EPA-420-D-10-100

July 2010

Heavy Duty Truck Retail Price Equivalent and Indirect Cost Multipliers

Draft Report

Prepared for

Chi Li
Office of Transportation and Air Quality
Assessment and Standard Division
2000 Traverwood Dr.
Ann Arbor, MI 48105

Prepared by

Alex Rogozhin
Michael Gallaher
Anthony Lentz
RTI International
3040 Cornwallis Road
Research Triangle Park, NC 27709

Walter McManus
Transportation Research Institute
University of Michigan
2901 Baxter Road
Ann Arbor, MI 48109

RTI Project Number 0211577.003.002

RTI Project Number
0211577.003.002

Heavy Duty Truck Retail Price Equivalent and Indirect Cost Multipliers

Draft Report

Prepared for

Chi Li
Office of Transportation and Air Quality
Assessment and Standard Division
2000 Traverwood Dr.
Ann Arbor, MI 48105

Prepared by

Alex Rogozhin
Michael Gallaher
Anthony Lentz
RTI International
3040 Cornwallis Road
Research Triangle Park, NC 27709

Walter McManus
Transportation Research Institute
University of Michigan
2901 Baxter Road
Ann Arbor, MI 48109

CONTENTS

LIST OF FIGURES

Number **Page**

LIST OF TABLES

Number **Page**

SECTION 1
INTRODUCTION

In order to produce a unit of output, heavy duty truck manufacturers incur direct and indirect costs. Direct costs include cost of materials and labor costs. Indirect costs may be related to production (such as research and development [R&D]), corporate operations (such as salaries, pensions, and health care costs for corporate staff), or selling (such as transportation, dealer support, and marketing). Similarly to direct costs, indirect costs are generally recovered by allocating a share of the costs to each unit of good sold (Vyas, Santini, and Cuenca, 2000). Although it is possible to account for direct costs allocated to each unit of good sold, it is more challenging to account for indirect costs allocated to a unit of good sold. To make a cost analysis process more feasible, markup factors, which relate indirect costs to the changes in direct costs, have been developed. These factors are often referred to as retail price equivalent (RPE) multipliers.

Cost analysts and regulatory agencies (including the U.S. Environmental Protection Agency [EPA]) have frequently used these multipliers to predict the resultant impact on costs associated with heavy duty truck manufacturers' responses to regulatory requirements. Clearly the best approach to determining the impact of changes in direct manufacturing costs on a manufacturer's indirect costs would be to actually estimate the cost impact on each indirect cost element. However, doing this within the constraints of an agency's time or budget is not always feasible, or the technical, financial, and accounting information to carry out such an analysis may simply be unavailable. Given this, EPA has continued to use RPE multipliers for some of their regulatory cost analyses.

RPE multipliers provide, at an aggregate level, the relative shares of revenues[1] to direct manufacturing costs. The numerator of this ratio comprises direct costs, indirect costs, and net income:

$$\text{RPE multiplier} = (\text{direct costs} + \text{indirect costs} + \text{net income})/(\text{direct costs})$$

Using RPE multipliers implicitly assumes that incremental changes in direct manufacturing costs produce common incremental changes in all indirect cost contributors as well as net income. A concern in using the RPE multiplier in cost analysis for new technologies (which result from regulations requiring reductions in emissions) is that the indirect costs of

[1] Revenue = Direct Costs + Indirect Costs + Net Income

vehicle modifications are not likely to be the same for different technologies. For example, less complex technologies could require fewer R&D efforts or less warranty coverage than more complex technologies. In addition, some simple technological adjustments may, for example, have no effect on the number of corporate personnel (Rogozhin et al., 2010).

To address this concern, modified multipliers have been developed. These multipliers are referred to as indirect cost multipliers (or IC multipliers). In contrast to RPE multipliers, IC multipliers assign unique incremental changes to each indirect cost contributor.

$$\text{IC multiplier} = (\text{direct cost} + \text{adjusted indirect cost})/(\text{direct cost})$$

The incremental change in indirect cost contributors varies based on the complexity of the technology and the time frame under consideration. Further, there is no reason to expect that the contributors would be the same for engine manufacturers as for truck manufacturers. This report uses the methodology developed for "Automobile Industry Retail Price Equivalent and Indirect Cost Multipliers Report" (the "LD RPE/IC study") (Rogozhin, Gallaher, and McManus, 2009). This report develops IC multipliers for the heavy duty truck manufacturing industry using financial data from, for reasons highlighted below, Hino, Cummins, PACCAR, Navistar, Daimler, and Volvo.

We derived two separate sets of IC multipliers: one for engine manufacturers (based on the data from Cummins and Hino) and another for heavy duty truck manufacturers (based on the information from PACCAR, Navistar, Daimler, and Volvo). Cummins' market share for heavy duty truck engines in North America equaled 45% in 2008 (Cummins, 2009), and Hino is one of the largest suppliers of heavy duty truck engines in Asia. The four heavy duty truck companies account for an 80% share of the heavy duty truck industry in North America (IBIS, 2010). Therefore, financial information from these companies serves as a good representation of the U.S. heavy duty engine and truck industry as a whole.

The remainder of the report is structured as follows: Section 2 discusses published studies that have attempted to estimate indirect costs without using cost multipliers. Section 3 describes the methodology, sources, and calculations of the RPE multiplier for the heavy duty engine and truck manufacturing industries. Section 4 describes the methodology and calculations of the IC multipliers for the same industries. Section 5 presents example technologies and the IC multipliers associated with them. Section 6 compares the RPE multiplier approach with the integrated IC multipliers and market model approach. Section 7 presents a summary of the

findings and our conclusions, and Appendix A outlines detailed calculations of the RPE multipliers for individual manufacturers.

SECTION 2
APPROACHES TO ESTIMATE INDIRECT COSTS WITHOUT USING MULTIPLIERS

This section describes studies that estimate indirect costs in the process of estimating total production costs. These studies do not rely on the use of multipliers but instead estimate indirect costs by adding overhead costs, distributing overhead costs in proportion to activities performed on a product during manufacturing, and mathematical modeling.

There is a set of studies that developed a "bottom-up" approach to calculating indirect costs, which estimate overhead costs by summing all overhead costs (for example, Son [1991]). This method requires detailed information about resources consumed to produce a product, including purchasing, processing, and maintenance costs. EPA also used a similar approach for its regulatory analyses of rules on nonroad diesel and on locomotive and marine compression ignition engines. In those analyses, EPA calculated R&D and tooling components of indirect costs (e.g., EPA, 2004; EPA, 2008).

Activity-based costing (ABC), developed by Cooper and Kaplan (1988), is another method to estimate indirect costs. This method distributes the overhead costs in proportion to the activities performed on a product to manufacture it. The method uses activity time estimates such as labor rates (direct labor costs or direct labor hour rates) or volume-based rates (machine hour, material cost, or units produced) as bases to calculate overhead rates.

Mathematical modeling has also been used to calculate indirect costs for an Asian electrical engineering company. Niazi et al. (2007) estimated indirect costs by modeling material and time-related overhead costs.

When in-depth information and resources are available, one of these approaches might be appropriate. However, when faced with limited information or time constraints, the multiplier approach provides an effective and efficient way to estimate indirect costs. In the next section, we present studies that estimated RPE multipliers in the past and describe our methodology to estimate RPE and IC multipliers.

SECTION 3
RPE MULTIPLIER

The RPE multiplier is a ratio that relates direct costs, indirect costs, and net income[1] to direct costs. When multiplied by the direct costs of a new technology, this multiplier is intended to estimate the effects of the new technology on the costs associated with heavy duty truck manufacturers' responses to regulatory requirements. RPE multipliers are typically calculated from a heavy duty truck company's financial statements under the implicit assumption that all technologies in a company bear the same proportion of indirect costs. The RPE multiplier is calculated as follows:

$$\text{RPE Multiplier} = \frac{(\text{Direct Cost} + \text{Indirect Cost} + \text{Net Income})}{\text{Direct Cost}} = 1 + \frac{(\text{Indirect Cost} + \text{Net Income})}{\text{Direct Cost}}$$

3.1 Previously Published Studies on RPE Multiplier

The authors of this report were unable to find any studies that estimated RPE multipliers specifically for heavy duty truck manufacturers (the 1985 Jack Faucett Associates report to EPA included multipliers for heavy duty engine manufacturers but none for heavy duty truck manufacturers). However, many of the cost contributors developed for light duty vehicles are applicable to heavy duty vehicles. Several studies estimated RPE multipliers for the light duty automobile manufacturing industry. These values are presented in Table 3-1 and range between 1.26 (a value developed for EPA in 1985) and 2.0 (the value for outsourced parts estimated by researchers at Argonne National Laboratory). The range of multiplier values should serve as an indicator that using one multiplier for all new technologies should be considered an approximation in the absence of better information.

3.2 Description of Cost Contributors to RPE Multiplier

Table 3-2 presents the contributors that constitute the RPE multiplier. Components of the multiplier include manufacturing costs, production overhead costs, corporate overhead costs, manufacturer selling costs, and manufacturer net income. In addition, we accounted for dealer costs of selling new vehicles and dealer net income from selling new vehicles. For each manufacturer, we gathered financial information using annual and 10-K reports and systematically assigned it to the contributors listed in Table 3-2.

[1] Net income is the accounting term that is used for measuring accounting profit.

Table 3-1. RPE Multipliers in Previous Studies

Study	Year	Findings
Jack Faucett Associates, EPA	1985	1.26
Spinney et al.	1998	1.5
Vyas, Santini, and Cuenca, Argonne National Laboratory	2000	2.0 for components developed internally 1.5 for outsourced components
National Research Council	2002	1.4
McKinsey & Company	2003	1.7
Sierra Research, Inc. for Alliance of Automobile Manufacturers	2007	2.0 at least
Rogozhin et al.	2009	1.46

3.3 Data Sources

We used publicly available sources so the results of this study would be replicable and transparent. We gathered financial information for two heavy duty engine manufacturers (Cummins, Hino) and four heavy duty truck manufacturers (PACCAR, Navistar, Daimler, and Volvo). Using several manufacturers instead of one provided more robustness to the results.

The majority of the information for the analysis was obtained from manufacturers' annual reports and 10-K reports to the Securities and Exchange Commission (SEC). The analysis was conducted using 2008 data for all manufacturers. Unfortunately, direct and indirect costs are not standard accounting terms. As a result, each manufacturer presented the breakdown of costs in a unique fashion, while still following acceptable accounting procedures. We tried to consolidate these costs in a systematic manner for each manufacturer to be able to average results for the industry.

Indirect costs associated with new technologies are expected to differ based on the degree of complexity of the technology and the time frame involved. Technology-specific adjustment factors used in our methodology were developed for the LD RPE/IC report. These factors were estimated using two different methods: consensus approach and Delphi-based method. These methods are briefly described in the remainder of this section. The estimates for both of these approaches are re-presented in Section 4.3 for convenience. We believe that these factors are appropriate to use for the heavy duty truck industry given the similar structures of the light duty vehicle and heady duty truck industries (e.g., similar R&D challenges, similar employee benefits, similar competitive environment).

Table 3-2. RPE Multiplier Cost Contributors

Contributor	Description
Manufacturing (Direct Cost)	
Manufacturing cost	Cost of materials and labor cost
Production Overhead (Indirect Cost)	
Warranty	Cost of providing product warranty
R&D (research and development)	Cost of developing and engineering the product
Depreciation and amortization	Cost related to depreciation and amortization of manufacturing facilities and equipment
Maintenance, repair, operations cost	Costs related to maintenance, repair, and operations of manufacturing facilities and equipment
Corporate Overhead (Indirect Cost)	
General and administrative (G&A)	Costs related to salaries of nonmanufacturing labor, operations of corporate office, etc.
Retirement	Cost of pension for nonmanufacturing labor
Health care	Costs of health care for nonmanufacturing labor
Selling (Indirect Cost)	
Transportation	Costs related to transporting manufactured goods
Marketing	Costs related to advertising of the manufactured goods (manufacturer costs).
Dealer (Indirect Cost)	
Dealer new vehicle net income	Net income to dealers from sales of new vehicles
Dealer new vehicle selling expense	Costs related to sales of the new vehicles by dealers (dealer costs).
Net Income	Net income to manufacturers

Consensus Approach: EPA's National Vehicle and Fuel Emissions Laboratory assembled a team of engineers with experience working for auto manufacturers to provide adjustment factors for the RPE multiplier cost contributors. The team had among them 11 bachelor's degrees in engineering and physics; 10 master's degrees in engineering, atmospheric chemistry, and business; and one Ph.D. in mechanical engineering.

Together the team had approximately 100 years of experience working for auto and engine manufacturers and service companies plus expertise in a wide range of auto technologies, including (among others) engines, powertrains, onboard diagnostics, fuel economy, and

emissions controls. The team met five times over a period of 3 weeks and developed consensus estimates for adjustment factors that capture the differences in the impact of low-, medium-, and high-complexity technologies on each of the cost contributors to the RPE multiplier.

Delphi-Based Method: EPA also used a process based on the Delphi method and developed a set of adjustment factors based on the technologies not considered in the RPE/IC report (Helfand and Sherwood, 2009). These technologies were representative of the low-, medium-, and high-complexity technology definitions as described in the LD RPE/IC report. The Delphi-based method used a panel of automotive experts who provided individual, anonymous estimates of the adjustment factors. These experts then met three times to discuss both the process and the estimates of adjustment factors. After each meeting, experts were given an opportunity to change their answers.

3.4 Adjustments to RPE Multiplier Contributors

The way that costs are reported in annual reports may differ from one business to another. Because of this, assumptions and adjustments were necessary to arrive at RPE multipliers that would be consistent across companies. For example, we used "cost of sales" reported in annual reports as an estimate of direct costs. Cost of sales refers to direct costs attributable to the production of the goods sold by a company, which includes the cost of the materials used in creating the good along with the direct labor costs used to produce the good. However, the exact expenses included in cost of sales might differ from one manufacturer to another (Forbes, 2010). Nevertheless, cost of sales was the best estimate of direct costs reported by all companies.

In some cases, information from secondary sources, such as Heavy Duty Truck Manufacturers Industry Report by Supplier Relations LLC (referred to as "SR LLC report," 2009) and Census (2009), was used to fill in the gaps. For instance, Cummins, Hino, PACCAR, and Daimler did not report maintenance, repair, and operations costs; the factors of 0.01 (for engine manufacturers Cummins and Hino) and 0.02 (for heavy duty truck manufacturers PACCAR and Daimler) were calculated using Census data (based on the data for the Other Engine Equipment Manufacturing Industry [NAICS 333618] and Heavy Duty Truck Manufacturing Industry [NAICS 336120]). Section A.1 of the appendix to this report provides more details about these adjustments. The results of the procedure are presented in Table 3-3.

We also used data from the SR LLC report and Census to construct an industry average RPE multiplier for comparison purposes. The average equaled 1.42, which is higher than the

Table 3-3. RPE Multipliers and Cost Contributors: 2008

Cost Contributor				Engine Manufacturers		Truck Manufacturers			
Vehicle Manufacturing	**Heavy Duty Truck Industry (Reports)**	**Engine Manufacturers Industry Average**	**Truck Manufacturers Industry Average**	**Hino**	**Cummins**	**PACCAR**	**Navistar**	**Daimler**	**Volvo**
Manufacturing cost	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Production Overhead									
Warranty	0.03	0.02	0.04	0.01	0.02	0.03	0.02	0.04	0.04
R&D (product development)	0.05	0.04	0.05	0.03	0.04	0.03	0.03	0.05	0.06
Depreciation and amortization	0.05	0.03	0.04	0.04	0.03	0.06	0.03	0.03	0.06
Maintenance, repair, operations cost	0.02	0.01	0.02	0.01	0.01	0.02	0.03	0.02	0.01
Total production overhead	0.14	0.08	0.14	0.10	0.08	0.13	0.12	0.13	0.17
Corporate Overhead									
General and administrative	0.12	0.11	0.07	0.09	0.12	0.03	0.12	0.03	0.12
Retirement	0.01	0.01	0.01	0.01	0.01	0.01	0.03	0.01	0.01
Health	0.01	0.01	0.01	0.02	0.01	0.001	0.02	0.01	0.004
Total corporate overhead	0.15	0.13	0.09	0.12	0.14	0.04	0.16	0.05	0.13
Selling									
Transportation	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00
Marketing	0.01	0.01	0.01	0.00	0.01	0.01	0.00	0.01	0.01

(continued)

Table 3-3. RPE Multipliers and Cost Contributors: 2008 (continued)

Cost Contributor				Engine Manufacturers		Truck Manufacturers			
Vehicle Manufacturing	**Heavy Duty Truck Industry (Reports)**	**Engine Manufacturers Industry Average**	**Truck Manufacturers Industry Average**	**Hino**	**Cummins**	**PACCAR**	**Navistar**	**Daimler**	**Volvo**
Dealers									
Dealer new vehicle net income	< 0.01	—	< 0.01	—	—	< 0.01	< 0.01	< 0.01	< 0.01
Dealer new vehicle selling expense	0.06	—	0.06	—	—	0.06	0.06	0.06	0.06
Total selling and dealer costs	0.08	0.01	0.08	0.01	0.01	0.08	0.07	0.08	0.08
Sum of Indirect Costs	0.37	0.23	0.31	0.23	0.23	0.24	0.35	0.26	0.38
Net Income	0.05	0.05	0.05	0.02	0.06	0.09	0.01	0.07	0.04
Other costs (not included in contributing costs)	0.00	0.01	0.00	0.01	0.01	0.00	0.00	0.00	0.01
RPE multiplier	**1.42**	**1.28**	**1.36**	**1.25**	**1.29**	**1.33**	**1.36**	**1.34**	**1.43**

average calculated based on manufacturers' annual reports (1.28 for engine manufacturers and 1.36 for truck manufacturers). The reason for this difference could be that SR LLC report defined heavy duty industry based on U.S. Census NAICS 336120 (Heavy Duty Truck Manufacturing Industry),[2] while the RPE multiplier calculations in this report are based on four heavy duty truck and two heavy duty engine manufacturers.

Health care and retirement costs provided in manufacturers' annual reports include expenditures for both manufacturing and corporate labor. The share of these costs related to manufacturing labor is a part of manufacturing expenses and, therefore, was added to the manufacturing cost (direct cost). The share related to corporate workers is a part of indirect costs and was counted in the health care and retirement cost contributors. To determine how to attribute these shares, we looked at the Census data (Supplier Relations LLC, 2009). It reported salaries and wages separately. Salaries are the cost of corporate labor and accounted for 30% of total labor cost, and wages are the cost of manufacturing labor and accounted for 70% of total labor cost. Using this information, we assumed that approximately 70% of workers were involved in manufacturing, while 30% were involved in corporate operations for both heavy duty engine and truck manufacturers. This assumption is consistent with manufacturing/corporate labor division calculated for the LD RPE/IC multiplier study (Rogozhin et al., 2009).

Cummins, PACCAR, Navistar, Daimler, and Volvo did not report transportation costs. Thus, the industry average of 0.004 (industry average based on SR LLC report) was used as a proxy. PACCAR, Daimler, and Volvo did not report marketing costs. The heavy duty trucks industry engages in business-to-business marketing rather than business-to-consumer marketing. Our judgment is that business-to-business marketing costs are significantly lower than business-to-consumer marketing costs, possibly as low as 3 to 5% of business-to-consumer marketing costs per unit. We defined business-to-business marketing costs as 20% of the business-to-consumer marketing costs per unit from Rogozhin et al. (2009) as an upper bound.

The only costs that were added (rather than redistributed from one of the cost items reported in manufacturers' annual reports) were dealer new vehicle net income and dealer new vehicle selling expenses. These expenses are acquired by heavy duty truck dealers and are part of the final price of a vehicle. Given the similar structures of light duty vehicle and heavy duty

[2] NAICS 336120 includes manufacturers of heavy duty truck chassis and assemblers of complete heavy duty trucks, buses, heavy duty motor homes, and other special purpose heavy duty motor vehicles for highways. It also includes manufacturers of heavy duty motor vehicles and car bodies.

truck dealers (similar employee benefits, similar competitive environment, etc.) the value from the LD RPE/IC multiplier report (Rogozhin et al., 2009) was used as a proxy.[3]

Appendix A presents detailed calculations of cost contributors for each of the six manufacturers and industry averages based on the secondary sources.

3.5 Engine vs. Truck Manufacturer Multipliers

We calculated two separate RPE multipliers: one for heavy duty engine manufacturers and another for heavy duty truck manufacturers. The reason for differentiating between engine and truck manufacturers was the difference in their target markets. Although engine manufacturers sell product primarily to heavy duty truck manufacturers, heavy duty truck manufacturers sell product to end users. Because of this, dealer new vehicle selling expenses and dealer net income are not applicable to engine manufacturers. As a result, the indirect cost contributors are likely to be different for engine and truck manufacturers; hence, two RPE multipliers were developed.

3.6 Company-Level RPE Multipliers

Table 3-3 presents the values of cost contributors and RPE multipliers for individual manufacturers in 2008. Selling and dealer cost contributors were higher for heavy duty truck manufacturers because of the inclusion of dealer costs and net income. Other expenses, which are not part of indirect cost contributors, are reflected in Table 3-3 for completeness; they did not exceed 0.01 for all manufacturers.

To ensure that 2008 was not an outlier year, we looked at a 4-year historical analysis of indirect cost contributors for individual manufacturers. It would be costly to perform analysis similar to the one used for the year 2008 for every year, for every manufacturer. However, manufacturers' readily provided three major indirect cost contributing factors in their annual reports (selling, administrative, and other expenses; operating and other expenses; and depreciation). The sum of these factors varied within 9 percentage points in the past 4 years (see Appendix A for a historical RPE analysis for individual manufacturers).[4] Individual manufacturers' RPE multipliers were averaged in the process of constructing an industry average RPE multiplier and, thus, diminished the effect of variability of cost contributors for individual

[3] In the LD RPE/IC multiplier report, dealer new vehicle net income and new vehicle selling expenses were constructed using National Automobile Dealers Association (NADA) data. Similar data were not available for heavy duty truck dealers.

[4] If we were to exclude Daimler, which went through restructuring in 2007, the sum of three major cost contributors varied within 5 percentage points over the 4 years analyzed.

manufacturers in 2008. This led us to believe that 2008 RPE multipliers are unlikely to be underestimated.

3.7 Industry Average RPE Multipliers

The industry average RPE multipliers were calculated separately for heavy duty engine manufacturers and heavy duty truck manufacturers. The industry averages were calculated by weighting company-level RPE multipliers by their 2008 worldwide production. Table 3-4 presents company-level production alongside company-level RPE multipliers. In 2008, the industry average RPE multiplier for heavy duty engine manufacturers equaled 1.28, while the industry average RPE multiplier for heavy duty truck manufacturers equaled 1.36. The 2008 production figures presented in Table 3-4 were also used in Table 3-3 to generate industry-weighted average individual cost components.

Table 3-4. Weighted RPE Multipliers: 2008

Engine Manufacturer	Annual Production (number of engines/trucks) (2008)	RPE Multiplier
Cummins	108,300	1.29
Hino	45,765	1.25
Weighted average		1.28
Truck manufacturer		
PACCAR	125,900	1.33
Navistar	244,100	1.36
Daimler	472,000	1.34
Volvo	251,151	1.43
Weighted average		1.36

Sources: Cummins Inc. 2009. 2008 Annual Report on 10-K Form. Available at: http://phx.corporate-ir.net/phoenix.zhtml?c=112916&p=irol-reportsannual. Accessed on February 15, 2010.

IHS Global Insight. September 30, 2009. HIS Global Insight Report: Volvo Trucks (Automotive). Waltham, MA: IHS Global Insight.

IHS Global Insight. October 01, 2009. HIS Global Insight Report: PACCAR (Automotive). Waltham, MA: IHS Global Insight.

IHS Global Insight. September 18, 2009. HIS Global Insight Report: Navistar (Automotive). Waltham, MA: IHS Global Insight.

IHS Global Insight. September 14, 2009. HIS Global Insight Report: Daimler Trucks (Automotive). Waltham, MA: IHS Global Insight.

IHS Global Insight. September 18, 2009. HIS Global Insight Report: Volvo Trucks (Automotive). Waltham, MA: IHS Global Insight.

SECTION 4
IC MULTIPLIER

This section describes calculations of IC multipliers for engine and truck manufacturers. IC multipliers reflect differences in technology complexity and changes in indirect costs over time. The motivation is to model the diversity of potential cost impacts under a wide range of potential future environmental regulations.

In Section 3, we calculated an average RPE multiplier for the heavy duty engine manufacturing industry of approximately 1.28 and for the heavy duty truck manufacturing industry of approximately 1.36. These numbers include direct cost components, indirect cost components, and net income. In this section, we focus solely on indirect cost components that are likely to be affected by future environmental regulations. We show that only a portion of indirect cost contributors should be included in the markup factor. Because the resulting markup factors reflect changes in indirect costs relative to change in direct costs, they are referred to as IC multipliers.

Regulations that result in implementing different levels of technology complexity are likely to affect the price of the unit of output with different magnitudes. Regulations that result in manufacturers implementing a technology with low complexity (such as simply replacing an existing technology with a better performing technology) would be associated with a lower IC multiplier. Regulations that result in manufacturers implementing technology with high complexity (such as installing a technology that requires significant integration efforts) would be associated with a higher IC multiplier. In addition, the magnitude of impacts of different technologies is also likely to change over time as new technologies are assimilated. For example, although R&D expenses are likely to be high in the short term, in the long term, R&D efforts become less important as technology matures.

In this section, we describe the methodology used to calculate a set of IC multipliers for engine and truck manufacturers. Table 4-1 lists the indirect cost contributors from Table 3-3 that are applicable to IC multipliers. In this study we do not include net income among these cost contributors, mostly because net income results from the interaction of supply and demand. However, an argument can be made that net income should be included in long-term multipliers, and this is discussed further in Section 4.5.

Our approach is then to scale cost contributor values up or down depending on the complexity of the technology (low, medium, or high) and the time frame (short or long term).

Table 4-1. Weighted Average IC Multiplier Contributors to RPE: 2008

Cost Contributor	Heavy Duty Engine Manufacturers	Heavy Duty Truck Manufacturers
Production Overhead		
Warranty	0.02	0.04
R&D (product development)	0.04	0.05
Depreciation and amortization	0.03	0.04
Maintenance, repair, operations cost	0.01	0.02
Total production overhead	0.08	0.14
Corporate Overhead		
General and administrative	0.11	0.07
Retirement	0.01	0.01
Health care	0.01	0.01
Total corporate overhead	0.13	0.09
Selling		
Transportation	0.01	0.00
Marketing	0.01	0.01
Dealers		
Dealer new vehicle selling cost	—	0.06
Total selling and dealer costs	0.01	0.08
Sum of Indirect Costs	0.23	0.31

4.1 Technology Complexity and Impact on Operations

We identify three levels of technology complexity: low, medium, and high. Technology complexity was based on work by Henderson and Clark (1990).[1]

Low-complexity technology introduces only minor changes to an existing product, using an established design. The underlying core design concepts and the links between them remain the same. An example of such technology in the heavy duty truck industry is single wide tires, because they simply replace existing tires and require no vehicle redesign or part-integration effort by the heavy duty truck manufacturer.

[1] A more thorough discussion of the rationale of using three technology levels and their impacts on operations can be found in Rogozhin et al. (2010).

Medium-complexity technology changes either the architecture of how the components interact with each other or the core concept of the technology, but not both. An example of such technology in the heavy duty truck industry is engine turbo compounding. This technology would require some redesign and integration effort, since the parts' interaction with each other would have to be changed.

High-complexity technology establishes a set of new core design concepts embodied in components that are linked together in a new architecture. An example of such technology in the heavy duty truck industry is hybrid-electric powertrains because they represent an entirely new approach to propulsion relative to reliance on an internal combustion engine.

4.2 Time Frame and Impact on Operations

The time frame adds another dimension to this study. Many of the indirect costs are likely to be one-time or short-term activities, such as educating dealers and upgrading mechanics' equipment. These costs will not appear in the long-term IC multipliers. In addition, incremental R&D expenditures will occur over a short period of time, even though they may be amortized over 5 to 10 years (IRS, 2008). Thus, we expect to see higher indirect costs initially and lower impacts in the long term as companies assimilate the new technologies.

4.3 Adjustment Factors to Cost Contributors

The reason for developing adjustment factors was the fact that the cost contributors in Table 4-1 would not all respond the same to new technologies. Warranty costs, for instance, would probably be higher per dollar of direct costs for more complex technologies, because there would be more opportunities for failure. There is, however, no public information to estimate how indirect costs vary with different technologies. Instead, we relied on expert judgment.

In two separate processes, a team of EPA engineers evaluated how new technologies of different complexities (low, medium, and high) would affect indirect cost contributors in the short and long terms for light duty vehicles. The first process was a consensus approach, and the second was based on the Delphi method (these approaches are described in Section 3.2).

In both approaches, the team developed the adjustment factors with 0 and 1 as calibration units. An adjustment factor of 1 indicates that implementing the technology had an effect equal to the average effect of that indirect cost contributor per dollar of direct cost. For instance, the warranty cost per dollar of a new technology would equal the average warranty cost per dollar for the company. An adjustment factor of 0 indicated that implementing the technology did not affect that indirect cost contributor. For example, a new technology might not affect corporate overhead.

Tables 4-2 and 4-3 present the adjustment factors from the consensus process for light duty vehicles. Table 4-2 presents adjustment factors for the short term, while Table 4-3 presents adjustment factors for the long term (for a detailed discussion of the development of these factors, refer to Rogozhin et al. [2009]).

Table 4-2. Short-term Adjustment Factors to Indirect Cost Contributors for Light Duty Vehicles: Consensus Approach

Indirect Cost	Low	Medium	High
Production Overhead			
Warranty	1.2	1.6	2.0
R&D	0.2	1.1	2.0
Depreciation and amortization	0	0	1.0
Maintenance, repair, operations	0	0	1.0
Corporate Overhead			
General and administrative	0	0	0.5
Retirement	0	0	0.5
Health care	0	0	0.5
Selling			
Transportation	0	0	0.3
Marketing	0	1	1.5
Dealer new vehicle selling expense	0.1	1	1.5

Table 4-3. Long-Run Adjustment Factors to Indirect Cost Contributors for Light Duty Vehicles: Consensus Approach

Indirect Cost	Low	Medium	High
Production Overhead			
Warranty	0.6	0.8	1
R&D	0	0	0.3
Depreciation and amortization	0	0	1
Maintenance, repair, operations	0	0	1
Corporate Overhead			
General and administrative	0	0	0.5
Retirement	0	0	0.5
Health care	0	1	0.5
Selling			
Transportation	0	0	0.3
Marketing	0	0	0
Dealer new vehicle selling expense	0	0.3	1

Tables 4-4 and 4-5 present the adjustment factors from the Delphi-based method for light duty vehicles. Table 4-4 presents adjustment factors for the short term, while Table 4-5 presents adjustment factors for the long term.[2]

Table 4-4. Short-Term Adjustment Factors to Indirect Cost Contributors for Light Duty Vehicles: Delphi-Based Method

Indirect Cost	Low	Med	High
Production Overhead			
Warranty	0.361	1.386	2.289
R&D	0.822	1.481	3.732
Depreciation and amortization	0.373	0.585	1.444
Maintenance, repair, operations	0.488	0.712	1.396
Corporate Overhead			
General and administrative	0.339	0.579	1.057
Retirement	0.385	0.412	0.565
Health care	0.346	0.408	0.635
Selling			
Transportation	0.436	0.143	0.829
Marketing	0.215	0.821	1.511
Dealer new vehicle selling expense	0.250	0.626	1.296

Table 4-5. Long-Term Adjustment Factors to Indirect Cost Contributors for Light Duty Vehicles: Delphi-Based Method

Indirect Cost	Low	Med	High
Production Overhead			
Warranty	0.168	0.964	1.518
R&D	0.372	0.901	2.018
Depreciation and amortization	0.281	0.466	0.951
Maintenance, repair, operations	0.377	0.451	1.092
Corporate Overhead			
General and administrative	0.286	0.425	0.671
Retirement	0.385	0.393	0.524
Health care	0.331	0.354	0.516
Selling			
Transportation	0.393	0.143	0.604
Marketing	0.207	0.569	0.829
Dealer new vehicle selling expense	0.229	0.426	0.694

[2] For a detailed discussion of the development of these factors, refer to Helfand and Sherwood (2009).

To arrive at the final adjustment factors used in this study, we averaged adjustment factors from two approaches for low- and medium-complexity technologies and kept estimates from the two approaches for high-complexity technologies (thus creating two sets: High 1 [from the consensus approach] and High 2 [from the Delphi-based method]).[3] The resulting adjustment factors are presented in Table 4-6 (short term) and Table 4-7 (long term).

Table 4-6. Resultant Short-Term Adjustment Factors to Indirect Cost Contributors for Light Duty Vehicles

Indirect Cost	Low	Med	High 1	High 2
Production Overhead				
Warranty	0.78	1.49	2.00	2.29
R&D	0.51	1.29	2.00	3.73
Depreciation and amortization	0.19	0.29	1.00	1.44
Maintenance, repair, operations	0.24	0.36	1.00	1.40
Corporate Overhead				
General and administrative	0.17	0.29	0.50	1.06
Retirement	0.19	0.21	0.50	0.57
Health care	0.17	0.20	0.50	0.64
Selling				
Transportation	0.22	0.07	0.30	0.83
Marketing	0.11	0.91	1.50	1.51
Dealer new vehicle selling expense	0.18	0.81	1.50	1.30

Table 4-7. Resultant Long-Term Adjustment Factors to Indirect Cost Contributors for Light Duty Vehicles

Indirect Cost	Low	Med	High 1	High 2
Production Overhead				
Warranty	0.38	0.88	1.00	1.52
R&D	0.19	0.45	0.30	2.02
Depreciation and amortization	0.14	0.23	1.00	0.95
Maintenance, repair, operations	0.19	0.23	1.00	1.09
Corporate Overhead				
General and administrative	0.14	0.21	0.50	0.67
Retirement	0.19	0.20	0.50	0.52
Health care	0.17	0.68	0.50	0.52
Selling				
Transportation	0.20	0.07	0.30	0.60
Marketing	0.10	0.28	0.00	0.83
Dealer new vehicle selling expense	0.11	0.36	1.00	0.69

[3] High 1 and High 2 are used because two processes yielded substantially different results for high-complexity technologies, and EPA believed these differences were meaningful given the two technologies considered in the two different processes.

4.4 Industry Average IC Multipliers

Each contributor in Table 4-1 was then multiplied by an associated set of adjustment factors presented in Tables 4-6 and 4-7. These calculations are presented in Tables 4-8 (engine manufacturers) and 4-9 (truck manufacturers). For example, the warranty cost contributor for engine manufacturers in Table 3-3 is 0.02. This value was then multiplied by 0.78, 1.49, 2.0, and 2.29 (from Table 4-2, for low, medium, High 1, and High 2 complexity technologies, respectively) to arrive at adjusted short-term indirect contributors of 0.01, 0.02, 0.03, and 0.04 (see Table 4-3). Finally, adjusted indirect cost contributors were added for each complexity and time frame to calculate the IC multipliers.

4.5 IC Multipliers and Net Income

The goal for either the RPE multiplier or the IC multiplier is to improve the estimate of the total costs of a new technology. In this context, the role of net income needs careful consideration. Net income results from an interaction of supply and demand curves for a product. The total effect on net income depends on the relative slopes of the supply and demand curves: although a reduction in quantity and an increase in cost hurt net income, a price increase can offset some or all of these effects (Rogozhin et al., 2010).

However, an argument can be made that net income is not only the result of supply and demand interactions; businesses repay shareholders for the use of their capital investment. In this sense, net income is a cost of doing business: if a business cannot pay a return on its capital costs comparable to that in other industries, investors will move their money into other businesses, and the company will not be able to survive. Shareholders may be willing to accept losses in the short term in exchange for higher returns over time, but, in the long term, net income should be sufficient to keep shareholders investing in a company. According to this argument, net income should be included at least in the long-term multipliers (Rogozhin et al., 2010).

The IC multipliers presented in this report do not include net income. Since the ratio of net income to indirect cost is estimated to be 0.05 (see Table 3-3), inclusion of net income in the long-term IC multipliers would increase these values by 0.05. Table 4-10 presents long-term IC multipliers with net income included.

Table 4-8. Short- and Long-Term IC Multiplier Calculations for Engine Manufacturers: 2008

RPE and IC Multiplier Contributors	RPE Multiplier Approach	IC Multiplier Approach															
		Short-Term Effects								Long-Term Effects							
	Weighted Average Industry Indirect Cost Contributors to RPE	Low-Complexity Technology		Medium-Complexity Technology		High-Complexity Technology 1		High-Complexity Technology 2		Low-Complexity Technology		Medium-Complexity Technology		High-Complexity Technology 1		High-Complexity Technology 2	
		Adjustment Factor	IC Multiplier	Adjustment Factor	IC Multiplier	Adjustment Factor	IC Multiplier	Adjustment Factor	IC Multiplier	Adjustment Factor	IC Multiplier	Adjustment Factor	IC Multiplier	Adjustment Factor	IC Multiplier	Adjustment Factor	IC Multiplier
Manufacturing																	
Manufacturing Cost	1.00		1.00		1.00		1.00		1.00		1.00		1.00		1.00		1.00
Production overhead																	
Warranty	0.02	0.78	0.01	1.49	0.02	2.00	0.03	2.29	0.04	0.38	0.01	0.88	0.01	1.00	0.02	1.52	0.02
R&D (product development)	0.04	0.51	0.02	1.29	0.05	2.00	0.07	3.73	0.13	0.19	0.01	0.45	0.02	0.30	0.01	2.02	0.07
Depreciation and amortization	0.03	0.19	0.01	0.29	0.01	1.00	0.03	1.44	0.04	0.14	<0.01	0.23	0.01	1.00	0.03	0.95	0.03
Maintenance, repair, operations cost	0.01	0.24	<0.01	0.36	0.01	1.00	0.01	1.40	0.02	0.19	<0.01	0.23	<0.01	1.00	0.01	1.09	0.01
Total production overhead	0.08		0.04		0.08		0.15		0.23		0.02		0.04		0.07		0.14
Corporate Overhead																	
General and administrative	0.11	0.17	0.02	0.29	0.03	0.50	0.06	1.06	0.12	0.14	0.02	0.21	0.02	0.50	0.06	0.67	0.07
Retirement	0.01	0.19	<0.01	0.21	<0.01	0.50	<0.01	0.57	<0.01	0.19	<0.01	0.20	<0.01	0.50	<0.01	0.52	<0.01
Health	0.01	0.17	<0.01	0.20	<0.01	0.50	0.01	0.64	0.01	0.17	<0.01	0.68	0.01	0.50	0.01	0.52	0.01
Total corporate overhead	0.13		0.02		0.04		0.07		0.13		0.02		0.03		0.07		0.09

(continued)

Table 4-8. Short- and Long-Term IC Multiplier Calculations for Engine Manufacturers: 2008 (continued)

RPE and IC Multiplier Contributors	RPE Multiplier Approach	IC Multiplier Approach															
	Weighted Average Industry Indirect Cost Contributors to RPE	Short-Term Effects								Long-Term Effects							
		Low-Complexity Technology		Medium-Complexity Technology		High-Complexity Technology 1		High-Complexity Technology 2		Low-Complexity Technology		Medium-Complexity Technology		High-Complexity Technology 1		High-Complexity Technology 2	
		Adjustment Factor	IC Multiplier	Adjustment Factor	IC Multiplier	Adjustment Factor	IC Multiplier	Adjustment Factor	IC Multiplier	Adjustment Factor	IC Multi-plier	Adjustment Factor	IC Multiplier	Adjustment Factor	IC Multiplier	Adjustment Factor	IC Multiplier
Selling																	
Transportation	0.01	0.22	<0.01	0.07	<0.01	0.30	<0.01	0.83	<0.01	0.20	<0.01	0.07	<0.01	0.30	<0.01	0.60	<0.01
Marketing	0.01	0.11	<0.01	0.91	0.01	1.50	0.01	1.51	0.01	0.10	<0.01	0.28	<0.01	0	0	0.83	0.01
Dealers																	
Dealer new vehicle net income	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
ealer new vehicle selling cost	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Total selling and dealer contributors	0.01		<0.01		0.01		0.01		0.02		<0.01		<0.01		<0.01		0.01
Sum of Indirect Costs	0.23		0.06		0.13		0.23		0.38		0.04		0.08		0.14		0.24
Net income	0.05	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Other costs (not included in contributing costs)	0.01	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
RPE/IC Multiplier	1.28		1.06		1.13		1.23		1.38		1.04		1.08		1.14		1.24

Table 4-9. Short- and Long-Term IC Multiplier Calculations for Truck Manufacturers: 2008

RPE and IC Multiplier Contributors	RPE Multiplier Approach	IC Multiplier Approach															
	Weighted Average Industry Indirect Cost Contributors to RPE	Short-Term Effects								Long-Term Effects							
		Low-Complexity Technology		Medium-Complexity Technology		High-Complexity Technology 1		High-Complexity Technology 2		Low-Complexity Technology		Medium-Complexity Technology		High-Complexity Technology 1		High-Complexity Technology 2	
		Adjustment Factor	IC Multiplier	Adjustment Factor	IC Multiplier	Adjustment Factor	IC Multiplier	Adjustment Factor	IC Multiplier	Adjustment Factor	IC Multi-plier	Adjustment Factor	IC Multiplier	Adjustment Factor	IC Multiplier	Adjustment Factor	IC Multiplier
Manufacturing																	
Manufacturing Cost	1.00		1.00		1.00		1.00		1.00		1.00		1.00		1.00		1.00
Production overhead																	
Warranty	0.04	0.78	0.03	1.49	0.05	2.00	0.07	2.29	0.08	0.38	0.01	0.88	0.03	1.00	0.04	1.52	0.06
R&D (product development)	0.05	0.51	0.02	1.29	0.06	2.00	0.09	3.73	0.17	0.19	0.01	0.45	0.02	0.30	0.01	2.02	0.09
Depreciation and amortization	0.04	0.19	0.01	0.29	0.01	1.00	0.04	1.44	0.06	0.14	0.01	0.23	0.01	1.00	0.04	0.95	0.04
Maintenance, repair, operations cost	0.02	0.24	<0.01	0.36	0.01	1.00	0.02	1.40	0.02	0.19	0.00	0.23	0.00	1.00	0.02	1.09	0.02
Total production overhead	0.14		0.06		0.13		0.22		0.33		0.03		0.07		0.11		0.20
Corporate Overhead																	
General and administrative	0.07	0.17	0.01	0.29	0.02	0.50	0.04	1.06	0.07	0.14	0.01	0.21	0.01	0.50	0.04	0.67	0.05
Retirement	0.01	0.19	<0.01	0.21	0.00	0.50	0.01	0.57	0.01	0.19	0.00	0.20	0.00	0.50	0.01	0.52	0.01
Health	0.01	0.17	<0.01	0.20	0.00	0.50	0.01	0.64	0.01	0.17	0.00	0.68	0.01	0.50	0.01	0.52	0.01
Total corporate overhead	0.09		0.02		0.03		0.05		0.09		0.01		0.02		0.05		0.06

(continued)

Table 4-9. Short- and Long-Term IC Multiplier Calculations for Truck Manufacturers: 2008 (continued)

RPE and IC Multiplier Contributors	RPE Multiplier Approach	IC Multiplier Approach															
		Short-Term Effects								Long-Term Effects							
	Weighted Average Industry Indirect Cost Contributors to RPE	Low-Complexity Technology		Medium-Complexity Technology		High-Complexity Technology 1		High-Complexity Technology 2		Low-Complexity Technology		Medium-Complexity Technology		High-Complexity Technology 1		High-Complexity Technology 2	
		Adjustment Factor	IC Multiplier	Adjustment Factor	IC Multiplier	Adjustment Factor	IC Multiplier	Adjustment Factor	IC Multiplier	Adjustment Factor	IC Multi-plier	Adjustment Factor	IC Multiplier	Adjustment Factor	IC Multiplier	Adjustment Factor	IC Multiplier
Selling																	
Transportation	0.00	0.22	<0.01	0.07	<0.01	0.30	<0.01	0.83	<0.01	0.20	<0.01	0.07	<0.01	0.30	<0.01	0.60	<0.01
Marketing	0.01	0.11	<0.01	0.91	0.01	1.50	0.01	1.51	0.01	0.10	<0.01	0.28	<0.01	0	0	0.83	0.01
Dealers																	
Dealer new vehicle net income	0.00																
Dealer new vehicle selling cost	0.06	0.18	0.01	0.81	0.05	1.50	0.09	1.30	0.08	0.11	0.01	0.36	0.02	1.00	0.06	0.69	0.04
Total selling and dealer contributors	0.08		0.01		0.06		0.10		0.09		0.01		0.02		0.06		0.05
Sum of Indirect Costs	0.31		0.09		0.21		0.37		0.52		0.05		0.11		0.22		0.31
Net income	0.05	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Other costs (not included in contributing costs)	0.00	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
RPE/IC Multiplier	1.36		1.09		1.21		1.37		1.52		1.05		1.11		1.22		1.31

Table 4-10. Long-Term Indirect Cost Multipliers with Net Income Included

Time Frame	Low	Medium	High 1	High 2
Engine manufacturers	1.09	1.13	1.19	1.29
Truck manufacturers	1.10	1.16	1.27	1.36

SECTION 5
EXAMPLE TECHNOLOGIES

This section provides examples of low-, medium-, and high-complexity technologies. Single wide tires is used as an example of a low-complexity technology, engine turbo compounding as an example of a medium-complexity technology, and hybrid-electric powertrains as an example of a high-complexity technology.

5.1 Low Complexity: Single Wide Tires

Single wide tires are designed to improve fuel economy by reducing the tires' rolling resistance and decreasing the mass of the tire and wheel assemblies. A 17-inch wide single tire replaces conventional dual tires on the drive and trailer axles. EPA estimated that, on average, this technology can reduce nitrogen oxides (NO_x) emissions by 30% and improve fuel efficiency by 6% when traveling at highway speeds (EPA, 2005).

Implementing this technology will require truck manufacturers to purchase single wide tires. Implementing this technology does not require a change in core structure or redesign of architecture. Single wide tires are installed in place of stock tires with a low degree of additional testing and development required. This example assumes that significant modifications will not be required in the chassis or suspension components. This technology is an example of a low-complexity technology. Short-term IC multipliers for this technology complexity equaled 1.06 for engine manufacturers and 1.09 for truck manufacturers. Long-term IC multipliers equaled 1.04 for engine manufacturers and 1.05 for truck manufacturers.

5.2 Medium Complexity: Engine Turbo Compounding

Engine turbo compounding adds a power turbine to the exhaust system downstream from the turbocharger, which extracts additional energy from exhaust gases and supplies it to the engine's crankshaft (Scania, 2010). Manufacturers claim a 5% increase in fuel economy coupled with an increase in horsepower (Detroit Diesel Corporation, 2010).

This example assumes that implementing this technology in mass production requires vehicle manufacturers to integrate the technology with the other vehicle systems, such as the engine and exhaust system. However, the core tasks of the engine and exhaust system are not changed. This technology is an example of a medium-complexity technology. Short-term IC multipliers for this technology complexity equaled 1.13 for engine manufacturers and 1.21 for truck manufacturers. Long-term IC multipliers equaled 1.08 for engine manufacturers and 1.11 for truck manufacturers.

5.3 High Complexity: Hybrid Electric Powertrains

Hybrid electric heavy duty vehicles are in various stages of development by almost all major heavy duty truck manufacturers. Hybrid vehicles have two basic types of driveline structure. The most common, parallel hybrid, is where the engine drives the powertrain and a generator helps recharge the battery. A second type, a series hybrid, is where the engine does not drive the powertrain but always drives the motor/generator to move the vehicle and recharge the battery. Reductions in carbon dioxide emissions vary between 15% and 30% (Ricardo Inc., 2008).

Production of a hybrid vehicle would require truck manufacturers to not only redesign the physical and electronic architecture to accommodate the additional electric drive components, but also to redesign the core structure of the main driveline components, including the transmission, engine, and other elements of the propulsion system. This technology is an example of a high-complexity technology. Short-term IC multipliers for this technology complexity (High 1) equaled 1.23 for engine manufacturers and 1.37 for truck manufacturers. Long-term IC multipliers equaled 1.14 for engine manufacturers and 1.22 (High 1) and for truck manufacturers.

High 2 technology complexity might be applicable for technologies currently in the research or development stage but not yet in the production phase. Plug-in hybrid was used as an example of such technology complexity in the LD RPE/IC study; it is not clear whether such technologies exist among heavy duty truck technologies. If they did exist, short-term multipliers that would be used equal 1.38 for engine manufacturers and 1.52 for truck manufacturers. Long-term multipliers for High 2 technology complexity equaled 1.24 for engine manufacturers and 1.31 for truck manufacturers.

SECTION 6
RPE MULTIPLIER APPROACH VS. INTEGRATED IC MULTIPLIER AND MARKET MODEL APPROACH

Executive Order 12866, "Regulatory Planning and Review," issued in 1993, requires federal agencies to estimate the benefits and costs of significant regulatory actions. Circular A-4 of the Office of Management and Budget and EPA's *Guidelines for Preparing Economic Analyses* stipulate use of a microeconomic framework to analyze the benefits and costs. This section discusses the relationship between the RPE and IC multipliers developed in this report and the microeconomic framework in which they are used.

The RPE multiplier approach has been used as a method to estimate the change in indirect costs that are included in the total cost of a regulation. This approach has typically included using all indirect cost categories and net income to develop a multiplier that is then applied to the estimated direct manufacturing costs. The projected change in the retail price times the quantity affected is then used in the estimate of the full cost of the regulation.

The IC multipliers approach addresses two shortcomings of the RPE multiplier approach. First, as we discuss in previous sections of this report, regulations will most likely not affect all categories of indirect costs. The indirect costs affected will vary by the complexity of the technology and will change over time (short term versus long term). In Section 4, we developed a series of IC multipliers to capture these factors. Second, applying the RPE alone does not account for market effects and hence does not yield an accurate estimate of the change in market price (and produces no estimate of the change in market quantity). The IC multiplier approach identifies the appropriate shift in the supply curve from which market effects (changes in price and quantity) can be analyzed.

6.1 Market Model and RPE Multiplier

Direct manufacturing costs and indirect costs resulting from a regulation reflect shifts in the total cost of production. In a market framework, this is represented by a shift in the supply function. Consider the following scenario presented in Figure 6-1. Initially the market is in equilibrium. Manufacturers produce quantity Q_1 and buyers purchase that quantity at the price of P_1 per vehicle (point A). Then a regulation is passed requiring manufacturers to implement a new technology. The added cost shifts the supply curve upward. The shift equals the per-unit cost of regulation, which includes both direct and indirect costs.

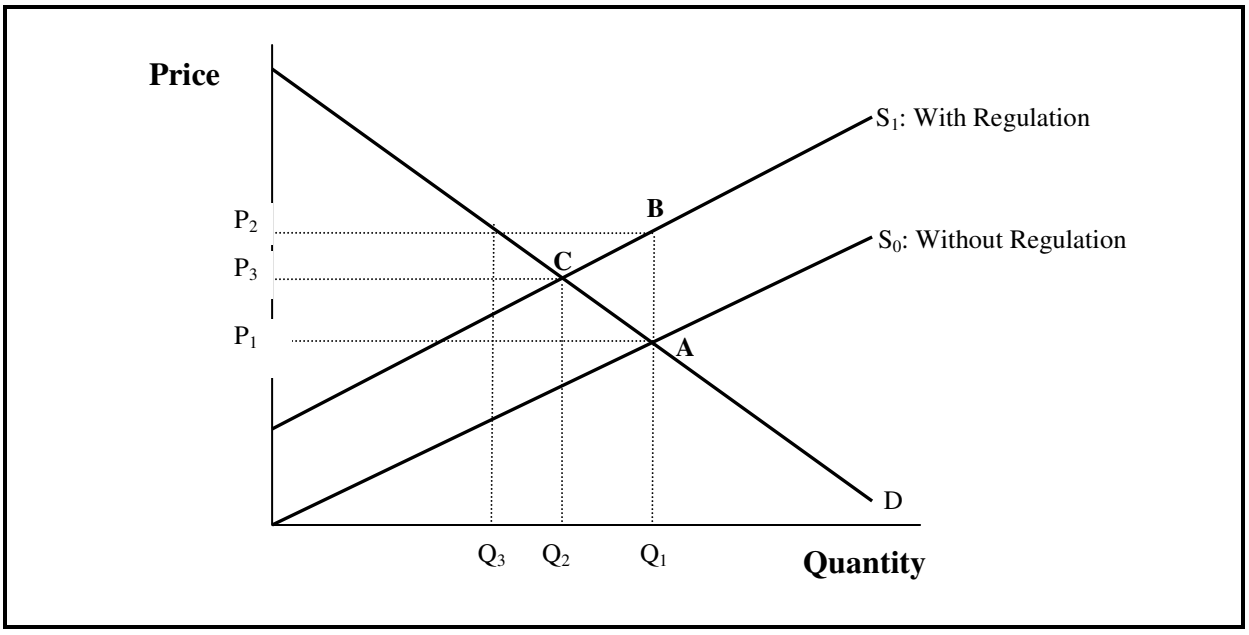

Figure 6-1. RPE Multiplier vs. IC Multiplier Approach

The RPE multiplier approach assumes that the multiplier captures the full market impact of the new cost. Sales continue at Q_1, and the price will rise to P_2 (point B). The RPE multiplier approach implies that demand is perfectly inelastic and there is a full pass-through of costs to consumers.

However, if the demand curve is less than perfectly inelastic (as shown in Figure 6-1), consumers will demand fewer vehicles as the price increases. A new equilibrium will be determined at the intersection of the supply and demand curves (point C). The new price will be P_3 and the new output will be Q_2. As a result, the final cost of the regulation (social cost) will be slightly less than the original cost estimate because of the decrease in quantity being produced. The original cost estimate, based on the operation at point B, would be the area between lines S_0 and S_1, the price axis, and quantity Q_1. The actual social cost is the area between lines S_0 and S_1, the price axis, and points A and C; it is smaller than the original cost estimate by triangle ABC.

The market analysis represented in Figure 6-1 also suggests the reason not to include net income in the IC multiplier. The RPE approach implicitly assumes disequilibrium in the market. Manufacturer net income is calculated by assuming production at point B, even though consumers are not willing to pay P_2 and buy Q_1 vehicles. In reality, both price and quantity will change in response to the shift in costs. The impact on manufacturer net income is determined by the elasticities of the supply and demand curves. Manufacturers and consumers typically share

the burden of the compliance costs. Indeed, if net income were fully included in costs, then producers would not be affected by regulations: their net income would be the same before and after the change. It is common, however, for a rule to affect net income; indeed, manufacturers often object to rules on this basis.

In a long-term model of a perfectly competitive industry, microeconomic theory predicts that full costs are passed along to consumers. The perfect competition model assumes that firms make zero economic profits (that is, net income including all opportunity costs) before the regulation; the increased costs associated with the regulation will make profits negative if they are not able to pass them along. This is similar to assuming that the supply curve is horizontal in the long term. As a result, firms will exit the industry, until quantity supplied equals quantity demanded at price P_2, quantity Q_3. In an imperfectly competitive industry, firms are predicted to have economic profits greater than zero. When imperfectly competitive firms face increased costs, they seek to mitigate losses in production by not passing along the full costs; the quantity will not fall as much as Q_3, and the price will not rise as much as P_2.

Another factor that is difficult to predict in this setting is the effects of new technologies on consumer demand. Some changes may be invisible to consumers and will not affect their demand. Others, such as technologies that increase fuel economy with little other observable effect to the consumer, may increase demand. Finally, some technological changes may reduce demand, although truck makers and regulators are not likely to pursue undesirable changes as long as more attractive alternatives exist. Any shifts in the demand curve due to new technologies should be included in regulatory impact analyses of new requirements. They should not, however, affect the estimate of indirect costs used to shift the supply curve. The RPE approach omits demand shifts as well as market adjustments due to the shifting supply curve.

The IC multiplier models the appropriate shift in the supply curve (including direct manufacturing costs and relevant indirect costs) that then can be used in a market analysis to determine a new equilibrium price and quantity and, hence, the total cost of the regulation. A market analysis, pivoting on the new equilibrium generated from the IC multiplier approach, determines the distribution of regulatory burden between producers and consumers consistent with economic theory.

SECTION 7
SUMMARY AND CONCLUSION

The RPE multiplier has historically been used to estimate the indirect costs that are included in the total cost of vehicle modification. This approach has typically included all indirect cost categories and net income to develop a multiplier that is then applied to the estimated direct manufacturing costs. The weighted average RPE multiplier for engine manufacturers equaled 1.28 in 2008, while the weighted average RPE multiplier for truck manufacturers equaled 1.36 in 2008. However, a key problem in using RPE multipliers in cost analysis is that not all contributors to indirect costs are affected in the same way by new technologies. Some changes may lead to higher indirect costs, and some lower, depending of the complexity and timing of the new technologies being introduced.

This report calculates modified multipliers, referred to as IC multipliers. IC multipliers explicitly recognize that technologies differ in their indirect cost requirements. In an ideal world, the calculation of costs of new technologies would include indirect costs specific to the technology. When resources are not available to conduct such an in-depth analysis, multipliers can provide an approximation of those indirect costs. Because those indirect costs are likely to vary both with the complexity of the technology and with the time frame, the IC multipliers calculated here are expected to provide superior estimates of the actual costs of a new technology compared to using RPE multipliers. We find that IC multipliers range from 1.06 to 1.38 in the short term and from 1.04 to 1.24 in the long term for heavy duty engine manufacturers, and from 1.09 to 1.52 in the short term and from 1.05 to 1.31 in the long term for heavy duty truck manufacturers.

SECTION 8
REFERENCES

Cooper, R., and R.S. Kaplan., 1988. "How Cost Accounting Distorts Product Costs." *Management Accounting* 69(10):20-7.

Cummins Inc. 2006. 2005 Annual Report on 10-K Form. Available at: http://phx.corporate-ir.net/phoenix.zhtml?c=112916&p=irol-reportsannual. Accessed on February 15, 2010.

Cummins Inc. 2009. 2008 Annual Report on 10-K Form. Available at: http://phx.corporate-ir.net/phoenix.zhtml?c=112916&p=irol-reportsannual. Accessed on February 15, 2010.

Daimler. 2006. Annual Report 2006. Available at: http://www.daimler.com/investor-relations/reports-and-key-figures/annual-documents/daimler-ag. Accessed February 7, 2010.

Daimler. 2008. Annual Report 2008. Available at: http://www.daimler.com/investor-relations/reports-and-key-figures/annual-documents/daimler-ag. Accessed February 7, 2010.

Detroit Diesel Corporation. 2010. Detroit Diesel: DD 15. Detroit, MI: Detroit Diesel Corporation. Available at: http://www.detroitdiesel.com /pdf/engines/2009-dd15-brochure.pdf. Accessed on March 30, 2010.

Forbes Inc. 2010. Investopedia. Cost of Goods Sold—COGS. Available at: http://www.investopedia.com/terms/c/cogs.asp>. Accessed on March 22, 2010.

Helfand, G., and T. Sherwood. 2009. "Memorandum: Documentation of the Development of Indirect Cost Multipliers for Three Automotive Technologies." Washington, DC: Office of Transportation and Air Quality, U.S. Environmental Protection Agency.

Henderson, R.M., and K.B. Clark. 1990. "Architectural Innovation: The Reconfiguration of Existing Product Technologies and the Failure of Established Firms." *Administrative Science Quarterly* 35(1):9-30.

Hino Motors, Ltd. and Consolidated Subsidiaries. 2009a. Hino: Financial Results of the Fiscal Year Ended March 31, 2009.

Hino Motors, Ltd. and Consolidated Subsidiaries. 2009b. Hino: Five-year Summary Ended March 31, 2009.

IBIS. January 2010, IBISWorld Industry Report 33612: Truck & Bus Manufacturing in the US. CA: IBIS.

IHS Global Insight. September 14, 2009. HIS Global Insight Report: Daimler Trucks (Automotive). Waltham, MA: IHS Global Insight.

IHS Global Insight. September 18, 2009. HIS Global Insight Report: Navistar (Automotive). Waltham, MA: IHS Global Insight.

IHS Global Insight. September 18, 2009. HIS Global Insight Report: Volvo Trucks (Automotive). Waltham, MA: IHS Global Insight.

IHS Global Insight. September 30, 2009. HIS Global Insight Report: Volvo Trucks (Automotive). Waltham, MA: IHS Global Insight.

IHS Global Insight. October 01, 2009. HIS Global Insight Report: PACCAR (Automotive). Waltham, MA: IHS Global Insight.

Jack Faucett Associates. September 4, 1985. *Update of EPA's Motor Vehicle Emission Control Equipment Retail Price Equivalent (RPE) Calculation Formula*. Chevy Chase, MD: Jack Faucett Associates.

McKinsey & Company. October 2003. "Preface to the Auto Sector Cases." In *New Horizons: Multinational Company Investment in Developing Economies*. San Francisco, CA: McKinsey & Company.

McManus, Walter. Personal communication on February 16, 2010.

National Research Council (NRC). 2002. *Technologies for Improving the Fuel Economy of Passenger Cars and Light-Duty Trucks*. Washington, DC: National Research Council. Available at: http://books.nap.edu/openbook.php?isbn =0309076013. Accessed on December 8, 2008.

Navistar. 2005. Annual Report 2005. Available at: http://ir.navistar.com/sec.cfm. Accessed February 7, 2010.

Navistar. 2008. Annual Report 2008. Available at: http://ir.navistar.com/sec.cfm. Accessed February 7, 2010.

Niazi, A., J. Dai, S. Balabani, and L. Seneviratne. 2007. "A New Overhead Estimation Methodology: A Case Study in an Electrical Engineering Company." *Proceedings of the Institution of Mechanical Engineers, Part B: Journal of Engineering Manufacture* 221(4):699-710.

PACCAR. 2006. PACCAR: Annual Report 2005. Available at: http://www.paccar.com/ investors/investor_resources_history.asp. Accessed on February 7, 2010.

PACCAR. 2009. PACCAR: Annual Report 2008. Available at: http://www.paccar.com/investors/investor_resources_history.asp. Accessed on February 7, 2010.

Ricardo, Inc. June 2008. *A Study of Potential Effectiveness of Carbon Dioxide Reducing Vehicle Technologies, Revised Final Report*. EPA420-R-08-004a. Washington, DC: Environmental Protection Agency. Available at: http://www.epa.gov/oms/technology/420r08004a.pdf. Accessed on February 17, 2009.

Rogozhin, A., M. Gallaher, and W. McManus. February 2009. *Automobile Industry Retail Price Equivalent and Indirect Cost Multipliers*. EPA-420-R-09-003. Washington, DC: Environmental Protection Agency. Available at: http://www. epa.gov/otaq/ld-hwy/420r09003.pdf.

Rogozhin, A., M. Gallaher, G. Helfand, and W. McManus. 2010. "Using Indirect Cost Multipliers to Estimate the Total Cost of Adding New Technology in the Automobile Industry." *International Journal of Production Economics* 124(2):360-368.

Scania Group. 2010. "Scania Turbocompound: Turbocompounding Converts Excess Energy Into Power." Available at: http://www.scania.com/products-services/trucks/main-components/engines/engine-technology/turbocompound/index.aspx. Accessed on March 30, 2010.

Sierra Research, Inc. November 21, 2007. *Study of Industry—Average Mark-Up Factors Used to Estimate Changes in Retail Price Equivalent (RPE) for Automotive Fuel Economy and Emissions Control Systems*. Sacramento, CA: Sierra Research, Inc.

Son, Y.K. 1991. "A Cost Estimation Model for Advanced Manufacturing Systems." *International Journal of Production Research* 29(3):441-52.

Spinney, B., B. Faigin, N. Bowie, and S. Kratzke. 1998. *Advanced Air Bag Systems Cost, Weight, and Lead Time Analysis. Summary Report*. Contract No. DTNH22-96-0-12003. Washington, DC: Department of Transportation.

Supplier Relations US LLC. December 5, 2009. "Heavy Duty Truck Manufacturing Industry in the U.S. and its International Trade. NAICS 336120." Irvine, CA: Supplier Relations US LLC.

U.S. Department of Commerce, Bureau of Census (Census). 2009. *American Factfinder: Sector 31: EC0731I1: Manufacturing: Industry Series: Detailed Statistics by Industry for the United States: 2007*. Washington, DC: Department of Commerce.

U.S. Census. 2010. *American Factfinder: Sector 31: EC0731I1: Manufacturing: Industry Series: Detailed Statistics by Industry for the United States: 2007*. Washington, DC: Department of Commerce.

U.S. Environmental Protection Agency (EPA). 2004. *Final Regulatory Analysis: Control of Emissions from Nonroad Diesel Engines*. EPA420-R-04-007. Ann Arbor, MI: Environmental Protection Agency. Available at: http://www.epa.gov/nonroad-diesel/2004fr/420r04007.pdf.

U.S. Environmental Protection Agency (EPA). 2005. "Effect of Single Wide Tires and Trailer Aerodynamics on Fuel Economy and NO_x Emissions of Class 8 Line-Haul Tractor-Trailers." Paper number 05CV-45. Available at: http://epa.gov/smartway/documents/sae-05cv045-110105.pdf. Accessed on March 30, 2010.

U.S. Environmental Protection Agency (EPA). 2008. *Regulatory Impact Analysis: Control of Emissions of Air Pollution from Locomotive Engines and Marine Compression Ignition Engines Less than 30 Liters per Cylinder*. EPA420-R-08-001a. Ann Arbor, MI: Environmental Protection Agency. Available at: http://www.epa.gov/otaq/regs/nonroad/420r08001a.pdf.

U.S. Internal Revenue Service (IRS). August 11, 2008. "Amortization of R&D Expenditures." Washington, DC: Internal Revenue Service. Available at: http://www.irs.gov/businesses/small/industries/article/0,,id=97642,00.html. Accessed on August 20, 2009.

Volvo Group. 2006. Annual Report 2006. Available at: http://www.volvogroup.com/GROUP/GLOBAL/EN-GB/INVESTORS/Pages/investor_relations.aspx. Accessed on February 7, 2010.

Volvo Group. 2008. Annual Report 2008. Available at: http://www.volvogroup.com/GROUP/GLOBAL/EN-GB/INVESTORS/Pages/investor_relations.aspx. Accessed on February 7, 2010.

Vyas, A., D. Santini, and R. Cuenca. April 2000. *Comparison of Indirect Cost Multipliers for Manufacturing*. Argonne, IL: Center for Transportation Research, Energy Systems Division, Argonne National Laboratory.

APPENDIX A
CALCULATION OF RPE MULTIPLIERS FOR INDIVIDUAL MANUFACTURERS

This appendix describes calculations of RPE multipliers for the heavy duty truck manufacturing industry as a whole and for individual heavy duty truck and engine manufacturers. The appendix is structured in the following manner:

- Appendix A.1: Heavy Duty Truck Industry (Supplier Relations LLC, Census)
- Appendix A.2: Cummins
- Appendix A.3: Hino
- Appendix A.4: PACCAR
- Appendix A.5: Navistar
- Appendix A.6: Daimler
- Appendix A.7: Volvo

A.1 Heavy Duty Truck Industry (Supplier Relations LLC, Census)

An industry report by Supplier Relations LLC (referred to as "SR LLC report") presents heavy duty truck industry income statements and balance sheets (2009). The industry report was based on data from the U.S. Census, McKinsey & Company, and industry associations. These costs are presented in Table A-1. In instances where cost contributors were unavailable from SR LLC report, we used Census data or pivoted off cost contributors from the LD RPE/IC study. We describe these calculations below.

The manufacturing cost was calculated by adding cost of materials and wages. One can notice that the total for manufacturing costs ($14,652 million) is less than the sum of manufacturing costs for four manufacturers (PACCAR, Navistar, Daimler, and Volvo). Manufacturing costs for these four companies include their global operations, while manufacturing costs from the SR LLC report are mainly based on U.S. operations. We can, nevertheless, compare cost contributors derived using the SR LLC report data with individual company contributors, because they represent ratios and not absolute quantities.

The SR LLC report did not report warranty and R&D costs. We used the LD RPE/IC study's cost contributors as a proxy. The SR LLC report also did not report maintenance, repair, and operations (MRO) costs. We used the data from the U.S. Census Other Engine Equipment

Table A-1. Supplier Relations LLC, Census RPE Multiplier Calculations: 2008

RPE Multiplier Contributor	Expense ($ Million)	Relative to Manufacturing Cost	Calculation and Source
Vehicle Manufacturing			
Manufacturing cost	14,652.0	1.00	Cost of materials (13,896) [p. 161, Supplier Relations LLC, 2009] + Wages (756) [p. 161, Supplier Relations LLC, 2009]
Production Overhead			
Warranty		0.03	LD RPE/IC Study (only used to break out G&A)
R&D (product development)		0.05	LD RPE/IC Study (only used to break out G&A)
Depreciation and amortization	692.0	0.05	Depreciation, depletion, and amortization of property, plant and equipment [p. 161, Supplier Relations LLC, 2009]
Maintenance, repair, operations cost for engine manufacturers (truck manufactures in brackets)	232.8	0.02	U.S. Census
Total production overhead		*0.14*	
Corporate Overhead			
General and administrative	3,118.1	0.12	Administrative, sales, and marketing costs (2,992) [p. 161, Supplier Relations LLC, 2009] – Marketing – Transportation -Salaries (330) [p. 161, Supplier Relations LLC, 2009]
Retirement for engine manufacturers (truck manufacturers in brackets)		0.01	Fringe benefits (433) [p. 161, Supplier Relations LLC, 2009]
Health for engine manufacturers (truck manufacturers in brackets)		0.01	Fringe benefits (433) [p. 161, Supplier Relations LLC, 2009]
Total corporate overhead		*0.15*	
Selling			
Transportation	58.0	0.004	Energy and fuel costs [p. 161, Supplier Relations LLC, 2009]
Marketing	145.9	0.01	LD RPE/IC Study Marketing * 20%, personal communication with Walter McManus
Dealers			
Dealer new vehicle net income	58.6	0.004	LD RPE/IC Study, personal communication with Walter McManus
Dealer new vehicle selling cost	879.1	0.06	LD RPE/IC Study, personal communication with Walter McManus
Total selling and dealer contributors		*0.08*	
Sum of Indirect Costs		0.37	
Net income		0.05	5-year average net income [p. 161, Supplier Relations LLC, 2009]
Other costs (not included as contributors)		0.00	
RPE multiplier		**1.42**	

Sources: Supplier Relations US LLC. December 5, 2009. "Heavy Duty Truck Manufacturing Industry in the U.S. and its International Trade. NAICS 336120." Irvine, CA: Supplier Relations US LLC.

Personal communication with Walter McManus

Manufacturing (NAICS 333618) and Heavy Duty Truck Manufacturing (NAICS 336120) industries to calculate cost contributors for heavy duty engine truck manufacturers, respectively. The resulting cost contributors equaled 0.01 for engine manufacturers and 0.02 for truck manufacturers. These calculations are presented in Table A-2.

Table A-2. Calculation of Maintenance, Repair, and Operations Cost Contributors

	Heavy Duty Engine Manufacturers (NAICS 333618)	Heavy Duty Truck Manufacturers (NAICS 336120)	Calculation
Payroll	$2,391,425	$1,335,228	A
Cost of materials	$18,348,214	$15,025,846	B
Manufacturing cost	$20,739,639	$16,361,074	C = A + B
Repair and maintenance	$160,217	$53,442	D
Contract work	$117,910	$206,492	E
Maintenance, repair, operations cost	$278,127	$259,934	F = D + E
Share of manufacturing cost	0.01	0.02	F/C

Source: U.S. Census. 2010. American Factfinder: Sector 31: EC0731I1: Manufacturing: Industry Series: Detailed Statistics by Industry for the United States: 2007. Washington DC: Department of Commerce.

General and administrative (G&A) costs were calculated by subtracting salaries' cost (costs of corporate labor) and marketing and transportation cost contributors from the administrative, sales, and marketing costs provided in the SR LLC report. The SR LLC report provided fringe benefits' cost ($433 million, or 0.0296 as a share of manufacturing costs [$14,652 million]) or a sum of health care and retirement costs for manufacturing labor. The report did not provide a clear breakout for health care and retirement costs. We used a ratio of health care to retirement costs from Cummins to calculate proxies of these costs for engine manufacturers and similar ratio from Navistar to calculate proxies of these costs for truck manufacturers. These calculations are presented in Table A-3.

Neither the SR LLC report nor the U.S. Census provided marketing costs; thus, we used a proxy from the LD RPE/IC report. However, we believe that heavy duty vehicle manufacturers spend a lot less on marketing than light duty vehicle manufacturers. The heavy duty trucks industry engages in business-to-business marketing rather than business-to-consumer marketing. Our judgment is that business-to-business marketing costs are significantly lower than business-to-consumer marketing costs, possibly as low as 3 to 5% of business-to-consumer marketing costs per unit. We defined business-to-business marketing costs as 20% of the

Table A-3. Calculation of Health Care and Retirement Cost Contributors

Cost Contributor	Fringe Benefits Share of Manufacturing Cost (SP LLC)[a]	Cost Contributors (from Cummins)[b]	Heavy Duty Engine Manufacturers	Cost Contributors (from PACCAR)[c]	Heavy Duty Truck Manufacturers
Retirement	0.0296	0.01	0.01	0.03	0.02
Health care		0.01	0.02	0.02	0.01

Sources: [a] Supplier Relations US LLC. December 5, 2009. "Heavy Duty Truck Manufacturing Industry in the U.S. and its International Trade. NAICS 336120." Irvine, CA: Supplier Relations US LLC.

[b] Table A-4; [c] Table A-10.

business-to-consumer marketing costs per unit from Rogozhin et al. (2009) as an upper bound. Finally, because no data were available to calculate dealer new vehicle net income nor dealer new vehicle selling cost contributors, we used the LD RPE/IC study contributors as a proxy. The LD RPE/IC study dealer new vehicle net income and dealer new vehicle selling cost contributors were based on National Association of Automobile Dealers (NADA) data. For an exact calculation of these cost contributors, refer to Section A.2 of the LD RPE/IC study.

A.2 Cummins Inc. (Engine Manufacturer)

The general approach to estimate cost contributors to RPE multipliers is presented in Section 3. This appendix outlines calculations specific to each manufacturer. We performed several adjustments to numbers presented in the Cummins annual report so they could be applied to our methodology. Calculations and citations for cost values (referencing pages where specific cost item is located) that we used in our analysis are outlined in Table A-4.

The Cummins annual report stated that manufacturing cost includes maintenance and repair costs (valued at $49 million). Therefore, we subtracted that cost from manufacturing cost. We also added 70% of health care and retirement costs, because these costs are attributable to manufacturing labor (see Section 3.3 for justification of this assumption).

The Cummins annual report did not clearly provide warranty costs for 2008. Warranty costs were estimated by subtracting the balance of warranty provisions at the beginning of 2008 from the balance of warranty provisions at the end of 2008. Cummins also did not clearly state operations costs, which is a large share of the MRO contributor. Therefore, we used the industry average (calculated using Census data) as a proxy. Calculations of industry averages, which are based on the data from the industry report by SR LLC and Census, are presented in Section A.1 of this appendix. Cummins' annual report also stated that transportation cost is a part of G&A costs; thus, the transportation cost contributor was subtracted from the G&A cost contributor.

Table A-4. Cummins' RPE Multiplier Calculations: 2008

RPE Multiplier Contributor	Expense ($ Million)	Relative to Cost of Sales Manufacturing Cost	Calculation and Source
Vehicle Manufacturing			
Manufacturing Cost	11,726.5	1.00	[p. 36, Cummins, 2009] – Maintenance and repair (49)+70% *(Health care + retirement)
Production Overhead			
Warranty	221.0	0.02	End of 2008 balance warranty provisions (962) – Beginning of 2008 Balance Warranty Provisions (749) [p. 104, Cummins, 2009]
R&D (product development)	422.0	0.04	[p. 24, Cummins, 2009]
Depreciation and amortization	314.0	0.03	[p. 71, Cummins, 2009]
Maintenance, repair, operations cost	152.9	0.01	Census
Total production overhead	*1,109.9*	*0.08*	
Corporate Overhead			
General and administrative	1,404.9	0.12	[p. 27, Cummins, 2009] – Transportation
Retirement	62.4	0.01	0.3 * Retirement ((71) [p. 56, Cummins, 2009] + (102) [p. 58, Cummins, 2009] + 35 [p. 71, Cummins 2009])
Health	142.2	0.01	0.3*Health care [p. 87, Cummins, 2009]
Total corporate overhead	*1,609.5*	*0.14*	
Selling			
Transportation	45.1	0.004	Supplier Relations, LLC
Marketing	120.0	0.01	Warranty and Marketing (341) [p. 87, Cummins, 2009] – Warranty Cost
Dealers			
Dealer new vehicle net income			
Dealer new vehicle selling cost			
Total selling and dealer contributors	*165.1*	*0.01*	
Sum of Indirect Costs		0.23	
Net income	755.0	0.06	[p. 27, Cummins, 2009] – Dealer Gross
Other costs (not included as contributors)	70.0	0.01	[p. 27, Cummins, 2009]
RPE multiplier		**1.29**	

Sources: Supplier Relations LLC (2009); Census (2010) (see references in Section A.1)

Cummins Inc. 2009. 2008 Annual Report on 10-K Form. Available at: http://phx.corporate-ir.net/phoenix.zhtml?c=112916&p=irol-reportsannual. Accessed on February 15, 2010.

We made an assumption that corporate labor represents 30% of total labor (total labor comprised of corporate and manufacturing labor). Thus, 30% of retirement and health care cost were attributed to retirement and health care cost contributors. Please refer to Section 3.3 for a

detailed explanation of this assumption. The Cummins annual report presented retirement costs by division; thus, retirement costs for the three divisions were added to calculate total retirement cost (see Table A-4).

Cummins did not provide transportation cost; thus, the industry average (based on the industry report and Census data) was used as a proxy. Finally, the Cummins annual report did not separate warranty and marketing costs but reported them as one figure. Therefore, we subtracted the warranty cost from the warranty and marketing cost to arrive at the marketing cost contributor. The remaining contributors to the RPE multiplier are shown in Table A-4. Based on these numbers, the RPE multiplier for Cummins was calculated to be 1.29 in 2008.

Table A-5 provides a sum of the largest indirect cost contributors to RPE for Cummins from 2002 to 2007. Largest indirect cost contributors were readily available in manufacturers' annual reports. Funds and timing of the project did not allow performing an extended analysis (similar to one done for year 2008) for historical data. The values of cost contributors are not adjusted as in Table A-4but cited as they were reported in annual reports. Table A-5 illustrates that the sum of the main indirect cost contributors had little variation between 2004 and 2007.

Table A-5. Cummins' Main Indirect Cost Contributors

Indirect Cost Contributor	2007	2006	2005	2004
Cost of sales	1.00	1.00	1.00	1.00
Selling, administrative, and other expenses	0.13	0.12	0.13	0.15
Operating and other expenses	0.04	0.03	0.04	0.04
Depreciation	< 0.01	< 0.01	< 0.01	< 0.01
Net income	0.03	0.03	0.03	0.04
Sum of main indirect cost contributors (including net income)	1.26	1.26	1.28	1.29

Sources: Cummins Inc. 2006. 2005 Annual Report on 10-K Form. Available at: http://phx.corporate-ir.net/phoenix.zhtml?c=112916&p=irol-reportsannual. Accessed on February 15, 2010.
Cummins Inc. 2009. 2008 Annual Report on 10-K Form. Available at: http://phx.corporate-ir.net/phoenix.zhtml?c=112916&p=irol-reportsannual. Accessed on February 15, 2010.

A.3 Hino Motor Company (Engine Manufacturer)

Relevant RPE contributing factors gathered from Hino's annual report are presented in Table A-6. The RPE multiplier calculations are based on 2008 data.

As Table A-6 shows, Hino's manufacturing cost includes 70% of health care and retirement costs, an assumption covered in Section 3.3 of this report. With the exception of the

Table A-6. Hino's RPE Multiplier Calculations: 2008

RPE Multiplier Contributor	Expense (¥ Millions)	Relative to Cost of Sales	Calculation and Source
Vehicle Manufacturing			
Manufacturing cost	1,137,120	1.00	[p. 1, Hino, 2009b] + 70% (Retirement)
Production Overhead			
Warranty	10,935	0.01	[p. 7, Hino, 2009a]
R&D (product development)	39,547	0.03	[p. 1, Hino, 2009b]
Depreciation and amortization	44,206	0.04	[p. 1, Hino, 2009b]
Maintenance, repair, operations cost	15,730	0.01	Census
Total production overhead	*110,418*	*0.10*	
Corporate Overhead			
General and administrative	99,066	0.09	General and Administrative (149,769) [p. 7, Hino, 2009a] – Retirement [p. 7, Hino, 2009a] – Transportation [p. 7, Hino, 2009a] – Advertising [p. 7, Hino, 2009a] – Health care
Retirement	11,555	0.01	Supplier Relations, LLC
Health	23,109	0.02	Supplier Relations, LLC
Total corporate overhead	*133,730*	*0.12*	
Selling			
Transportation	12,158	0.01	[p. 7, Hino, 2009a]
Marketing	3,879	0.003	Advertising [p. 7, Hino, 2009a]
Dealers			
Dealer new vehicle net income			
Dealer new vehicle selling cost			
Total selling and dealer contributors	*16,037*	*0.01*	
Sum of Indirect Costs	260,185	0.23	
Net income	22,178	0.02	[p. 7, Hino, 2009a]
Other costs (not included as contributors)	10,602	0.01	Total nonoperating expenses [p. 7, Hino, 2009a]
RPE multiplier	**1,419,483**	**1.25**	

Sources: Supplier Relations LLC (2009); Census (2010) (see references in Section A.1)

Hino Motors, Ltd. and Consolidated Subsidiaries, 2009a. Hino: Financial Results of the Fiscal Year Ended March 31, 2009.

Hino Motors, Ltd. and Consolidated Subsidiaries, 2009b. Hino: Five-year Summary Ended March 31, 2009.

MRO costs, values for production overhead were reported from Hino's financial statements. Because Hino did not report MRO costs, an industry average (based on Census data) was used as a proxy. Hino's G&A expense included retirement, health care, transportation, and advertising. These costs have been subtracted from the G&A cost reported by Hino. Hino did not report health care and retirement costs, so we used an industry average as a proxy (based on data

from SR LLC report; see Section A.1 for a detailed calculation). Hino's remaining contributors to the RPE multiplier are shown in Table A-6. Based on these figures, Hino's RPE for 2008 was 1.25.

Hino's sum of the main indirect cost contributors remained relatively flat from 2004 to 2007. The sum of the main indirect cost contributors varied between 1.21 and 1.25 in the 2004 to 2007 time period (Table A-7).

Table A-7. Hino's Main Indirect Cost Contributors

Indirect Cost Contributor	2007	2006	2005	2004
Cost of sales	1.00	1.00	1.00	1.00
Selling, administrative, and other expenses	0.13	0.13	0.13	0.14
Operating and other expenses	NA	NA	NA	NA
Depreciation	0.03	0.03	0.03	0.03
Net income	0.02	0.03	0.02	0.04
Sum of main indirect cost contributors (including net income)	1.22	1.23	1.21	1.25

Sources: Hino Motors, Ltd. and Consolidated Subsidiaries, 2009b. Hino: Five-year Summary Ended March 31, 2009.

A.4 PACCAR (Heavy Duty Truck Manufacturer)

Relevant RPE contributing factors gathered from PACCAR's annual report are presented in Table A-8. PACCAR included "transportation expense" in its cost of sales, representing approximately 0.4% of the cost of sales. We subtracted this line item, $46.5 million (see Table A-8), from the cost of sales to arrive at an adjusted value for the manufacturing cost of $11.5 billion. PACCAR's reported G&A cost included transportation ($46.5) and marketing costs ($115 million), which were subtracted from G&A to arrive at an adjusted cost contributor of $308.7 million. Marketing costs were not reported by PACCAR, so an industry average of 0.01 was used as a proxy. Also, PACCAR did not directly report transportation costs, which were assumed to be an industry average based on SR LLC data (see Section A.1 for these calculations).

PACCAR did not report MRO costs; therefore, we used an industry average of 0.02 (based on the Census data) as a proxy. Results of these calculations are presented in Table A-8.

Table A-8. PACCAR RPE Multiplier Calculations: 2008

RPE Multiplier Contributor	Expense ($ Million)	Relative to Cost of Sales	Calculation and Source
Vehicle Manufacturing			
Manufacturing cost	11,550	1.00	Cost of sales – transportation expense (0.4%) [Walter McManus, personal communication]
Production Overhead			
Warranty	304.6	0.03	[p. 40, PACCAR, 2008]
R&D (product development)	341.8	0.03	[p. 31, PACCAR, 2008]
Depreciation and amortization	649.4	0.06	[p. 49, PACCAR, 2008]
Maintenance, repair, operations cost	186.5	0.02	Census
Total production overhead	*1,482.3*	*0.13*	
Corporate Overhead			
General and administrative	308.7	0.03	General & administrative (470.2) [p. 24, PACCAR, 2008] – Transportation (46.5) – Marketing (115.0)
Retirement	118.7	0.01	Benefits paid (48.8) [p. 42 of PACCAR Annual Report 2008] + Employer contributions (69.9) [p. 42 of PACCAR Annual Report 2008]
Health	12.0	0.001	Benefits paid (4.1) [p. 43, PACCAR, 2009] + Service cost (3.2) [p. 43, PACCAR, 2009] + Interest cost (4.7) [p. 43, PACCAR, 2009]
Total corporate overhead	*439.4*	*0.04*	
Selling			
Transportation	46.5	0.004	Supplier Relations, LLC
Marketing	115.0	0.01	20% * [Marketing cost from LD Study] (Walter McManus, personal communication)
Dealers			
Dealer new vehicle net income	46.2	0.004	Walter McManus, personal communication
Dealer new vehicle selling cost	693.0	0.06	Walter McManus, personal communication
Total selling and dealer contributors	*900.7*	*0.08*	
Sum of Indirect Costs	1,921.7	0.24	
Net income	1,017.9	0.09	[p. 1, PACCAR, 2008]
Other costs (not included as contributors)	1.1	<0.001	[p. 34, PACCAR, 2008]
RPE multiplier		**1.33**	

Sources: Supplier Relations LLC (2009); Census (2010) (see references in Section A.1)

PACCAR, 2008. PACCAR: Annual Report 2008. Available at: http://www.paccar.com/investors/investor_resources_history.asp. Accessed on February 7, 2010.

Walter McManus, personal communication on February 16, 2010.

As mentioned in Section 3.3 of this report, health care and retirement costs include expenditures for manufacturing and corporate workers. PACCAR's annual report provided figures for retirement costs in two categories: "benefits paid" of $48.8 million and "employer contributions" of $69.9 million in 2008. These two costs were summed, totaling $118.7 million for our retirement cost contributor. As with retirement, PACCAR disaggregated 2008 health care costs into several categories: "benefits paid" of $4.1 million, "service cost" of $3.2 million, and "interest cost" of $4.7. These costs were summed together, bringing the health care cost contributor to a total of $12.0 million. The industry average values of 0.004 and 0.06 were used for dealer new vehicle net income and dealer new vehicle selling cost contributors. As a result, the value of the RPE multiplier for PACCAR was 1.33 in 2008.

Table A-9 presents PACCAR's sum of the main indirect cost contributors for years prior to 2008. The sum of the main indirect cost contributors for earlier years was lower than the RPE multiplier value derived for 2008; however, the main cost contributors reported in Table A-9 range within 0.02 from cost contributors reported in Table A-8.

Table A-9. PACCAR Main Indirect Cost Contributors

Indirect Cost Contributor	2007	2006	2005	2004
Cost of sales	1.00	1.00	1.00	1.00
Selling, administrative, and other expenses	0.04	0.04	0.04	0.04
Operating and other expenses	NA	NA	NA	NA
Depreciation	0.04	0.03	0.03	0.03
Net income	0.10	0.11	0.10	0.10
Sum of main indirect cost contributors (including net income)	1.21	1.20	1.18	1.19

Sources: PACCAR, 2006. PACCAR: Annual Report 2005. Available at: http://www.paccar.com/investors/investor_resources_history.asp. Accessed on February 7, 2010.

PACCAR, 2009. PACCAR: Annual Report 2008. Available at: http://www.paccar.com/investors/investor_resources_history.asp. Accessed on February 7, 2010.

A.5 Navistar (Heavy Duty Truck Manufacturer)

Table A-10 presents relevant RPE cost contributors and the RPE multiplier for Navistar in 2008. Navistar allocates a portion of "postretirement benefit expense" in its cost of sales reporting. Thus, we subtracted this cost ($33 million) from the cost of sales to arrive at an adjusted manufacturing cost of $11,849 million. Navistar also allocates a portion of

Table A-10. Navistar RPE Multiplier Calculations: 2008

RPE Multiplier Contributor	Expense ($ Millions)	Relative to Cost of Sales	Calculation and Source
Vehicle Manufacturing			
Manufacturing cost	11,849.4	1.00	Cost of sales [p. 23, Navistar, 2008] – Truck postretirement benefit expense allocated to costs of products sold (22) [p. 42, Navistar, 2008] – Engine postretirement benefit expense allocated to costs of products sold (11) [p. 45, Navistar, 2008]
Production Overhead			
Warranty	257.0	0.02	[p. 24, Navistar, 2008]
R&D (product development)	384.0	0.03	[p. E-28, Navistar, 2008]
Depreciation and amortization	393.0	0.03	[p. 72, Navistar, 2008]
Maintenance, repair, operations cost	358.0	0.03	[p. E-28, Navistar, 2008]
Total production overhead	*1,392.0*	*0.12*	
Corporate Overhead			
General and administrative	1,389.8	0.12	[p. E-28, Navistar, 2008] – Postretirement benefits expense allocated to selling, general and administrative expenses (6) [p. 43, Navistar, 2008] – Transportation (47.2) [Supplier Relations, LLC]
Retirement	355.0	0.03	[p. 116, Navistar, 2008]
Health	209.0	0.02	[p. 116, Navistar, 2009]
Total corporate overhead	*1,953.8*	*0.16*	
Selling			
Transportation	47.2	0.004	Supplier Relations, LLC
Marketing	24.0	0.00	[p. 83, Navistar, 2008]
Dealers			
Dealer new vehicle net income	47.4	0.004	Walter McManus, personal communication
Dealer new vehicle selling cost	711.0	0.06	Walter McManus, personal communication
Total selling and dealer contributors	*829.6*	*0.07*	*[p. 25, Navistar, 2008]*
Sum of Indirect Costs	4,175.4	0.35	
Net income	134.0	0.01	[p. 23, Navistar, 2008]
Other costs (not included as contributors)	14.0	0.001	[p. 26, Navistar, 2008]
RPE multiplier		**1.36**	

Sources: Supplier Relations LLC (2009) (see references in Section A.1)

Navistar, 2008. Annual Report 2008. Available at: http://ir.navistar.com/sec.cfm. Accessed February 7, 2010.

Walter McManus, personal communication on February 16, 2010.

"postretirement benefit expense" ($6 million) to G&A cost. Thus, we subtracted this expense from G&A. As with all the heavy duty truck manufacturers, we assumed the transportation cost ($47.2 million) was 0.4% of manufacturing costs (SR LLC). Based on the light duty vehicle study and personal communications with Walter McManus (February 16, 2010), we imputed a dealer cost of $758 million. Navistar's RPE multiplier value was calculated to be 1.36 for 2008.

Navistar's annual reports were available dating back to 2004. Similar to PACCAR, Navistar's sum of the main indirect cost contributors from 2004 to 2007 is lower than the RPE derived for 2008 (see Table A-11). However, the main cost contributors reported in Table A-9 range within 0.03 of cost contributors reported in Table A-8.

Table A-11. Navistar Main Indirect Cost Contributors (as a Share of Cost of Sales)

Indirect Cost Contributor	2007	2006	2005	2004
Cost of sales	1.00	1.00	1.00	1.00
Selling, administrative, and other expenses	0.14	0.11	0.10	0.11
Operating and other expenses	< 0.01	< 0.01	< 0.01	< 0.01
Depreciation	0.04	0.03	0.03	0.03
Net income	−0.01	0.03	0.01	−0.01
Sum of main indirect cost contributors (including net income)	1.21	1.21	1.19	1.18

Sources: Navistar, 2005. Annual Report 2005. Available at: http://ir.navistar.com/sec.cfm. Accessed February 7, 2010.

Navistar, 2008. Annual Report 2008. Available at: http://ir.navistar.com/sec.cfm. Accessed February 7, 2010.

A.6 Daimler (Heavy Duty Truck Manufacturer)

Relevant RPE contributing factors gathered from Daimler's annual report are presented in Table A-12. As with Volvo, Daimler has several operating divisions, one of which is exclusive to the manufacturing of heavy duty diesel trucks. The following reporting of cost contributors is based on Daimler's truck division. Daimler's annual report did not provide an estimate of MRO cost; therefore, the industry average (based on Census data) was used as a proxy (see Table A-12). In congruence with the other manufacturers that did not directly report health care cost, we assumed manufacturing cost would reflect the industry average of 70% of health care cost (see Table A-12). Warranty costs were reported as containing a portion of pension (€15 million) and health care costs (€3.2 million), and these two costs were subtracted to arrive at an adjusted warranty cost contributor of €953.7 million.

Table A-12. Daimler (Truck) RPE Multiplier Calculations: 2008

RPE Multiplier Contributor	Expense (€ Millions)	Relative to Cost of Sales	Calculation and Source
Vehicle Manufacturing			
Manufacturing cost	22,345.9	1.00	Cost of sales [p. 207, Daimler, 2008] + (70% * Health care)
Production Overhead			
Warranty	953.7	0.04	[p. 73, Daimler, 2008] (Warranty, pensions, and Health care lumped together (18.2) – Pensions provisions (15.0))*Adjustment factor from Daimler Group to Daimler Trucks
R&D (product development)	1,056.0	0.05	[p. 62, Daimler, 2008]
Depreciation and amortization	646.0	0.03	[p. 207, Daimler, 2008]
Maintenance, repair, operations cost	355.0	0.02	Census
Total production overhead	*3,010.7*	*0.13*	
Corporate Overhead			
General and administrative	655.4	0.03	[p. 144, Daimler, 2008] (General & administrative for Daimler Group was reported as 4,124) – Health care – Transportation – Marketing
Retirement	236.0	0.01	30% * [p. 53, Daimler, 2008]
Health	261.8	0.01	Supplier Relations, LLC
Total corporate overhead	*1,153.2*	*0.05*	
Selling			
Transportation	87.7	0.004	Supplier Relations, LLC
Marketing	222.6	0.01	20% * [Marketing cost from LD Study] (Walter McManus, personal communication)
Dealers			
Dealer new vehicle net income	89.4	0.004	Walter McManus, personal communication
Dealer new vehicle selling cost	1,340.8	0.06	Walter McManus, personal communication
Total selling and dealer contributors	*1,740.4*	*0.08*	
Sum of Indirect Costs	5,904.2	0.26	
Net income	1,607.0	0.07	[p. 207, Daimler, 2008]
Other costs (not included as contributors)		0	
RPE multiplier		**1.34**	

Sources: Supplier Relations LLC (2009); Census (2010) (see references in Section A.1)

Daimler, 2008. Annual Report 2008. Available at: http://www.daimler.com/investor-relations/reports-and-key-figures/annual-documents/daimler-ag. Accessed February 7, 2010.

Walter McManus, personal communication on February 16, 2010.

Daimler (truck) did not directly report G&A expenses. Our methodology for determining G&A for Daimler (truck) was based on an imputed ratio of Daimler Group's G&A expense to Daimler Group's cost of sales (see Table A-12). G&A costs were reported to contain health care costs and transportation costs, both of which were subtracted from the imputed G&A cost to arrive at an adjusted G&A cost contributor for Daimler's truck division. Selling expenses (transportation, marketing, dealer support, and dealer discount) were reported as an industry average based on information from SR LLC and personal communication with Walter McManus. Daimler also did not provide an estimate of health care cost, so we calculated the health care cost contributor based on an industry average (SR LLC). Daimler's (truck) RPE multiplier value was calculated to be 1.34 in 2008.

Daimler experienced mild variation in its sum of main indirect cost contributors (see Table A-13). Between 2005 and 2007, the sum of main indirect cost contributors varied between 1.33 and 1.42.

Table A-13. Daimler Main Indirect Cost Contributors

Indirect Cost Contributor	2007	2006	2005
Cost of sales	1.00	1.00	1.00
Selling, administrative, and other expenses	0.17	0.17	0.17
Operating and other expenses	< 0.01	0.01	0.00
Depreciation	0.11	0.16	0.16
Net income	0.05	0.05	—
Sum of main indirect cost contributors (including net income)	1.37	1.42	1.33

Sources: Daimler, 2006. Annual Report 2006. Available at: http://www.daimler.com/investor-relations/reports-and-key-figures/annual-documents/daimler-ag. Accessed February 7, 2010.

Daimler, 2008. Annual Report 2008. Available at: http://www.daimler.com/investor-relations/reports-and-key-figures/annual-documents/daimler-ag. Accessed February 7, 2010.

A.7 Volvo (Heavy Duty Truck Manufacturer)

RPE calculations for Volvo's truck division are presented in Table A-14. Volvo's annual report segregated its financials among six operating divisions, one of which was the heavy duty diesel truck division. In 2008, Volvo's (truck) manufacturing cost equaled SEK 231,435. Volvo (truck) did not report transportation, marketing, or dealer costs; therefore, imputed values from SR LLC and personal communications with Walter McManus were used as proxies. G&A costs were reported for Volvo (truck) and included transportation and marketing costs; these costs

Table A-14. Volvo (Truck) RPE Multiplier Calculations: 2008

RPE Multiplier Contributor	Expense (SEK Millions)	Relative to Cost of Sales	Calculation and Source
Vehicle Manufacturing			
Manufacturing cost	231,435.5	1.00	[p. 75, Volvo, 2008]
Production Overhead			
Warranty	10,354.0	0.04	[p. 86, Volvo, 2008]
R&D (product development)	14,348.0	0.06	[p. 75, Volvo, 2008]
Depreciation and amortization	13,524.0	0.06	[p. 78, Volvo, 2008]
Maintenance, repair, operations cost	1,915.0	0.01	[p. 78, Volvo, 2009]
Total production overhead	*40,141.0*	*0.17*	
Corporate Overhead			
General and administrative	28,518.4	0.12	Administrative expenses and selling expenses (31,763.9) [p. 75, Volvo, 2008] – Transportation (940.5) – Marketing (2,301.1)
Retirement	1,365.0	0.01	
Health	847.2	0.004	30% * [p. 106, Volvo, 2008]
Total corporate overhead	*30,730.6*	*0.13*	
Selling			
Transportation	940.5	0.004	30% * [p. 106, Volvo, 2008]
Marketing	2,305.1	0.01	20% * [Marketing cost from LD Study] (Walter McManus, personal communication)
Dealers			
Dealer new vehicle net income	925.7	0.004	Walter McManus, personal communication
Dealer new vehicle selling cost	13,886.1	0.06	Walter McManus, personal communication
Total selling and dealer contributors	*18,057.4*	*0.08*	
Sum of Indirect Costs		0.38	
Net income	10,016.0	0.04	[p. 93, Volvo, 2008]
Other costs (not included as contributors)	1,802.0	0.01	Dealer bonus [p.109, Volvo, 2008]
RPE multiplier		**1.43**	

Sources: Supplier Relations LLC (2009); Census (2010) (see references in Section A.1)

Volvo Group, 2008. Annual Report 2008. Available at: http://www.volvogroup.com/GROUP/GLOBAL/EN-GB/INVESTORS/Pages/investor_relations.aspx. Accessed February 7, 2010.

Walter McManus, personal communication on February 16, 2010.

were subtracted to determine G&A (see Table A-12). The RPE multiplier for Volvo (truck) equaled 1.43 in 2008.

Table A-15 presents Volvo's sum of the main indirect cost contributors, which are again lower than the RPE value derived above for 2008.

Table A-15. Volvo Main Indirect Cost Contributors

Indirect Cost Contributor	2007	2006	2005	2004
Cost of sales	1.00	1.00	1.00	1.00
Selling, administrative, and other expenses	0.15	0.14	0.14	0.15
Operating and other expenses	< 0.01	< 0.01	< 0.01	< 0.01
Depreciation	0.06	0.06	0.05	0.06
Net income	0.07	0.08	0.07	0.06
Sum of main indirect cost contributors (including net income)	1.33	1.33	1.31	1.32

Sources: Volvo Group, 2006. Annual Report 2006. Available at: http://www.volvogroup.com/GROUP/GLOBAL/EN-GB/INVESTORS/Pages/investor_relations.aspx. Accessed on February 7, 2010.

Volvo Group, 2008. Annual Report 2008. Available at: http://www.volvogroup.com/GROUP/GLOBAL/EN-GB/INVESTORS/Pages/investor_relations.aspx. Accessed on February 7, 2010.