CHAPTER 5. MARKUPS FOR EQUIPMENT PRICE DETERMINATION

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CHAPTER 5. MARKUPS FOR EQUIPMENT PRICE DETERMINATION

5.1 INTRODUCTION

To carry out the engineering and life-cycle cost analyses (LCC), DOE needed to determine the cost to the customer of a baseline model furnace or boiler unit and the cost of more-efficient units. However, the customer price of such units is not generally known. By applying a multiplier called a "markup" to the manufacturers' costs estimated in the engineering analysis, DOE estimated the customers' prices for baseline model and more-efficient equipment. In addition to estimating average markups, the Department characterized the markups with probability distributions through a statistical analysis of U.S. Census data. The Department used these distributions in the LCC analysis.

The equipment price to the customer depends on how the customer purchases the equipment. Two types of distribution channels describe how most equipment passes from the manufacturer to the customer. The first distribution channel applies to furnaces and boilers installed in retrofit applications. In this distribution channel, the manufacturer sells the equipment to a wholesaler, who in turn sells it to a contractor, who in turns sells it to the customer. The second distribution channel applies to furnaces and boilers installed in new construction, and thus includes an additional link in the chain—the home builder. In this distribution channel, the manufacturer sells the equipment to a wholesaler, who in turn sells it to a contractor, who in turn sells it to a builder, who in turns sells it to the customer.[a]

Figure 5.1.1 illustrates the two main distribution channels for furnaces and boilers. These two channels apply to five of the six product classes (all but mobile home gas furnaces). The Department calculated the markups for non-weatherized gas furnaces, and used these markups to develop the markups for weatherized gas furnaces, oil-fired furnaces, gas boilers, and oil-fired boilers.

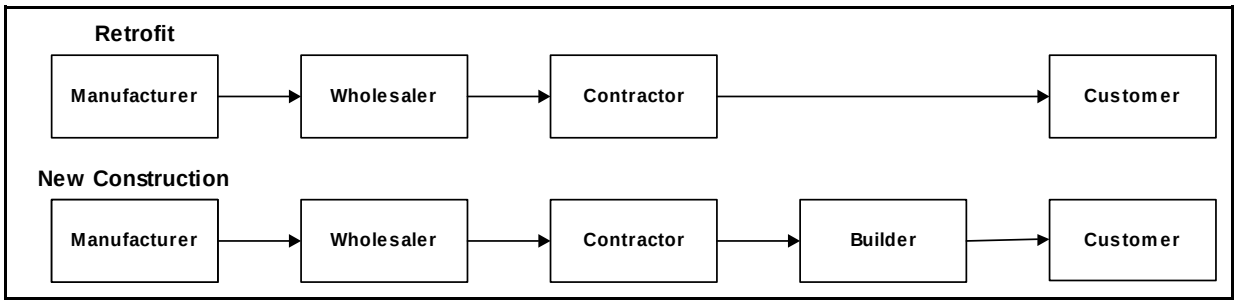

Figure 5.1.1 Distribution Channel for Residential Furnaces and Boilers

[a]One manufacturer uses a one-step distribution chain (manufacturer to contractor) and is the only known exception. Several large retailers are trying to step between wholesalers and contractors, but most experts do not expect the trend to change the distribution chain significantly in the near term.

Mobile home gas furnaces are sold as part of mobile homes, so these furnaces have a specific distribution chain (Figure 5.1.2). The heating-equipment manufacturer sells to the maker of the mobile home, who installs the equipment in the home. The mobile home maker sells the home to a reseller, who in turns sells it to a homebuyer. The equipment manufacturer markup for mobile home gas furnaces is identical to the manufacturer markup for other furnaces, as described in section 5.2 below. The additional markup for mobile home gas furnaces is described in section 5.5.

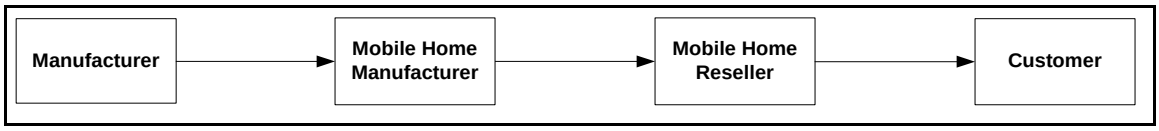

Figure 5.1.2 Distribution Channel for Mobile Home Gas Furnaces

At each point in the distribution chain, companies mark up the price of the equipment to cover their business costs and profit margin. In financial statements, gross margin is the difference between the company revenue and the company cost of sales. It includes all corporate overhead costs (sales, general, and administration); research and development (R&D) and interest expenses; depreciation and taxes; and profits. In order for sales of a product to contribute positively to company cash flow, the product's markup must be greater than the corporate gross margin. Individual products may command a lower or higher markup, depending on their perceived added value and the competition they face from similar products in the market.

Equipment manufacturers sell most of their products directly to wholesalers. Wholesalers sell to contractors at the wholesale price. Wholesalers absorb short-term imbalances in supply and demand, allowing manufacturers to operate more efficiently and satisfying consumer needs for fast deliveries. In addition, wholesalers are important sources for parts. Most contractors compete at the local level. Many carry more than one brand of furnace or boiler, and most install the products they sell. The trend is for contractors to consolidate into larger companies, following similar trends set by wholesalers and manufacturers.

In addition to the wholesale and general contractor markups, in new construction the builder adds a markup. In retrofit installations, sales tax applies to the final consumer cost.

The following equation describes how the Department determined the equipment price in existing housing:

$$EQP_{CUST} = (MFG_{BASE/STD} \cdot MU_{WHOLE} \cdot MU_{CONT} \cdot ST)$$

where:

EQP_{CUST} = equipment price to the customer ($),

$MFG_{BASE/STD}$	=	manufacturer price of baseline model or standard-level equipment ($),
MU_{WHOLE}	=	wholesaler markup,
MU_{CONT}	=	contractor markup, and
ST	=	sales tax.

For equipment in new construction, the equation is the same as above, except that the builder markup (MU_{build}) is substituted for the sales tax (ST).

For each of the markups presented above, the Department further differentiated between a baseline markup and an incremental markup, as described below.

5.1.1 Baseline Markups

The Department defines a baseline markup as a coefficient that relates the manufacturer price of equipment that DOE chose as the baseline model to the wholesale or contractor sales price of such equipment, as shown in the following equations:

$$EQP_{WHOLE\ BASE} = MFG_{BASE} \cdot MU_{WHOLE\ BASE}$$

$$EQP_{CONT\ BASE} = EQP_{WHOLE\ BASE} \cdot MU_{CONT\ BASE}$$

where:

$EQP_{WHOLE\ BASE}$	=	baseline model equipment price to the wholesaler ($),
MFG_{BASE}	=	manufacturer price for baseline model equipment ($),
$MU_{WHOLE\ BASE}$	=	wholesaler markup for baseline model equipment,
$EQP_{CONT\ BASE}$	=	contractor price for baseline model equipment ($),
$MFG_{WHOLE\ BASE}$	=	wholesaler price for baseline model equipment ($), and
$MU_{CONT\ BASE}$	=	contractor markup for baseline model equipment.

5.1.2 Incremental Markups

The incremental markup is a coefficient that relates change in the manufacturer price of higher-efficiency equipment to change in the wholesale or contractor sales price, as shown in the following equations:

$$EQP_{WHOLE\ INCR} = MFG_{INCR} \cdot MU_{WHOLE\ INCR}$$

$$EQP_{CONT\ INCR} = EQP_{WHOLE\ INCR} \cdot MU_{CONT\ INCR}$$

where:

$EQP_{WHOLE\ INCR}$ = incremental wholesaler price for equipment with increased efficiency ($),

MFG_{INCR} = incremental manufacturer price for equipment with increased efficiency ($),

$MU_{WHOLE\ INCR}$ = incremental wholesaler markup for equipment with increased efficiency,

$EQP_{CONT\ INCR}$ = incremental contractor price for equipment with increased efficiency ($), and

$MU_{CONT\ INCR}$ = incremental contractor markup for equipment with increased efficiency.

5.2 MANUFACTURER MARKUP

Publicly held corporations file annual reports (10-Ks) with the Securities and Exchange Commission (SEC) [http://www.sec.gov/, April 2004]. The Department used five representative sets of 10-K reports of publicly traded furnace and boiler manufacturers as the basis for estimating the manufacturer markups. Table 5.2.1 lists the average corporate gross margin during the last five years, and corresponding markups, for each of the five manufacturers. All companies sell products other than residential furnaces and boilers, including air-conditioning equipment and after-market parts. Many of these other products command higher profit margins than do baseline model furnaces and boilers. The Department deducted outbound freight, since it is included in the reverse-engineering cost estimates (see Chapter 6).

Table 5.2.1 Manufacturer Gross Margins and Markups

	Mfr A	Mfr B	Mfr C	Mfr D	Mfr E
Total Revenues related (Million)	$2399	$6983	$200	$3639	$1651
Corporate Gross Margin	31%	25%	28%	20%	26%
Markup	1.40	1.28	1.37	1.23	1.26
Markup (less freight–out)	1.34	1.22	1.31	1.17	1.2

Source: SEC 10-K reports (1997-2001)[1]

The average markup (less freight-out) value is 1.25, which is very close to the value of 1.26 used in the Residential Air-Conditioner and Heat Pump rulemaking analysis. For consistency, the Department used a manufacturer markup of 1.26.

5.2.1 Estimation of Manufacturer Markup Probability Distribution

The Department characterized the manufacturer markups developed from the above financial data as a discrete distribution. The Department assigned the weights (Table 5.2.2) using the reported total revenue values from Table 5.2.1.

Table 5.2.2 Manufacturer Markups and Weights from Five Manufacturers

	Mfr A	Mfr B	Mfr C	Mfr D	Mfr E
Markup	1.34	1.22	1.31	1.17	1.20
Weight	16%	47%	1%	24%	11%

5.3 WHOLESALE AND CONTRACTOR MARKUPS

5.3.1 Assumptions

The Department based the wholesale and contractor markups on firm balance sheet data. The Department obtained the firm balance sheets from reports published by the trade associations representing wholesalers[2] and contractors.[3] The Department put the building construction data used for developing builder markups into the same form as the balance sheet data for wholesalers.[4] These balance sheets break down all cost components incurred by firms that supply and install furnaces and boilers.[b] The key assumptions that DOE used to estimate markups using these financial data were:

1. The firm balance sheets faithfully represent the various average costs incurred by firms distributing and installing residential furnaces and boilers and light-commercial furnaces.

2. These costs can be divided into two categories: a) costs that vary in proportion to the manufacturer price of furnaces and boilers (variable costs), and b) costs that do not vary with the manufacturer price of furnaces and boilers (fixed costs).

3. Residential furnace and boiler wholesale and contractor prices vary in proportion to residential furnace and boiler wholesale and contractor costs included in the balance sheets.

In support of the first assumption, the balance sheets itemize firm costs into a number of expense categories, including direct costs to purchase or install the equipment, operating labor and occupancy costs, and other operating costs and profit. Although wholesalers and contractors

[b] Wholesalers and contractors to whom these reports refer handle multiple commodity lines, including residential and commercial air conditioning and warm-air furnaces.

tend to handle multiple commodity lines, including air conditioners, furnaces, and boilers, the data provide the most accurate available indication of residential furnace and boiler expenses (Census 2000).

Information obtained from the trade literature, and from selected heating, ventilating, and air-conditioning (HVAC) wholesalers, contractors, and consultants, tends to support the second assumption. This information indicates that wholesale and contractor markups vary according to the quantity of labor and materials used to distribute and install appliances, with markups on labor tending to be much larger than markups on materials.[c,5] Finally, the obtained information describes markups as varying much more in relation to sales volume than in relation to other factors, including appliance efficiency. This last finding strongly suggests that labor inputs vary more with sales volume than with appliance cost or efficiency. In the following discussion, the Department assumes a division of costs between those that do not scale with the manufacturer price (labor and occupancy expenses), and those that do (operating expenses and profit). This division of costs led to the estimate of wholesale and contractor markups described below.

In support of the third assumption, the HVAC wholesale and contractor industry is relatively competitive, and consumer demand for residential furnaces and boilers is inelastic, i.e. the demand is not expected to decrease significantly with an increase in price. The large number of HVAC firms listed in the 1997 *Census of Manufacturers* indicates the competitive nature of the market. For example, there are more than 5,500 HVAC wholesalers, more than 37,000 general contractors, and 84,000 HVAC contractors listed in the 1997 Census. Following standard economic theory, competitive firms facing inelastic demand either set prices in line with costs or quickly go out of business.[6]

5.3.2 Estimation of Wholesaler Markups

Wholesalers reported median data in a confidential survey of 37 firms.[7] The survey itemized revenues and costs into cost categories, including direct equipment expenses (cost of goods sold), labor expenses, occupancy expenses, other operating expenses, and profit. Appendix 5.1 presents these data in full. The first data column in Table 5.3.1 provides a summary of the data as cost-per-dollar revenue. For example, the direct equipment expenses (cost of goods sold) represent about $.74 per dollar of sales revenue. Labor expenses represent $.15 per dollar of sales revenue, occupancy expenses represent $.04 per dollar of sales revenue, and other operating expenses and profit make up $.09 per dollar of sales revenue.

[c] One HVAC spokesperson advocates pricing according to the amount of labor and material inputs, based on the concept of Dual Overhead Accounting. Stated markups for mechanical contractors were 15 percent on equipment and materials and 200-300 percent on labor.

Table 5.3.1 Wholesale Expenses and Markups

Wholesale Firm Expenses or Revenue	Per Dollar of Sales Revenue	Per Dollar Cost of Goods Sold
Direct Cost of Equipment Sales: Cost of goods sold	$0.74	$1.00
Labor Expenses: Salaries, payroll, benefit plans	$0.15	$0.20
Occupancy Expenses: Rent, utilities	$0.04	$0.05
Other Operating Expenses: Insurance, depreciation	$0.06	$0.07
Profit	$0.03	$0.04
Baseline Markup (MUw): Revenue per dollar cost of goods		$1.36
Incremental Markup (MUiw): Increased revenue per dollar		$1.11

The Department converted the data from costs-per-dollar of revenue into revenue-per-dollar of cost of goods sold, by dividing each cost category in the first data column of Table 5.3.1 by $0.74 (i.e., appliance expenditure per dollar of revenue). This conversion indicates that wholesalers earn $1.00 in sales revenue per dollar spent on the manufactured equipment. Similar calculations suggested that wholesalers earn $.25 in revenue per dollar spent on labor and occupancy, and $.11 in revenue per dollar spent on other operating expenses and profit.

The assumption that wholesale prices vary in proportion to changes in wholesale costs permits the use of these figures to estimate markups on the cost of goods sold. For example, this assumption implies that a $1.00 increase in the manufacturer equipment price leads to a $1.00 increase in revenue, if no other costs change at the same time. Similarly, the assumption implies that the $1.00 equipment increase leads to $1.36 revenue increase, if all other costs scale with the manufacture price, as indicated in the wholesale balance sheets.

Finally, the assumption implies that the $1.00 manufacturer price increase leads to a $1.11 revenue increase, if labor and occupancy costs are fixed and other operating costs and profit scale with the manufacturer price. The $1.11 figure represents the sum of revenue-per-dollar cost of goods sold for the manufacturer price, operating expenses, and profit categories.

The markup in the first case (assuming no change in other firm costs) would be 1.0. In that case, a $1.00 rise in the manufacturer price leads to a $1.00 increase in the wholesale price. The markup in the second case (assuming proportional changes in all firm cost categories) would be 1.36 (equaling the sum of manufacturing price, labor operating expenses, other operating expenses, and profits). The markup in this second case represents the Department's best estimate of the wholesale markup ($MU_{WHOLE\ BASE}$), since the wholesale markup includes labor and occupancy costs, along with other operating costs and profits. The markup in the third case is 1.11. This case represents the Department's best estimate of the incremental wholesaler markup ($MU_{WHOLE,\ INCR}$), where only profits and other operating costs vary with the manufacturer price. In that case, a $1.00 increase in the manufacturer price leads to a $1.11 increase in the wholesale

price. Note that 1.11 equals the sum of the manufacturing price, other operating expenses, and profit expenditures per dollar increase in the cost of goods (Table 5.3.1).[d]

5.3.2.1 Estimation of Wholesaler Markup Probability Distribution

The Department characterized the markups developed from the above financial data with probability distributions through a statistical analysis of the U.S. Census data for the wholesalers. Appendix 5.1 details the statistical analysis DOE carried out to determine the standard deviation of markups of HVAC firms in the United States. The Department applied the standard deviation to the single-point baseline and incremental markups discussed above, to create normal probability distributions for these markups.

Based on the analysis of U.S. Census data for wholesalers, DOE calculated a standard deviation of 8.2 percent for the baseline markup. Appendix 5.1 describes this calculation. The Department assumed that the variation determined for the baseline markup applied on a proportional basis to the incremental markup as well. For the baseline markup of 1.36, a standard deviation of 8.2 percent translates into an absolute value of 0.112. For the incremental markup of 1.11, a standard deviation of 8.2 percent translates into an absolute value of 0.091.

Figures 5.3.1 and 5.3.2 show the probability distributions that DOE used to characterize the wholesale baseline and incremental markups. Note that, for the incremental markup, the standard deviation of 0.091 results in markup values that are less than 1.0. Since a markup value of less than 1.0 would not allow the wholesaler to recover its costs, DOE truncated all values less than 1.0 from the normal distribution. In order to retain the same mean value of 1.11, DOE truncated an equal percentage of markup values from the high end of the normal distribution.

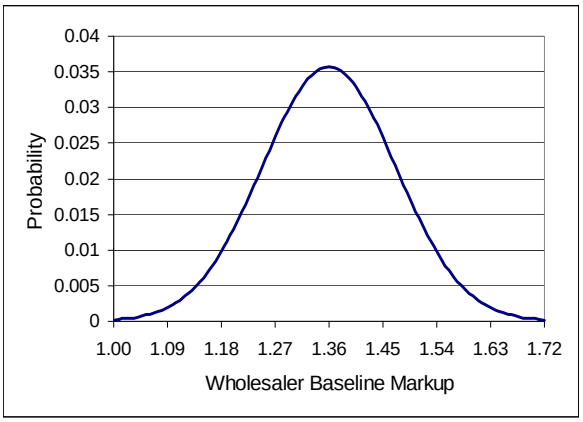

Figure 5.3.1 Wholesaler Baseline Markup Probability Distribution

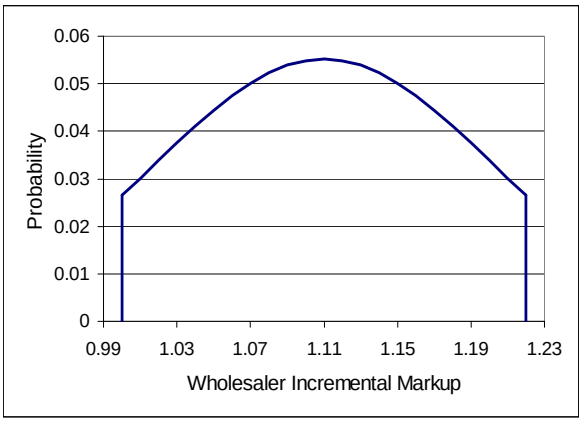

Figure 5.3.2 Wholesaler Incremental Markup Probability Distribution

[d]Appendix 5.1 shows the complete classification of expenses -- whether they scale with all costs or only with overhead labor cost.

5.3.3 Estimation of Contractor Markups

Contractors reported median cost data in an Air-Conditioning Contractors of America (ACCA) financial analysis of the HVAC industry.[2] Data reported in that analysis are similar to the itemized revenues and costs that wholesalers report, breaking expenses out into direct cost of appliance sales, payroll expense, occupancy expense, other operating expense, and profit categories. For convenience, the first data column in Table 5.3.2 summarizes these expenses as expenses per dollar of sales revenue. The only important difference from wholesalers is that the direct cost of appliance sales in this table includes out-of-pocket installation costs as well as the cost of goods sold.[e] For example, the direct cost of sales represents about $.65 per dollar of sales revenue to the contractor. Labor expenses represent $.15 per dollar of sales revenue; occupancy expenses represent $.01 per dollar of sales revenue; and other operating expenses and profit make up $.19 per dollar of sales revenue. Interestingly, the contractor expenditures per dollar of sales revenue in Table 5.3.2 are similar to the wholesaler expenditures per dollar of sales revenue discussed above. Table 5.1.4.1 in Appendix 5.1 shows the complete breakdown of contractor costs and expenses, including the direct cost components.

Table 5.3.2 Contractor Expenses and Markups

Contractor Expenses or Revenue	Per Dollar of Sales	Per Dollar
Direct Costs of Sales: Cost of goods sold	$0.65	$1.00
Labor Operating Expenses: Salaries, payroll, benefit plans	$0.15	$0.23
Occupancy Expenses: Rental and other occupancy costs	$0.01	$0.02
Other Operating Expenses: Advertising, depreciation, insurance	$0.14	$0.21
Operating Profit and Other Income	$0.05	$0.07
Markup (*MUCONT*): Contractor revenue per dollar direct cost of sales		$1.53
Incremental Markup (*MUINCR CONT*): Increase revenue per dollar	$0.15	$1.28

Dividing each figure in the first data column by $.65 converts the expenses per dollar of sales into revenue per dollar of cost of goods sold. For example, dividing the appliance price by $.65 implies that contractors earn $1.00 in sales revenue per dollar of cost of goods sold (wholesale price). Similar calculations suggest that contractors earn $.25 in revenue per dollar of labor and occupancy expense, and $.28 in revenue per dollar of other operating expenses and profit.

[e]In Table 5.3.2, the direct cost of appliance sales included only the cost of goods sold, since those are the only direct outlays of the firm related to HVAC appliances.

The assumption that contractor price is proportional to cost permits the use of these figures to estimate contractor markups. At one extreme, holding other cost categories constant, a $1.00 increase in the appliance price leads to a $1.00 increase in the contractor revenue. At the other extreme, allowing all costs to vary with the wholesale appliance price implies that a $1.00 increase in the appliance price leads to a $1.53 increase in contractor revenue. Finally, if only other operating expenses and profit scale with the wholesale price, a $1.00 increase in the appliance price leads to a $1.28 increase in contractor revenue. Note that 1.28 equals the sum of manufacturing appliance price, other operating expenses, and profit expenditures per dollar increase in the cost of goods (Table 5.3.2).

In these three cases, the contractor markup varies between 1.0 and 1.53, depending on the assumptions about contractor expenses and how they vary with the direct cost of sales. The contractor markup (MU_{CONT}), where all costs vary in proportion to the cost of goods sold, is thus 1.53. The incremental contractor markup ($MU_{CONT\ INCR}$), where only other operating costs and profit scale with the cost of goods sold, is 1.28.[f] The Department used a contractor markup of 1.53 and an incremental markup of 1.28. The Department assumed that the warranty cost is included in the contractor markup.

5.3.3.1 Contractor Markups in the Replacement and New Construction Markets

The baseline and incremental markups derived above are average values for all contractors, across both the replacement and new construction markets. The Department further disaggregated these markups into those pertaining to the replacement market and those pertaining to the new construction market. Additional refinement permitted the Department to calculate baseline and incremental markups separately for both categories, using the ACCA financial data that provide contractor gross margin data as a function of market type. Market type refers to new or replacement, in residential or light-commercial settings. Margin is the sum of all contractor labor and operating expenses plus profit.

Table 5.3.3 summarizes the gross margin and resulting baseline markup data for contractors as a function of market type. The table presents data for contracting businesses serving the residential and light-commercial market.

[f]Appendix 5.1 shows the complete classification of contractor expenses—whether they scale with all costs or only with overhead labor costs.

Table 5.3.3 Contractor Expenses and Baseline Markups by Market Type

Description	Contractor Expenses or Revenue by Market Type					
	All Residential and Light Commercial		New Construction Resid. and Light Comm.		Replacement Resid. and Light Comm.	
	Per Dollar Sales Revenue	Per Dollar of Direct Sale Costs	Per Dollar Sales Revenue	Per Dollar of Direct Sale Costs	Per Dollar Sales Revenue	Per Dollar of Direct Sale Costs
Direct Cost of Equipment Sales:* Cost of goods sold; Installation cost	$0.64	$1.00	$0.71	$1.00	$0.62	$1.00
Gross Margin: Operating and Labor Expenses plus profit	$0.36	$0.57	$0.29	$0.41	$0.38	$0.62
Baseline Markup ($MU_{MECH\ CONT\ BASE}$): Contractor revenue per dollar direct cost of sales		1.57		1.41		1.62

* Direct cost of equipment sales determined by subtracting the Gross Margin from $1.00.

Source for Gross Margin: *Financial analysis for the HVACR Contracting Industry, 1995 Edition.*

The data in Table 5.3.3 show that the markup for the replacement market is 1.62, which is slightly higher than the overall replacement/new construction markup of 1.57. The markup for the new construction market is 1.41, which is 10 percent lower than the markup across both market types. These numbers are influenced by the fact that the replacement market is larger than the new construction market.

To calculate the incremental contractor markups for each market type, the Department needed to separate the variable costs from the fixed costs for each contractor type in each market type. However, the data are divided only into direct costs and gross margin for each of these categories. The direct costs are a variable cost, but the gross margin includes labor costs, which are fixed, and non-labor costs, which are variable. The Department used the data in Table 5.3.3 to divide the gross margin into labor and non-labor components. The average gross margin (which is the sum of all labor and operating expenses plus profit) in all market types is $0.36. The non-labor component of gross margin is the sum of the other operating expenses plus profit ($0.14 + $0.05), which is $0.19. The non-labor (variable) component of gross margin is thus 53 percent of the total gross margin. The Department assumed, for both the replacement and the new construction markets, that the non-labor component of the total gross margin was also 53 percent. Following this assumption, the Department estimated contractor incremental markups for new markets to be 1.22. Similarly, DOE estimated contractor incremental markups for replacement markets to be 1.33 (Table 5.3.4).

Table 5.3.4 Incremental Markups by Contractor Size and Market Type

Description	New Construction		Replacement	
Baseline Markup ($MU_{MECHCONTBASE}$)	$1.41		$1.62	
Direct Cost of Equipment Sales (per dollar sales revenue)	$.71	$1.00	$.62	$1.00
Gross Margin (per dollar sales revenue)	$.18	$.29	$.23	$.38
Non-Labor percent of Gross Margin	53%		53%	
Non-Labor (per dollar sales revenue)	$.10	$.22	$.20	$.33
Incremental Markup ($MU_{CONT\ INCR}$)	1.22		1.33	

5.3.3.2 Estimation of Contractor Markup Probability Distribution

The Department characterized the markups developed from the ACCA financial data with probability distributions through a statistical analysis of U.S. Census data for plumbing, heating, and air-conditioning contractors.[1] The statistical analysis provided a standard deviation on the markups of contractors in the U.S. The Department then applied the standard deviation to the single-point baseline and incremental markups calculated above, to create normal probability distributions for these markups.

The Department calculated a standard deviation of 3.0 percent for the contractor markups. Figures 5.3.3 and 5.3.4 show the probability distributions that the Department used to characterize the contractor baseline and incremental markups in the new construction market. The probability distributions for the replacement contractor markups have similar shapes. Appendix 5.1 details the analysis that DOE carried out to determine the standard deviation of baseline contractor markups.

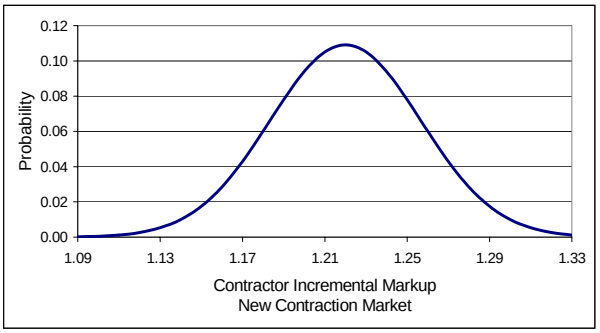

Figure 5.3.3 Contractor Baseline Prob. Distribution, New Constr.Market

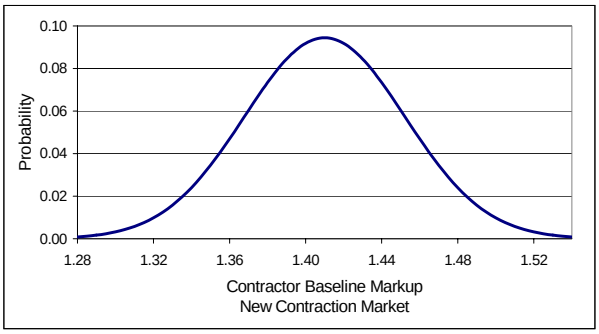

Figure 5.3.4 Contractor Incremental Markup Prob. Distribution, New Constr. Market

5.4 BUILDER MARKUP

In new construction, the builder marks up the cost of the property, including heating equipment. The Department based the builder markups on U.S. Census data[8] and on HVAC industry data.[3] Appendix 5.1 details the analysis that DOE carried out to determine the markups. The Department characterized the markups developed from these data with probability distributions through a statistical analysis of the above sources. The Department then applied the standard deviation of 5 percent of the mean baseline and incremental markups to create normal probability distributions for these markups. Table 5.4.1 shows the markups that DOE applied to the manufacturing cost of baseline equipment and the incremental cost of higher-efficiency equipment. Figures 5.4.1 and 5.4.2 show the probability distributions.

Table 5.4.1 Builder Markups

Type	Mean
Baseline Markup	1.43
Incremental Markup	1.33

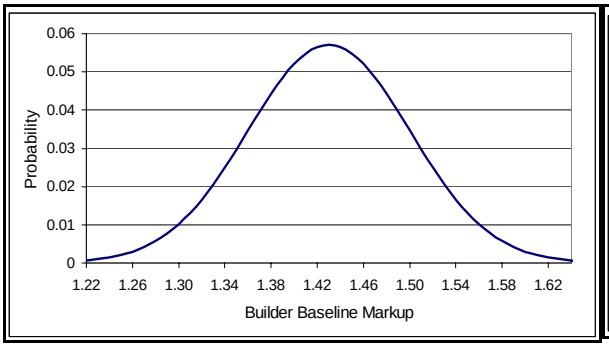

Figure 5.4.1 Builder Baseline Markup Probability Distribution

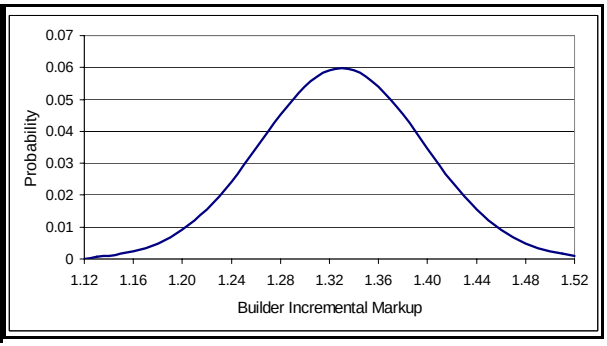

Figure 5.4.2 Builder Incremental Markup Probability Distribution

5.5 MARKUP FOR MOBILE HOME GAS FURNACES

In a comment to DOE,[9] the Manufactured Housing Institute (MHI) indicated that the total markup of the mobile home manufacturer and the mobile home retailer has traditionally been a factor of 2.22. The Department applied this number to the estimated manufacturer price of a mobile home gas furnace for both the baseline and for incremental costs. For this analysis, DOE considered all mobile home gas furnaces to be new installations provided together with the home.[g]

[g]In the case of mobile home furnace (MHF) replacement, the wholesaler and contractor markup that is typical for all furnace product classes would apply. However, given the lack of data for this replacement market, in this analysis DOE assumed that all MHFs are part of a new home.

5.6 SALES TAX

The sales tax represents state and local sales taxes that are applied to the customer price of the equipment. The sales tax is a multiplicative factor that increases the customer equipment price.

The Department derived representative state and local taxes from 1997 state and local sales tax data.[10, 11] The Department weighted the state and local sales tax data by population. The Department aggregated the sales tax data into one-percentage-point bins (e.g., sales taxes from 5 to 5.99 percent, sales taxes from 6 to 6.99 percent).[12, 13]

The distribution of sales tax rates ranges from a minimum of 0 percent to a maximum of 10 percent, with a mean value of 6.7 percent. The Department applied sales taxes to the customer equipment price, irrespective of the distribution channel and the market in which the customer is located. Table 5.6.1 provides the distribution of sales tax rates based on the percentage of equipment shipments in each sales tax bin.

Table 5.6.1 Distribution of Sales Tax Rates

	Sales Tax Rate					
	0%	5%	6%	7%	8%	10%
Probability of Rate	1%	10%	29%	37%	22%	1%

5.7 OVERALL MARKUPS

The overall baseline and overall incremental markups relate the manufacturing cost to the customer price, as indicated by the following equations:

$$EQP_{CUST\ BASE} = MFG_{BASE} \cdot MU_{WHOLE\ BASE} \cdot MU_{CONT\ BASE} \cdot ST$$
$$= MFG_{BASE} \cdot MU_{OVERALL\ BASE}$$

$$EQP_{CUST\ INCR} = MFG_{INCR} \cdot MU_{WHOLE\ INCR} \cdot MU_{CONT\ INCR} \cdot ST$$
$$= MFG_{INCR} \cdot MU_{OVERALL\ INCR}$$

where:

$MU_{OVERALL\ BASE}$ = baseline overall markup, which is the product of all the other baseline markups ($MU_{WHOLE\ BASE} \cdot MU_{CONT\ BASE} \cdot ST$), and

$MU_{OVERALL\ INCR}$ = incremental overall markup, which is the product of all the other incremental markups ($MU_{WHOLE\ INCR} \cdot MU_{CONT\ INCR} \cdot ST$).

For a particular efficiency level that increases manufacturer price, the total equipment price to the customer is simply the sum of the baseline customer price ($EQP_{CUST\ BASE}$) and the incremental customer price ($EQP_{CUST\ INCR}$). The markup on incremental costs (relative to the baseline unit) is lower than the markup on the baseline cost for wholesalers and contractors, because only profits and other operating costs typically scale with the manufacturer price or (for contractors) the cost of goods sold.

The overall markups are different for new and replacement installations, since different markups apply to each of these. New construction installations have a lower overall markup than replacement installations.

The Department estimated that 26 percent of gas furnaces go to new construction, based on the ratio of housing starts and gas furnace shipments for year 2000. A limited number of sources[14] indicate that shipment volumes of oil equipment and boilers to new construction are very low, so the Department assumed that oil-fired equipment and boilers are exclusively employed in retrofit installations. As shown in Table 5.7.1, the total markup is lower for gas furnaces due to the higher fraction of shipments in new construction.

The Department used the overall markup to estimate the customer price of baseline equipment, given the manufacturer cost of baseline equipment. Similarly, the Department used the overall incremental markup to estimate changes in the customer price, given changes in the manufacturer cost above the baseline price resulting from a standard to raise equipment efficiency. For example, if a standard increases the gas furnace manufacturer cost by $100, the Department multiplied this by the overall incremental markup of 2.05 to estimate that the customer price will increase $205.

Table 5.7.1 Summary of Markups on Residential Furnaces and Boilers

	Baseline Model Cost	Incremental Cost
Manufacturer	1.26	1.26
Wholesaler	1.36	1.11
Contractor (new/replacement)	1.41/1.62	1.22/1.33
Builder (new construction only)	1.43	1.33
Sales tax (replacements only)	1.07	1.07
Total markup (on manufacturing cost)		
Non-weatherized gas furnace	3.12	2.07
Weatherized gas furnace		
Oil-fired furnace	2.97	1.99
Hot-water gas boiler		
Hot-water oil-fired boiler		
Mobile home gas furnace	2.22	2.22

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