilibrium condition that quantity supplied equals quantity demanded in year t creating a system of three equations in three variables . The interaction of the specified market forces solves this system generating equilibrium values for the variables P_t* and $Q_t^* = Q_t^{d*} = Q_t^{s*.}$

Since the objective is to generate estimates of the supply equation for use in the economic model, the EPA employed the two-stage least squares (2SLS) regression procedure to estimate only the parameters of the supply equation. Similar techniques for the demand equation were unsuccessful. EPA specified the logarithm of the quantity supplied as a linear function of the logarithm of the price so that the coefficient on the price variable yields the estimate of the constant elasticity of supply for OHM. All prices employed in the estimation process were deflated by the gross domestic product (GDP) implicit price deflator to reflect real rather than nominal prices. The first stage produces fitted (or predicted) values for the price variables that are, by definition, highly correlated with the error term. In the second stage, these fitted values are then employed as observations of the right hand side price variable in the supply function. This fitted value is uncorrelated with the error term by construction and thus does not incur the endogeneity bias.

Data

Price and quantity data were provided by MIC for the period 1990 through 2000. Thus the study uses annual data for the period 1990 through 2000. For the supply equation estimated, supply is postulated to be a function of price, a trend variable to recognize technology changes over time, and the price of inputs of production. A number of factor prices were considered including the price of materials, labor, and capital. Unfortunately these inputs price are some cases highly correlated. For this reason, the price of materials is used in estimation. A listing of the data used in the analysis and the source of the data are shown in Table 9.5-9. All data used in the analysis are deflated to real values using the real gross domestic product implicit price deflator. Sales quantities and income values are restated to per US household values. All values are restated to natural logs.

Table 9.5-9
Data Inputs for Off-Highway Motorcycle Supply Estimation[50,51,52,53,54,55,56,57]

Variable	Unit of Measure
1. Quantity of OHM sold	units
2. US households	number
3. Average price OHM	dollars
4. Time trend	N/A
5. Price index for materials used in production	price index
6. Price of a substitute product (SIC 3799/NAICS 336999)	price index
7. Disposable household income	dollars
8. Real implicit GDP deflator	price index

Results

The results of the supply estimation are shown in Table 9.5-10

Table 9.5-10
Estimated Supply Model for the Off-Highway Motorcycle Industry

Parameter	Parameter Estimate	Standard Error
Intercept	-10.7632*	0.179407
log (Trend Variable)	-0.03399*	0.005626
log (Real Price)	0.93323*	0.017468
log (Price of materials used in production of OHM)	-0.36977	0.294203
Adjusted R Square F-Value Durbin Watson	0 .9996 8867.69* 1.65	

* Statistically significant at the 1% significance level.

The estimated equation and coefficients have the expected sign and are statistically significant at a 1% significance level with the exception of the cost of materials variable. While the coefficient for the price of materials variable has the expected sign, it is not statistically significant. The coefficient for the natural log of the real price variable of 0.93 is the estimate of the price elasticity of supply for the off-highway motorcycle market. The uncertainty surrounding this estimate is recognized and a sensitivity analysis of this model input is conducted in the appendix to this chapter.

9.6 Marine

The following section describes the baseline characterization of the market in the year 2001, the per unit regulatory control costs incurred by producers of recreational diesel marine vessels, and the economic impacts that would have resulted had the emissions control program been implemented in the baseline year. We also examine the economic impacts on the diesel inboard cruiser market using baseline year data for each change in the per unit control costs that occurs. This section concludes with a comparison of the stream of engineering costs and estimated welfare losses (excluding fuel efficiency gains) projected to occur after the regulation's implementation. No fuel efficiency gains are projected to occur from the standard affecting diesel recreational marine vessels, therefore the social costs (surplus losses net fuel cost savings) are equal to the surplus losses projected from the model.

9.6.1 Marine Baseline Market Characterization

Inputs to the economic analysis are a year 2001 baseline characterization of the diesel inboard cruiser market that includes the domestic quantity produced, quantity of imports, baseline market price, demand elasticity, and domestic and foreign supply elasticity measures. Table 9.6-1 provides the baseline data on the U.S. diesel inboard cruiser market used in this analysis.

Table 9.6-1
Baseline Characterization of the U.S. Diesel Inboard Cruiser Market: 2001

Inputs	Baseline Observation
Market price ($/boat)	$341,945.00
Market output (boats)	8435
Domestic	8098
Foreign	337
Elasticities	
Domestic supply (estimated)	1.57
Foreign supply (assumed)	1.57
Demand (previously estimated)	-1.44

The total market output of diesel inboard cruiser marine vessels was derived from data taken from publications of the National Marine Manufacturers Association[58,59]. EPA projected the quantity of CI marine engines for the years 1998 through 2030 based upon NMMA's historical data on the quantity of inboard cruisers sold in the U.S. For the year 2001, EPA's projection shows that 16,068 engines were sold domestically. This total includes those engines sold in the U.S. whether they were produced domestically or abroad. A simplifying assumption has been made that all of these engines are used in inboard cruisers, though we acknowledge that there is an extremely small fraction of these engines that are used in inboard runabouts (approximately 2 percent) and an even smaller fraction used in marine vessels with outboard engine configurations.[60] A majority (95 percent) of inboard cruisers contain two engines.[61] Using this information, we find that the 16,068 recreational diesel marine engines sold in 2001 would yield 8,435 diesel inboard cruisers.

Market output is not partitioned into domestically produced and imported quantities of recreational diesel marine engines. In order to determine the share of imported boats, historical import quantities of inboard cruisers were compared with the domestically produced quantities reported in Table 2.1-7 for the years 1992 to 2000[62]. On average, imported inboard cruisers were equal to about 4 percent of the inboard cruisers produced and sold in the U.S. This information was used to partition the total quantity of diesel inboard boats for the year 2001.

The price of diesel inboard cruisers was taken to be equal to the average retail price of all inboard cruisers sold in the year 2001. NMMA quotes this price at $341,945.[63] The estimates of demand and supply elasticity have been discussed in detail in Section 9.5.2.1. A separate estimate of foreign supply elasticity has not been carried out. For modeling purposes, we assume that the foreign supply elasticity is equal to the domestic supply elasticity.

9.6.2 Marine Control Costs

In order to determine a per diesel inboard cruiser cost over the years 2006 to 2030 for use in the economic analysis, the future stream of engineering costs (without fuel savings) provided in Chapter 7 is divided by the number of boats EPA projected from the NMMA data. This yields a stream of average cost per diesel inboard cruiser. As stated in the section above, the EPA projected the quantity of recreational diesel marine engines sold in the U.S. for the years 1998 through 2030. Using these engine quantities and the fact that approximately 95 percent of inboard cruisers contain two engines, we developed a projected stream of domestic diesel inboard cruiser sales. The total stream of engineering costs from Chapter 7, the projected number of diesel inboard cruisers, and the average regulatory cost per boat are provided in Table 9.6-2. During the initial years of implementation, the per unit costs change but by 2014, they are projected to remain the same.

Table 9.6-2
Projected Future Stream of Engineering Costs ($\$10^3$), Quantity of Diesel Inboard Cruisers, and Per Diesel Inboard Cruiser Regulatory Costs

Year	Estimated Engineering Costs	Projected Quantity of Diesel Inboard Cruisers	Cost Per Diesel Inboard Cruiser
2006	$7,806.0	9665	$808
2007	$8,365.3	9913	$844
2008	$8,573.8	10159	$844
2009	$9,413.5	10407	$905
2010	$9,637.0	10653	$905
2011	$5,213.4	10899	$478
2012	$5,176.7	11145	$464
2013	$5,290.8	11390	$464
2014	$4,958.1	11636	$426
2015	$5,062.7	11882	$426
2016	$5,167.7	12128	$426
2017	$5,272.7	12374	$426
2018	$5,377.6	12621	$426
2019	$5,482.6	12867	$426
2020	$5,587.6	13113	$426
2021	$5,692.5	13360	$426
2022	$5,797.5	13606	$426
2023	$5,902.5	13853	$426
2024	$6,007.4	14099	$426
2025	$6,112.4	14345	$426
2026	$6,217.2	14591	$426
2027	$6,322.0	14837	$426
2028	$6,426.9	15083	$426

2029	$6,531.7	15329	$426
2030	$6,636.5	15575	$426

9.6.3 Marine Economic Impact Results

The economic impacts of the emissions control program for recreational diesel marine vessels are estimated for each year in which the per vessel regulatory costs change, assuming the baseline year 2001 price and quantity. Though we possess projected quantities of diesel inboard cruiser marine vessels through the year 2030, we do not have future year prices. We are therefore unable to estimate the economic impacts of the future costs assuming future year quantities and prices. For this reason, we rely upon the most current year of data to inform the model when we impose the future costs per vessel on producers. Using baseline year data allows us to estimate relative changes in price and quantity as opposed to absolute changes. The estimated percent changes in price and quantity, the changes consumer and producer surplus, and the total loss in surplus are presented for various years in Tables 9.6-3 and 9.6-4.

Table 9.6-3
Price and Quantity Changes for the Diesel Inboard Cruiser Market*

Impact Measure	2006	2007/8	2009/10	2011	2012/13	2014+
Cost Per Unit	$808	$844	$905	$478	$464	$426
Change in Market Price	0.12%	0.13%	0.14%	0.07%	0.07%	0.06%
Change in Market Output	-0.18%	-0.19%	-0.20%	-0.10%	-0.10%	-0.09%
Domestic	-0.18%	-0.19%	-0.20%	-0.10%	-0.10%	-0.09%
Foreign	-0.18%	-0.19%	-0.20%	-0.10%	-0.10%	-0.09%

*Results are the same for the years 2007 and 2008, 2009 and 2010, and for the years 2012 and 2013. They are also the same for the years 2014 and beyond. These results are not reported in separate columns to avoid repetition. Results are based on baseline year 2001 market conditions and fuel cost savings are not included.

Table 9.6-4
Annual Losses in Consumer and
Producer Surplus and for the Diesel Inboard Cruiser Market*

Impact Measure	2006	2007/8	2009/10	2011	2012/13	2014+
Loss in CS** ($\$10^3$)	$3,551.8	$3,709.9	$3,977.7	$2,101.9	$2,040.4	$1,873.4
Loss in PS*** ($\$10^3$)	$3,251.9	$3,396.4	$3,641.1	$1,925.8	$1,869.5	$1,716.6
Domestic	$3,122.0	$3,260.7	$3,495.6	$1,848.9	$1,794.8	$1,648.0
Foreign	$129.9	$135.7	$145.5	$76.9	$74.7	$68.6
Loss in Surplus ($\$10^3$)	$6,083.7	$7,106.3	$7,618.8	$4,027.7	$3,909.9	$3,590.0

*Results are the same for the years 2007 and 2008, 2009 and 2010, and for the years 2012 and 2013. They are also the same for the years 2014 and beyond. These results are not reported in separate columns to avoid repetition. Results are based on baseline year 2001 market conditions and fuel cost savings are not included.

** CS refers to consumer surplus and is rounded to the nearest hundredths. For a description of the change in consumer surplus, see Section 9.2.2
*** PS refers to producer surplus and is rounded to the nearest hundredths. For a description of the change in producer surplus, see Section 9.2.2.

As Table 9.6-3 shows, the relative increases in price due to the regulatory costs are less than two-tenths of a percent while the reductions in output are less than one-quarter of a percent. These impacts are considered minimal. Also notable is that the percent changes in price and quantity peak in the years 2009 and 2010 but then are smaller further out into the future. The percent reduction in quantity is the same for both domestic and foreign output because it has been assumed that domestic and foreign supply have the same price elasticity.

Table 9.6-4 presents the loss in consumer surplus, the loss in producer surplus, and the loss in surplus (equal to the sum of the changes in consumer and producer surplus). These results show that the losses in consumer and producer surplus are approximately equal in size, though the loss in producer surplus is slightly less than the loss in consumer surplus. Consumer surplus losses range from a high of just under $4 million to a low of $1.9 million, while the losses in producer surplus vary from $3.6 million to $1.7 million. Like the price and quantity changes, these measures are largest in the years 2009 and 2010. They then decline to their lowest value in 2014 and beyond.

9.6.4 Marine Engineering Cost and Surplus Loss Comparison

Table 9.6-5 presents the future stream of estimated engineering costs holding quantity constant to the baseline year quantity and the loss in surplus that has been estimated from the economic impact model. Because economic modeling takes into account consumer and producer behavior, the estimated surplus losses are less than the engineering costs under a perfectly competitive market setting. In this case, surplus losses are, on average equal to over 99 percent of the calculated engineering costs. Note that the costs provided in this table are not discounted.

Based upon the annual ratio of surplus losses to engineering costs holding quantity constant to baseline year quantity, a projection of surplus losses over the future year stream is calculated from the future stream of engineering costs that appear in Chapter 7. The projected future stream of surplus loss is calculated by multiplying the annual ratio by the future stream of engineering costs and is presented in Table 9.6-6. Again, these costs are not discounted.

9.6.5 Marine Economic Impact Results with Fuel Cost Savings

No fuel savings are projected for the recreational diesel marine engine category, therefore there are no alternative results to present for this vehicle category. The stream of social costs for this vehicle category are equal to the stream of estimated surplus losses shown in Table 9.6-6.

Table 9.6-5
Interim Engineering Cost and Surplus Loss Comparison for the Recreational Diesel Marine Vessel Market Based on Year 2001 Quantity (Q =8,435 inboard cruisers)

Year	Estimated Engineering Costs	Estimated Surplus Loss
2006	$6,812,980	$6,803,645
2007	$7,119,006	$7,106,227
2008	$7,119,006	$7,106,227
2009	$7,630,744	$7,618,828
2010	$7,630,982	$7,618,828
2011	$4,035,120	$4,027,788
2012	$3,918,352	$3,909,937
2013	$3,918,326	$3,909,937
2014	$3,594,386	$3,590,020
2015	$3,594,365	$3,590,020
2016	$3,594,403	$3,590,020
2017	$3,594,441	$3,590,020
2018	$3,594,328	$3,590,020
2019	$3,594,365	$3,590,020
2020	$3,594,401	$3,590,020
2021	$3,594,436	$3,590,020
2022	$3,594,470	$3,590,020
2023	$3,594,365	$3,590,020
2024	$3,594,399	$3,590,020
2025	$3,549,432	$3,590,020
2026	$3,594,373	$3,590,020
2027	$3,594,444	$3,590,020
2028	$3,594,388	$3,590,020
2029	$3,594,456	$3,590,020
2030	$3,594,401	$3,590,020

Table 9.6-6
Engineering Costs and Surplus Loss Comparison for the Recreational Diesel Marine Vessel Market

Year	Estimated Engineering Costs	Estimated Surplus Loss
2006	$7,806,010	$7,795,314
2007	$8,365,319	$8,350,303
2008	$8,573,839	$8,558,165
2009	$9,413,530	$9,398,831
2010	$9,637,035	$9,621,686
2011	$5,213,411	$5,203,938
2012	$5,176,672	$5,165,555
2013	$5,290,764	$5,279,437

2014	$4,958,052	$4,952,029
2015	$5,062,713	$5,056,593
2016	$5,167,682	$5,161,380
2017	$5,272,652	$5,266,167
2018	$5,377,623	$5,371,178
2019	$5,482,592	$5,475,965
2020	$5,587,562	$5,580,752
2021	$5,692,532	$5,685,539
2022	$5,797,503	$5,790,326
2023	$5,902,472	$5,895,337
2024	$6,007,442	$6,000,124
2025	$6,112,413	$6,104,911
2026	$6,217,227	$6,209,698
2027	$6,322,042	$6,314,262
2028	$6,426,858	$6,419,049
2029	$6,531,673	$6,523,512
2030	$6,636,488	$6,628,400

9.7 Large SI Engines

As described in Chapter 2 and illustrated in Table 6.2.2-1, Large SI engines are used in nearly 50 different applications ranging from fairly small, low horsepower equipment used in lawncare applications to agricultural and construction equipment exceeding 100 horsepower. Forklifts are clearly the dominant application in this category, accounting for about 52 percent of the 2000 populations of Large SI engines. The next largest applications are generators, accounting for about 15 percent, and commercial turf applications, accounting for about 6 percent. Forklifts are also used more than other applications, for about 15,000 hours over the average operating life of the equipment, compared to about 6,000 hours for the next most-used applications (e.g., aerial lifts, refrigeration/AC, cranes). Similarly, forklifts accounted for nearly 81 percent of the NOx, 64 percent of the HC, 54 percent of the CO, and 76 percent of the PM emissions from Large SI engines in 2000. Because of their dominant position in this category, the following economic impact analysis focuses on the forklift segment. Specifically, we estimate the change in price and quantity, and the sum of consumer and producer surplus losses only for forklifts. To estimate the total social costs/gains for Large SI, we use the engineering costs to approximate the sum of consumer and producer surplus losses for Large SI engines other than forklifts. This approach slightly overestimates the surplus losses for the category since engineering costs are higher than surplus losses.

While it would be possible to perform a market analysis for each of the Large SI applications, we chose not to. Annual sales in some of these categories are so small that the results of separate analysis would not be meaningful and would imply a degree of precision that would not be reflected in the data inputs. Grouping the applications by horsepower, load factor, or usage rates would not necessarily reduce the complexity of the analysis because equipment that use similar size engines are often not used with the same intensity. In addition, their markets may not necessarily share the same demand and supply characteristics.

The results of our economic impact analysis for forklifts with regard to price and quantity changes is not meant to be interpreted as representing the estimated impacts for all Large SI engines. Changes in price and quantity are likely to be different for applications other than forklifts due to differences in their market characteristics.

The remainder of this section describes the baseline characterization of the forklift market in the year 2000, the regulatory control costs incurred by producers of forklifts, and the economic impacts that would have resulted had the emissions control program been imposed in the baseline year. We examine the economic impacts on the forklift market using the baseline year data for each change in the per unit control costs that occurs. A comparison is then made between the engineering cost and surplus loss streams projected to occur after the regulation's implementation. This initial comparison of the cost streams assumes no fuel cost savings. A comparison is then made between engineering costs and social costs/gains accounting for fuel cost savings of the emissions control program. Finally, an estimate of the social costs/gains for Large SI engines other than forklifts is presented, using engineering costs as a substitute for consumer and producer surplus losses.

9.7.1 Forklift Baseline Market Characterization

Inputs to the economic analysis are a year 2000 baseline characterization of the forklift market that includes the domestic quantity produced, quantity of imports, baseline market price, demand elasticity, and domestic and foreign supply elasticity measures. Table 9.7-1 provides the baseline data on the U.S. forklift market used in this analysis.

Table 9.7-1
Baseline Characterization of the U.S. Forklift Market: 2000

Inputs	Baseline Observation
Market price ($/forklift)	$26,380.00
Market output (forklifts)	65000
Domestic	48750
Foreign	16250
Elasticities	
Domestic supply (estimated)	0.714
Foreign supply (assumed)	0.714
Demand (assumed)	-1.5

The total quantity of Large SI engines sold in the U.S. was retrieved from the PSR database, which contains projections of U.S. sales of Large SI engines for the year 2000 and the years 2004 through 2030. Though we possess year 2000 quantity of imports and domestic shipments of forklifts from the International Trade Commission and the Industrial Truck Association, respectively, we have chosen to rely on PSR's database to maintain consistency with the projections of forklift engines used in other sections of this rule's analysis. Based on the PSR database, we have determined that approximately 50 percent of the population of Large SI engines are used in the production of forklifts. This quantity of engines is taken as a measure of the quantity of forklifts sold, based on the assumption that each forklift contains one engine.

The PSR database does not separate the quantity of forklift engines that are produced and used in the U.S. from those that are imported. In order to determine the share of imported forklifts of this total, historical import quantities of forklifts were compared with domestically produced quantities. On average, imported forklifts were equal to about 25 percent of forklifts produced in the U.S. in the past 10 years. This information was used to partition the total quantity of forklifts listed in the PSR database into the share of domestically produced forklifts and the share of imports for the year 2000.

The price of forklifts used in the model is taken as the year 2000 price of a representative model of Class 5 forklift. The year 2000 price of Nissan's JC50 pneumatic tire IC engine forklift was $26,380 and it is used as the nationwide market price of forklifts. It is acknowledged that there are a variety of Class 4, 5, and 6 forklifts with varying prices. The range of prices of these forklifts are discussed in Chapter 2. However, we require a single price to operationalize the perfectly competitive national-level market model used to examine the economic impacts of this rule on the U.S. forklift market.

The estimates of demand and supply elasticity have been discussed in detail in Section 9.5.2.2. A separate estimate of foreign supply elasticity has not been carried out. For modeling purposes, we assume that the foreign supply elasticity is equal to the domestic supply elasticity.

9.7.2 Forklift Control Costs

The emissions control costs used in the economic analysis are developed and reported in Chapter 5. In this section, we briefly recount the estimated regulatory cost per forklift that are used to in the model. The regulatory cost per unit faced by forklift producers leads to a parallel shift inward of the market supply curve. As stated earlier, the compliance costs per forklift are projected to change in future years as different phases of the emissions control program are implemented and as the learning curve is applied (see Chapter 5 for a discussion of the learning curve). The regulatory cost per forklift are presented in Table 9.7-2 for the years in which they change.

Table 9.7-2
Regulatory Costs Per Forklift

Year	Cost Per Forklift	Cost Description
2004/5	$610	Phase 1/year 1 costs
2006	$493	Phase 1/year 3 costs
2007/8	$537	Phase 1/year 3 costs + Phase 2/year 1 costs
2009/10/11	$418	Phase 1/year 6 costs + Phase 2/year 3 costs
2012 - 2030	$390	Phase 1/year 6 costs + Phase 2/year 6 costs

Economic impacts are estimated based upon these costs. In the model, the baseline year quantity and price of forklifts are used and the per unit costs are imposed on the model to determine price, quantity, and consumer and producer surplus changes.

9.7.3 Forklift Economic Impact Results

The economic impacts of the regulation on the forklift market are estimated for each year in which the per engine regulatory costs change, assuming the baseline year 2000 price and quantity. We possess projected quantities of forklifts through the year 2030, however we do not have projected future year prices. Without this information, we cannot estimate the economic impacts of the future costs assuming future year quantities and prices. We instead rely upon the most current year of data to inform the model when we impose the future costs per forklift on producers. Using baseline year data allows us to estimate relative changes in price and quantity as opposed to absolute changes. The estimated percent changes in price and quantity, the losses in consumer and producer surplus, and total surplus loss are presented for various years in Tables 9.7-3 and 9.7-4. These results do not account for fuel cost savings that may arise from this emissions control program.

Table 9.7-3
Price and Quantity Changes for the Forklift Market*

Impact Measure	2004/5	2006	2007/8	2009	2012
Cost Per Unit	$610	$493	$537	$418	$390
Change in Market Price	0.75%	0.60%	0.66%	0.51%	0.48%
Change in Market Output	-1.12%	-0.90%	-0.98%	-0.77%	-0.72%
Domestic	-1.12%	-0.90%	-0.98%	-0.77%	-0.72%
Foreign	-1.12%	-0.90%	-0.98%	-0.77%	-0.72%

*Results are the same for the years 2004 and 2005, 2007 and 2008, and the years 2009, 2010, and 2011. They are also the same for the years 2012 and beyond. These results are not reported in separate columns to avoid repetition. Results are based on baseline year 2000 market conditions and fuel cost savings are not included.

Table 9.7-4
Annual Losses in Consumer and Producer Surplus for the Forklift Market*

Impact Measure	2004/5	2006	2007/8	2009	2012
Loss in CS ($\$10^3$)**	$12,715.3	$10,287.6	$11,201.2	$8,728.6	$8,146.0
Loss in PS* ($\$10^3$)**	$26,412.4	$21,416.3	$23,299.1	$18,196.2	$16,990.5
Domestic	$19,809.3	$16,062.2	$17,474.3	$13,647.2	$12,742.9
Foreign	$6,603.1	$5,354.1	$5,824.8	$4,549.0	$4,247.6
Loss in Surplus ($\$10^3$)	$39,127.7	$31,703.9	$34,500.3	$26,924.8	$25,136.5

*Results are the same for the years 2004 and 2005, 2007 and 2008, and the years 2009, 2010, and 2011. They are also the same for the years 2012 and beyond. These results are not reported in separate columns to avoid repetition. Results are based on baseline year 2000 market conditions and fuel cost savings are not included.
** CS refers to consumer surplus and is rounded to the nearest hundredths. For a description of the change in consumer surplus, see Section 9.2.2
*** PS refers to producer surplus and is rounded to the nearest hundredths. For a description of the change in producer surplus, see Section 9.2.2.

For the per forklift engine costs resulting from the implementation of the emissions control program, the relative increases in price over the future time period examined are three-quarters of one percent or less. By the year 2014, the relative price increase falls to approximately one-half of one percent. The percent reductions in the market quantity of forklifts are initially projected to be slightly greater than one percent, but by 2006, the relative reduction in market quantity falls below one percent. Though these impacts are larger than those in the inboard diesel cruiser market, they are still considered minimal. Note that the percent reduction in quantity is the same for both domestic and foreign output because it has been assumed that domestic and foreign supply have the same price elasticity.

Table 9.7-4 above presents the loss in consumer surplus, the loss in producer surplus, and the total loss in surplus (equal to the sum of the changes in consumer and producer surplus) without fuel cost savings. As the table shows, the consumer surplus loss is approximately half the size of the loss in producer surplus. Consumer surplus losses range from $12.7 million in year 2004 when the rule is first implemented to $8.1 million in 2012 and the years beyond through 2030. The losses in producer surplus are at their largest at $26.4 million in the first year of implementation and they reach their lowest value in 2012 and the years beyond at just below $17 million. Note that the annual surplus loss associated with the forklift market declines as the per forklift engine costs fall. Loss in surplus is equal to $39.1 million in 2004 and it falls to $25.1 million by 2012.

9.7.4 Forklift Engineering Cost and Surplus Loss Comparison

This section presents a comparison of the future stream of engineering costs (excluding fuel cost savings) and surplus losses for the forklift market. In Table 9.7-5, we first present an interim comparison of the estimated engineering costs, holding quantity constant to the baseline year quantity, with the surplus losses that were estimated from the economic impact model.

Because economic modeling takes into account consumer and producer behavior, the estimated loss in surplus is less than the engineering costs under a perfectly competitive market setting. In this case, the annual surplus losses are, on average, equal to 98 to 99 percent of the calculated engineering costs. The cost numbers in this table and Table 9.7-6 are not discounted.

Based upon a ratio of the loss in surplus to engineering costs, holding baseline quantity constant, a projection of the surplus loss over the future year stream is calculated from the future stream of engineering costs that appear in Chapter 7. This projection of the future stream of surplus losses is compared to the future stream of engineering costs in Table 9.7-6. Note that these results are not discounted nor do they account for fuel cost savings.

9.7.5 Forklift Economic Impact Results with Fuel Cost Savings

In Table 9.7-7, the social costs/gains are calculated by adding the annual savings in fuel costs (presented initially in Chapter 7) to the projected annual surplus loss. These social gains are compared to the engineering costs with fuel efficiency gains. As you can see from this table, the emissions control program is expected to yield social gains rather than losses beyond the initial year of implementation. Only the initial year of implementation results in a social loss from this regulation for the forklift market.

Table 9.7-5
Interim Engineering Cost and Surplus Loss Comparison for the Forklift Market Based on Year 2000 Quantity (Q = 65,000 forklifts)

Year	Estimated Engineering Costs	Estimated Surplus Loss
2004	$39,645,853	$39,127,756
2005	$39,645,853	$39,127,756
2006	$32,047.483	$31,703,880
2007	$34,914,619	$34,500,273
2008	$34,914,619	$34,500,273
2009	$27,143,050	$26,924,774
2010	$27,143,050	$26,924,774
2011	$27,143,050	$26,924,774
2012	$25,329,069	$25,136,527
2013	$25,329,069	$25,136,527
2014	$25,329,069	$25,136,527
2015	$25,329,069	$25,136,527
2016	$25,329,069	$25,136,527
2017	$25,329,069	$25,136,527
2018	$25,329,069	$25,136,527
2019	$25,329,069	$25,136,527
2020	$25,329,069	$25,136,527
2021	$25,329,069	$25,136,527
2022	$25,329,069	$25,136,527
2023	$25,329,069	$25,136,527
2024	$25,329,069	$25,136,527
2025	$25,329,069	$25,136,527
2026	$25,329,069	$25,136,527
2027	$25,329,069	$25,136,527
2028	$25,329,069	$25,136,527
2029	$25,329,069	$25,136,527
2030	$25,329,069	$25,136,527

Table 9.7-6
Engineering Cost and Surplus Loss Comparison for the Forklift Market without Fuel Cost Savings

Year	Estimated Engineering Costs	Estimated Surplus Loss
2004	$44,403,355	$43,823,087
2005	$45,592,731	$44,996,919
2006	$37,816,030	$37,410,578
2007	$42,246,689	$41,745,330
2008	$43,294,128	$42,780,339
2009	$34,471,674	$34,194,463
2010	$35,285,965	$35,002,206
2011	$36,100,257	$35,809,949
2012	$34,447,534	$34,185,677
2013	$35,207,406	$34,939,773
2014	$35,967,278	$34,693,868
2015	$36,727,150	$36,447,964
2016	$37,487,022	$37,202,060
2017	$38,246,894	$37,956,156
2018	$39,006,766	$38,710,252
2019	$39,766,638	$39,464,347
2020	$40,526,510	$40,218,443
2021	$41,286,382	$40,972,539
2022	$42,046,254	$41,726,635
2023	$42,806,126	$42,480,731
2024	$43,565,998	$43,234,826
2025	$44,325,871	$43,988,922
2026	$45,085,743	$44,743,018
2027	$45,845,615	$45,497,114
2028	$46,605,487	$46,251,210
2029	$47,365,359	$47,005,305
2030	$48,125,231	$47,759,401

Table 9.7-7
Engineering and Social Cost Comparison for the Forklift Market with Fuel Cost Savings

Year	Estimated Engineering Costs with Fuel Cost Savings	Estimated Social Costs/Gains (Surplus Loss - Fuel Savings)*
2004	$7,305,024	$6,724,756
2005	($29,112.307)	($29,708,119)
2006	($74,949,193)	($75,354,645)
2007	($107,719,996)	($108,221,355)
2008	($142,910,106)	($143,423,895)
2009	($186,910,292)	($187,187,502)
2010	($220,128,020)	($220,411,779)
2011	($248,696,789)	($248,987,097)
2012	($263,429,050)	($263,690,906)
2013	($273,365,256)	($273,632,888)
2014	($282,258,050)	($282,531,460)
2015	($290,155,574)	($290,434,760)
2016	($297,059,701)	($297,344,663)
2017	($303,544,978)	($303,835,716)
2018	($309,618,970)	($309,915,484)
2019	($315,291,768)	($315,594,059)
2020	($320,384,517)	($320,692,585)
2021	($325,478,111)	($325,791,955)
2022	($330,572,494)	($330,892,113)
2023	($336,095,973)	($336,421,369)
2024	($341,680,638)	($342,011,810)
2025	($347,267,003)	($347,603,952)
2026	($352,193,263)	($352,535,988)
2027	($357,123,770)	($357,472,271)
2028	($362,058,551)	($362,412,827)
2029	($366,996,593)	($367,356,646)
2030	($371,938,165)	($372,303,995)

* ( ) represents a negative cost (social gain). Cost estimates are based upon 2000$.

9.7.6 Economic Impacts - Other Large SI Engines

To complete the analysis of the economic impacts of this rulemaking on Large SI engines, we used engineering costs as a surrogate for consumer and producer surplus losses. As noted above, this approach slightly overestimates the surplus losses, suggesting that the standards will have a slightly larger total impact on consumers and producers. This approach does not allow disaggregating to determine the portion of the costs borne by consumers and the portion borne by producers. The estimated fuel cost savings for Large SI engines other than forklifts are based on the methodology used for forklifts. The results of this analysis are contained in Table 9.7-8. According to this analysis, the emissions control program is expected to yield social gains rather than losses beyond the first two years of implementation.

Table 9.7-8
Engineering Cost and Surplus Loss Comparison for Large SI Engines Other Than Forklifts

Year	Estimated Surplus Loss (Engineering Costs)	Estimated Fuel Savings	Estimated Social Costs/Gains (Surplus Loss - Fuel Savings)*
2004	$44,403,355	($15,627,144)	$28,776,211
2005	$45,592,731	($28,275,848)	$17,316,883
2006	$37,816,030	($40,160,970)	($2,344,940)
2007	$42,246,689	($48,976,681)	($6,729,992)
2008	$43,294,128	($56,624,806)	($13,330,678)
2009	$34,471,674	($63,712,068)	($29,240,394)
2010	$35,285,965	($70,327,718)	($35,041,753)
2011	$36,100,257	($76,172,728)	($40,072,471)
2012	$34,447,534	($81,521,871)	($47,074,337)
2013	$35,207,406	($86,460,491)	($51,253,085)
2014	$35,967,278	($90,759,859)	($54,792,581)
2015	$36,727,150	($94,347,999)	($57,620,849)
2016	$37,487,022	($97,888,686)	($60,401,664)
2017	$38,246,894	($101,329,714)	($63,082,820)
2018	$39,006,766	($104,666,222)	($65,659,456)
2019	$39,766,638	($107,916,691)	($68,150,053)
2020	$40,526,510	($111,080,698)	($70,554,188)
2021	$41,286,382	($114,155,459)	($72,869,077)
2022	$42,046,254	($117,123,427)	($75,077,173)
2023	$42,806,126	($117,123,427)	($74,317,301)
2024	$43,565,998	($122,621,375)	($79,055,377)
2025	$44,325,871	($125,268,725)	($80,942,854)
2026	$45,085,743	($128,102,036)	($83,016,293)
2027	$45,845,615	($130,896,877)	($85,051,262)
2028	$46,605,487	($133,533,546)	($86,928,059)
2029	$47,365,359	($135,988,425)	($88,623,066)
2030	$48,125,231	($138,409,359)	($90,284,128)

9.8 Snowmobiles

The following section describes the baseline characterization of the snowmobile market in the year 2001, the regulatory control costs incurred by producers of snowmobiles, and the economic impacts that would have resulted had the emissions control program been imposed in the baseline year. We examine the economic impacts on the snowmobile market using the baseline year data for each change in the per unit control costs that occurs. A comparison is then made between the engineering cost and surplus loss streams projected to occur after the regulation's implementation. This initial comparison of the cost streams assumes no fuel cost savings. A comparison is then made between engineering costs and social costs/gains accounting for fuel cost savings of the emissions control program.

9.8.1 Snowmobile Baseline Market Characterization

Inputs to the economic analysis are provide a baseline characterization for the snowmobile market for the year 2001. Baseline market data include the domestic quantity produced, quantity of imports, baseline market price, demand elasticity, and domestic and foreign supply elasticity measures. Table 9.8-1 provides the baseline data for the U.S. snowmobile market used in this analysis.

Table 9.8-1
Baseline Characterization of the U.S. Snowmobile Market: 2001[64,65]

Inputs	Baseline Observation
Market price ($/snowmobile)	$6,360.00
Market output (snowmobiles)	140,629
Domestic	80,015
Foreign	60,614
Elasticities	
Domestic supply (estimated)	2.1
Foreign supply (assumed)	2.1
Demand (assumed)	-2

The market sales and quantity data are available from the ISMA website. Import and export estimates are based upon data from the PSR. PSR lists vehicles that are imports. For the year 2000, approximately 60 percent of snowmobiles produced by the 4 largest producers were produced domestically by Polaris and Arctic Cat. It is assumed that the production relationship between imports and exports is mirrored in sales for 2001. Based upon this import ratio, we estimate that approximately 61 thousand of the snowmobiles sold in the US in 2001 were imported.

The estimates of demand and supply elasticity have been discussed in detail in Section 9.5.2.3. A separate estimate of foreign supply elasticity has not been carried out. For modeling purposes, we assume that the foreign supply elasticity is equal to the domestic supply elasticity. It is important to note that imports and domestically produced vehicles must meet the US emission standards in order to be sold in this country.

9.8.2 Snowmobile Control Costs

The emissions control costs used in the economic analysis are developed and reported in Chapter 5. In this section, we briefly recount the estimated regulatory cost per snowmobile that are used in the model. The regulatory cost per unit faced by snowmobile producers leads to a parallel shift inward of the market supply curve. As stated earlier, the compliance costs per snowmobile are projected to change in future years as different phases of the emissions control program are implemented and as the learning curve is applied (see Chapter 5 for a discussion of the learning curve). The regulatory cost per snowmobile are presented in Table 9.8-2 for the years in which they change.

Table 9.8-2
Regulatory Costs Per Snowmobile

Year	Cost Per Snowmobile	Cost Description
2006	$35	Phase 1/year 1 costs
2007	$69	Phase 1/year 2 costs
2008-2009	$65	Phase 1/year 3 and 4 costs
2010	$185	Phase 2/year 1 costs
2011	$181	Phase 2 /year 2 costs
2012	$239	Phase 3 /year 1 costs
2013	$239	Phase 3/year 2 costs
2014	$202	Phase 3/year 3 costs
2015	$196	Phase 3/year 4 costs
2016	$182	Phase 3/year 5 costs
2017-2030	$180	Phase 3/year 6 and years thereafter costs

Economic impacts are estimated based upon these costs. In the model, the baseline year quantity and price of snowmobiles are used and the per unit costs are imposed on the model to determine price, quantity, and consumer and producer surplus changes.

9.8.3 Snowmobile Economic Impact Results

The economic impacts of the regulation on the snowmobile market are estimated for each year in which the per engine regulatory costs change, assuming the baseline year 2001 price and quantity. We possess projected quantities of snowmobiles through the year 2030, however we do not have projected future year prices. Without this information, we cannot estimate the economic impacts of the future costs assuming future year quantities and prices. We instead rely upon the most current year of data to inform the model when we impose the future costs per snowmobile on producers. Using baseline year data allows us to estimate relative changes in price and quantity as opposed to absolute changes. The estimated percent changes in price and quantity, the losses in consumer and producer surplus, and total surplus loss are presented for various years in Tables 9.8-3 and 9.8-4. These results do not account for fuel cost savings that may arise from this emissions control program.

Table 9.8-3
Price and Quantity Changes for the Snowmobile Market*

Impact Measure	2006	2007	2008-2009	2010	2011	2012-2013	2014	2015	2016	2017-2030
Cost Per Unit	$35	$69	$65	$185	$181	$239	$202	$196	$182	$180
Change in Price	0.28%	0.56%	0.52%	1.49%	1.46%	1.92%	1.63%	1.58%	1.47%	1.45%
Change in Output:	-0.56%	-1.11%	-1.05%	-2.98%	-2.92%	-3.85%	-3.25%	-3.16%	-2.93%	-2.9%

*Based upon 2001baseline market conditions and impacts estimated to occur from the regulation. Assumes 2001$.

Table 9.8-4
Annual Losses in Consumer and Producer Surplus for the Snowmobile Market*

Impact Measure	Year			
	2006	**2007**	**2008-2009**	**2010**
Loss in CS** ($$10^3$)	$2,513.9	$4,942.4	$4,657.4	$13,126.9
Loss in PS*** ($$10^3$)	$2,380.7	$4,654.5	$4,338.9	$12,123.7
Domestic	$1,354.6	$2,648.3	$2,497.2	$6,898.1
Foreign	$1,026.1	$2,006.2	$1,891.7	$5,225.6
Loss in Surplus ($$10^3$)	$4,894.6	$9,596.9	$9,049.4	$25,250.6
	2011	**2012-2013**	**2014**	**2015**
Loss in CS** ($$10^3$)	$12,847.3	$16,883.7	$14,313.3	$13,894.9
Loss in PS*** ($$10^3$)	$11,873.5	$15,448.6	$13,180.8	$12,808.8
Domestic	$6,755.8	$8,798.9	$7,499.6	$7,287.9
Foreign	$5,117.7	$6,658.7	$5,681.2	$5,520.9
Loss in Surplus ($$10^3$)	$24,720.8	$32,332.3	$27,494.1	$26,703.7
	2016	**2017-2030**		
Loss in CS** ($$10^3$)	$12,917.2	$12,777.4		
Loss in PS*** ($$10^3$)	$11,936.1	$11,810.9		
Domestic	$6,791.4	$6,720.2		
Foreign	$5,144.7	$5,090.8		
Loss in Surplus ($$10^3$)	$24,853.3	$24,588.3		

* Based upon 2001 baseline market conditions and the impact of the regulations on those market conditions. Assumes 2001$.

** CS refers to consumer surplus and is rounded to the nearest hundredths. For a description of the change in consumer surplus, see Section 9.2.2

*** PS refers to producer surplus and is rounded to the nearest hundredths. For a description of the change in producer surplus, see Section 9.2.2.

For the per snowmobile engine costs resulting from the implementation of the emissions control program, the relative increases in price over the future time period examined ranges from 0.28% to approximately 1.92% and achieve a steady state in 2017 of approximately 1.45%. The percent reductions in the market quantity of snowmobiles are initially projected to be 0.28% but increase to around 3.85% in 2012, the first year of the Phase 3 regulations. The steady state quantity reductions begin in 2017 and are approximately 2.9%. The percentage change in domestic and foreign production are the same. This is based upon the assumption that the foreign price elasticity of demand is equivalent to the domestic price elasticity of demand, and the fact that both foreign and domestic snowmobiles are subject to the emission standards. All price quantity change estimates are based upon 2001 baseline market conditions and the impact of the regulation on those baseline market conditions.

Table 9.8-4 above presents the loss in consumer surplus, the loss in producer surplus, and the total loss in surplus (equal to the sum of the changes in consumer and producer surplus) without fuel cost savings. As the table shows, the consumer surplus loss is approximately half the size of the loss in producer surplus. Producer surplus losses range from $2.4 million to $15.4 million in 2012 and reach a steady state value of $11.8 million in 2017 and beyond. The losses in consumer surplus range from $2.5 to $16.9 million and reach a steady state of $12.8 in 2017. Note that the annual surplus loss associated with the snowmobile market increases as the per snowmobile engine costs increase and declines as the per snowmobile engine costs fall. Annual loss in surplus ranges from $4.9 million to $32.3 million in 2010 and decrease to a steady state level in 2017 of $24.6 million. It is important to note that these estimates are based upon 2001 baseline conditions and the impact of the regulation on those market conditions.

9.8.4 Snowmobile Engineering Cost and Surplus Loss Comparison

This section presents a comparison of the future stream of engineering costs (excluding fuel cost savings) and surplus losses for the snowmobile market. In Table 9.8-5, we first present an interim comparison of the estimated engineering costs, holding quantity constant to the baseline year quantity. The surplus losses are estimated from the economic impact model. Because economic modeling takes into account consumer and producer behavior, the estimated loss in surplus is less than the engineering costs under a perfectly competitive market setting. In this case, the annual surplus losses are, on average, equal to 96 to 99 percent of the calculated engineering costs. It is important to note that the relationship between engineering and economic costs are based upon this comparison. It is the relationship between these costs that are assumed to actually occur in the market in future years. The cost numbers in Table 9.8-5 and 9.8-6 are not discounted.

Based upon a ratio of the loss in surplus to engineering costs, holding baseline quantity constant, a projection of the surplus loss over the future year stream is calculated from the future stream of engineering costs that appear in Chapter 7. This projection of future stream of engineering costs is based upon projected snowmobiles sales provided by ISMA and estimated per unit engineering engine modification costs. This projection of the future stream of surplus losses is compared to the future stream of engineering costs in Table 9.8-6. Note that these results are not discounted nor do they account for fuel cost savings. The relationship between engineering costs and surplus losses are determined using the market model are assumed to occur in future years. Thus the engineering costs and surplus losses shown in Table 9.8-6 are based upon forecasted sales volumes in the future, the engineering cost estimate for those sales. Surplus losses represent the estimated value of those losses as informed by the market model, but accounting for projected sales growth in the future.

Table 9.8-5
Interim Engineering Cost and Surplus Loss Comparison for the Snowmobile Market Based on Year 2001 Baseline Market Conditions
(millions of 2001 $)

Year	Estimated Engineering Costs	Estimated Surplus Loss
2006	$4.9	$4.9
2007	$9.7	$9.6
2008 - 2009 (annually)	$9.1	$9.0
2010	$26.0	$25.2
2011	$25.5	$24.7
2012 - 2013 (annually)	$33.6	$32.3
2014	$28.4	$27.5
2015	$27.6	$26.7
2016	$25.6	$24.9
2017 - 2030 (annually)	$25.3	$24.6

9.8.5 Snowmobile Economic Impact Results with Fuel Cost Savings

In Table 9.8-7, the social costs/gains are calculated by adding the annual savings in fuel costs (presented initially in Chapter 7) to the projected annual surplus loss. These social gains are compared to the engineering costs with fuel efficiency gains. As you can see from this table, the emissions control program is expected to yield social gains rather than losses beyond the year 2014.

Table 9.8-6
Engineering Cost and Surplus Loss Comparison for the Snowmobile Market without Fuel Cost Savings Assumes Sales Growth in Future Years*
(millions of 2001 $)

Year	Estimated Engineering Costs	Estimated Surplus Loss
2006	$6.6	$6.5
2007	$13.5	$13.4
2008	$13.2	$13.0
2009	$13.5	$13.3
2010	$38.9	$37.8
2011	$38.7	$37.6
2012	$52.0	$50.0
2013	$52.7	$50.7
2014	$45.3	$43.9
2015	$44.4	$43.0
2016	$41.9	$40.6
2017	$41.7	$40.5
2018	$42.2	$41.0
2019	$42.7	$41.5
2020-2030	$43.1	$41.9

* Snowmobile sales growth provided by ISMA. Sales are not projected to grow after 2020.

Table 9.8-7
Engineering and Social Cost Comparison for the Snowmobile Market with Fuel Cost Savings - Assumes Sales Growth In Future Years*
(millions of 2001$)

Year	**Estimated Engineering Costs with Fuel Cost Savings**	**Estimated Social Costs/Gains (Surplus Loss - Fuel Savings)***
2006	$6.2	$6.2
2007	$12.3	$12.1
2008	$10.7	$10.6
2009	$9.7	$9.6
2010	$29.4	$28.2
2011	$23.1	$21.9
2012	$26.9	$24.9
2013	$17.8	$15.8
2014	$0.4	($1.0)
2015	($10.5)	($12.0)
2016	($23.2)	($24.4)
2017	($33.2)	($34.4)
2018	($42.3)	($43.5)
2019	($50.9)	($52.1)
2020	($59.0)	($60.3)
2021	($67.0)	($68.3)
2022	($73.5)	($74.8)
2023	($78.4)	($79.6)
2024	($82.0)	($83.3)
2025	($84.5)	($85.8)
2026	($86.5)	($87.8)
2027	($88.3)	($89.5)
2028	($89.8)	($91.0)
2029	($90.9)	($92.2)
2030	($91.8)	($93.2)

* ( ) represents a negative cost (social gain). Cost estimates are based upon 2001$

9.8.6 Economic Impacts on Individual Engine Manufacturers, Snowmobile Retailers and Snowmobile Rental Firms

Insufficient data were obtained to conduct an analysis of the impact of the regulation on individual producers in the market. Thus, this analysis does not address individual producer impacts. Each snowmobile manufacturer must meet the emission standards for vehicles sold domestically. Since Yamaha and Bombardier produce their own engines, it is possible that these firms may be at a competitive advantage relative to Arctic Cat and Polaris who purchase engines from other firms. No analysis has been conducted to determine the impact of the difference in cost of production or cost of compliance for the individual firms within the industry. The EPA sought information concerning individual firm's cost of producing snowmobiles, but was unable to obtain sufficient data to conduct an analysis.

With regard to snowmobile retail and rental firms. To the extent that the price of snowmobiles increases, these firms will be impacted by the regulation The increase in market price estimated for the steady state of 1.45% does not appear sufficient to create significant impacts for these firms. In addition, most retail firms sell a variety of products, and snowmobiles are only one product in their product line. This will tend to mitigate the impact for these firms.

9.9 All-Terrain Vehicles (ATVs)

9.9.1 ATV Baseline Market Characterization

Inputs to the economic analysis are for the year 2001. Baseline characterization of the ATV market includes the domestic quantity of ATVs produced, quantity of imports, baseline market price, demand elasticity, and domestic and foreign supply elasticity measures. Table 9.9-1 provides the baseline data on the U.S. ATV market used in this analysis.

Table 9.9-1
Baseline Characterization of the U.S. ATV Market: 2001

Inputs	Baseline Observation
Market price ($/ATV)	$5,123.00
Market output (ATV)	880000
Domestic	874746
Foreign	5254
Elasticities	
Domestic supply (assumed)	1
Foreign supply (assumed)	1
Demand (assumed)	-2

The total quantity of ATVs sold in the U.S. was retrieved from the MIC. Trade data specific to the ATV market were unavailable. However, the International Trade Commission publishes international trade data for NAICS code 336999 - Other Transportation Equipment. According to ITC data, imports for NAICS code 336999 account for less than 1 percent of domestic sales. The import ratio for Other Transportation Equipment is assumed to be a reasonable proxy for imports for the ATV market.

The price of ATVs used in the model is the average ATV price in 2001 provided by MIC. An average ATV market price is required to operationalize the perfectly competitive national-level market model used to examine the economic impacts of this rule on the U.S. ATV market.

The estimates of demand and supply elasticity have been discussed in detail in Section 9.5.2.4. A separate estimate of foreign supply elasticity has not been carried out. For modeling purposes, we assume that the foreign supply elasticity is equal to the domestic supply elasticity.

9.9.2 ATV Control Costs

The emission control costs used in the economic analysis are developed and reported in Chapter 5. In this section, we briefly recount the estimated regulatory cost per ATV that are used in the model. The regulatory cost per unit faced by ATV producers leads to a parallel shift inward of the market supply curve. As stated earlier, the compliance costs per ATV are projected to change in future years as different phases of the emissions control program are implemented and as the learning curve is applied (see Chapter 5 for a discussion of the learning curve). The regulatory cost per ATV are presented in Table 9.9-2 for the years in which these costs change.

Table 9.9-2
Regulatory Costs Per ATV

Year	Cost Per ATV	Cost Description
2006	$43	Phase 1/year 1 costs
2007	$82	Phase 1/year 2 costs
2008	$78	Phase 1/year 3 costs
2009	$71	Phase 1/year 4 costs
2010	$66	Phase 1/year 5 costs
2011	$57	Phase 1/year 6 costs
2012-2015	$53	Phase 1/year 7-10 costs
2016	$51	Phase 1/year 11 costs
2017-2030	$48	Phase 1/year 12-25 costs

Economic impacts are estimated based upon these costs. In the model, the baseline year quantity and price of ATVs are used and the per unit costs are imposed on the model to determine price, quantity, and consumer and producer surplus changes.

9.9.3 ATV Economic Impact Results

The economic impacts of the regulation on the ATV market are estimated for each year in which the per engine regulatory costs change, assuming the baseline year 2001 price and quantity. Estimated projected quantities of ATVs sales through the year 2030 are available, however we do not have projected future year prices. Any price projections would be subject to significant uncertainties. Without this information, we cannot estimate the economic impacts of the future costs assuming future year quantities and prices. We instead rely upon the most current year of data to inform the model when we impose the future costs per ATV on producers. Assuming annual sales and average prices are increasing for ATVs, this model approach tends to overstate potential price and quantity impacts. Using baseline year data allows us to estimate relative changes in price and quantity as opposed to absolute changes. The estimated percent changes in price and quantity, the losses in consumer and producer surplus, and total surplus loss are presented for various years in Tables 9.9-3 and 9.9-4. These results do not account for fuel cost savings that may arise from this emissions control program.

Table 9.9-3
Price and Quantity Changes for the ATV Market*

Impact Measure	Year				
	2006	**2007**	**2008**	**2009**	**2010**
Cost Per Unit	$43	$82	$78	$71	$66
Change in Market Price	0.28%	0.53%	0.51%	0.46%	0.43%
Change in Market Output	-.56%	-1.07%	-1.02%	-.92%	-.86%
Domestic	-.56%	-1.07%	-1.02%	-.92%	-.86%
Foreign	-.56%	-1.07%	-1.02%	-.92%	-.86%
	2011	**2012/2015**	**2016**	**2017/2030**	
Cost Per Unit	$57	$53	$51	$48	
Change in Market Price	0.37%	0.34%	0.33%	0.31%	
Change in Market Output	-.74%	-.69%	-0.66%	-0.62%	
Domestic	-.74%	-.69%	-0.66%	-0.62%	
Foreign	-.74%	-.69%	-0.66%	-0.62%	

*Results are the same for the years 2012 through 2015 and for 2017 through 2030. These results are not reported in separate columns to avoid repetition. Results are based on baseline year 2001 market conditions and fuel cost savings are not included.

Table 9.9-4
Annual Losses in Consumer and Producer Surplus for the ATV Market*

Impact Measure	Year								
	2006	**2007**	**2008**	**2009**	**2010**	**2011**	**2012-2015**	**2016**	**2017-2030**
Loss in CS** ($\$10^3$)	$12,578.0	$23,925.0	$22,763.9	$20,730.5	$19,276.9	$16,658.0	$15,493.0	$14,910.4	$14,036.0
Loss in PS*** ($\$10^3$)	$25,015.0	$47,336.7	$45,063.3	$41,076.0	$38,221.2	$33,068.0	$30,771.7	$29,622.1	$27,896.2
Domestic	$24,865.6	$47,054.0	$44,794.2	$40,830.8	$37,993.0	$32,870.5	$30,587.9	$29,445.3	$27,729.6
Foreign	$149.4	$282.6	$269.1	$245.2	$228.2	$197.4	$183.7	$176.9	$166.6
Loss in Surplus ($\$10^3$)	$37,593.0	$71,261.7	$67,827.2	$61,806.5	$57,498.0	$49,726.0	$46,264.7	$44,532.5	$41,932.2

*Results are based on baseline year 2001 market conditions and fuel cost savings are not included.
** CS refers to consumer surplus and is rounded to the nearest hundred. For a description of the change in consumer surplus, see Section 9.2.2
*** PS refers to producer surplus and is rounded to the nearest hundred. For a description of the change in producer surplus, see Section 9.2.2.

For the per ATV engine costs resulting from the implementation of the emissions control program, the relative increases in price over the future time period examined are one-half of one percent or less. The market quantity reductions are estimated to be approximately one percent or less and reach a steady state decrease of 0.62 percent in 2017. Note that the percent reduction in quantity is the same for both domestic and foreign output because it has been assumed that domestic and foreign supply have the same price elasticity.

Table 9.9-4 above presents the loss in consumer surplus, the loss in producer surplus, and the total loss in surplus (equal to the sum of the changes in consumer and producer surplus) without fuel cost savings. As the tables show, the consumer surplus loss is approximately half the size of the loss in producer surplus. Consumer surplus losses range from nearly $12.6 million in year 2006 when the rule is first implemented, it rises to $23.9 million in 2007 and falls to $14 million in 2017 and the years beyond. The losses in producer surplus range from $25 million in the first year of implementation, rising to $47.3 million in 2007 and falls to $27.9 million in 2012 and the years beyond. Note that the annual surplus loss associated with the ATV market declines as the per ATV engine costs fall starting in 2008. Loss in surplus is equal to $37.6 million in 2006, rises to 71.3 in 2007 and it falls to $42 million by 2017. The surplus estimate presented in Table 9.9-4 is based upon 2001 baseline market conditions and do not consider fuel cost savings.

9.9.4 ATV Engineering Cost and Surplus Loss Comparison

This section presents a comparison of the future stream of engineering costs (excluding fuel cost savings) and surplus losses for the ATV market. In Table 9.9-5, we first present an interim comparison of the estimated engineering costs, holding quantity constant to the baseline year quantity, with the surplus losses that were estimated from the economic impact model. Because economic modeling takes into account consumer and producer behavior, the estimated loss in surplus is less than the engineering costs under a perfectly competitive market setting. In this case, the annual surplus losses are, on average, equal to 98 to 99 percent of the calculated engineering costs. The cost numbers in Table 9.9-5 are not discounted.

Based upon a ratio of the loss in surplus to engineering costs, holding baseline quantity constant, a projection of the surplus loss over the future year stream is calculated from the future stream of engineering costs that appear in Chapter 7. This projection of the future stream of surplus losses is compared to the future stream of engineering costs in Table 9.9-6. Note that these results are not discounted nor do they account for fuel cost savings.

Table 9.9-5
Interim Engineering Cost and Surplus Loss Comparison for the ATV Based on Year 2001 Quantity (Q = 880,000 ATV)*

Year	Estimated Engineering Costs	Estimated Surplus Loss
2006	$37,840.0	$37,593.0
2007	$72,160.0	$71,261.7
2008	$68,640.0	$67,827.2
2009	$62,480.0	$61,806.5
2010	$58,080.0	$57,498.0
2011	$50,160.0	$49,726.0
2012	$46,640.0	$46,264.7
2013	$46,640.0	$46,264.7
2014	$46,640.0	$46,264.7
2015	$46,640.0	$46,264.7
2016	$44,880.0	$44,532.5
2017-2030	$42,240.0	$41,932.2

*Estimates are based on baseline year of 2001 and reflect 2001 dollars.

Table 9.9-6
Engineering Cost and Surplus Loss Comparison for the ATV Market without Fuel Cost Savings (Q = ATV projected sales for 2006 through 2030)*

Year	Estimated Engineering Costs	Estimated Surplus Loss
2006	$42,463.9	$42,186.6
2007	$81,270.6	$80,258.8
2008	$76,518.0	$75,611.8
2009	$70,287.0	$69,529.4
2010	$65,302.2	$64.681.3
2011	$56,379.5	$55,891.6
2012	$52,441.5	$52,019.5
2013	$52,441.5	$52,019.5
2014	$52,441.5	$52,019.5
2015	$52,441.5	$52,019.5
2016	$50,000.0	$49,612.0
2017-2030	$47,556.8	$47,210.3

*Estimates reflect growth in sales projected in the future and are based on 2001 dollars.

9.7.5 ATV Economic Impact Results with Fuel Cost Savings

In Table 9.9-7, the social costs/gains are calculated by adding the annual savings in fuel costs (presented initially in Chapter 7) to the projected annual surplus loss. These social gains are compared to the engineering costs with fuel efficiency gains. As you can see from this table, the emissions control program is expected to yield social gains rather than losses beginning in 2019.

Table 9.9-7
Engineering and Social Cost Comparison for the ATV Market with Fuel Cost Savings (Q = ATV projected sales for 2006 through 2030)

Year	Estimated Engineering Costs with Fuel Cost Savings	Estimated Social Costs/Gains (Surplus Loss - Fuel Savings)*
2006	$41,529.9	$41,252.7
2007	$77,878.5	$76,563.7
2008	$69,563.1	$68,657.0
2009	$59,363.1	$58,605.5
2010	$50,192.8	$49,541.9
2011	$36,888.3	$36,400.4
2012	$28,565.3	$28,143.4
2013	$24,252.7	$23,830.7
2014	$20,127.2	$19,705.2
2015	$16,223.2	$15,801.2
2016	$10,167.9	$9,780.7
2017	$4,433.1	$4,086.6
2018	$1,706.8	$1,360.2
2019	($109.4)	($456.0)
2020	($1,283.9)	($1,630.4)
2021	($2,083.2)	($2,429.8)
2022	($2,577.5)	($2,924.0)
2023	($2,951.6)	($3,298.2)
2024	($3,234.2)	($3,580.7)
2025	($3,443.4)	($3,790.0)
2026	($3,596.0)	($3,942.6)
2027	($3,707.7)	($4,054.2)
2028	($3.786.4)	($4,132.9)
2029	($3,842.7)	($4,189.3)
2030	($3,881.4)	($4,227.9)

* ( ) represents a negative cost (social gain). Cost estimates are based upon 2001$

9.10 Off-Highway Motorcycles

9.10.1 Off-Highway Motorcycle Baseline Market Characterization

Inputs to the economic analysis are for the year 2001. Baseline characterization of the off-highway motorcycle market includes the domestic quantity of off-highway motorcycles produced, quantity of imports, baseline market price, demand elasticity, and domestic and foreign supply elasticity measures. Table 9.10-1 provides the baseline data on the U.S. off-highway motorcycle market used in this analysis.

Table 9.10-1
Baseline Characterization of the U.S. Off-Highway Motorcycle Market: 2001

Inputs	Baseline Observation
Market price ($/off-highway motorcycle)	$2,253.00
Market output (off-highway motorcycle)	195250
Domestic	82463
Foreign	112787
Elasticities	
Domestic supply (estimated)	0.93
Foreign supply (assumed)	0.93
Demand (assumed)	-2

The total quantity of off-highway motorcycle sold in the U.S. was obtained from the MIC The quantity of imports of off-highway motorcycle from the International Trade Commission. According to ITC data, imports for NAICS code 336991 account for nearly 58 percent of domestic sales.

The price of off-highway motorcycles used is the average off-highway motorcycle price in 2001 provide by MIC. An average off-highway motorcycle market price is required to operationalize the perfectly competitive national-level market model used to examine the economic impacts of this rule on the U.S. off-highway motorcycle market. The import ratios for Motorcycles, Bicycles, and Parts Manufactures are assumed to be a reasonable proxy for off-highway motorcycle imports.

The estimates of demand and supply elasticity have been discussed in detail in Section 9.5.2.5. A separate estimate of foreign supply elasticity has not been carried out. For modeling purposes, we assume that the foreign supply elasticity is equal to the domestic supply elasticity.

9.10.2 Off- Highway Motorcycle Control Costs

The emissions control costs used in the economic analysis are developed and reported in Chapter 5. In this section, we briefly recount the estimated regulatory cost per off-highway motorcycle that are used to in the model. The regulatory cost per unit faced by off-highway motorcycle producers leads to a decrease in the market supply curve. As stated earlier, the compliance costs per off-highway motorcycle are projected to change in future years as different phases of the emissions control program are implemented and as the learning curve is applied (see Chapter 5 for a discussion of the learning curve). The regulatory cost per off-highway motorcycles are presented in Table 9.10-2 for the years in which they change.

Table 9.10-2
Regulatory Costs Per Off-Highway Motorcycle

Year	Cost Per Off-Highway Motorcycle	Cost Description
2006	$79	Phase 1/year 1 costs
2007	$155	Phase 1/year 2 costs
2008	$143	Phase 1/year 3 costs
2009	$128	Phase 1/year 4 costs
2010	$117	Phase 1/year 5 costs
2011	$102	Phase 1/year 6 costs
2012-2030	$99	Phase 1/year 7 costs

Economic impacts are estimated based upon these costs. In the model, the baseline year quantity and price of off-highway motorcycle are used and the per unit costs are imposed on the model to determine price, quantity, and consumer and producer surplus changes.

9.10.3 Off-Highway Motorcycles Economic Impact Results

The economic impacts of the regulation on the off-highway motorcycle market are estimated for each year in which the per engine regulatory costs change, assuming the baseline year 2001 price and quantity. Estimated projected quantities of off-highway motorcycle sales through the year 2030 are available, however we do not have projected future year prices. Without this information, we cannot estimate the economic impacts of the future costs assuming future year quantities and prices. Any price projections would be subject to significant uncertainties. We instead rely upon the most current year of data to inform the model when we impose the future costs per off-highway motorcycle on producers. Assuming annual sales and average prices are increasing for off-highway motorcycles, this model approach tends to overstate the potential price and quantity impacts. Using baseline year data allows us to estimate relative changes in price and quantity as opposed to absolute changes. The estimated percent changes in price and quantity, the losses in consumer and producer surplus, and total surplus loss are presented for various years in Tables 9.10-3. These results do not account for fuel cost savings that may arise from this emissions control program.

Table 9.10-3
Price and Quantity Changes for the Off-Highway Motorcycle Market*

Impact Measure	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012-2030**
Cost Per Unit	$79	$155	$143	$128	$117	$102	$99
Change in Market Price	1.11%	2.18%	2.01%	1.80%	1.65%	1.44%	1.39%
Change in Market Output	-2.23%	-4.37%	-4.03%	-3.61%	-3.30%	-2.87%	-2.79%
Domestic	-2.23%	-4.37%	-4.03%	-3.61%	-3.30%	-2.87%	-2.79%
Foreign	-2.23%	-4.37%	-4.03%	-3.61%	-3.30%	-2.87%	-2.79%

*Results are the same for the years 2012 through 2030. These results are not reported in separate columns to avoid repetition. Results are based on baseline year 2001 market conditions and fuel cost savings are not included.

For the per off-highway motorcycle engine costs resulting from the implementation of the emissions control program, the relative increases in price over the future time period examined are 2.18 percent or less. By the year 2012, the relative price increase falls to approximately 1.4 percent. The percent reductions in the market quantity of off-highway motorcycles ranges from 2.23 percent to 4.37 percent, reaching a steady state of 2.79 percent in 2012. Note that the percent reduction in quantity is the same for both domestic and foreign output because it has been assumed that domestic and foreign supply have the same price elasticity.

Table 9.10-4 presents the loss in consumer surplus, the loss in producer surplus, and the total loss in surplus (equal to the sum of the changes in consumer and producer surplus) without fuel cost savings. As the table shows, the consumer surplus loss is approximately half the size of the loss in producer surplus. Consumer surplus losses range from nearly $5 million in year 2006 when the rule is first implemented, it rises to $9 million in 2007 and falls to $ 6 million in 2012 and the years beyond. The losses in producer surplus range from $10 million in the first year of implementation, rising to $19 million in 2007 and falls to $12.7 million in 2012 and the years beyond. Note that the annual surplus loss associated with the off-highway motorcycle market declines as the per off-highway motorcycle engine costs fall starting in 2008. Loss in surplus is equal to $15 million in 2006, rises to 28.7 in 2007 and it falls to $18.7 million by 2012. The surplus estimate presented in Table 9.10-4 is based upon 2001 baseline market conditions and do not consider fuel cost savings.

Table 9.10-4
Annual Losses in Consumer and
Producer Surplus for the Off-Highway Motorcycle Market*

Impact Measure	Year			
	2006	**2007**	**2008**	**2009**
Loss in CS** ($\$10^3$)	$ 4,841.4	$ 9,369.1	$ 8,683.7	$ 7,789.6
Loss in PS*** ($\$10^3$)	$10,177.3	$19,304.6	$17,906.7	$16,136.5
Domestic	$ 4,298.3	$ 8,153.2	$ 7,562.8	$ 6,815.2
Foreign	$ 5,879.0	$11,151.4	$10,343.9	$ 9,321.3
Loss in Surplus ($\$10^3$)	$15,018.7	$28,700.7	$26,590.3	$23,926.1
	2010	**2011**	**2012-2030**	
Loss in CS** ($\$10^3$)	$ 7,131.4	$ 6,230.5	$ 6,049.8	
Loss in PS*** ($\$10^3$)	$14,822.3	$13,008.2	$12,642.3	
Domestic	$ 6,260.2	$ 5,493.9	$ 5,339.4	
Foreign	$ 8,562.1	$ 7,514.2	$ 7,302.9	
Loss in Surplus ($\$10^3$)	$21,953.7	$19,238.6	$18,692.1	

*Results are based on baseline year 2001 market conditions and fuel cost savings are not included.
** CS refers to consumer surplus and is rounded to the nearest hundredths. For a description of the change in consumer surplus, see Section 9.2.2
*** PS refers to producer surplus and is rounded to the nearest hundredths. For a description of the change in producer surplus, see Section 9.2.2.

9.10.4 Off-Highway Motorcycle Engineering Cost and Surplus Loss Comparison

This section presents a comparison of the future stream of engineering costs (excluding fuel cost savings) and surplus losses for the off-highway motorcycle market. In Table 9.10-5, we first present an interim comparison of the estimated engineering costs, holding quantity constant to the baseline year quantity, with the surplus losses that were estimated from the economic impact model. Because economic modeling takes into account consumer and producer behavior, the estimated loss in surplus is less than the engineering costs under a perfectly competitive market setting. In this case, the annual surplus losses are, on average, equal to 98 to 99 percent of the calculated engineering costs. The cost numbers in this table and Table 9.10-6 are not discounted.

Based upon a ratio of the loss in surplus to engineering costs, holding baseline quantity constant, a projection of the surplus loss over the future year stream is calculated from the future stream of engineering costs that appear in Chapter 7. This projection of the future stream of surplus losses is compared to the future stream of engineering costs in Table 9.10-6. Note that these results are not discounted nor do they account for fuel cost savings.

9.10.5 Off-Highway Motorcycle Economic Impact Results with Fuel Cost Savings

In Table 9.10-7, the social costs/gains are calculated by adding the annual savings in fuel costs (presented initially in Chapter 7) to the projected annual surplus loss. These social gains are compared to the engineering costs with fuel efficiency gains. As you can see from this table, the emissions control program is expected to yield social gains rather than losses beyond the initial year of implementation. Only the initial year of implementation results in a social loss from this regulation for the off-highway motorcycle market.

Table 9.10-5
Interim Engineering Cost and Surplus Loss Comparison for the Off-Highway Motorcycle Market Based on Year 2001 Quantity
(Q = 195,250 off-highway motorcycle)

Year	Estimated Engineering Costs	Estimated Surplus Loss
2006	$15,424.8	$15,018.7
2007	$30,263.8	$28,700.7
2008	$27,920.8	$26,590.3
2009	$24,992.0	$23,926.1
2010	$22,844.3	$21,953.7
2011-2030	$19,915.5	$19,238.6

Table 9.10-6
Engineering Cost and Surplus Loss Comparison for the Off-Highway Motorcycle Market without Fuel Cost Savings
(Q = Off-Highway Motorcycle projected sales for 2006 through 2030)

Year	Estimated Engineering Costs	Estimated Surplus Loss
2006	$16,269.1	$15,840.8
2007	$32,215.0	$30,551.2
2008	$29,846.5	$28,424.3
2009	$27,127.3	$25,970.3
2010	$24,957.7	$23,984.8
2011	$22,079.4	$21,328.9
2012	$21,630.7	$20,895.5
2013	$21,847.0	$21,104.4
2014	$22,065.4	$21,315.5
2015	$22,286.1	$21,528.6
2016	$22,508.9	$21,743.9
2017	$22,734.0	$21,961.4
2018	$22,961.4	$22.181.0
2019	$23,191.0	$22,402.8
2020	$23,422.9	$22.626.8
2021	$23,657.1	$22,853.1
2022	$23,893.7	$23,081.6
2023	$24,132.6	$23,312.4
2024	$24,374.0	$23,545.6
2025	$24,617.7	$23,781.0
2026	$24,863.9	$24,018.8
2027	$25,112.5	$24,259.0
2028	$25,363.6	$24,501.6
2029	$25,617.3	$24,746.6
2030	$25,873.5	$24,994.1

Table 9.10-7
Engineering and Social Cost Comparison for the Off-Highway Motorcycle Market with Fuel Cost Savings
(Q = Off-Highway Motorcycle projected sales for 2006 through 2030)

Year	Estimated Engineering Costs with Fuel Cost Savings	Estimated Social Costs/Gains (Surplus Loss - Fuel Savings)*
2006	$15,635.6	$15,207.4
2007	$30,153.2	$28,489.4
2008	$26,080.9	$24,658.7
2009	$21,459.3	$20,302.3
2010	$17,305.2	$16,332.2
2011	$12,409.1	$11,658.7
2012	$9,978.0	$9,242.8
2013	$8,293.5	$7,551.0
2014	$6,660.8	$5,910.8
2015	$5,090.2	$4,332.7
2016	$3,658.5	$2,893.5
2017	$2,529.9	$1,757.2
2018	$1,818.9	$1,039.5
2019	$1,397.3	$609.1
2020	$1,121.1	$325.0
2021	$923.2	$119.2
2022	$777.1	($35.0)
2023	$686.8	($133.4)
2024	$633.0	($195.4)
2025	$596.1	($240.6)
2026	$589.0	($256.0)
2027	$601.6	($252.0)
2028	$617.6	($244.9)
2029	$656.3	($214.4)
2030	$708.7	($170.7)

* ( ) represents a negative cost (social gain). Cost estimates are based upon 2001$

Appendix to Chapter 9: Sensitivity Analyses

This appendix presents the results from a series of sensitivity analyses completed for the recreational vehicles emissions standard. The sensitivity analyses examine how the market impacts for each vehicle category would be affected if different measures of supply and demand elasticities were used. For each vehicle category, changes in market price, quantity, and loss of consumer and producer surplus are calculated by first varying the elasticity of supply, holding the elasticity of demand fixed at the original value and then varying the elasticity of demand, holding supply elasticity fixed at its original value. The sensitivity analyses are conducted using the highest per vehicle costs over the future time stream of the regulation. We use the highest annual per vehicle costs to ensure that our sensitivity analysis examines a worst-case scenario. Analysis results are presented in comparison tables.

In order to estimate the economic impacts of the regulation on the each of the vehicle markets, we rely upon the most current year of data (either 2000 or 2001, depending on the vehicle category) to inform the model when we impose the regulatory costs per vessel on producers. Using baseline year data allows us to estimate relative changes in price and quantity as opposed to absolute changes. The results presented in these sensitivity analyses do not account for fuel cost savings that may arise from this emissions control program.

Some general observations can be made about the market impacts resulting from a regulation that affects production costs when different measures of supply and demand elasticity are used and when demand and supply are assumed to be linear. The changes in market price and quantity are smaller for an inward shift in the supply curve the more inelastic is the supply curve. The more inelastic is the demand curve, the larger is the equilibrium change in market price and the smaller is the change in market quantity from an inward shift in the supply curve.

9A.1 Sensitivity Analyses for Marine

The original estimates of supply and demand elasticity for the diesel inboard cruiser market are $\varepsilon = 1.57$ (for domestic and foreign supply) and $\eta = -1.44$, both of which are elastic. Using the highest per vessel costs of $905 which first occur in the year 2009, the market impacts on price, quantity, and surplus losses are calculated first by varying measures of supply elasticity holding demand elasticity constant and then by varying measures of demand elasticity holding supply elasticity constant. These results are presented in Tables 9A.1-1 and 9A.1-2.

In the first column of Table 9A.1-1, we reproduce the original market impacts for the year 2009 that were originally presented in Section 9.6 and compare them to the market impacts calculated when supply elasticity is assumed to be equal to $\varepsilon = 1.00$ (supply is unit elastic) and $\varepsilon = 0.50$ (supply is inelastic). Demand elasticity is assumed to equal -1.44 for each of these cases. As the results show, the relative increase in market price and decrease in market output are smaller as supply becomes more inelastic. Additionally, the more inelastic is supply, the smaller is the loss in consumer surplus and larger is the loss in producer surplus. Consumer surplus loss falls to just below $2 million from approximately $4 million while producer surplus losses increases to $5.7 million from $3.6 million. While there is a change in the distribution of surplus loss across consumers and producers, there is almost no change in the overall loss in surplus with more inelastic supply. The overall surplus loss increases only by $5.6 thousand.

Table 9A.1-1
Supply Elasticity Sensitivity Analysis: Market Impacts for the Diesel Inboard Cruiser Market*

Impact Measures	**Original Results** $\xi = 1.57, \eta = -1.44$	**Unit Elastic Supply** $\xi = 1.00, \eta = -1.44$	**Inelastic Supply** $\xi = 0.50, \eta = -1.44$
Change in Market Price	0.14%	0.11%	0.07%
Change in Market Output	-0.20%	-0.16%	-0.10%
Loss in CS ($\$10^3$)**	$3,977.7	$3,126.1	$1,966.5
Loss in PS* ($\$10^3$)**	$3,641.1	$4,494.6	$5,657.9
Loss in Surplus ($\$10^3$)	$7,618.8	$7.620.7	$7,624.4

*Results are calculated using the highest per vehicle regulatory costs, which are equal to $905 and are projected to occur in the year 2009/10. Results are based on baseline year 2001 market conditions.
** CS refers to consumer surplus and is rounded to the nearest hundredths.
*** PS refers to producer surplus and is rounded to the nearest hundredths.

Table 9A.1-2 presents a comparison of the market impacts when demand elasticity is varied while holding supply elasticity constant at 1.57. We calculate the changes in market price, quantity, and surplus losses assuming $\eta = -1.00$ (demand is unit elastic) and $\eta = -0.50$ (demand is inelastic) and compare these results to the original results first presented in Section 9.6. As we assume a more inelastic demand curve, the change in market price increases while the change in quantity decreases. However, even when we assume inelastic demand, the change in market price for diesel inboard cruisers is still under one-quarter of one percent. We also can examine the change in consumer and producer surplus. In this case, consumer surplus loss increases and producer surplus loss decreases as demand becomes more inelastic. The loss in consumer surplus rises from $3.9 million to $5.9 million while producer surplus loss decreases from $3.6 million to $1.8 million. Overall surplus loss rises by approximately $9.2 thousand as demand becomes more inelastic, again a minuscule amount.

Table 9A.1-2
Demand Elasticity Sensitivity Analysis: Market Impacts for the Diesel Inboard Cruiser Market*

Impact Measures	Original Results $\xi = 1.57, \eta = -1.44$	Unit Elastic Demand $\xi = 1.57, \eta = -1.00$	Inelastic Demand $\xi = 1.57 \eta = -0.50$
Change in Market Price	0.14%	0.16%	0.20%
Change in Market Output	-0.20%	-0.16%	-0.10%
Loss in CS ($\$10^3$)**	$3,977.7	$4,659.6	$5,786.9
Loss in PS* ($\$10^3$)**	$3,641.1	$2,963.1	$1,841.1
Loss in Surplus ($\$10^3$)	$7,618.8	$7,622.7	$7,628.0

*Results are calculated using the highest per vehicle regulatory costs, which are equal to $1,552 and are projected to occur in the year 2009/10. Results are based on baseline year 2001 market conditions.
** CS refers to consumer surplus and is rounded to the nearest hundredths.
*** PS refers to producer surplus and is rounded to the nearest hundredths.

9A.2 Sensitivity Analyses for Forklifts

For the forklift market, the original economic impact analysis used an inelastic estimate of supply, equal to ε = 0.714 (for domestic and foreign supply), and an elastic estimate of demand, equal to η = -1.5. The highest per vehicle costs for the forklift market, $610, are incurred during 2004, which is the first year the regulation is implemented. Tables 9A.2-1 and 9A.2-2 present the sensitivity analyses assuming varying supply elasticities and varying demand elasticities, respectively. The results include the changes in market price, quantity, and losses in consumer and producer surplus.

Table 9A.2-1 presents the original results for the year 2004 from Section 9.7 of the analysis and then presents the market impacts assuming ε = 1.00 (supply is unit elastic) and ε = 1.50 (supply in elastic). According to these results, we find that as the supply curve becomes more elastic, the changes in both market price and quantity are larger. Assuming elastic supply, we find that the increase in market price is equal to 1.16 percent and the decrease in market quantity is equal to -1.73 percent. These market impacts, though larger than those we find when supply is assumed to be inelastic, are not significant. We also examine the changes in consumer and producer surplus to find that as supply becomes more elastic, the loss in consumer surplus increases from $12.7 million to $19.7 million and the loss in producer surplus falls from $26.4 million to $19.3 million. Along with this redistribution of surplus loss is a reduction in the overall loss in surplus as supply is assumed to be elastic. The overall loss in surplus originally was equal to $39.1 million but falls to just under $39 million when ε = 1.50.

Table 9A.2-1
Supply Elasticity Sensitivity Analysis: Market Impacts for the Forklift Market*

Impact Measures	**Original Results** $\xi = 0.714, \eta = -1.50$	**Unit Elastic Supply** $\xi = 1.00, \eta = -1.50$	**Elastic Supply** $\xi = 1.50, \eta = -1.50$
Change in Market Price	0.75%	0.92%	1.16%
Change in Market Output	-1.12%	-1.39%	-1.73%
Loss in CS ($\$10^3$)**	$12,715.3	$15,750.0	$19,653.1
Loss in PS* ($\$10^3$)**	$26,412.4	$23,294.9	$19,309.3
Loss in Surplus ($\$10^3$)	$39,127.7	$29,044.9	$38,962.4

*Results are calculated using the highest per vehicle regulatory costs, which are projected to occur in the year 2004 and are equal to $610 per forklift. Results are based on baseline year 2000 market conditions.
** CS refers to consumer surplus and is rounded to the nearest hundredths.
*** PS refers to producer surplus and is rounded to the nearest hundredths.

In the next table, demand elasticity is varied holding supply elasticity constant. The original results were generated assuming $\varepsilon = 0.714$ and $\eta = -1.5$. To conduct the sensitivity analysis, we estimated the market impacts when demand elasticity was equal to -1 (unit elastic) and also when it was equal to -0.5 (inelastic). The results in Table 9A.2-2 show that as demand becomes more inelastic, the change in market price increases while the change in quantity decreases. The largest change in market price is approximately 1.4 percent, which is still small in scale. An examination of the surplus measures shows that the loss in consumer surplus increases and the loss in producer surplus decreases as demand is more inelastic. Originally, consumer surplus loss was equal to $12.7 million and producer surplus was equal to $26.4 million. For the inelastic demand case, consumer surplus loss increases to $23.4 million while the loss in producer surplus falls to $16.2 million. Like the diesel marine vessel case, the overall change in the total loss in surplus is negligible, approximately $3 thousand.

A sensitivity analysis for forklifts was also conducted using the estimated elasticity of demand discussed in Section 9.5 of Chapter 9. The demand elasticity estimated is equal to -5.76, a rather large estimate. Table 9A.2-3 presents a comparison of the original market impacts originally presented in Chapter 9 with the market impacts when $\varepsilon = 0.714$ and $\eta = -5.76$. From this sensitivity analysis, EPA finds that the relative increase in market price is one-quarter of one percent while the decrease in market output is approximately one and one-half percent. The price increase is smaller relative to the original results because of the extremely elastic demand measure. Overall, these market impacts are not very different from the original results.

What does differ a great deal is the distribution of the loss in welfare. Originally, the loss in producer surplus was approximately two times the size of the loss in consumer surplus. When the elasticity of demand is equal to -5.76, however, virtually all of the loss in economic welfare is incurred by producers. Almost 90 percent of the loss in welfare is borne by producers while 10 percent is borne by consumers.

Table 9A.2-2
Demand Elasticity Sensitivity Analysis: Market Impacts for the Forklift Market*

Impact Measures	**Original Results** $\xi = 0.714, \eta = -1.50$	**Unit Elastic Demand** $\xi = 0.714, \eta = -1.00$	**Inelastic Demand** $\xi = 0.714, \eta = -0.50$
Change in Market Price	0.75%	0.96%	1.36%
Change in Market Output	-1.12%	-0.96%	-0.68%
Loss in CS ($\$10^3$)**	$12,715.3	$16,437.4	$23,240.4
Loss in PS* ($\$10^3$)**	$26,412.4	$22,798.8	$16,163.7
Loss in Surplus ($\$10^3$)	$39,127.7	$39,236.2	$39,404.1

*Results are calculated using the highest per vehicle regulatory costs, which are projected to occur in the year 2004 and are equal to $610 per forklift. Results are based on baseline year 2000 market conditions.

** CS refers to consumer surplus and is rounded to the nearest hundredths.

*** PS refers to producer surplus and is rounded to the nearest hundredths.

Table 9A.2-3
Alternative Demand Elasticity Sensitivity Analysis: Market Impacts for the Forklift Market*

Impact Measures	**Original Results** $\xi = 0.714, \eta = -1.50$	**Alternative Elastic Demand** $\xi = 0.714, \eta = -5.76$
Change in Market Price	0.75%	0.25%
Change in Market Output	-1.12%	-1.47%
Loss in CS ($\$10^3$)**	$12,715.3	$4,340.8
Loss in PS* ($\$10^3$)**	$26,412.4	$34,499.8
Loss in Surplus ($\$10^3$)	$39,127.7	$38,840.6

*Results are calculated using the highest per vehicle regulatory costs, which are projected to occur in the year 2004 and are equal to $610 per forklift. Results are based on baseline year 2000 market conditions.

** CS refers to consumer surplus and is rounded to the nearest hundredths.

*** PS refers to producer surplus and is rounded to the nearest hundredths.

9A.3 Sensitivity Analyses for Snowmobiles

For the snowmobile market, the original economic impact analysis used an elastic estimate of supply, equal to ε = 2.1 (for domestic and foreign supply), and an elastic estimate of demand, equal to η = -2.0. The steady state per vehicle engine modification costs resulting from the regulation for the snowmobiles market of $180, are incurred during 2017 through 2030. This per unit vehicle cost of emission controls is based upon 2001 price levels, Phase 3 regulatory requirements, and incorporates the impact of the learning curve for the engine modification costs. The EPA contends these per unit costs represent those the snowmobile manufacturers will experience on an ongoing basis due to this regulation. Tables 9A.3-1 and 9A.3-2 present the sensitivity analyses assuming varying supply elasticities and varying demand elasticities, respectively. The results include the changes in market price, quantity, and losses in consumer and producer surplus. All estimates are based upon the 2001 baseline market conditions.

Table 9A.3-1 presents the original results for the year 2017-2030 from Section 9.8 of the analysis and then presents the market impacts assuming ε = 2.6 (supply is more elastic) and ε = 1.60 (supply is less elastic). According to these results, we find that as the supply curve becomes more elastic, the changes in both market price and quantity are somewhat larger. These market impacts, though larger than those we find when supply is assumed to be 2.1, are not significantly different. We also examine the changes in consumer and producer surplus to find that as supply becomes more elastic, the loss in consumer surplus increases from $12.8 million to $14.1 million and the loss in producer surplus falls from $11.8 million to $10.5 million. Along with this redistribution of surplus loss is a reduction in the overall loss in surplus as supply is assumed to be more elastic. When supply is assumed to be less elastic, price and quantity impacts decrease. With less elastic supply producers bear more of the cost of the regulation. As illustrated by this sensitivity analysis, price and quantity market impacts do not change substantially with reasonable changes in the supply elasticity measures. As supply become less elastic producers bear more of the cost of the regulation.

Table 9A.3-1
Supply Elasticity Sensitivity Analysis: Market Impacts for the Snowmobile Market*

Impact Measures	**Original Results** $\xi = 2.1, \eta = -2.0$	**More Elastic Supply** $\xi = 2.6, \eta = -2.0$	**Less Elastic Supply** $\xi = 1.60, \eta = -.2.0$
Change in Market Price	1.45%	1.60%	1.26%
Change in Market Output	-2.90%	-3.20%	-2.52%
Loss in CS (10^3)**	$12,777.4	$14,078.6	$11,108.8
Loss in PS* (10^3)**	$11,810.9	$10,447.6	$13,532.7
Loss in Surplus (10^3)	$24,588.3	$24,556.2	$24,641.0

*Results are calculated using the steady-state per vehicle regulatory costs, which are projected to occur in the year 2015 through 2030 and are equal to $178 per snowmobile. Results are based on baseline year 2001 market conditions.

** CS refers to consumer surplus and is rounded to the nearest hundred.

*** PS refers to producer surplus and is rounded to the nearest hundred.

In the next table, demand elasticity is varied holding supply elasticity constant. The original results were generated assuming ε = 2.1 and η = -2.0. To conduct the sensitivity analysis, we estimated the market impacts when demand elasticity was equal to -2.5 (more elastic) and also when it was equal to -1.5 (less elastic). The results in Table 9A.3-2 show that as demand becomes more elastic, the change in market price decreases while the change in quantity increases. With more elastic demand, producers bear more of the burden of the regulation, while consumers bear less. The overall surplus loss declines slightly. With less elastic demand, the price change increases and quantity change decreases somewhat. Consumers pay a larger share of the cost of the regulation with less elastic demand and producers a smaller share. The surplus losses associated with the regulation increase slightly.

On August 2, 2002, National Economic Research Associates (NERA) provided the EPA with the document *Economic Assessments of Alternative Emission Standards for Snowmobile Engines* on behalf of ISMA. In this report, an estimate of the price elasticity of demand for snowmobiles is presented. The EPA does not accept the validity of this elasticity estimate for a number of reasons (see September 11, 2002 memorandum from Chris Lieske and Linda Chappell to Docket A-2000-01, Document IV-B-45). In an effort to provide additional information to quantify the market impacts of a more elastic price elasticity of demand, market impacts for a price elasticity of demand estimate of -4.63 are presented in Table 9A.3-2. As shown in the third column of this table, projected price increases are smaller and market quantity decreases are somewhat larger assuming a price elasticity of demand estimate of -4.63. In addition, producers bear a greater portion of the burden of the regulation assuming the more elastic price elasticity of demand.

Table 9A.3-2
Demand Elasticity Sensitivity Analysis: Market Impacts for the Snowmobile Market*

Impact Measures	Original Results $x = 2.1, h = -2.0$	More Elastic Demand $\xi = 2.1, \eta = -2.5$	More Elastic Demand $x = 2.1, h = -4.63$	Less Elastic Demand $\xi = 2.1, \eta = -1.5$
Change in Market Price	1.45%	1.29%	0.88%	1.65%
Change in Market Output	-2.90%	-3.23%	-1.09%	-2.48%
Loss in CS ($\$10^3$)**	$12,777.4	$11,369.4	$7,737.1	$14,583.2
Loss in PS* ($\$10^3$)**	$11,810.9	$13,090.6	$16,364.5	$10,155.4
Loss in Surplus ($\$10^3$)	$24,588.3	$24,460.0	$24,083.6	$24,738.6

*Results are calculated using the steady-state per vehicle regulatory costs, which are projected to occur in the year 2015 through 2030 and are equal to $$178 per snowmobile. Results are based on baseline year 2001 market conditions.

** CS refers to consumer surplus and is rounded to the nearest hundred.

*** PS refers to producer surplus and is rounded to the nearest hundred.

In general, the sensitivity analysis indicates that market impacts are not particularly sensitive to reasonable changes in the price elasticity of supply and demand. However, this sensitivity analysis does indicate that the surplus losses borne by consumers and producers are impacted by these estimates. Less elastic supply leads to the producer bearing a greater percentage of the losses due to the regulation. Less elastic demand leads to consumers bearing more of the cost of the regulation.

9A.4 Sensitivity Analyses for ATV

For the ATV market, the original economic impact analysis used an original estimate of supply, equal to $\varepsilon = 1.0$ (for domestic and foreign supply), and an elastic estimate of demand, equal to $\eta = -2.0$. The steady state per vehicle costs for the ATV market, $48, are incurred during 2012 through 2030. Tables 9A.4-1 and 9A.4-2 present the sensitivity analyses assuming varying supply elasticities and varying demand elasticities, respectively. The results include the changes in market price, quantity, and losses in consumer and producer surplus.

Table 9A.4-1 presents the original results for the year 2012 from Section 9.9 of the analysis and then presents the market impacts assuming $\varepsilon = 1.50$ (supply is more elastic) and $\varepsilon = .50$ (supply in elastic). Assuming the more elastic supply of $\varepsilon = 1.50$, we find that the increase in market price is equal to 0.40 percent and the decrease in market quantity is equal to -0.80 percent. Assuming the in elastic supply of $\varepsilon = 0.50$, we find that the increase in market price is equal to 0.19 percent and the decrease in market quantity is equal to -0.37 percent. We also examine the changes in consumer and producer surplus to find that as supply becomes more elastic, the loss in consumer surplus increases were \$18.0 million and \$8.4 million and the loss in producer surplus are \$23.8 million and \$33.4 million, respectively . The overall loss in surplus originally was equal to \$41.9 million and \$42.0 million, respectively.

Table 9A.4-1
Supply Elasticity Sensitivity Analysis: Market Impacts for the ATV Market*

Impact Measures	**Original Results** $\xi = 1.0, \eta = -2.0$	**More Elastic Supply** $\xi = 1.5, \eta = -2.0$	**InElastic Supply**
Change in Market Price	0.31%	0.40%	0.19%
Change in Market Output	-0.62%	-0.80%	-0.37%
Loss in CS ($\$10^3$)**	\$14,036.0	\$18,030.2	\$8,432.2
Loss in PS* ($\$10^3$)**	\$27,896.2	\$23,846.4	\$33,401.4
Loss in Surplus ($\$10^3$)	\$41,932.2	\$41,876.5	\$42,034.2

*Results are calculated using the steady state per vehicle regulatory costs, which are projected to occur in the year 2012 through 2030 and are equal to \$48 per ATV. Results are based on baseline year 2001 market conditions.
** CS refers to consumer surplus and is rounded to the nearest hundredths.
*** PS refers to producer surplus and is rounded to the nearest hundredths.

In the next table, demand elasticity is varied holding supply elasticity constant. The original results were generated assuming $\varepsilon = 1.0$ and $\eta = -2.0$. To conduct the sensitivity analysis, we estimated the market impacts when demand elasticity was equal to -2.5 (more elastic) and also when it was equal to -1.5 (less elastic). The results in Table 9A.4-2 show that as demand becomes more inelastic, the change in market price increases while the change in quantity decreases. An examination of the surplus measures shows that the loss in consumer surplus increases and the loss in producer surplus decreases as demand is more inelastic. Originally, consumer surplus loss was equal to \$14.0 million and producer surplus was equal to \$27.9 million. For the more elastic demand case, consumer surplus loss falls to \$12.0 million while the loss in producer surplus increase to \$29.9 million. The overall change in the total loss in surplus is negligible, approximately \$20.

Table 9A.4-2
Demand Elasticity Sensitivity Analysis: Market Impacts for the ATV Market*

Impact Measures	**Original Results** a2	**More Elastic Demand** -2	**Inelastic Demand** $x = 1.0, h = -1.5$
Change in Market Price	0.31%	0.27%	0.37%
Change in Market Output	-0.62%	-0.67%	-0.56%
Loss in CS (\$$10^3$)**	\$14,036.0	\$12,028.2	\$16,848.5
Loss in PS* (\$$10^3$)**	\$27,896.2	\$29,868.6	\$25,130.3
Loss in Surplus (\$$10^3$)	\$41,932.2	\$41,876.7	\$41,978.8

*Results are calculated using the steady state per vehicle regulatory costs, which are projected to occur in the year 2012 through 2030 and are equal to $48 per ATV. Results are based on baseline year 2001 market conditions.
** CS refers to consumer surplus and is rounded to the nearest hundredths.
*** PS refers to producer surplus and is rounded to the nearest hundredths.

9A.5 Sensitivity Analyses for Off-Highway Motorcycle

For the off-highway motorcycle market, the original economic impact analysis used an original estimate of supply, equal to $\varepsilon = 0.93$ (for domestic and foreign supply), and an elastic estimate of demand, equal to $\eta = -2.0$. The steady state per vehicle costs for the off-highway motorcycle market, $99, are incurred during 2012 through 2030. Tables 9A.5-1 and 9A.5-2 present the sensitivity analyses assuming varying supply elasticities and varying demand elasticities, respectively. The results include the changes in market price, quantity, and losses in consumer and producer surplus.

Table 9A.5-1 presents the original results for the year 2012 from Section 9.10 of the analysis and then presents the market impacts assuming $\varepsilon = 1.50$ (supply is more elastic) and $\varepsilon = .50$ (supply in elastic). Assuming the more elastic supply of $\varepsilon = 1.50$, we find that the increase in market price is equal to 1.88 percent and the decrease in market quantity is equal to -3.77 percent. Assuming the in elastic supply of $\varepsilon = 0.50$, we find that the increase in market price is equal to 0.88 percent and the decrease in market quantity is equal to -1.76 percent. We also examine the changes in consumer and producer surplus to find that as supply becomes more elastic, the loss in consumer surplus increases were $8.1 million and $3.8 million and the loss in producer surplus are $10.4 million and $15.1 million, respectively . The overall loss in surplus originally was equal to $18.6 million and $18.9 million, respectively.

Table 9A.5-1
Supply Elasticity Sensitivity Analysis: Market Impacts for the Off-highway Motorcycle Market*

Impact Measures	**Original Results** $x = 0.93, h = -2.0$	**More Elastic Supply** $x = 1.5, h = -2.0$	**InElastic Supply** $x = .50, h = -2.0$
Change in Market Price	1.39%	1.88%	.88%
Change in Market Output	-2.79%	-3.77%	-1.76%
Loss in CS ($10^3)**	$6,049.8	$8,128.2	$3,832.0
Loss in PS* ($10^3)**	$12,642.3	$10,421.5	$15,056.1
Loss in Surplus ($10^3)	$5,339.42	$18,549.7	$18,888.1

*Results are calculated using the steady state per vehicle regulatory costs, which are projected to occur in the year 2012 through 2030 and are equal to $99 per off-highway motorcycle. Results are based on baseline year 2001 market conditions.
** CS refers to consumer surplus and is rounded to the nearest hundredths.
*** PS refers to producer surplus and is rounded to the nearest hundredths.

In the next table, demand elasticity is varied holding supply elasticity constant. The original results were generated assuming $\varepsilon = 0.93$ and $\eta = -2.0$. To conduct the sensitivity analysis, we estimated the market impacts when demand elasticity was equal to -2.5 (more elastic) and also when it was equal to -1.5 (less elastic). The results in Table 9A.2-5 show that as demand becomes more inelastic, the change in market price increases while the change in quantity decreases. An examination of the surplus measures shows that the loss in consumer surplus increases and the loss in producer surplus decreases as demand is more inelastic. Originally, consumer surplus loss was equal to $6.1 million and producer surplus was equal to $12.7 million. For the more elastic demand case, consumer surplus loss falls to $5.6 million while the loss in producer surplus increase to $13.5 million. The overall change in the total loss in surplus is negligible, approximately $10.

Table 9A.5-2
Demand Elasticity Sensitivity Analysis: Market Impacts for the Off-highway Motorcycle Market*

Impact Measures	**Original Results** $\xi = 0.93, \eta = -2.0$	**More Elastic Demand** $\xi = 0.93, \eta = -2.5$	**Inelastic Demand** $\xi = 0.93, \eta = -1.5$
Change in Market Price	1.39%	1.19%	1.68%
Change in Market Output	-2.79%	-2.98%	-2.52%
Loss in CS (\$$10^3$)**	\$6,049.8	\$5,163.0	\$7,304.5
Loss in PS* (\$$10^3$)**	\$12,649.3	\$13,459.3	\$11,480.5
Loss in Surplus (\$$10^3$)	\$18,692.1	\$18,622.2	\$18,785.0

*Results are calculated using the steady state per vehicle regulatory costs, which are projected to occur in the year 2012 through 2030 and are equal to $99 per off-highway motorcycle. Results are based on baseline year 2001 market conditions.

** CS refers to consumer surplus and is rounded to the nearest hundredths.

*** PS refers to producer surplus and is rounded to the nearest hundredths.

Chapter 9 References

1. International Snowmobile Manufacturing Association. www.snowmobile.org. 2002. Docket A-2000-01, Document IV-A-140.

2. U.S. EPA. 1999. OAQPS Economic Analysis Resource Document. Office of Air Quality Planning and Standards, Air Quality Strategies and Standards Division, Innovative Strategies and Economics Group. April. Docket A-2000-01, Document IV-A-71.

3. National Park Service *News Release*. Final Snowmobile Regulations For Yellowstone and Grand Teton National Parks Published in Federal Register. January 23, 2001. Docket A-2000-01, Document No. IV-A-119.

4. See Letter from Linc Wehrly to Docket, titled "News Articles for Yamaha 4-Stroke Snowmobile." Docket A-2000-01. Docket A-2000-01, Document IV-B-25.

5. Internet Search. www.yamaha-motors.com. August 2002. Docket A-2000-01, Document Nos. IV-A-111, IV-A-121, and IV-A-139.

6. Production data were taken from OELINK Database owned by Power Systems Research.

7. Internet Search. www.yamaha-motors.com. June 2002. Docket A-2000-01, Document Nos. IV-A-111, IV-A-121, and IV-A-139.

8. Estimated based upon submission of data by ISMA manufacturers and Southwest Research Institute. Carroll (1999), White et.al. (1997), Hare and Springer 1974, White and Wright (1998). These documents can be found in Docket A-2000-01, Documents II-B-19, II-D-15, IV-A-142, II-A-50, and II-D-05.

9. Estimated based upon submission of data by ISMA manufacturers and Southwest Research Institute. Carroll (1999), White et.al. (1997), Hare and Springer 1974, White and Wright (1998). These documents can be found in Docket A-2000-01, Documents II-B-19, II-D-15, IV-A-142, II-A-50, and II-D-05.

10. Internet Search. www.polarisindustries.com/product/default.asp?contentid=sno June 2002. Docket A-2000-01, Document Nos. IV-A-111, IV-A-120, and IV-A-139.

11. Internet Search. www.yamaha-motors.com. June 2002 Docket A-2000-01, Document Nos. IV-A-111, IV-A-120, and IV-A-139.

12. Internet Search. www.yamaha-motors.com. June 2002. Docket A-2000-01, Document Nos. IV-A-111, IV-A-120, and IV-A-139.

13. Internet Search. http://www.arctic-cat.com/snowmobiles/index.asp June 2002. Docket A-2000-01, Document Nos. IV-A-111, IV-A-120, and IV-A-139.

14. Internet Search. www.polarisindustries.com/product/default.asp?contentid=sno, www.yamaha-motors.com., www.yamaha-motors.com., http://www.arctic-cat.com/snowmobiles/index.asp June 2002. Docket A-2000-01, Document Nos. IV-A-111, IV-A-120, IV-A-121, and IV-A-139.

15. Internet Search. www.polarisindustries.com/product/default.asp?contentid=sno, www.yamaha-motors.com., www.yamaha-motors.com., http://www.arctic-cat.com/snowmobiles/index.asp June 2002. Docket A-2000-01, Document Nos. IV-A-111, IV-A-120, IV-A-121, and IV-A-139

16. Internet Search. www.polarisindustries.com/product/default.asp?contentid=sno, www.yamaha-motors.com., www.yamaha-motors.com., http://www.arctic-cat.com/snowmobiles/index.asp June 2002. Docket A-2000-01, Document Nos. IV-A-111, IV-A-120, IV-A-121, and IV-A-139.

17. Internet Search. www.polarisindustries.com/product/default.asp?contentid=sno, www.yamaha-motors.com., www.yamaha-motors.com., http://www.arctic-cat.com/snowmobiles/index.asp June 2002. Docket A-2000-01, Document Nos. IV-A-111, IV-A-120, IV-A-121, and IV-A-139.

18. Raboy, David G. 1987. Results of an Economic Analysis of Proposed Excise Taxes on Boats mimeo. Washington DC: Patton, Boggs, and Blow. Prepared for the National Marine Manufacturing Association. Docket A-2000-01, Document IV-A-129.

19. National Bureau of Economic Research and U.S. Census Bureau, Center for Economic Research. 2002. NBER-CES Manufacturing Industry Database, 1958 - 1996. http://www.nber.org/nberces/nbprod96.htm Docket A-2000-01, Document IV-A-48 and IV-A-190.

20. U.S. Department of Commerce. 2001. 1999 Annual Survey of Manufactures - Statistics for Industry Groups and Industries. Washington, DC: Government Printing Office. Docket A-2000-01, Document IV-A-58

21. Bureau of Economic Analysis. 2002. Survey of Current Business - D. Domestic Perspectives. January. http://www.bea.doc.gov/bea/ARTICLES/2002/01January/D-Pages/0102DpgD.pdf. Docket A-2000-01, Document IV-A-55.

22. Bureau of Economic Analysis.1999. Survey of Current Business - D. Domestic Perspectives. December. http://www.bea.doc.gov/bea/ARTICLES/NATIONAL/NIPAREL/1999/1299dpgd.pdf. Docket A-2000-01, Document IV-A-56.

23. Bureau of Economic Analysis. 2002. Shipments of Manufacturing Industries. http://www.bea.doc.gov/bea/dn2/gpo.htm Docket A-2000-01, Document IV-A-44 and IV-A-191.

24. Bureau of Economic Analysis. National Income and Product Accounts Tables. Table 7.1 - Quantity and Price Indices for GDP. http://www.bea.gov/bea/dn/nipaweb/SelectTable.asp?Selected=Y#s7 Docket A-2000-01, Document IV-A-192.

25. Pindyck, Robert S. and Daniel L. Rubinfeld. Econometric Models and Economic Forecasts, 2nd edition. McGraw Hill Publishing. 1981. Pages174-201.

26. Industrial Truck Association. 2002. Membership Handbook. http://www.indtrk.com/ Copies of relevant pages can be found in Docket A-2000-01, Document IV-A-188.

27. National Bureau of Economic Research and U.S. Census Bureau, Center for Economic Research. 2002. NBER-CES Manufacturing Industry Database, 1958 - 1996. http://www.nber.org/nberces/nbprod96.htm Docket A-2000-01, Document IV-A-48 and IV-A-190.

28. U.S. Department of Commerce. 2001. 1999 Annual Survey of Manufactures - Statistics for Industry Groups and Industries. Washington, DC: Government Printing Office. Docket A-2000-01, Document IV-A-58.

29. Bureau of Economic Analysis. 2002. Survey of Current Business - D. Domestic Perspectives. January. http://www.bea.doc.gov/bea/ARTICLES/2002/01January/D-Pages/0102DpgD.pdf Docket A-2000-01, Document IV-A-55

30. Bureau of Economic Analysis. 1999. Survey of Current Business - D. Domestic Perspectives. December. http://www.bea.doc.gov/bea/ARTICLES/NATIONAL/NIPAREL/1999/1299dpgd.pdf Docket A-2000-01, Document IV-A-56.

31. Bureau of Economic Analysis. 2002. Shipments of Manufacturing Industries. http://www.bea.doc.gov/bea/dn2/gpo.htm Docket A-2000-01, Document IV-A-44 and IV-A-191.

32. Bureau of Economic Analysis. National Income and Product Accounts Tables. Table 7.1 - Quantity and Price Indices for GDP. http://www.bea.gov/bea/dn/nipaweb/SelectTable.asp?Selected=Y#s7 Docket A-2000-01, Document IV-A-192.

33. National Bureau of Economic Research and U.S. Census Bureau, Center for Economic Research. 2002. NBER-CES Manufacturing Industry Database, 1958 - 1996. http://www.nber.org/nberces/nbprod96.htm Docket A-2000-01, Document IV-A-48 and IV-A-190.

34. U.S. Department of Commerce. 2001. 1999 Annual Survey of Manufactures - Statistics for Industry Groups and Industries. Washington, DC: Government Printing Office. Docket A-2000-01, Document IV-A-58.

35. Bureau of Economic Analysis. 2002. Survey of Current Business - D. Domestic Perspectives. January. http://www.bea.doc.gov/bea/ARTICLES/2002/01January/D-Pages/0102DpgD.pdf Docket A-2000-01, Document IV-A-55.

36. Bureau of Economic Analysis. 1999. Survey of Current Business - D. Domestic Perspectives. December. http://www.bea.doc.gov/bea/ARTICLES/NATIONAL/NIPAREL/1999/1299dpgd.pdf Docket A-2000-01, Document IV-A-56.

37. Bureau of Economic Analysis. 2002. Shipments of Manufacturing Industries. http://www.bea.doc.gov/bea/dn2/gpo.htm Docket A-2000-01, Document IV-A-44 and IV-A-191.

38. Bureau of Economic Analysis. National Income and Product Accounts Tables. Table 7.1 - Quantity and Price Indices for GDP. http://www.bea.gov/bea/dn/nipaweb/SelectTable.asp?Selected=Y#s7 Docket A-2000-01, Document IV-A-192.

39. Raboy, David G. 1987. Results of an Economic Analysis of Proposed Excise Taxes on Boats mimeo. Washington DC: Patton, Boggs, and Blow. Prepared for the National Marine Manufacturing Association. Docket A-2000-01, Document IV-A-129.

40. National Bureau of Economic Research and U.S. Census Bureau, Center for Economic Research. 2002 NBER-CES Manufacturing Industry Database, 1958 - 1996. Docket A-2000-01, Document IV-A-48 and IV-A-190.

41. U. S. Department of Commerce. 2001. 1999 Annual Survey of Manufacturers - Statistics for Industry Groups and Industries. Washington, DC Government Printing Office. Docket A-2000-01, Document IV-A-58.

42. U. S. Department of Commerce. 2001. 2000 Annual Survey of Manufacturers - Statistics for Industry Groups and Industries. Washington, DC Government Printing Office.

43. Bureau of Economic Analysis. 2002. Shipments of Manufacturing Industries. http://bea.gov/bea/dn2/gpo.htm Docket A-2000-01, Document IV-A-44 and IV-A-191.

44. Bureau of Economic Analysis. 2002. Survey of Current Business -D Domestic Perspectives. January. http://www.bea.doc/bea/ARTICLES/2002/01January/D-Pages/0102Dpg.pdf Docket A-2000-01, Document IV-A-55.

45. Bureau of Economic Analysis. 1999. Survey of Current Business -D Domestic Perspectives. December. http://www.bea.doc/bea/ARTICLES/NATIONAL/NIPAREL/19991299dpgd.pdf Docket A-2000-01, Document IV-A-56.

46. International Snowmobile Manufacturers Association. www.snowmobile.org. June 2002.

47. US Census Bureau, Historical Income Tables – Households, Table H-6, Regions – Households (All Races) by Median and Mean Income, 1975-2000. A copy of this information can be found in Docket A-2000-01, Document VI-A-203.

48. Raboy, David G. 1987. Results of an Economic Analysis of Proposed Excise Taxes on Boats mimeo. Washington DC: Patton, Boggs, and Blow. Prepared for the National Marine Manufacturing Association. Docket A-2000-01, Document IV-A-129.

49. Raboy, David G. 1987. Results of an Economic Analysis of Proposed Excise Taxes on Boats mimeo. Washington DC: Patton, Boggs, and Blow. Prepared for the National Marine Manufacturing Association. Docket A-2000-01, Document IV-A-129.

50. National Bureau of Economic Research and U.S. Census Bureau, Center for Economic Research. 2002 NBER-CES Manufacturing Industry Database, 1958 - 1996. Docket A-2000-01, Document IV-A-48 and IV-A-190.

51. U. S. Department of Commerce. 2001. 1999 Annual Survey of Manufacturers - Statistics for Industry Groups and Industries. Washington, DC Government Printing Office. Docket A-2000-01, Document IV-A-58.

52. Bureau of Economic Analysis. 2002. Shipments of Manufacturing Industries. http://bea.gov/bea/dn2/gpo.htm Docket A-2000-01, Document IV-A-44 and IV-A-191.

53. Bureau of Economic Analysis. 2002. Survey of Current Business -D Domestic Perspectives. January. http://www.bea.doc/bea/ARTICLES/2002/01January/D-Pages/0102Dpg.pdf Docket A-2000-01, Document IV-A-55.

54. Bureau of Economic Analysis. 2002. Shipments of Manufacturing Industries. http://bea.gov/bea/dn2/gpo.htm Docket A-2000-01, Document IV-A-44 and IV-A-191.

55. Bureau of Economic Analysis. 1999. Survey of Current Business -D Domestic Perspectives. December. http://www.bea.doc/bea/ARTICLES/NATIONAL/NIPAREL/19991299dpgd.pdf Docket A-2000-01, Document IV-A-56.

56. Motorcycle Industry Council, Inc. 2002. Docket A-2000-01, Document No. IV-A-138.

57. US Census Bureau, Historical Income Tables – Households, Table H-6, Regions – Households (All Races) by Median and Mean Income, 1975-2000. A copy of this information can be found in Docket A-2000-01, Document VI-A-203.

58. National Marine Manufacturing Association. *U.S. Recreational Boating Domestic Shipment Statistics, 1970 - 1998*. http://63.236.237.146/facts/history.pdf Docket A-2000-01, Document IV-A-49.

59. National Marine Manufacturing Association. Boating 2001 - Facts and Figures at a Glance. http://www.nmma.org/facts/boatingstats/2001/ Docket A-2000-01, Document IV-A-50.

60. Teleconference with John McKnight of the National Marine Manufacturers Association on April 15, 2002.

61. Boating Industry. 1996. The Boating Business, 1995 Annual Industry Review. January. Docket A-2000-01, Document IV-A-43.

62. National Marine Manufacturing Association. 2002. Economic Impact Analysis of the Diesel Engine Rule on the U.S. Boat Market. Table 4 - Product Analysis: Inboard Boats, Imports. Docket A-2000-01, Document IV-A-53.

63. National Marine Manufacturing Association. 2002. Economic Impact Analysis of the Diesel Engine Rule on the U.S. Boat Market. Docket A-2000-01, Document IV-A-53.

64. ISMA Snowmobile Statistics www.snowmobile.org. June 2002.

65. Production data were taken from OELINK Database owned by Power Systems Research.