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# An Analysis of Price Determination and Markups in the Air-Conditioning and Heating Equipment Industry

Larry Dale, Dev Millstein, Katie Coughlin, Robert Van Buskirk,
Gregory Rosenquist, Alex Lekov, and Sanjib Bhuyan

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Energy Analysis Department
Environmental Energy Technologies Division
Lawrence Berkeley National Laboratory
University of California
Berkeley, CA 94720

and

Department of Agricultural, Food & Resource Economics
Rutgers, The State University of New Jersey
New Brunswick, NJ 08901

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# ABSTRACT

In this report we calculate the change in final consumer prices due to minimum efficiency standards, focusing on a standard economic model of the air-conditioning and heating equipment (ACHE) wholesale industry. The model examines the relationship between the marginal cost to distribute and sell equipment and the final consumer price in this industry. The model predicts that the impact of a standard on the final consumer price is conditioned by its impact on marginal distribution costs. For example, if a standard raises the marginal cost to distribute and sell equipment a small amount, the model predicts that the standard will raise the final consumer price a small amount as well.

Statistical analysis suggest that standards do not increase the amount of labor needed to distribute equipment—the same employees needed to sell lower efficiency equipment can sell high efficiency equipment. Labor is a large component of the total marginal cost to distribute and sell air-conditioning and heating equipment. We infer from this that standards have a relatively small impact on ACHE marginal distribution and sale costs. Thus, our model predicts that a standard will have a relatively small impact on final ACHE consumer prices. Our statistical analysis of U.S. Census Bureau wholesale revenue tends to confirm this model prediction.

Generalizing, we find that the ratio of manufacturer price to final consumer price prior to a standard tends to exceed the ratio of the change in manufacturer price to the change in final consumer price resulting from a standard. The appendix expands our analysis through a typical distribution chain for commercial and residential air-conditioning and heating equipment.

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## 1.0 INTRODUCTION

This report investigates the effects of energy efficiency regulations on the final price of the consumer good. A change in appliance energy efficiency regulations usually increases appliance manufacturing prices and this report describes a method to estimate the resulting change in the final consumer price. We focus on the example of air-conditioning and heating equipment, but this approach can be generalized to other appliances and equipment. We observe that a change in energy efficiency regulations increases manufacturing prices of a piece of equipment by a predictable amount. There is a distribution chain which the equipment passes through before it is sold to the final consumer. Each time the equipment changes hands, the price is increased by a certain amount. We will describe a method for predicting this "markup" in price for each step of the distribution chain.

We define two types of markups: (1) the "baseline markup", the ratio of final consumer price to original manufacturing price, and (2) the "incremental markup", the ratio of change in final consumer price to change in manufacturing price (also called cost of good). The incremental markup tends to be lower than the baseline markup because the labor component of marginal cost at the wholesale and retail level does not increase due to a standard, despite the increase in the cost of goods sold. Our analysis supports using the incremental markup to predict final consumer prices. Our method for predicting final prices using an incremental markup is described in detail in section 3. We focus on the air-conditioning and heating equipment (ACHE) wholesale industry, as an illustrative example.

This industry is characterized by a limited number of equipment manufacturers and a large number of wholesalers, general contractors, and heating, ventilating, and air-conditioning (HVAC) contractors to distribute and deliver appliances to final consumers. In the case of commercial unitary air conditioners, equipment is typically distributed according to the following distribution channel: the manufacturer sells the equipment to a wholesaler, the wholesaler sells to an HVAC (i.e., mechanical) contractor, the HVAC contractor sells to a general contractor, and the general contractor sells to a consumer. The Census of Manufactures suggests that the distribution channel in the industry is relatively competitive, with many firms at each distribution level. For example, over 5,500 ACHE wholesalers, 37,000 general contractors, and 84,000 HVAC contractors are listed in the U.S. Census (U.S. Department of Commerce, 1997). As a result, our basic model assumes perfect competition and constant marginal cost curves in the industry. We discuss the impact of different market and cost curve assumptions on the predictions of this model.

The model is used to estimate baseline and incremental markups using ACHE wholesaler survey information. This estimate indicates that the ACHE incremental markup is different than the ACHE baseline markup. Next, we estimate baseline and incremental markups using ACHE U.S. Census Bureau information. The markups estimated from Census Bureau information are remarkably similar to markups estimated using ACHE survey information. The similarity of the markup estimated using two different data sets supports the basic model and suggests the accuracy of the incremental markup approach described in this report.

## 2.0 THE MODEL

### 2.1 Notation

We consider two cases, a base case which represents the existing situation, and an efficiency case. The latter assumes that existing equipment is modified to improve efficiency, but otherwise retains the general characteristics that define it in the market. The modification leads to an increment in the manufacturer unit price (i.e., the price which the manufacturer sells a single piece of equipment (unit) to a wholesaler). The manufacturer unit price is equivalent to the wholesaler's cost of good sold (CGS).[1] The incremental markup, $\alpha$, is the markup on this manufacturer price increment. The markup is the ratio of the final consumer unit price (i.e., the price which the consumer pays for a single piece of equipment) to the manufacturer unit price. The markup in the base case is also referred to as the baseline markup. In symbolic form we have the following definitions:

- $P_0$ = manufacturer unit price or the wholesaler's CGS in the base case.
- $P_0'$ = manufacturer unit price or the wholesaler's CGS in the efficiency case.
- $\Delta_0 = P_0' - P_0$ = change in manufacturer unit price
- $P_F$ = final consumer unit price in the base case
- $P_F'$ = final consumer unit price in the efficiency case
- $\Delta_F = P_F' - P_F$ = change in the final consumer unit price
- $m = P_F / P_0$ = markup in the base case = baseline markup
- $m' = P_F' / P_0'$ = markup in the efficiency case = modified markup
- $\alpha = \Delta_F/\Delta_0$ = incremental markup, increase revenue per dollar increase CGS.

It is also useful to represent the increment to the manufacturer price as a percentage:

$$\epsilon = \Delta_0 / P_0 \text{ or equivalently } P_0' = P_0 \bullet ( 1 + \epsilon ).$$

It is then easy to show that the relationship between the baseline and modified markups is

$$m' = (m + \alpha \bullet \epsilon ) / ( 1 + \epsilon ).$$

By definition $\alpha \leq m$, so that $m' \leq m$. If $\epsilon$ is sufficiently small we have the approximate relationship

$$m - m' \simeq \epsilon * ( m - \alpha ).$$

[1] For a wholesaler, the cost of goods sold (CGS) consists of the wholesaler's direct equipment expenses.

This shows that the difference in markup between the base case and the efficiency case may be relatively small, being the product of two small quantities.

## 2.2 Economic Theory of Markups Under Different Assumptions About Market Structure

In this section we indicate the impact of different assumptions about market structure, including markets that face rising marginal costs, exogenous demand shifts, and oligopoly power.

### 2.2.1 Wholesale Incremental Markups Assuming Perfect Competition with Constant Costs

Under perfect competition with constant costs, products are priced at marginal cost (Pindyck and Rubinfeld, 1998). Assuming constant costs (perfectly elastic supply), marginal cost equals average unit manufacturing price plus average unit wholesale cost. This implies that the customer price ($P_F$) is set equal to unit costs faced by the wholesaler. As represented by the following equation, the change in customer price ($\Delta_F$) due to an efficiency standard, equals the change in manufacturer unit price ($\Delta_0$) added to the change in unit wholesale cost ($MC_w$):

$$\Delta_F = \Delta_0 + MC_w.$$

This change in customer price due to an efficiency standard assuming perfect competition and constant costs is illustrated in Figure 2.1.

This model of markup determination in the case of perfect competition and constant costs implies that the increase in final price that a consumer sees will equal those changes in costs associated with the increasing cost of a good. Some wholesale/retail costs, such as insurance and equipment financing costs, are likely to increase when appliance efficiency goes up and will contribute to the increase in the final price. Other costs, including labor and occupancy costs, are not likely to increase when appliance efficiency goes up and will not contribute to the increase in final price or be included in the incremental markup.

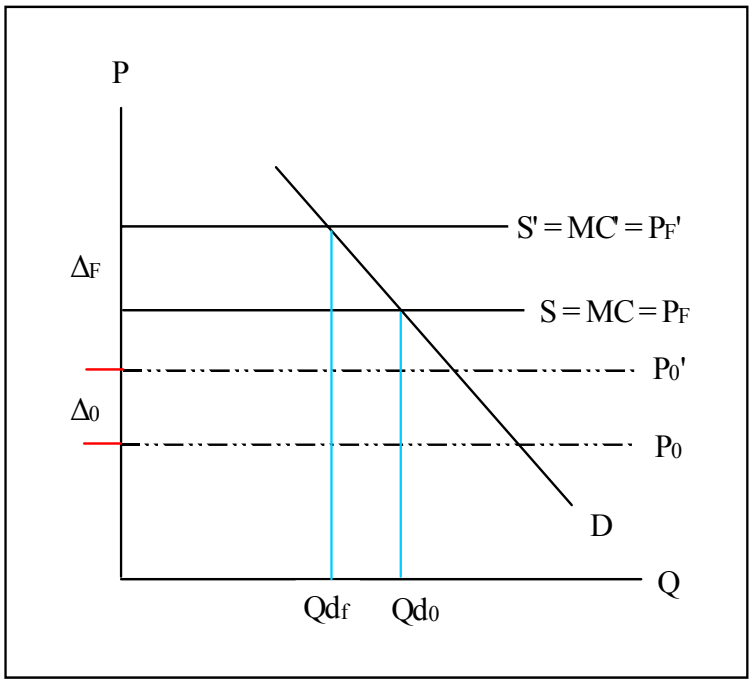


**Figure 2.1 Relationship between Consumer Price and Marginal Cost assuming Perfect Competition and Constant Costs**

### 2.2.2 Impact of Rising Costs on Markups

As shown in Figure 2.2, under perfect competition with rising costs, products are priced at marginal cost. In this case, the upward shift in marginal cost (the supply curve) caused by standards is shared between the producers and the consumers such that $\Delta_F$ could be less than the shift in marginal cost. Thus, in this case, the final price to the consumer rises less than the upward shift in marginal cost. The fraction of the shift in marginal cost which is paid by the consumers, called the pass-through fraction, is dependent on the elasticities of supply and demand (Pindyck and Rubinfeld, 1998):

$$\text{Pass-through fraction} = E_s / (E_s - E_d),$$

Where,

$E_s$ = supply elasticity and
$E_d$ = demand elasticity.

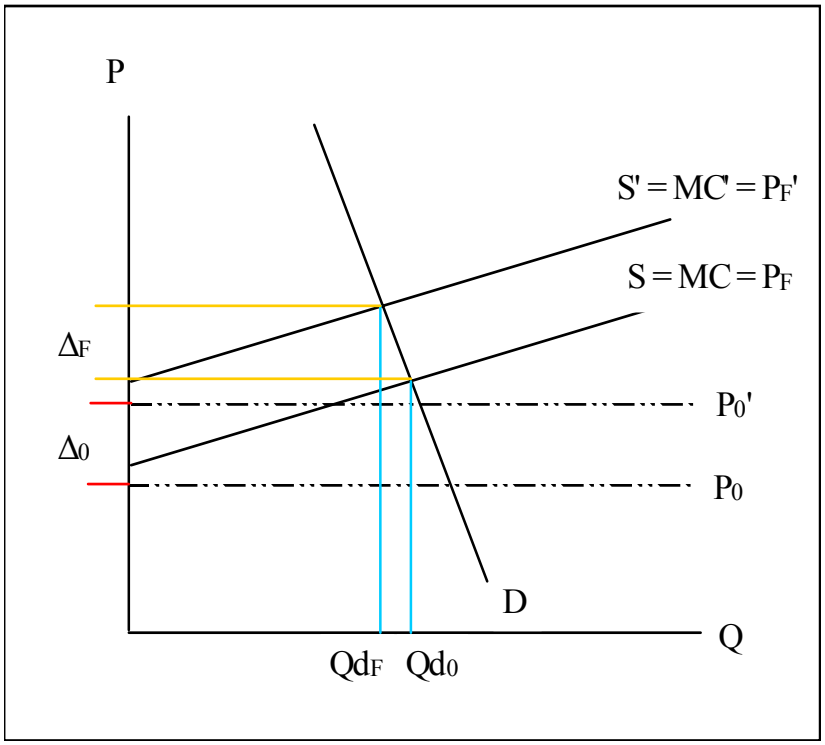


**Figure 2.2 Customer Price as a function of Marginal Cost with upward shift in Supply Curve**

Thus, the fraction of the upwards shift in marginal cost that is passed through to the consumer varies inversely with the market wide elasticity of demand, and varies directly with the elasticity of supply.[2]

### 2.2.3 Impact of Demand Shift on Markups

It is likely that efficiency standards would create no shift, or a small upward shift in the demand curve as the quality of the good increases due to the efficiency standard (Hausman, 1979; Fredrick et. al., 2002).[3] While the size of this shift is hard to predict, we can gauge its effects by examining the quantity of goods demanded by consumers. If there is no shift in the demand curve, the quantity of goods demanded falls depending on the elasticites of demand and supply.

We could define a small upward demand curve shift as one that leaves the quantity of goods demanded at or below pre-standard levels, but greater than the quantity demanded assuming only a shift in the supply curve. In this case we would find the pass through fraction to be larger than seen under just the supply curve shift, but it would still range from zero to one. If there was a large

[2] $E_d$ is defined as negative. (Price increases result in lower quantity demanded.)

[3] The sources cited support high implicit discount rates and thus low demand shift (due to a low consumer value for time discounted energy savings).

demand curve shift, the quantity demanded would increase to a level greater than that demanded before the standard was implemented. In this case the pass through fraction would be greater than one, and would depend on the size of the increase in demand.

We can summarize the effects of elasticity and demand shift based on one measurement. If, after the standard is implemented, the quantity of good demanded falls the pass through fraction will range from zero to one. If, after the standard is implemented, the quantity of good demanded increases, the pass through fraction will be greater than one. If, after the standard is implemented, the quantity of good demanded stays the same then the pass through fraction will equal one.

In a situation with rising marginal costs, where the market demand is extremely elastic, we might see very little change in price due to a given shift in marginal cost. In this situation, provided most of the cost increases seen by the firm came in the form of an increase in cost of good, we might find an incremental markup of less than one. In a situation where demand shifted outwards due to increased appreciation of the benefits of efficient appliances, we might see a larger incremental markup. However, this effect is due to changing consumer preferences as opposed to increased costs to manufacturers, wholesalers, and retailers.

### 2.2.4 Impact of Market Power on Markups

Unlike a firm in competition, a firm with market power is not a "price taker." A firm may choose its quantity that it sells and charge the maximum price given the demand. The profit maximization rule--marginal revenue equal to marginal cost--applies when firms with market power maximize their profit. Under market power, price will be greater than marginal cost. Here, we define a "economic markup", $m_e$, as:

$$m_e = \Delta_F / MC_w.$$

Figure 2.3 shows such firms facing a highly elastic residual demand. This is a case where a firm has very limited market power. Such firms will see an economic markup of less than one. In Figure 2.4 we see an example of a firm that faces an inelastic residual demand. In this case, the economic markup is greater than one (Pindyck and Rubinfeld, 1998).

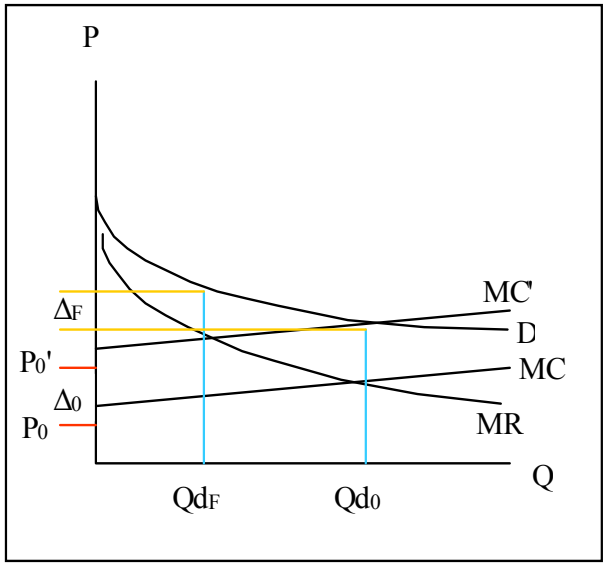


**Figure 2.3 Elastic Residual Demand**

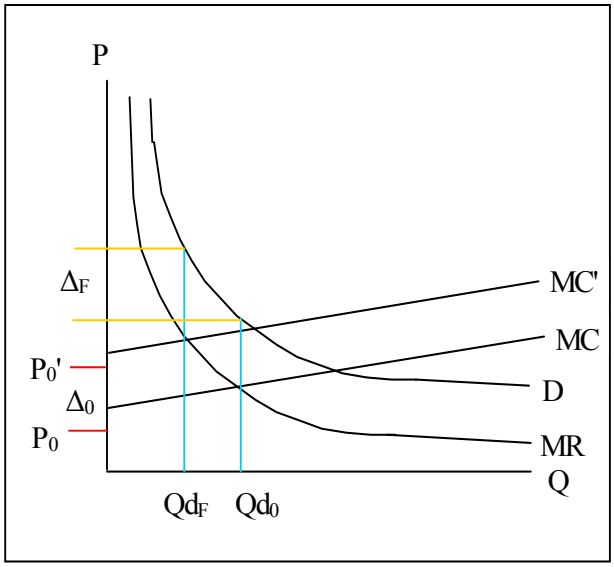


**Figure 2.4 Inelastic Residual Demand**

The economic markup is estimated as a function of the elasticity of market demand in the following equation (Bhuyan and Lopez,1995):

$$L = (P_F' - MC_w) / P_F' = (H + \alpha (1-H)) / E_d$$

In this equation, $P_F'$, $MC_w$ , H, $\alpha$ and $E_d$ represent the price, marginal cost, Herfindhal-Hirschman index, collusion parameter, and absolute value of the demand elasticity, respectively. The collusion parameter ($\alpha$) represents the degree of industry wide collusion, where Cournot and perfectly collusive behavior are represented by $\alpha = 0$ and $\alpha = 1$, respectively. The Herfindahl-Hirchman index (H) measures industry concentration (H approaches 0 under perfect competition and exceeds 1000 for moderately concentrated industries). The market demand elasticity ($E_d$) indicates the responsiveness of production to changes in the price ($E_d < 0$). The other variables in the equation are defined above.

Solving for $P_F'$ gives,

$$P_F' = MC_w \bullet [E_d / ( E_d - (H + \alpha (1-H))]$$

This expression demonstrates how marginal cost, demand elasticity and other variables interact to determine the consumer price. When firms have market power as described by this equation, our method for calculating markups needs to be adjusted. In the equation, price equals marginal cost times a multiplier ($E_d / ( E_d - (H + \alpha (1-H)))$). Since the multiplier is itself a function of the price elasticity, the economic markup varies according to price elasticity value. Depending upon the size and potential changes in elasticity value, the multiplier may be larger or smaller than one as

illustrated above (Figure 2.3 and Figure 2.4).[4]

## 3.0 ESTIMATING MARKUPS

### 3.1 Estimating Markups Using Balance Sheet Data

The wholesale ACHE markup is based on firm balance sheet survey data obtained from the trade associations representing ACHE wholesalers. Wholesalers reported median data in a confidential survey conducted by the Air-conditioning and Refrigeration Wholesalers Association (ARW). These balance sheets break out the components of all costs incurred by wholesale firms that handle ACHE (Air-conditioning and Refrigeration Wholesalers Association, 1998).

The wholesale cost data are summarized as revenue per dollar CGS in Table 3.1.[5] The data show that for every $1.00 spent by the wholesaler on equipment costs, $1.00 in sales revenue is earned to cover the equipment cost, $0.20 is earned to cover labor costs, $0.05 is earned to cover occupancy expenses, $0.07 is earned for other operating expenses, and $0.04 is earned in profits. This totals to $1.36 in sales revenue earned for every $1.00 spent on equipment costs. This tells us that the wholesale baseline markup is 1.36, since the wholesaler earns $1.36 in sales revenue for every $1.00 spent to purchase the equipment. In other words, for every $1.00 taken in as sales revenue, $0.74 is used to pay the direct equipment costs. Labor expenses represent $0.15 per dollar sales revenue, occupancy expenses represent $0.04, other operating expenses represent $0.06, and profit accounts for $0.03 per dollar sales revenue.[6]

[4] Here we need to adjust the method used to calculate incremental markups. Unlike the case of perfect competition, firm profits are positive and firm income exceeds the opportunity cost of capital. As long as the firm makes as much or equal to the opportunity cost of capital, it will continue to produce. Thus, the opportunity cost of capital (the profit section of the survey) would not be included in markup calculations using the Lerner index.

[5] The data in Table 3.1 were converted from costs per dollar revenue to revenue per dollar CGS by dividing each cost category in the survey date by $0.74 (i.e., the CGS per dollar revenue). Appendix B provides a detailed description of ACHE wholesaler costs and expenses as provided by ARW.

[6] This adds up to $1.02 due to independent rounding.

**Table 3.1 Wholesale Expenses and Markups**

| Description | Firm Revenue Per Dollar Cost of Goods Sold |
|---|---|
| **Cost of goods sold:** Primarily ACHE manufacturing cost | $1.00 |
| **Labor Expenses:** Salaries, Payroll, Benefit plans | $0.20 |
| **Occupancy Expenses:** Rent, Utilities | $0.05 |
| **Other Operating Expenses:** Insurance, Depreciation | $0.07 |
| **Profit** | $0.04 |
| **Baseline Markup:** Revenue per dollar CGS. | 1.36 |
| **Incremental Markup:** Increase revenue per dollar increase cost of goods sold. | 1.11 |

**Source:** 1998 ARW Wholesale Profit Survey Report.

In order to interpret the cost data we must first understand the structure of the wholesale industry. Past studies on market power have found a variety of results based on the method used and the industry surveyed. We have found some results supporting the idea of low market power in the appliance wholesale market (Norrbin, 1993). The competitive nature of the market is also suggested by the large number of ACHE firms listed in the 1997 Census of Manufactures. For example, there are over 5,500 ACHE wholesalers, over 37,000 general contractors, and 84,000 HVAC contractors listed in the 1997 Census (U.S. Department of Commerce, 1997). In addition, wholesale and retail appliance markets are considered to have few barriers to entry so that even new firms that wish to enter these markets can do so without making large up front capital investments, acquiring expensive patents or overcoming government regulations. Markets with limited barriers to entry, termed contestable markets, behave like competitive markets, even when the number of firms is small (Mansfield, 1997). Finally, we have no data about the shape of the marginal cost curve, but a conservative assumption in this case would be to assume that the cost curve is horizontal. Thus, we expect to see firms set prices at marginal costs as shown in Figure 2.1.

We use the data in Table 3.1 to calculate baseline markups on existing equipment (prior to efficiency changes resulting from enactment of efficiency standards) by making assumptions about changes in labor and occupancy expenses resulting from changes in appliance efficiency. The incremental markup will depend on which of the costs in Table 3.1 are variable with respect to cost of good, and which are fixed with respect to cost of good.

For example, for a $1.00 increase in the manufacturer equipment price, if *all* of the other costs scale with the manufacturer price (i.e. all costs are variable), the increase in wholesaler price will be $1.36, implying that the incremental markup is 1.36, or the same as the baseline markup. At the other extreme, if none of the other costs are variable, then a $1.00 increase in the manufacturer price will lead to a $1.00 increase in the wholesaler price, for an incremental mark-up of 1.0. Actually, we expect that the labor and occupancy costs will be fixed and that the other operating costs and profit will scale with the manufacturer price (i.e. are variable). That is because in our judgment it requires no more labor to handle high efficiency equipment than it takes to handle existing, lower

efficiency equipment.[7] In this case, for a $1.00 increase in the manufacturer price, the wholesaler price will increase by $1.11, giving a wholesale incremental markup of 1.11.

### 3.2 Estimating Markups Using U.S. Census Bureau Data

The ACHE census data includes firm revenue, the CGS, and labor wage data for ACHE firms in different U.S. states (U.S. Department of Commerce, 1997). The data allow us to compare the trend in average firm CGS in different states with the trend in average firm payroll, both as functions of firm revenue (Figure 3.1). Each square shape in Figure 3.1 indicates average firm payroll and revenue in one state. The square shapes in the Figure indicate that average firm payroll increases across states as a rough linear function of average firm revenue. Each diamond shape in the Figure indicates the average firm CGS and revenue in one state. The diamond shapes in the Figure suggest that average firm CGS increase across states as a rough linear function of average firm revenue.

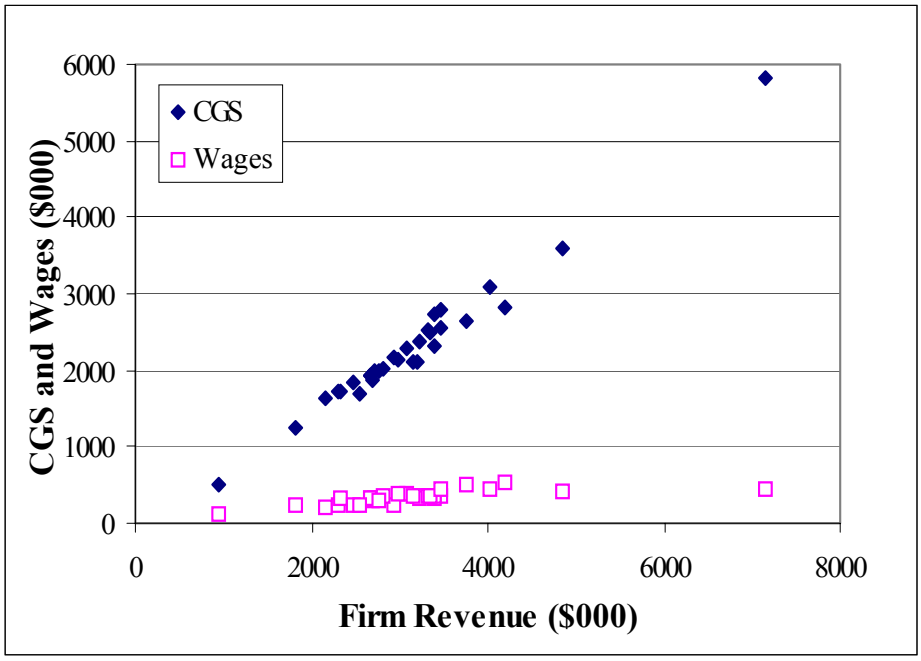


**Figure 3.1 CGS and Wages as a function of Firm Revenue**

We calculated the national baseline markup of ACHE firms by dividing total firm revenue (summed across all States) by total firm CGS (summed across all States). The national baseline markup calculated in this manner is 1.39. Note that this markup estimate is very close to the 1.36 baseline markup calculated using ARW survey data.

[7] Appendix B provides a detailed analysis of the equipment markups associated with the typical distribution of commercial and residential air-conditioning and heating equipment. Because the distribution channel consists of several parties, including wholesalers, markups are calculated for each party involved in the distribution of the equipment.

We calculate the incremental markup of ACHE firms from a regression analysis of the revenue, CGS, and payroll census data. First, we use the data to estimate the following regression equation of firm revenue as a linear function of the CGS and firm payroll:

$$\underset{}{\text{Firm Revenue}} = \underset{(1.7)}{181.4} + \underset{(26.5)}{1.1} \bullet \text{CGS} + \underset{(3.1)}{1.3} \bullet \text{Payroll}$$

$$(R2 = .98)$$
$$(N = 30)^{8}$$

In the above equation, 181.4 is a constant term, 1.1 is a coefficient associated with changes in the CGS and 1.3 is a coefficient associated with changes in firm payroll. For example, average firm revenue in a State with CGS averaging $1,000 and wages averaging $200 is estimated using this equation to be $1,541. The statistical fit ($R^2$ equal to .98) and significant t statistics associated with the coefficients for CGS and Payroll suggest that the equation is accurate and well specified.

We estimate the incremental markup using this equation from the coefficient associated with CGS. The coefficient associated with CGS in this equation indicates the change in firm revenue associated with a change in CGS, holding payroll constant (the partial derivative of CGS). Following our assumption that labor and occupancy costs are fixed, this coefficient provides an independent estimate of the ACHE wholesale incremental markup. We note that the value of this coefficient (1.10) is almost identical to the incremental markup calculated from ARW survey data as discussed earlier (1.11).

## 4.0 CONCLUSION

In this report we establish an approach for estimating incremental markups based on a reasonable set of assumptions about costs that vary with changes in appliance efficiency and costs that do not vary with changes in efficiency. We apply this approach to calculate ACHE wholesale incremental markups using two sets of data—ARW survey data and U. S. Census Bureau data. Following this approach these two data sets give almost identical estimates of ACHE incremental markups, increasing our confidence in our estimation approach and methods. In addition, we show in each case that the incremental markup is significantly lower than the baseline markup under perfect competition.[9]

Following our focused discussion on the wholesale ACHE industry, we evaluate markups under different market structures, including markets characterized by rising marginal costs, exogenous demand shifts and market power. We conclude that rising marginal costs tend to lower markups, demand shifts may lower or increase markups and market power tends to increase markups, compared to markups in the baseline case under perfect competition. This approach can be easily

[8] Twenty states were excluded from the regression analysis due to lack of U.S. census data.

[9] A table of our results can be seen at the end of Appendix B (Table B.6). These results show that a standard will have a less than proportional impact on final ACHE consumer prices.

duplicated for other appliance industries that might be subject to regulation to increase energy efficiency standards.

## APPENDIX A: CORRELATION BETWEEN APPLIANCE LABOR AND EFFICIENCY

The correlation between wholesale labor and appliance efficiency is evaluated with a regression analysis and correlation matrix of appliance efficiency, shipments, and wholesale labor trends between 1990 and 2000. Labor is total labor in the retail home appliance sector (thousands) (U.S. Department of Labor, 2000). Shipments are total refrigerator, freezer, home air-conditioning, clothes washer, and dishwasher shipments in each year (thousands) (Association of Home Appliance Manufacturers, 2000). Efficiency is the weighted average change in the efficiency of these appliances (average change in efficiency since 1981, weighted by appliance shipments) (Association of Home Appliance Manufacturers, 2000).[10]

The correlation matrix suggests that there is a negative correlation between labor and efficiency (Table A.1).

**Table A.1 Correlation Matrix of Appliance Variables (N = 10)**

| | Year | Efficiency | Labor | Shipments |
|---|---|---|---|---|
| **Year** | 1.00 | | | |
| **Efficiency** | 0.93 | 1.00 | | |
| **Labor** | -0.83 | -0.70 | 1.00 | |
| **Shipments** | 0.94 | 0.86 | -0.67 | 1.00 |

The regression equation specified for the regression analysis is:

$$\text{Labor} = A + B_1 \bullet (\text{Shipments}) + B_2 \bullet (\text{Efficiency}) + B_3 \bullet (\text{Year}) + e$$

In this equation, Labor, Shipments, Efficiency and Year are defined above, $B_i$ are coefficients to be estimated and e is the error term. All coefficients in the regression analysis show the expected relationship between the variables and labor (Table A.2). No significant relationship is established between wholesale labor and appliance efficiency.

**Table A.2 Regression Summary for Dependent Variable (N = 10)**

| Variables | Coefficients | t statistics (six degrees of freedom) | $R^2$ |
|---|---|---|---|
| Intercept | 5005 | 3.49 ** | 0.81 |
| Efficiency | -0.028 | -0.177 | |
| Total Shipments | 0.00104 | 1.97 * | |
| Time | -1.83 | -3.41** | |

* Significant at the 90th percentile.
** Significant at the 95th percentile.

[10] Note, for the efficiency value, we examined the yearly percent change of efficiency from 1980. We took the weighted average of this based on the relative number of shipments for each year of each appliance to create a final value for yearly total change in efficiency in the home appliance sector.

# APPENDIX B: EQUIPMENT MARKUPS FOR THE TYPICAL DISTRIBUTION OF COMMERCIAL AND RESIDENTIAL AIR-CONDITIONING AND HEATING EQUIPMENT

## B.1 INTRODUCTION

The customer price of commercial and residential air-conditioning and heating equipment depends on the parties involved in the distribution of the equipment. In a typical distribution channel for commercial air-conditioning and heating equipment, the manufacturer sells the equipment to a wholesaler, who in turn sells it to a mechanical contractor, who in turn sells it (and its installation) to a general contractor, who in turn finally sells it to the customer. For residential equipment in new construction, the general contractor is replaced by a home builder.[11] Figure B.1 illustrates the typical distribution channel for commercial unitary air-conditioning and residential furnace equipment. Each party in the distribution of the equipment applies a multiplier called a "markup" to the manufacturer's price. By multiplying the various markups by the manufacturer price the customer price is determined.


**Figure B.1 Typical Distribution Channel of Commercial and Residential Air-Conditioning and Heating Equipment**

For each of the parties involved in the distribution of the equipment, the markups presented above are further differentiated between a "baseline" markup and an "incremental markup", as described below. A third type of markup, the overall markup, describes the product of all the markups within a distribution channel.

### B.1.1 Baseline Markups

Baseline markups are defined as coefficients that relate the manufacturer price of baseline equipment to the wholesale or contractor baseline sales price, as shown in the following equations for commercial air-conditioning and heating equipment:

$$P_{Fw} = P_O \bullet m_w$$

[11] The actual distribution of commercial and residential air-conditioning and heating equipment and its resultant price to the customer is dependent on the size of the mechanical contractor (as measured in revenue) and the type of market being served (i.e., whether the equipment is purchased for new construction or as a replacement). In addition, in the case of commercial equipment, some large customers, such as large retail chains, purchase equipment directly from the manufacturer through what is called a national account. Due to large volume purchases, large customers realize substantial equipment price savings over customers purchasing equipment through typical distribution channels.

$$P_{Fmc} = P_{Fw} \bullet m_{mc}$$

$$P_{Fgc} = P_{Fmc} \bullet m_{gc}$$

$$P_{FC} = P_{Fgc} \bullet st$$

In the above equations, $P_O$ refers to the manufacturer price of baseline commercial equipment, while $m_w$, $m_{mc}$, and $m_{gc}$ refer to the wholesaler, mechanical contractor, and general contractor markups, respectively, on baseline commercial equipment. The use of the markups results in the wholesaler ($P_{Fw}$), mechanical contractor ($P_{Fmc}$), and general contractor ($P_{Fgc}$) prices of baseline commercial unitary air conditioners. The customer price ($P_{FC}$) is determined by multiplying the general contractor price by a sales tax (st).

For residential equipment in new construction, general contractors are replaced by home builders. Thus, the terms for the baseline general contractor markup ($m_{gc}$) and price ($P_{Fgc}$) are replaced by terms specific to home builders (i.e., $m_b$ for the markup and $P_{Fb}$ for the price).

### B.1.2 Incremental Markups

Incremental markups are coefficients that relate changes in the manufacturer price of baseline equipment to changes in the wholesaler or contractor sales price, as shown in the following equations for commercial air-conditioning and heating equipment:

$$\Delta_{Fw} = \Delta_0 \bullet \alpha_w$$

$$\Delta_{Fmc} = \Delta_{Fw} \bullet \alpha_{mc}$$

$$\Delta_{Fgc} = \Delta_{Fmc} \bullet \alpha_{gc}$$

$$\Delta_{FC} = \Delta_{Fgc} \bullet st$$

In the above equations, $\Delta_0$ refers to a change in the manufacturer price (e.g., brought about by an increase in equipment efficiency due to new standards) and $\alpha_w$, $\alpha_{mc}$, and $\alpha_{gc}$ refer to the incremental wholesaler, incremental mechanical contractor, and incremental general contractor markups, respectively. The use of the incremental markups results in the incremental wholesaler ($\Delta_{Fw}$), incremental mechanical contractor ($\Delta_{Fmc}$), and incremental general contractor ($\Delta_{Fgc}$) prices. The incremental customer price ($\Delta_{FC}$) is determined by multiplying the general contractor price by a sales tax (st).

For residential equipment in new construction, general contractors are replaced by home builders. Thus, the terms for the incremental general contractor markup ($\alpha_{gc}$) and price ($\Delta_{Fgc}$) are replaced by terms specific to home builders (i.e., $\alpha_b$ for the markup and $\Delta_{Fb}$ for the price).

### B.1.3 Overall Markups

Overall markups, including both overall baseline and overall incremental markups, relate the manufacturer price to the final customer price ($P_{FC}'$) as indicated by the following equation for commercial air-conditioning and heating equipment:

$$P_{FC}' = P_{FC} + \Delta_{FC} = P_O \bullet (m_w \bullet m_{mc} \bullet m_{gc} \bullet st) + \Delta_O \bullet (\alpha_w \bullet \alpha_{mc} \bullet \alpha_{gc} \bullet st)$$

In the above equation, the overall baseline markup ($m_{OV}$) is the product of the wholesale, mechanical contractor, and general contractor baseline markups and the sales tax. The overall incremental markup ($\alpha_{OV}$) is the product of the wholesale, mechanical contractor, and general contractor incremental markups and the sales tax. As noted above, for residential equipment in new construction, the general contractor markups are replaced by markups specific to home builders. Thus, the above equation can be represented with the following expression:

$$P_{FC}' = P_O \bullet m_{OV} + \Delta_O \bullet \alpha_{OV}$$

## B.2 ESTIMATION OF WHOLESALE MARKUPS

As stated earlier in the main report, wholesalers reported median data in a confidential ARW survey of 37 member firms (Air-conditioning and Refrigeration Wholesalers Association, 1998). In the survey, ARW itemized revenues and costs into cost categories, including direct equipment expenses (cost of goods sold (CGS)), labor expenses, occupancy expenses, other operating expenses, and profit (Table B.1). In the second column of Table B.1, the CGS, the aggregated labor expenses, the aggregated occupancy expenses, the aggregated other operating expenses, and the profit are summarized as cost per dollar revenue. For example, the CGS represent about $0.74 per dollar sales revenue; in other words, for every $1.00 wholesalers take in as sales revenue, they use $0.74 to pay the CGS. Labor expenses represent $0.15 per dollar sales revenue, occupancy expenses represent $0.04, other operating expenses represent $0.05, and profit accounts for $0.03 per dollar sales revenue.

**Table B.1 Wholesaler Expenses and Markups**

| Item | Percent of Revenue | Per Dollar Sales Revenue [a] | Per Dollar Cost of Goods Sold |
|---|---|---|---|
| **Cost of Goods Sold** | **73.6%** | **$0.74** | **$1.00** |
| Gross Margin[b] | 26.4% | $0.26 | $0.36 |
| **Payroll Expenses** | | | |
| Executive Salaries & Bonuses | 2.7% | | |
| Inside Sales Salaries/Wages | 3.2% | | |
| Outside Sales Salaries/Commissions | 2.2% | | |
| Warehouse & Delivery Salaries/Wages | 2.3% | **$0.15** | **$0.20** |
| All Other Salaries/Wages & Bonuses | 2.1% | | |
| Payroll Taxes | 1.1% | | |
| Group Insurance | 0.7% | | |
| Benefit Plans | 0.5% | | |
| **Total Payroll Expenses** | **14.8%** | | |
| **Occupancy Expenses** | | | |
| Utilities: Heat, Light, Power, Water | 0.4% | | |
| Telephone | 0.6% | **$0.04** | **$0.05** |
| Building Repairs & Maintenance | 0.2% | | |
| Rent or Ownership in Real Estate | 2.4% | | |
| **Total Occupancy Expenses** | **3.6%** | | |
| **Other Operating Expenses** | | | |
| Advertising and Promotion | 0.9% | | |
| Insurance | 0.4% | | |
| Depreciation | 0.7% | **$0.05** | **$0.07** |
| Bad Debt Losses | 0.3% | | |
| All Other Operating Expenses | 3.2% | | |
| **Total Other Operating Expenses** | **5.4%** | | |
| **Operating Profit** | **2.7%** | **$0.03** | **$0.04** |
| **Baseline Markup ($m_w$):** Revenue per dollar cost of goods sold | | | **1.36** |
| **Incremental Markup ($\alpha_w$):** Increased revenue per dollar increase cost of goods sold | | | **1.11** |

[a] Values do not add up to $1.00 due to independent rounding.

[b] Gross Margin consists of payroll expenses, occupancy expenses, other operating expenses, and operating profit.

**Source:** *1998 ARW Wholesaler Profit Survey Report*.

The third data column of Table B.1 shows the data converted from costs per dollar revenue into revenue per dollar cost of CGS. This conversion was accomplished by dividing each cost category in the second data column of Table B.1 by $0.74 (i.e., equipment expenditure per dollar revenue). The data in column three show that, for every $1.00 the wholesaler spends on CGS, the wholesaler earns $1.00 in sales revenue to cover the equipment cost, $0.20 to cover labor costs, $0.05 to cover occupancy expenses, $0.07 for other operating expenses, and $0.04 in profits. This totals to $1.36 in sales revenue earned for every $1.00 spent on CGS. Therefore, the wholesale baseline markup

($m_w$) is 1.36, since the wholesaler earns $1.36 in sales revenue for every $1.00 spent to purchase the equipment.

The data in column three was also used to estimate the incremental markups. The incremental markup will depend upon which of the costs in Table B.1 are variable and which are fixed. For example, for a $1.00 increase in the manufacturer equipment price, if all of the other costs scale with the manufacturer price (i.e., all costs are variable), the increase in wholesaler price will be $1.36, implying that the incremental markup is 1.36, or the same as the baseline markup. At the other extreme, if none of the other costs are variable, then a $1.00 increase in the manufacturer price will lead to a $1.00 increase in the wholesaler price, for an incremental markup of 1.0. We actually believe that the labor and occupancy costs will be fixed and that the other operating costs and profit will scale with the manufacturer price (i.e., be variable). In this case, for a $1.00 increase in the manufacturer price, the wholesaler price will increase by $1.11, giving a wholesale incremental mark-up ($\alpha_w$) of 1.11.

## B.3 ESTIMATION OF MECHANICAL CONTRACTOR MARKUPS

Air-conditioning and heating equipment (ACHE) contractors, defined here as mechanical contractors, reported median cost data in an Air Conditioning Contractors of America (ACCA) financial analysis of the HVAC industry (Air Conditioning Contractors of America, 1995). Data reported in that analysis are similar to the itemized revenues and costs reported by wholesalers, including expenses broken out by direct cost of equipment sales, payroll expense, occupancy expense, other operating expense, and profit categories (Table B.2). In the second column of Table B.2, the direct cost of equipment sales, the aggregated labor expenses, the aggregated occupancy expenses, the aggregated other operating expenses, and the profit are summarized as cost per dollar revenue. The second data column in Table B.2 summarizes these expenses as expenses per dollar sales revenue. The only important difference is that the direct cost of equipment sales in this table includes out-of-pocket installation costs as well as the cost of goods sold (CGS). As shown in the table, the direct cost of sales represents about $0.65 per dollar sales revenue to the contractor. Labor expenses represent $0.15 per dollar sales revenue, occupancy expenses represent $0.01 per dollar sales revenue, other operating expenses are $0.14 per dollar sales revenue, and profit is $0.05 per dollar sales revenue. Interestingly, the contractor expenditures per dollar sales revenue in Table B.2 are similar to the wholesaler expenditures per dollar sales revenue reported earlier.

**Table B.2 Mechanical Contractor Expenses and Markups**

| Item | Percent of Revenue | Per Dollar Sales Revenue | Per Dollar Cost of Goods Sold |
|---|---|---|---|
| **Cost of Equipment Sales** | | | |
| Direct Materials | 22.70% | | |
| Equipment Installed | 14.22% | | |
| Direct Labor | 19.01% | **$0.65** | **$1.00** |
| Direct Subcontract | 5.55% | | |
| Direct Other | 3.97% | | |
| **Total Cost of Equipment Sales** | **65.45%** | | |
| Gross Margin[a] | 34.55% | $0.35 | $0.53 |
| **Payroll Expenses** | | | |
| Payroll Taxes/Fringe Benefits | 4.02% | | |
| Officer Salaries | 3.80% | | |
| Sales and Estimating Salaries | 2.69% | **$0.15** | **$0.23** |
| Administration Salaries | 3.18% | | |
| Warehouse Salaries | 0.46% | | |
| Unapplied Labor | 1.04% | | |
| **Total Payroll Expenses** | **15.19%** | | |
| **Occupancy Costs** | **1.24%** | **$0.01** | **$0.02** |
| **Other Operating Expenses** | | | |
| Advertising | 1.10% | | |
| Bad Debts | 0.16% | | |
| Depreciation | 1.02% | | |
| Interest Expenses | 0.33% | | |
| Liability Insurance | 1.12% | **$0.14** | **$0.21** |
| Other Insurance | 1.36% | | |
| Selling Expense | 1.49% | | |
| Vehicle/Maintenance Repairs | 1.82% | | |
| Other Operating Expenses | 5.13% | | |
| **Total Other Operating Expenses** | **13.53%** | | |
| Net Operating Profit | 4.59% | | |
| Other Income | 0.79% | **$0.05** | **$0.07** |
| Other Expenses | -0.49% | | |
| **Net Profit Before Income Taxes** | **4.89%** | | |
| **Baseline Markup ($m_{mc}$):** Revenue per dollar cost of goods sold | | | **1.53** |
| **Incremental Markup ($\alpha_{mc}$):** Increased revenue per dollar increase cost of goods sold | | | **1.28** |

[a] Gross Margin consists of payroll expenses, occupancy expenses, other operating expenses, and net profit before

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

These expenses were converted from per dollar sales into revenue per dollar cost of goods sold by

dividing each figure in the first data column by $0.65. For every $1.00 the mechanical contractor spends on equipment costs, the mechanical contractor earns $1.00 in sales revenue to cover the equipment cost, $0.23 to cover labor costs, $0.02 to cover occupancy expenses, $0.21 for other operating expenses, and $0.07 in profits. This totals to $1.53 in sales revenue earned for every $1.00 spent on equipment costs. This tells us that the mechanical contractor baseline markup ($m_{mc}$) is 1.53, since the contractor earns $1.53 in sales revenue for every $1.00 spent to purchase the equipment.

As with the wholesaler data in the previous section, the data in column three of Table B.2 are used to estimate the incremental markups. The incremental markup will depend on which of the costs in Table B.2 are variable and which are fixed. At one extreme, if all of the other costs scale with the equipment price (i.e., all costs are variable), the increase in mechanical contractor price will be $1.53, implying that the incremental markup is 1.53, or the same as the baseline markup. At the other extreme, if none of the other costs are variable, then a $1.00 increase in the equipment price will lead to a $1.00 increase in the mechanical contractor price, for an incremental markup of 1.0. We expect the labor and occupancy costs to be fixed and the other operating costs and profit to scale with the equipment price (i.e., be variable). In this case, for a $1.00 increase in the equipment price, the mechanical contractor price will increase by $1.28, giving a mechanical contractor incremental markup ($\alpha_{mc}$) of 1.28.

## B.4 ESTIMATION OF GENERAL CONTRACTOR MARKUPS

Markups for general contractors for commercial air-conditioning and heating equipment were derived from U.S. Census Bureau data for the commercial and institutional building construction sector (U.S. Department of Commerce, 1997). This sector includes establishments primarily engaged in construction work, including new construction work, additions, alterations, and repairs. The U.S. Census Bureau data for the construction sector include detailed statistics for establishments with payrolls, similar to the data reported by ARW for wholesalers and ACCA for mechanical contractors. The primary difference is that the U.S. Census Bureau reports itemized revenues and expenses for the construction industry as a whole in total dollars rather than in typical values for an average or representative business. Because of this, it was assumed that the total dollar values that the U.S. Census Bureau reported, once converted to a percentage basis, represented revenues and expenses for an average or typical contracting business (Table B.3). As with the data for wholesalers and mechanical contractors, Table B.3 summarizes the expenses for general contractors as expenses per dollar sales revenue, in the thrid data column. For example, the direct cost of sales represents about $0.81 per dollar sales revenue to the general contractor. Labor expenses represent $0.07 per dollar sales revenue, occupancy expenses represent $0.01 per dollar sales revenue, other operating expenses represent $0.01, and profit makes up $0.10 per dollar sales revenue.

**Table B.3 General Contractor Expenses and Markups**

| Item | Dollar Value | Percent of Revenue | Per Dollar Sales Revenue [a] | Per Dollar Cost of Goods Sold |
|---|---|---|---|---|
| **Cost of Equipment Sales** | | | | |
| Cost of materials, components, and supplies | $28,087,296 | 16.03% | | |
| Payroll, construction workers | $10,797,116 | 6.16% | | |
| Cost of construction work subcontracted out to others | $101,952,864 | 58.18% | **$0.81** | **$1.00** |
| Cost of selected power, fuels, and lubricants | $827,160 | 0.47% | | |
| **Total Cost of Equipment Sales** | **$141,664,436** | **80.84%** | | |
| Gross Margin[b] | $33,566,396 | 19.16% | $0.19 | $0.24 |
| **Payroll Expenses** | | | | |
| Fringe benefits, all employees | $4,524,436 | 2.58% | **$0.07** | **$0.09** |
| Payroll, other employees | $8,379,046 | 4.78% | | |
| **Total Payroll Expenses** | **$12,903,482** | **7.36%** | | |
| **Occupancy Expenses** | | | | |
| Rental cost for machinery, equipment, and buildings + Purchased communication services | $1,657,257 | 0.95% | **$0.01** | **$0.01** |
| **Other Operating Expenses** | | | | |
| Depreciation charges during year | $808,477 | 0.46% | | |
| Cost of repairs to buildings and other structures + Cost of repairs to machinery and equipment | $558,930 | 0.32% | **$0.01** | **$0.01** |
| **Total Other Operating Expenses** | **$1,367,407** | **0.78%** | | |
| **Net Profit Before Income Taxes** | **$17,638,250** | **10.07%** | **$0.10** | **$0.12** |
| **Baseline Markup ($m_{gc}$):** Revenue per dollar cost of goods sold | | | | **1.24** |
| **Incremental Markup ($\alpha_{gc}$):** Increased revenue per dollar increase cost of goods | | | | **1.13** |

[a] Values do not add up to $1.00 due to independent rounding.

[b] Gross Margin consists of payroll expenses, occupancy expenses, other operating expenses, and net profit before taxes.

**Source:** Commercial and Institutional Building Construction, 1997 Economic Census, EC97C-2333B, U.S. Department of Commerce, January 2000, Table 4 (Detailed Statistics for Establishments with Payroll: 1997).

The expenses per dollar sales were converted into revenue per dollar cost of goods sold, by dividing each figure in the third data column by $0.81. The data in column four show that, for every $1.00 the general contractor spends on equipment costs, the general contractor earns $1.00 in sales revenue to cover the equipment cost, $0.09 to cover labor costs, $0.01 to cover occupancy expenses, $0.01 for other operating expenses, and $0.12 in profits. This totals to $1.24 in sales revenue earned for every $1.00 spent on equipment costs. This tells us that the general contractor baseline markup ($m_{gc}$) is 1.24, since the general contractor earns $1.24 in sales revenue for every $1.00 spent to purchase the equipment.

As in the previous sections, the data in column four in Table B.3 were used to estimate the

incremental markups. The incremental markup will depend on which of the costs in Table B.3 are variable and which are fixed. At one extreme, if all of the other costs scale with the equipment price (i.e., all costs are variable), the increase in general contractor price will be $1.24, implying that the incremental markup is 1.24, or the same as the baseline markup. At the other extreme, if none of the other costs are variable, then a $1.00 increase in the equipment price will lead to a $1.00 increase in the general contractor price, for an incremental markup of 1.0. We believe the labor and occupancy costs to be fixed and the other operating costs and profit to scale with the equipment price (i.e. be variable). In this case, for a $1.00 increase in the equipment price, the general contractor price will increase by $1.13, giving a general contractor incremental markup ($\alpha_{gc}$) of 1.13.

## B.5 ESTIMATION OF HOME BUILDER MARKUPS

Markups for home builders for residential air-conditioning and heating equipment were derived from U.S. Census Bureau data for the commercial and institutional building construction sector (U.S. Department of Commerce, 1999). This sector includes establishments primarily engaged in construction work, including new construction work, additions, alterations, and repairs. The U.S. Census Bureau data for the construction sector include detailed statistics for establishments with payrolls, similar to the data reported by ARW for wholesalers and ACCA for mechanical contractors. The primary difference is that the U.S. Census Bureau reports itemized revenues and expenses for the construction industry as a whole in total dollars rather than in typical values for an average or representative business. Because of this, it was assumed that the total dollar values that the U.S. Census Bureau reported, once converted to a percentage basis, represented revenues and expenses for an average or typical contracting business (Table B.4). As with the data for wholesalers and mechanical contractors, Table B.4 summarizes the expenses for general contractors as expenses per dollar sales revenue, in the third data column. For example, the direct cost of sales represents about $0.70 per dollar sales revenue to the general contractor. Labor expenses represent $0.07 per dollar sales revenue, occupancy expenses represent $0.01 per dollar sales revenue, other operating expenses represent $0.01, and profit makes up $0.22 per dollar sales revenue.

**Table B.4 Home Builder Expenses and Markups**

| Item | Dollar Value | Percent of Revenue | Per Dollar Sales Revenue [a] | Per Dollar Cost of Goods Sold |
|---|---|---|---|---|
| **Cost of Equipment Sales** | | | | |
| Cost of materials, components, and supplies | $41,052,528 | 27.64% | | |
| Payroll, construction workers | $7,739,858 | 5.21% | | |
| Cost of construction work subcontracted out to others | $53,996,600 | 36.35% | **$0.70** | **$1.00** |
| Cost of selected power, fuels, and lubricants | $895,215 | 0.60% | | |
| **Total Cost of Equipment Sales** | **$103,684,201** | **69.81%** | | |
| Gross Margin[b] | $44,846,055 | 30.19% | $0.30 | $0.43 |
| **Payroll Expenses** | | | | |
| Fringe benefits, all employees | $2,623,197 | 1.77% | **$0.07** | **$0.10** |
| Payroll, other employees | $7,224,726 | 4.86% | | |
| **Total Payroll Expenses** | **$9,847,923** | **6.63%** | | |
| **Occupancy Expenses** | | | | |
| Rental cost for machinery, equipment, and buildings + Purchased communication services | $1,278,206 | 0.86% | **$0.01** | **$0.01** |
| **Other Operating Expenses** | | | | |
| Depreciation charges during year | $871,329 | 0.59% | | |
| Cost of repairs to buildings and other structures + Cost of repairs to machinery and equipment | $520,732 | 0.35% | **$0.01** | **$0.01** |
| **Total Other Operating Expenses** | **$1,392,061** | **0.94%** | | |
| **Net Profit Before Income Taxes** | **$32,327,865** | **21.77%** | **$0.22** | **$0.31** |
| **Baseline Markup ($m_b$):** Revenue per dollar cost of goods sold | | | | **1.43** |
| **Incremental Markup ($\alpha_b$):** Increased revenue per dollar increase cost of goods | | | | **1.33** |

[a] Values do not add up to $1.00 due to independent rounding.

[b] Gross Margin consists of payroll expenses, occupancy expenses, other operating expenses, and net profit before taxes.

**Source:** Single-Family Housing Construction, 1997 Economic Census, EC97C-2332A(RV), U.S. Department of Commerce, January 2000, Table 4 (Detailed Statistics for Establishments with Payroll: 1997).

The expenses per dollar sales were converted into revenue per dollar cost of goods sold, by dividing each figure in the third data column by $0.71. The data in column four show that, for every $1.00 the general contractor spends on equipment costs, the general contractor earns $1.00 in sales revenue to cover the equipment cost, $0.10 to cover labor costs, $0.01 to cover occupancy expenses, $0.01 for other operating expenses, and $0.31 in profits. This totals to $1.43 in sales revenue earned for every $1.00 spent on equipment costs. This tells us that the general contractor baseline markup ($m_b$) is 1.43, since the general contractor earns $1.43 in sales revenue for every $1.00 spent to purchase the equipment.

As in the previous sections, the data in column four in Table B.4 were used to estimate the

incremental markups. The incremental markup will depend on which of the costs in Table B.3 are variable and which are fixed. At one extreme, if all of the other costs scale with the equipment price (i.e., all costs are variable), the increase in general contractor price will be $1.43, implying that the incremental markup is 1.43, or the same as the baseline markup. At the other extreme, if none of the other costs are variable, then a $1.00 increase in the equipment price will lead to a $1.00 increase in the general contractor price, for an incremental markup of 1.0. We believe the labor and occupancy costs to be fixed and the other operating costs and profit to scale with the equipment price (i.e. be variable). In this case, for a $1.00 increase in the equipment price, the general contractor price will increase by $1.33, giving a general contractor incremental markup ($\alpha_b$) of 1.33.

## B.6 SALES TAX

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

Sales taxes representative of both state and local sales taxes were derived from 2003 state and local sales tax data (Sales Tax Clearing House, 2003). Using state unitary air conditioner shipment data from 1994 (Air-Conditioning and Refrigeration Institute, 1994) the state and local sales tax data were weighted by the percentage of unitary air conditioners shipped to each state, to derive a probability distribution of sales taxes. The sales tax data were than aggregated into one percentage point bins (i.e., sales taxes from 5.5 to 6.49 percent, sales taxes from 6.5 to 7.49 percent, etc.).

Table B.5 provides the distribution of sales tax rates based on the percentage of unitary air conditioner shipments in each sales tax bin. The distribution of sales tax rates range from a minimum of zero percent to a maximum of 9.35 percent with a mean value of 6.7 percent.

**Table B.5 Distribution of Sales Tax Rates**

| | Sales Tax Rate | | | | | |
|---|---|---|---|---|---|---|
| | **0%** | **5%** | **6%** | **7%** | **8%** | **9%** |
| **Probability of Rate** | 5% | 9% | 14% | 40% | 28% | 4% |

## B.7 OVERALL MARKUPS

Table B.6 summarizes the wholesaler, mechanical contractor, general contractor, and home builder baseline and incremental markups as well as the sales tax. The overall baseline and incremental markups are also provided.

**Table B.6 Summary of Baseline and Incremental Markups**

| | Baseline Markups | | Incremental Markups | |
|---|---|---|---|---|
| **Type** | **Commercial** | **Residential** | **Commercial** | **Residential** |
| Wholesaler | 1.36 | 1.36 | 1.11 | 1.11 |
| Mechanical Contractor | 1.53 | 1.53 | 1.28 | 1.28 |
| General Contractor | 1.24 | NA | 1.13 | NA |
| Home Builder | NA | 1.43 | NA | 1.33 |
| Sales Tax | 1.07 | 1.07 | 1.07 | 1.07 |
| Overall | 2.75 | 3.17 | 1.71 | 2.02 |

To illustrate the use of the overall markups for commercial equipment, assume that a baseline piece of equipment meeting today's minimum efficiency standards has a manufacturer price of $2000. Also assume that a more efficient product has a manufacturer price which is $200 greater than the baseline equipment. The baseline customer price is determined by taking the baseline manufacturer price of $2000 and multiplying it by the overall baseline markup of 2.75. This yields a baseline customer price of $5500. The customer price of the more efficient equipment is determined by taking the baseline customer price of $5500 and adding to it the product of the incremental manufacturer price of $200 and the overall incremental markup of 1.71. This calculation yields a customer price of the more efficient equipment of $5842.

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