Energy Use By Apartment Tenants When Landlords Pay For Utilities

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Abstract

Energy costs are included in the monthly rent of nearly one-third of U.S. apartment residents. Because these tenants do not face the marginal cost of their own energy use, they have little incentive to use energy efficiently. Explanations for this apparent market failure fall into two categories: the tenants value such arrangements more than they value the extra energy, or the landlords value the arrangements more than the cost of the extra energy. We use data from the U.S. Department of Energy's Residential Energy Consumption Survey and the Census Bureau's American Housing Survey to estimate energy consumption by tenants in utility-included apartments, and the rent premium for those apartments. While market rents for utility-included apartments are higher than for otherwise similar metered apartments, the difference is smaller than the cost of the energy used, a finding that supports landlord-side explanations for the persistence of these seemingly inefficient rental contracts.

Introduction

About 30 percent of rental apartments in the U.S. have the cost of utilities included in their rent. Because tenants in these apartments choose how much energy to use after the monthly rent has been determined, they have no price incentive to conserve energy, and therefore use more energy than tenants in otherwise similar individually metered apartments. Moreover, the cost of the extra energy use, if added to tenants' monthly rent, will be more than tenants would be willing to pay for that energy separately. Tenants or landlords, or both, must be worse-off under utility-included contracts than with individual metering. The existence of these utility-included contracts raises two questions, which we address in this paper: (1) how much extra energy is used by tenants in these apartments, and (2) what explains the persistence of this seemingly inefficient institution.

The obvious explanation for this apparent inefficiency, that individual metering is costly, cannot be the entire story. Many new, electrically heated apartments include utilities in their rents. Explanations in addition to metering costs must account for some of the utility-included rental contracts: economies of scale in master-metering, tax advantages of landlords paying for utilities, signaling costs associated with investments in energy efficiency, risk averse or liquidity constrained tenants, or tenants who simply dislike considering marginal costs. We discuss each of these explanations below.

Beyond academic curiosity, a number of important policy concerns hinge on the answer to these two questions -- how much extra energy is used and why the contracts persist. Residential and commercial buildings account for about 35 percent of U.S. energy consumption, and the energy sector is one of the largest contributors to national and global environmental problems. Each of the potential explanations for the persistence of utility-included rental contracts has its own set of welfare implications and policy prescriptions.

For example, the Public Utilities Regulatory Policy Act of 1978 (PURPA) required newly constructed apartments to be individually metered for electricity.[1] Similarly, federal energy efficiency guidelines encourage individual metering for residential buildings: "Tenant submetering can be one of the most cost-effective energy conservation measures available. A large portion of the energy use in tenant facilities occurs simply because there is no economic incentive to conserve."[2] If, however, landlords with utility-included contracts invest in more energy efficient construction and appliances, a ban on such contracts may *increase* energy consumption, and decrease welfare.

On the other hand, the federal tax code provides incentives to include utilities in rent by allowing landlords to deduct the cost of utilities paid from their rental income. The social cost of this tax-induced price difference may be far larger than a simple Harberger triangle would suggest, if the deduction encourages landlords to offer utilities to tenants at zero marginal cost. In this case, the federal mandates may be second-best policies to counter the inefficiencies created by the tax deduction.

Another policy implication involves the so-called "energy paradox" -- the surprisingly slow adoption of cost-effective residential energy-conservation technologies.[3] Common

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[1]PURPA did not, however, prohibit utility-included rental contracts, and some new, individually metered, electrically heated apartments are rented with utilities included.

[2] 1998 Code of Federal Regulations, Title X, part 435.106.

[3]See for example, Hausmann (1979), Jaffe and Stavins (1994), and Hassett and Metcalf (1995).

rationalizations of slow adoption include the irreversibility of energy efficiency investments, high discount rates, and liquidity constraints. This paper describes what may be another important explanation for the slow adoption: rental contracts with zero-marginal-cost energy use. And, because energy is heavily regulated, some have suggested that "win-win" policies would both increase measured economic welfare and reduce pollution. Utility-included rental contracts seem a likely source of such win-win policies. If some market failure, policy-induced or otherwise, underlies the utility-included rents, then correcting that market failure will increase measured economic welfare while reducing energy consumption and pollution.

In what follows, we use data on apartment rental configurations and utility use to examine the competing explanations for utility-included rents, and to derive implications for energy and environmental policy. We first measure the scale of the deadweight loss from utility-included apartments by estimating how much more energy their tenants use, after controlling for self-selection by individuals and landlords. Then we estimate rent differentials between utility-included and metered apartments, controlling for other observable apartment characteristics. The difference in rent, when compared to the difference in energy use, sheds light on the potential explanations for the existence of these utility-included rental contracts. In particular, we show that the rent differential is significantly less than the cost of the extra fuel, and argue that this outcome favors explanations that depend on landlord costs such as metering, taxes, or signaling.

Deadweight loss and explanations for utility-included apartments

Figure 1 depicts one tenant's consumption choices between heat, $\boldsymbol{H}$, and all other goods except rent, $\boldsymbol{X}$. The tenant's indifference curves are U-shaped because heat becomes undesirable beyond a satiation point, represented by the minimum point on each curve. Line $\boldsymbol{ab}$ represents the tenant's budget constraint, excluding rent costs, where the tenant pays his own utility bill, and the price of heat is $\boldsymbol{a/b}$. A utility-maximizing tenant will choose $\boldsymbol{H^1}$ units of heat and $\boldsymbol{x^1}$ other goods, spending ($\boldsymbol{a-x^1}$) on heat.

Now suppose the landlord includes heat in the monthly rent. Since the tenant faces zero marginal costs for heating, he will consume heat to the satiation point, the minimum of some indifference curve. If the landlord is to break even, the monthly rent must increase by enough to cover the utility bill. This in turn means that the consumption bundle chosen by the tenant must lie on his original budget line. Point ($\boldsymbol{H^2}$, $\boldsymbol{x^2}$) in figure 1 satisfies this condition, resulting in a rent increase of ($\boldsymbol{a-x^2}$), an increase in combined housing and heating costs to the tenant of ($\boldsymbol{x^1-x^2}$), and a lower level of utility $\boldsymbol{U^2}$. The compensating variation, the amount the tenant would be willing to pay to have heat included in his rent is ($\boldsymbol{a-x^3}$), but the increased costs to the landlord are ($\boldsymbol{a-x^2}$). The difference, ($\boldsymbol{x^3-x^2}$), represents the deadweight loss of the inefficient rental contract.

In a perfectly competitive market, with unconstrained credit, economically rational, fully informed, risk-neutral tenants and landlords, with no taxes and costless metering of energy use, landlords would demand ($\boldsymbol{a-x^2}$) in higher rents in order to include utilities, and tenants would only be willing to pay ($\boldsymbol{a-x^3}$). There would be no reason for landlords to include energy use in rents. To do so, they would have to charge more additional rent than tenants would be willing to pay. However, about 30 percent of apartments in the U.S. are rented with utilities included, so some underlying imperfection must characterize this market.

Explanations for the existence of utility-included apartments fall into two categories. The first is that landlords face some cost of charging tenants for their energy use, the most obvious of which would be metering costs. In large or older buildings, with one heat source serving multiple apartments, it may be costly to meter individual units. If metering costs are high enough, landlords may simply choose to include average expected utility costs in their rent calculations. Buildings with high metering costs will rent apartments with utilities included, and buildings with low metering costs will rent apartments with utilities not included. Furthermore, since tenants presumably do not care about metering costs, they will be borne by landlords in the form of rent differentials that do not cover the energy expenditures.

Figure 2 depicts a tenant in an unmetered apartment, consuming H^1 and paying ($\boldsymbol{a}$-$\boldsymbol{x^1}$) in extra rent to cover the utility bill. The tenant would be willing to pay as much as ($\boldsymbol{a}$-$\boldsymbol{c}$) in extra base rent to have a metered apartment. If the metering costs are higher than ($\boldsymbol{a}$-$\boldsymbol{c}$), the landlord will not benefit from converting to individual meters. If the metering costs are less than ($\boldsymbol{a}$-$\boldsymbol{c}$), the landlord can meter the apartment individually, pass the cost of doing so on to the tenant, and pocket the difference. In either case, the rent difference between metered and heat-included apartments will be less than ($\boldsymbol{a}$-$\boldsymbol{x^1}$), the observed cost of the utilities consumed.

Though the metering cost story may be the most obvious explanation, a lot of evidence suggests that it does not account for all of the utility-included apartments. Munley, *et al*. (1990) present experimental evidence that tenants in heat-included apartments use substantially more energy, and that it would be cost effective to retrofit many existing master-metered buildings. Furthermore, our calculations using the Residential Energy Consumption Survey find that many new, electrically heated apartments have heat included in their rents. Eleven percent of apartments with electric heat in 1993 had heat included, as did 8 percent of apartment buildings less that 15 years old. Because these buildings, with an easily metered heat source, built since the energy crises of the 1970s, include heat in their rents, we believe that other explanations account for at least some of the persistence of utility-included rental contracts.

A second explanation, similar to metering costs, is that there may be economies of scale in master-metered apartment buildings. Suppose that apartments can be individually metered, with marginal cost of heat a/b, as in figure 3. Tenants will consume H^1 units of heat at cost $(a-x^1)$. Suppose further that a cheaper energy source is available, for fixed cost $(a-c)$, but that this alternative cannot be individually metered, and so rental contracts must include unlimited energy. (Think of steam heat from a central boiler.) The most a tenant will be willing to pay for such a contract is $(a-x^2)$, the compensating variation of moving from budget line ab to one with free heat. On the other hand, the landlord must charge at least $(a-x^3)$ more rent in order to break even. The difference, (x^3-x^2) represents the gain from moving to a cheaper heat source that cannot be metered individually.

A third landlord-side explanation involves income taxes. Landlords can deduct utility expenditures from rental income, while tenants cannot. Figure 4 depicts a tenant in a metered apartment, with budget constraint ab, consuming H^1. Because the landlord can deduct utility bills, his relevant energy price is a/d, or $a/b(1-t)$ where t is the landlord's marginal tax rate. The tenant would be willing to pay $(a-x^2)$ in extra rent for a utility-included apartment, and would consume $(a-x^1)$ worth of heat, but this would only cost the landlord $(a-x^3)$.[4] In figure 4, (x^2-x^3) represents the gain to landlords and tenants from including utilities in rent, at the expense of the

[4]We assume, for simplicity, that heat and other goods are additive separable in utility, so that the minima of the indifference curves lie on a vertical line.

tax collector. Again, the observed rent difference between utility-included and individually metered apartments will be insufficient to cover the costs of the energy used.

A final landlord-side explanation rests on asymmetric information. Landlords know the energy efficiency of their apartments, while prospective tenants do not. Landlords would like to convey that information credibly to prospective tenants, so that they can charge higher rent and recoup their energy efficiency investments. One way would be to display past utility bills. Another, perhaps more convincing, would be to offer to pay the utility costs up front in exchange for higher rent.

Figure 5 depicts two apartments, identical but for the amount of insulation. Apartment ***A*** is well insulated and has low heating costs. Apartment ***B*** is poorly insulated and has high heating costs. If heating costs are known in advance, prospective tenants will be willing to pay at most (***a-c***) more in rent for apartment ***A*** than for apartment ***B*** -- the compensating variation of moving from ***B*** to ***A***.

Suppose, however, that tenants cannot tell the difference between insulated and uninsulated apartments in advance. Then the equilibrium rent for individually metered apartments must be somewhere between the rent for ***A*** and the rent for ***B***.[5] If identical risk-neutral tenants cannot discern in advance apartments of type ***A*** and type ***B***, they have some expected utility **E**[**U**], depicted as an indifference curve.[6] The amount (a-x^1) is the largest rent premium tenants will be willing to pay to have the utilities included in their rent. The extra cost

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[5]Or, the market for insulated apartments may collapse, as in Akerlof (1970), so that no well-insulated apartments are leased.

[6]We ignore tenants' risk aversion for the time being.

incurred by landlords of type-***A*** insulated apartments would be ($\boldsymbol{a}$-$\boldsymbol{x^2}$). The difference, ($\boldsymbol{x^2}$-$\boldsymbol{x^1}$), reflects gains by insulated landlords from leasing their apartments with utilities included. The inclusion of utilities in rent, in this case, is a costly signal of energy efficiency. In other words, owners of insulated apartments can capitalize on their energy efficiency by charging higher rents, but only by bearing some of the deadweight loss from inefficiently priced utilities. The extra energy cost incurred by landlords of type-***B*** uninsulated apartments would be ($\boldsymbol{a}$-$\boldsymbol{x^3}$), and no such apartments will be leased with utilities included.

A key stylized fact emerges from all of these landlord-side explanations, metering costs, economies of scale, taxes, and signaling costs: the extra rent charged by landlords of observably equivalent apartments whose utilities are included will be insufficient to cover the cost of those utilities.

By contrast, a second category of explanations for the existence of utility-included apartments rests on tenant preferences and has the opposite outcome. If tenants prefer utilities included, they will be willing to compensate landlords for the extra cost. There are several reasons why tenants might do so. First, if tenants cannot borrow or lend small amounts easily, and utility bills vary seasonally, tenants that prefer constant monthly housing expenses may be willing to pay for expense-smoothing in the form of rents that include the average annual market value of the extra energy they use.[7]

Alternatively, tenants may be risk-averse. When tenants sign a lease, they cannot forecast the year's weather or fuel prices. As with any insurance, to avoid risk tenants may be willing to

[7]Some utilities offer this service in the form of constant averaged monthly bills.

pay a premium in the form of a rent differential between utility-included and metered apartments that at least covers the difference in utility costs.

Finally, tenants may simply prefer not to face marginal costs when choosing energy consumption, though economists tend to ignore such preferences. These types of pre-paid transactions occur in many settings, from buffet-style restaurants to all-inclusive resorts. Each involves a deadweight loss of the type depicted in figure 1. If these institutions persist because customers prefer not to think about marginal costs, then tenants in utility-included apartments will be willing to pay for their extra energy usage in the form of rent differentials that cover the higher utility bills.

In sum, there are two categories of explanations for the persistence of utility-included apartments: a supply-side explanation and a demand-side explanation. In the first, landlords avoid some costs by including energy use in rent, but the rent differential falls short of the energy costs. In the second, tenants prefer utility-included apartments and are willing to pay for them via rent differentials that fully offset the landlords' extra costs.

In what follows, we first estimate the extra energy use by tenants in otherwise similar utility-included apartments, and then estimate the corresponding rent differential. If the rent differentials compensate landlords for their extra utility costs, then the tenant-side explanations account for the persistence of utility-included apartments. If the rent differentials are too small to compensate landlords for their extra utility costs, then the landlord-side explanations must be behind the persistence of utility-included apartments. Unfortunately, all of the data necessary for both sides of the question -- utility differences and rent differences -- are not available in one survey. Therefore, we tackle each problem in order, starting with the extra energy use by tenants.

Energy use by tenants in utility-included apartments

The Department of Energy's Residential Energy Consumption Survey (RECS) contains information on energy use and efficiency characteristics of housing units, and is conducted approximately every 3 years. Several features make the RECS particularly useful. It identifies apartments where heat is included in rent, it details the demographics of tenants and the structural characteristics of apartments, and it contains information about fuel use for every apartment in which tenants pay utility bills. For most utility-included apartments, however, fuel use is imputed. We therefore use a proxy for energy use that is collected for both utility-included and metered apartments: winter indoor temperatures settings.

Table 1 compares RECS apartments where heat is included to those in which tenants pay their own heating bills, weighting the observations to represent all 29 million apartments in the U.S. On average, apartments for which heat is included in the rent are kept warmer than those where tenants pay for heat. The temperature difference is largest when no one is home, indicating that tenants who pay for heat are more likely to take simple conservation measures such as turning down the thermostat when leaving home.

Table 1 also suggests reasons why landlords might pay for heating. Apartments where heat is included in rent are generally found in older, larger buildings, and are more likely to have a fuel oil heating system. Each of these characteristics is likely to make individual metering of apartments more difficult and more expensive. Notice also that apartments where landlords pay for heating are better insulated, have fewer windows, and do not have air conditioning that uses the same fuel as the heating system, attributes that make the cost to landlords of providing free heating lower and that are consistent with pre-paid heat as a signal of energy efficiency.[8]

Table 2 describes the prevalence of heat-included rental contracts by region, and by building size and age. Not surprisingly, older apartments in large buildings in the Midwest and Northeast have the largest fraction of apartments with heat included. However, apartments with heat included exist in all regions and in all age and size classifications.

To estimate excess energy use by these tenants, we begin by restricting the sample to apartments and rental houses that use space heating during the winter and receive no government aid for heating costs. We only include apartments that use natural gas, fuel oil, electricity, or liquefied propane gas (LPG) for heating. These comprise the vast majority of fuels used for space heating in the U.S., and prices for other fuels are not in the RECS.[9]

We assume that tenants choose the interior temperature, *T*, in order to maximize utility, given prices, income, and individual preferences. *T* is then a function of the marginal cost of an additional degree of interior temperature, *C*, income, *Y*, individual characteristics, *X*, structural apartment characteristics, *S*, and weather, *W*, so that

$$T_i = f(C_i, Y_i, X_i, S_i, W_i). \qquad \textbf{(1)}$$

The marginal cost of heating, *C*, is determined by several factors. If heat is included in rent the marginal cost is zero. If the tenant pays for heating, the marginal cost of turning up the

[8]Insulation data were not collected in 1987. However, half of the 1987 respondents were revisited in 1990. We impute 1987 insulation data from those respondents. (This was the only year where respondents were revisited.)

[9]Only 3.3 percent of the apartments in the RECS use other heating fuels, including kerosene, wood, and coal.

thermostat is determined by the price of heating fuel, weather, and structural characteristics of the apartment. Thus,

$$T_i = f(C(I_i, P_i, S_i, W_i),\ Y_i,\ X_i,\ S_i,\ W_i), \qquad \textbf{(2)}$$

where I=1 if heat is included in rent and zero otherwise, and P is the price of heating fuel. We estimate a reduced form version of equation **(2)**:

$$\ln(T_i) = \alpha + \beta I_i + \gamma_1 \ln(P_i) + \gamma_2 lnP_i(1 - I_i) + \gamma_3 \ln(Y_i) + \gamma_4' X_i + \gamma_5' S_i + \gamma_6' W_i + \varepsilon_i, \qquad \textbf{(3)}$$

where α, β, and γ_1-γ_6 are estimated parameters and ε_i is a residual term. The coefficients β and γ_2 reveal the change in temperature in heat-included apartments relative to metered apartments, controlling for tenant and apartment characteristics.

The price of heating fuel is included in a normalized form. Prices in the RECS are reported per BTU of energy input, not heating output. Consequently, the price of heat to consumers is determined by the efficiency of the energy systems used. One BTU of electricity costs more than one BTU of natural gas, but because electric heating systems are more efficient (less heat goes up the furnace chimney), the difference in heating costs is less than would be indicated by the difference in fuel costs. To make prices comparable across fuels, we normalize each set of fuel prices using a log-normal distribution.[10] The remaining variation in fuel prices is due to differences across regions, over time, and within regions across different energy suppliers.

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[10]Fuel prices are non-negative, and skewed, and fit the log-normal distribution well. Electricity and natural gas prices fit best. Heating oil prices are skewed slightly towards zero, relative to the log normal distribution.

In the analyses below, we use the normalized fuel price and dummy variables for fuel type to separate fuel-related and system-related heating cost differences.

We use heating-degree-days (HDD) to control for weather, which could have positive or negative effects on temperature choice.[11] Similarly, structural characteristics have both direct and indirect effects that make signing the parameters in γ_5 difficult. The variables included in *S*, heated floor space, the number of windows, insulation, and building age, all make the marginal cost of heating more expensive and thus might be expected to lower inside temperatures. However, since these characteristics also make apartments more drafty and less comfortable at any given temperature, they may lead to warmer thermostat settings. The tenant characteristics included in *X* are education of the head of household, household size, and indicators for the presence of household members under 5 or over 65 years old.

As a benchmark, Table 3 presents ordinary least squares estimates of equation **(3)**, making no adjustment for selection by landlords or tenants into heat-included rental contracts. The first column presents the means and standard deviations of regressors (in levels not logs). The second column estimates equation **(3)** where the dependent variable, *T*, is the log of winter indoor temperature when someone is home. The third column uses the log temperature when nobody is home. In both cases, the coefficient on the heat-included dummy variable is positive

[11] Friedman (1987) notes that, all else equal, the marginal cost of raising the temperature of a home in cold weather is likely to be lower than in warm weather due to the physics of heat loss and possible returns to scale in heating, implying that interior temperatures will be higher in colder climates. This is the indirect effect that *W* has through *C* in equation **(2)**. However, Dewees and Wilson (1990) point out that exterior temperatures also directly influence thermostat settings through humidity and air circulation, and the overall effect of outside temperature on thermostat setting is therefore ambiguous.

and statistically significant. Also, as one might expect, the effect is larger in the case when no one is home.

Table 3 includes as regressors normalized heating fuel prices, both alone and interacted with the metered dummy. We expect, of course, that fuel prices will have a larger effect for tenants who pay for heating, meaning the interaction term should be negative. While this is true for the third column, when the tenants are not home, it is not statistically significant.

The coefficient on the heat-included indicators will consistently estimate the true effect of heat-included rental contracts only if selection into heat-included apartments is exogenous. However, selection into heat-included and metered apartments is unlikely to be independent of the heat demand by tenants or the heat-using characteristics of apartments. Two processes determine this selection. First, the landlord must decide to include heat expenses in the rent of the apartment. Landlords will be more likely to do so if the metering costs would be relatively high, and the expected energy costs low. Second, tenants must choose to reside in the apartment, and they are more likely to do so if they have strong preferences for heating, or are risk averse or liquidity constrained.

Since we only observe the confluence of these two processes, we cannot separately identify them. Thus the selection equation is necessarily a reduced form of two separate random utility models:[12]

[12]This type of model is described by Heckman and MaCurdy (1985).

$$
\begin{aligned}
I_i^* &= \eta Z_i + \nu_i \\
I_i &= 1 \text{ if } I_i^* > 0 \\
I_i &= 0 \text{ otherwise}
\end{aligned}
\qquad \textbf{(4)}
$$

where I^* is a composite of the relative expenses of the landlord and the relative utility of the tenants under the two regimes. If $I_i^*>0$ then landlord *i* chooses to include heat in the rent, and tenant *i* chooses to live there.[13] Z_i is a vector of landlord and tenant variables.

Once selection by landlords and tenants has been estimated using a probit version of equation **(4)**, we then model winter indoor temperatures using

$$
\begin{aligned}
\ln(T_i^I) &= \alpha^I + \beta_1^I \ln(P_i) + \beta_2^I \ln(Y_i) + \delta X_i^I + \lambda_i^I + \varepsilon_i^I, \quad \text{if } I_i = 1 \\
\ln(T_i^N) &= \alpha^N + \beta_1^N \ln(P_i) + \beta_2^N \ln(Y_i) + \delta X_i^N + \lambda_i^N + \varepsilon_i^N, \quad \text{if } I_i = 0,
\end{aligned}
\qquad \textbf{(5)}
$$

where T_i^I is the winter indoor temperature in apartments whose rent includes heat, T_i^N is the winter indoor temperature in apartments whose rent does not include heat, and $\lambda_i^I = \phi(\eta Z_i)/(1-\Phi(\eta Z_i))$ and $\lambda_i^N = -\phi(\eta Z_i)/\Phi(\eta Z_i)$ are the selection correction terms.[14] The selection probit **(4)** uses the entire sample, the top heating equation in **(5)** uses only the observations for which heat is included in rent (I=1), and the bottom heating equation in **(5)** uses only the observations where heat is not included (I=0). The increase in temperature resulting from heat being included in rent is $\ln(T_i^I) - \ln(T_i^N)$ using predicted values of T_i^I and T_i^N from **(5)**.

[13]The RECS does not identify landlords, or even buildings, so there is no way to separate landlord and tenant characteristics. Hence, all observations are subscripted *i*, and equation **(4)** combines the decisions of both landlords and tenants.

[14] See, for example, Maddala (1983) Ch. 9.

Table 4 gives the coefficients from the first-stage probit, equation **(4)**. We use several instruments for the heat-included variable, all of which should be exogenous to indoor temperature, and which are excluded from the temperature equations in **(5)**. First, we use the number of units in the apartment building, as larger buildings may have economies of scale from master-metering. Second, if the apartment has an air conditioner that uses the same fuel as the heating system, providing free heating will also mean providing free air conditioning, raising the landlord's cost of including utilities in the rent. And, if the heating fuel also powers an air conditioning unit, the amount of warm weather in the area will increase the value tenants place on free utilities and the cost to landlords of providing free utilities, so cooling-degree-days (CDD) are included, both alone and interacted with an indicator for whether the same fuel source powers both heat and air conditioning. Finally, regional dummies capture potential differences in regional housing markets that make inclusion of utilities more or less common. These variables are unlikely to affect thermostat settings, aside from regional differences due to temperature and fuel prices, both of which are already controlled for in the final stage.

Generally, variables associated with higher metering costs, such as building age and fuel types, are positively associated with heat being included in rent. The tenant characteristics associated with more heat use, children under 5 and persons over 65, also have positive coefficients. Of the three exclusion restrictions, only the regional indicators and the building size are statistically significant, although the dummy for air conditioning using the same fuel as the heat has the expected negative sign and is large.[15]

[15]We have performed several sensitivity tests of these exclusion restrictions. First, we dropped each of the three excluded variables, instead including them in the second stage: number of units, the air conditioning variables, and the regional dummies. Second, we added

Table 5 shows the results for the second stage regressions. Consistent with our intuition, fuel price appears to have a larger effect on demand for heating when heat is not included in monthly rents. For these metered apartments, fuel price has a negative and statistically significant coefficient both when tenants are home and when they are gone. For heat-included apartments, price has a smaller and statistically insignificant relationship to temperature.

To calculate the temperature difference between heat-included and metered apartments, adjusting for selection, in Table 6 we compare the predicted values from Tables 3 and 5. The top panel displays the difference between predicted temperature settings when somebody is home. The middle column calculates this difference using only heat-included apartments, making out-of-sample predictions for what the temperature settings would be in those apartments if they were individually metered. The rightmost column uses only metered apartments, making out-of-sample predictions for temperature settings in those apartments if heat were included. And the left hand column calculates this difference for all apartments, making out-of-sample predictions for part of the data. The difference in each case is less than 1 degree Fahrenheit. The middle panel of the table shows that same difference when nobody is home, about 2 F^{o}. The estimated effects are each smaller in magnitude than the OLS estimates from Table 3 (0.84 F^{o} and 2.73 F^{o}, respectively), suggesting that tenants who prefer warmer temperatures self-select into heat-included apartments.

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building age to the exclusion restrictions by dropping it from the second stage. The key results that follow in Tables 7 and 9 are robust to these changes. However, tests for joint significance of the exclusion restrictions included in the final stage in each of the sensitivities showed that the null hypothesis that the coefficients on the exclusion restrictions were zero could be rejected in all cases except for the test with the air conditioning variables.

These results show that tenants who rent apartments with utilities included behave differently than they would if they paid heating costs separately from rent: they use more heating and turn back thermostats less when away from home. However, in order to understand the importance of this effect, we need to translate these temperature settings into fuel use. We can approximate this in two independent ways.

First, to estimate the additional fuel use that results from tenants' reduced conservation incentives, we extrapolate from the metered apartments, for which the RECS contains data on fuel consumption. Table 7 contains the coefficients from a regression of log heating fuel expenditures on log temperature when home, log temperature when gone, and apartment characteristics, estimated using only the RECS observations where heat is *not* included in rent.[16] Unsurprisingly, higher temperature settings correspond with higher fuel use. To estimate the change in fuel expenditures associated with a change in temperature, we use the Table 7 coefficients to predict fuel expenditures for each apartment, both for the case when the landlord pays for heating and the case when the tenant pays. The bottom panel of Table 6 presents estimates of the change in fuel expenditures due to the inclusion of heat in rental contracts. In general the change is small -- less than one percent.

As an alternative, we can use published engineering estimates of energy cost savings from lower temperature settings. According to the Center for Renewable Energy and Sustainable Technology, home heating costs fall by 2 percent for every degree the temperature is lowered.[17]

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[16]Because these metered apartments are less well insulated, Table 7 overstates the fuel cost per degree of temperature for heat-included apartments.

[17]CREST web site (http://solstice.crest.org).

Additionally, the U.S. Department of Energy claims that for each degree thermostats are lowered over an 8 hour period, heating costs fall one percent.[18] Based on these figures, we estimate that energy costs are 1.7 percent higher in heat-included apartments than they would be if these same apartments, with the same tenants, were individually metered.[19]

As we suggested in the introduction, tenants in heat-included apartments value this extra heat at less than its marginal cost. If the premium for heat-included apartments is less than the utility costs, that will support landlord-side explanations for these inefficient rental contracts, and if the rent premium makes up for the increased utility costs, that would support tenant-side explanations. To try to distinguish between the landlord-side and tenant-side explanations, we next examine data on the rent differences between utility-included and metered apartments.

Rent differences for utility-included apartments

Because the RECS contains no information about rents, we instead turn to the American Housing Survey (AHS), a biennial survey conducted by the Bureau of the Census for the Department of Housing and Urban Development. We use the 1985 through 1993 national core

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[18]U.S. Department of Energy, Energy Efficiency and Renewable Energy Network, (www.eren.doe.gov/erec/factsheets/thermo.html).

[19]The average temperature of heat-included apartments is 70.7 Fahrenheit. We estimate that such apartments are 0.9 percent warmer (0.64 degrees) when the tenants are home, and 3.7 percent warmer (2.6 degrees) when tenants are gone. Using the CREST estimate for the savings, and assuming tenants are gone for 8 hours each day, this translates to a 1.7 percent higher energy cost in apartments where heat is included in rent.

samples, limited to apartments not subject to rent control and for which metropolitan area is identified.[20] The sample contains 24,238 rental units from 148 metropolitan areas.

The AHS describes the fuels used in each apartment, identifies who pays the various utility costs, and reports the monthly rent. Among the variables in the AHS are several related to energy use, such as presence and age of appliances, age of the building, and the local climate. For apartments where tenants pay for utilities, the data contain the average monthly costs of water, gas, and electricity.

Table 8 compares AHS apartments where tenants pay for heat to those where heat is included in the rent. The average rent is not statistically significantly larger in apartments where heat is included. However, these heat-included apartments are smaller and older, and more likely to be in larger, multi-family buildings.

Table 9 presents cross-tabulations of the AHS analogous to those from the RECS in Table 2. As in the RECS data, AHS apartments that are older, in larger buildings, and in the Northeast and Midwest are more likely to have heat included in the rent. However, building size, age, and region do not explain all of the variation in metering arrangements.[21]

We use the AHS to compare the rent paid by tenants in heat-included apartments to the rent paid by other tenants. This approach is an application of the hedonic price model outlined

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[20]SMSA is the only geographic identifier available in the public AHS data.

[21]The RECS and the AHS differ substantially, as can be seen by comparing tables 2 and 9. The principal difference is that the AHS represents only apartments in SMSAs, and thus is more urban.

by Rosen (1974). The hedonic approach has been used to estimate the implicit price of neighborhood, community, and housing unit amenities.[22] We estimate

$$Rent_i = \beta_0 + \beta_1' X_i + I_i \cdot (\beta_2 + \beta_3' X_i) + \beta_4' Z_i + \epsilon_i \qquad \textbf{(6)}$$

where $Rent_i$ is monthly apartment rent, I_i is a dummy for inclusion of heat in rent, X_i is a vector of apartment characteristics related to the cost of heating (and thus the value of free heat), and Z_i is a vector of other apartment characteristics, including dummy variables for each of 148 metropolitan areas.

We present 2 different specifications of equation **(6)** in Table 10: an OLS regression with the dollar value of rent as the dependent variable, and a log linear specification. Each contains dummy variables for the inclusion of heat, air conditioning, hot water, and cold water in rent. And, because we expect the rent premium for included utilities to be larger depending on their expected usage, we include interaction terms between these dummy variables and apartment characteristics related to the utility usage: climate dummies, building age, and apartment size. As expected, rents are higher when utilities are paid by the landlord. The linear and log-linear estimates are very similar. The results from Table 10, calculated at the average values in the data, predict that including heat in utilities raises rent by about 4 percent, or $22 per month.

Because hedonic models are typically estimated for individual cities, rather than a national sample, we have also estimated models similar to Table 10 separately for the 14 metropolitan areas most heavily represented in the AHS. The coefficients on the heat-included and AC-included variables (for specifications without the interactive terms) are shown in Table

[22] See, for example, Clark and Nieves (1994) or Rubin (1993).

11. Many of the coefficients are imprecisely estimated, in part because of the smaller sample sizes, but all of the statistically significant coefficients are large and positive, and follow a sensible pattern given cities' climates. (Boston rents are significantly higher when heat is included, while Washington, DC rents are higher when AC is included).

To determine if these rent premiums fully offset the extra energy used by heat-included apartments, the premiums for free utilities need to be compared to the utility bills in apartments where tenants pay the cost directly. Unfortunately, unlike the RECS, the AHS does not provide separate measures of different utility uses such as heating and air conditioning. Instead, the AHS provides the *total* utility bills for all purposes. We therefore compare the estimated increase in rent associated with having *all* utilities included to the cost paid by tenants in similar apartments where the tenants pay *all* utility bills. Table 12 presents these comparisons by apartment size and region.

These comparisons reveal, to a rough approximation, who bears the inefficiency cost of heat-inclusive rental contracts, and why they exist. If landlord-side costs explain their existence, then the implicit price of free utilities will be less than the average costs of utilities in metered apartments, inflated to account for the extra utility use by tenants facing zero marginal costs. If tenant preferences explain the persistence of heat-included rental contracts, then the implicit price of free utilities will fully compensate landlords for the extra costs they incur. The AHS-based analysis in Table 10 provides the implicit price for including utilities, and the RECS-based analysis in Table 5 provides the increased energy use when heat is included in rent.

The top line of Table 12 contains the average utility bill, for all utilities, for those apartments where the tenants pay for utilities, calculated from the AHS. The second line presents that average utility bill inflated by 2 percent, a rough estimate of the increase in usage from the RECS survey, and the engineering estimates in footnote 17. The third line presents the hedonic price of having all utilities included in rent, calculated from Table 10.

With the exception of one-bedroom apartments in cold climates, the increase in rent is never large enough to offset the costs of utilities, even before the 2 percent increase. This suggests that landlord-side explanations account for at least part of the inclusion of heat in rent, since landlords do not appear to recover the full cost of doing so. Why would landlords include utilities in their rental contracts despite consumers' unwillingness to pay increased rent sufficient to offset the cost? Because metering is expensive, because there are economies of scale or tax advantages in master-metering, or because their energy efficiency investments cannot be passed through to uncertain renters.

Conclusion

The intuition outlined in Figure 1 suggests that in a perfectly competitive market, landlords will never include heating or cooling costs in rents. Yet in practice they often do. Either landlords or tenants value utility-included apartments more than the extra energy costs. In the former case, we should expect the rent differential to less than fully compensate landlords for their energy expenditures. In the latter case, landlords will be fully compensated.

We find that tenants in heat-included apartments do use more energy, *ceteris paribus*, but that the additional utility costs are not large. If tenants are risk averse, do not want volatile utility bills, or simply prefer not facing the marginal cost of energy, they may be willing to pay this small additional cost. However, we also find that the implicit cost of free utilities, paid as higher rents, is less than the utility costs in metered apartments. Together these findings support landlord-side explanations for the persistence of inefficient heat-included rental contracts: metering costs, economies of scale, tax advantages, or signaling costs.

However, Figure 1 does not describe the entire set of inefficiencies confronting residential apartments' energy use. A second inefficiency occurs if landlords *do not* include the cost of utilities in monthly rents -- such landlords have little incentive to invest in energy efficient construction, appliances, or insulation. Indeed, we have shown that heat-included apartments tend to be relatively more energy efficient. We cannot be certain in which direction the causality flows. Landlords of heat-included apartments may provide more energy efficiency to minimize costs, or landlords of energy-efficient apartments may lease them with utilities included to signal their efficiency. Nevertheless, it does appear that the inefficient energy use by tenants in utility-included apartments is at least partly offset by the increased energy efficiency of such apartments.

Some federal policies, such as the tax deductibility of energy costs paid by landlords, encourage the inclusion of energy costs in base rents. This would be appropriate if having landlords responsible for utilities led to greater *efficiency*, via investments in energy efficient construction. Other policies, such as PURPA and the federal buildings guidelines, explicitly encourage individual metering. This would be appropriate if having landlords responsible for utilities led to greater *inefficiency*, in the form of wasteful use by tenants. Our findings indicate that landlord-side explanations underlie utility-included rental contracts, but this is not quite enough information to discern which set of federal policies are more appropriate.

To assess fully the welfare and policy implications of landlord costs, we need to know *which* of the landlord-side explanations is most important. If landlords use utility-included apartments to signal energy efficiency, that may represent a second-best market solution to an information asymmetry. Prohibited from including utilities, landlords might be unable to capitalize on energy efficiency investments, and might not make those investments. On the other hand, if landlords include utilities in rent to arbitrage on the tax advantage they have in paying for utilities, then the government inducements to meter apartments individually may be second-best responses to the inefficiency created by the tax code in the first place. Distinguishing among the various landlord-side explanations for heat-included rent, however, is beyond the scope of this paper, and we leave that for future work.

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Table 1

Comparison of RECS Apartments With and Without Heat Included in Rent[1] (Means Weighted to Represent All U.S. Apartments)

	Heat Included		Heat Not Included	
Variable	**Mean**	**Std. Dev.**	**Mean**	**Std. Dev**
Winter Indoor Temperature (F°) When Home	70.71	4.30	70.21	4.44
Winter Indoor Temperature (F°) When Gone [2]	68.69	5.39	66.36	6.01
Heated Floor Space (Sq. Ft.)	857	476	1,113	616
Heating Degree Days (Base 60)	3,683	1,557	2,753	1,844
Building Age	36	19	28	20
Units in Building	38	66	9	24
Well Insulated*	0.33	0.47	0.23	0.42
Poorly Insulated*	0.22	0.41	0.34	0.47
Number of Windows	6	4	8	5
Natural Gas Furnace*	0.72	0.45	0.50	0.50
Electric Furnace*	0.11	0.31	0.43	0.50
Fuel Oil Furnace*	0.17	0.37	0.05	0.21
LPG Furnace*	0.01	0.08	0.03	0.17
AC Uses Same Fuel as Furnace*	0.08	0.27	0.34	0.47
Income	20,835	19,148	24,386	21,039
Education of Household Head	12.63	2.95	13.02	2.85
Number of Persons in Household	1.98	1.21	2.44	1.43
Children under 5*	0.16	0.36	0.22	0.42
Persons over 65*	0.25	0.43	0.13	0.34
Sample Size	1,019		2,453	

Source: U.S. Energy Information Administration, 1987, 1990, 1993 Residential Energy Consumption Survey.

[1] A difference in means test shows that each of differences in the values above between the heat-included apartments and the metered apartments is statistically significant at 1 percent or better.
[2] Temperature when gone only observed for 908 heat-included apartments and 1,802 metered apartments.

* Denotes dummy variables.

Table 2

Percentage of Apartments with Heat Included in the Rent
By Age, Census Region, and Building Size[1]

	Built Before 1950			Built 1950-1979			Built after 1979		
Region	**Small Building**	**Medium-Sized Building**	**Large Building**	**Small Building**	**Medium-Sized Building**	**Large Building**	**Small Building**	**Medium-Sized Building**	**Large Building**
Northeast	42.4%	91.8%	99.0%	57.2%	67.0%	86.3%	8.5%	18.8%	47.1%
Midwest	30.2%	75.9%	100.0% [2]	30.9%	68.4%	87.7%	6.8%	48.4%	50.0%
South	14.0%	78.6%	57.1% [2]	19.0%	29.7%	75.7%	9.2%	1.1%	11.5%
West	18.9%	34.6%	0.0% [2]	16.9%	31.4%	30.0%	5.3%	2.3%	10.3%

Source: Energy Information Administration, 1987, 1990, 1993 Residential Energy Consumption Survey.

[1] Small = 8 or Fewer Apartments; Medium = 9 - 29 Apartments; Large = 30+ Apartments.

[2] Based on limited sample size (10 or fewer observations).

Table 3

Winter Indoor Temperature
OLS Estimates

Variable	Mean (std. dev.)	ln (Temp when home)	ln (Temp when gone)
Cost of Heating Included in Rent		0.0121 *	0.0390 *
		(0.0027)	(0.0043)
ln (Heating Fuel Price)		-0.0031	-0.0013
		(0.0018)	(0.0027)
ln (Heating Fuel Price) x Metered Apartment		0.0006	-0.0049
		(0.0023)	(0.0036)
Heating Degree Days	3216	-0.0006 *	-0.0009 *
	(1861)	(0.0001)	(0.0001)
Heated Floor Space	1043	0.0001	0.0010 *
	(604)	(0.0002)	(0.0003)
Building Well Insulated	0.26	-0.0004	0.0004
	(0.44)	(0.0026)	(0.0043)
Building Poorly Insulated	0.31	0.0008	-0.0037
	(0.46)	(0.0025)	(0.0042)
Number of Windows	8	-0.0007 *	-0.0020 *
	(5)	(0.0003)	(0.0005)
Building Age	31	-0.00004	0.00005
	(21)	(0.0001)	(0.0001)
Fuel Oil Furnace	0.09	-0.0170 *	-0.0061
	(0.29)	(0.0039)	(0.0058)
Electric Furnace	0.32	-0.0057 *	-0.0041
	(0.47)	(0.0027)	(0.0046)
LPG Furnace	0.03	-0.0064	0.0033
	(0.16)	(0.0069)	(0.0111)
ln (Household Income)	22897	-0.0005	0.0032
	(20760)	(0.0013)	(0.0021)
Education of Household Head	12.8	-0.0010 *	-0.0015 *
	(2.9)	(0.0004)	(0.0007)
Number of Persons in Household	2.39	0.0038 *	0.0063 *
	(1.41)	(0.0010)	(0.0017)
Children Under 5 in Household	0.21	0.0060	-0.0029
	(0.41)	(0.0031)	(0.0052)
Persons Over 65 in Household	0.16	0.0178 *	0.0249 *
	(0.37)	(0.0032)	(0.0051)
Intercept		4.2756 *	4.2172 *
		(0.0072)	(0.0123)
R^2		0.065	0.089
Sample Size	3472	3427	2716

Standard errors in parentheses.
* Statistically significant at 5 percent.

Table 4

Selection Model
First Stage Probit
Dependent Variable = Heat Included in Rent

Variable	Coeff. (S.E.)	Marg. Eff. (S.E.)
Number of Units in Building ‡	0.0090 *	0.0027 *
	(0.0009)	(0.0003)
AC Uses Same Fuel as Furnace ‡	-0.2592	-0.0727
	(0.1800)	(0.0476)
Cooling Degree Days (CDD) ‡	-0.0037	-0.0011
	(0.0092)	(0.0027)
CDD × AC Same Fuel as Heat ‡	-0.0031	-0.0009
	(0.0110)	(0.0033)
New England ‡	0.2831 *	0.0910 *
	(0.1238)	(0.0426)
West North Central ‡	-0.2120	-0.0586 *
	(0.1129)	(0.0289)
East South Central ‡	-0.2403	-0.0654
	(0.1476)	(0.0366)
West South Central ‡	-0.4107 *	-0.1056 *
	(0.1471)	(0.0319)
Mid-Atlantic ‡	0.4420 *	0.1458 *
	(0.1088)	(0.0391)
South Atlantic ‡	0.1105	0.0337
	(0.1234)	(0.0388)
Mountain ‡	-0.3472 *	-0.0911 *
	(0.1242)	(0.0283)
Pacific ‡	-0.6975 *	-0.1672 *
	(0.1427)	(0.0264)
Urban	0.2250 *	0.0663 *
	(0.0584)	(0.0171)
Price of Heat (Normalized)	-0.0821 *	-0.0243 *
	(0.0360)	(0.0107)
Heating Degree Days	0.0052	0.0016
	(0.0030)	(0.0009)
Heated Floor Space	-0.0299 *	-0.0089 *
	(0.0061)	(0.0018)
Building Well Insulated	0.1629 *	0.0497 *
	(0.0668)	(0.0209)
Building Poorly Insulated	-0.2583 *	-0.0736 *
	(0.0662)	(0.0181)

(Continued)

(Table 4, continued)

Number of Windows	-0.0883 *	-0.0262 *
	(0.0084)	(0.0025)
Electric Furnace	-1.0881 *	-0.2702 *
	(0.1245)	(0.0253)
Fuel Oil Furnace	0.2966 *	0.0956 *
	(0.1045)	(0.0362)
LPG Furnace	-0.2271	-0.0616
	(0.1904)	(0.0467)
Building Age	0.0068 *	0.0020 *
	(0.0016)	(0.0005)
Household Income	-0.000004 *	-0.000001 *
	(0.000002)	(0.000000)
Education of Household Head	-0.0098	-0.0029
	(0.0106)	(0.0031)
Number of Persons in Household	-0.0511	-0.0151
	(0.0273)	(0.0081)
Children Under 5 in Household	0.0626	0.0188
	(0.0840)	(0.0256)
Persons over 65 in Household	0.2289 *	0.0717 *
	(0.0782)	(0.0258)
Intercept	0.4352	
	(0.2510)	

Standard errors are reported in parentheses.

* Statistically significant at 5 percent.

‡ Exclusion restriction.

Table 5

Selection Model
Final Stage Regressions

	ln (Winter temperature when home)		ln (Winter temperature when gone)	
Variable	**Heat not Included**	**Heat Included**	**Heat not Included**	**Heat Included**
ln (Price of Heating Fuel)	-0.0032 *	-0.0021	-0.0062 *	-0.0012
	(0.0014)	(0.0019)	(0.0025)	(0.0026)
Heating Degree Days	-0.0007 *	-0.0003 *	-0.0009 *	-0.0009 *
	(0.0001)	(0.0001)	(0.0001)	(0.0002)
Heated Floor Space	0.0002	0.0005	0.0014 *	0.0005
	(0.0003)	(0.0005)	(0.0004)	(0.0007)
Building Well Insulated	-0.0012	-0.0007	-0.0094	0.0129 *
	(0.0033)	(0.0048)	(0.0057)	(0.0064)
Building Poorly Insulated	0.0011	0.0026	-0.0057	0.0089
	(0.0030)	(0.0053)	(0.0053)	(0.0072)
Number of Windows	-0.0004	-0.0002	-0.0013 *	-0.0009
	(0.0004)	(0.0009)	(0.0006)	(0.0012)
Building Age	-0.00002	-0.0002	-0.0001	0.0002
	(0.0001)	(0.0001)	(0.0001)	(0.0002)
Electric Furnace	-0.0003	-0.0024	0.0062	-0.0086
	(0.0039)	(0.0087)	(0.0071)	(0.0125)
Fuel Oil Furnace	-0.0176 *	-0.0166 *	-0.0147	-0.0096
	(0.0058)	(0.0062)	(0.0091)	(0.0082)
LPG Furnace	-0.0050	-0.0047	0.0090	-0.0026
	(0.0074)	(0.0199)	(0.0128)	(0.0254)
ln (Household Income)	-0.0009	0.0007	0.0039	0.0016
	(0.0016)	(0.0024)	(0.0028)	(0.0032)
Education of Household Head	-0.0011 *	-0.0004	-0.0024 *	-0.0001
	(0.0005)	(0.0008)	(0.0009)	(0.0010)
Number of Persons in Household	0.0044 *	0.0023	0.0063 *	0.0087 *
	(0.0011)	(0.0023)	(0.0020)	(0.0031)
Children Under 5 in Household	0.0079 *	0.0003	0.0024	-0.0203 *
	(0.0035)	(0.0069)	(0.0063)	(0.0095)
Persons over 65 in Household	0.0168 *	0.0147 *	0.0298 *	0.0159 *
	(0.0041)	(0.0054)	(0.0073)	(0.0072)

(continued)

(Table 5 continued)

Lambda	-0.0132	-0.0039	-0.0153	-0.0227 *
	(0.0074)	(0.0069)	(0.0126)	(0.0096)
Intercept	4.2712 *	4.2725 *	4.2145 *	4.2461 *
	(0.0098)	(0.0137)	(0.0181)	(0.0192)
R^2	0.083	0.030	0.072	0.061
Observations	2,453	1,019	1,807	909

Standard errors are reported in parentheses.

* Statistically significant at 5 percent.

Table 6

Average Predicted Winter Indoor Temperature (F°)
(Weighted to Represent All U.S. Apartments, 1987-1993)

Variable	All Apartments	Apartments with Heat Included	Apartments with Heat Not Included
Average predicted temperature (F°) when home			
Heat Included	70.74*	70.60	70.81**
Heat Not Included	70.11*	70.18**	70.18
Difference (Temperature Change)	0.63	0.42	0.63
OLS Estimate Difference	0.84		
Average predicted temperature (F°) when gone			
Heat Included	67.56*	68.37	67.15**
Heat Not Included	65.83*	65.89**	65.83
Difference (Temperature Change)	1.73	2.48	1.32
OLS Estimate Difference	2.73		
Predicted percent increase in fuel expenditures from including heat in rent[1]			
Selection adjusted estimate.	0.763	0.780	0..680
OLS estimate.	1.10		

[1] Applies predicted fuel expenditures from Table 7.
* Partly out-of-sample prediction.
** Out-of-sample prediction.

Table 7

Winter Indoor Temperatures and Fuel Use
OLS Estimates from
Metered Apartments in RECS Sample
Dependent Variable = ln (Annual expenditure on fuel)

Variable	Coeff. (S.E.)
ln (Temperature When Home)	0.449 *
	(0.226)
ln (Temperature When Gone)	0.138
	(0.140)
Heating Degree Days	0.016 *
	(0.001)
Heated Floor Space	0.015 *
	(0.002)
Building Well Insulated	0.012
	(0.029)
Building Poorly Insulated	0.120 *
	(0.027)
Number of Windows	0.043 *
	(0.003)
Electric Furnace	0.149 *
	(0.028)
Fuel Oil Furnace	0.090 *
	(0.046)
LPG Furnace	0.222 *
	(0.066)
Building Age	0.007 *
	(0.001)
Intercept	1.673 *
	(0.848)
R^2	0.544
Observations	1801

Standard errors in parentheses.

* Statistically significant at 5 percent.

Table 8

Selected Means for AHS Apartments
With and Without Heat-Included in Rent
Means Weighted to Represent All U.S. Apartments
1985, 1987, 1989, 1991, and 1993

		Apartments with Heat Included		Apartments with Heat Not Included	
Variable		**Mean**	**Std. Dev.**	**Mean**	**Std. Dev.**
Monthly Rent (1993 $)		$532	$215	$530	$222
Air Conditioning in Rent	*	0.23	0.42	0.004	0.066
Number of Bedrooms	*	1.43	0.78	1.91	0.86
Building Age	*	39	23	29	22
Multi-family Structure	*	0.95	0.22	0.73	0.45
Units in Building	*	23	26	11	16
Central City	*	0.61	0.49	0.58	0.49
Located in Cold Climate	*	0.50	0.50	0.28	0.45
Observations		5053		17871	

Source: American Housing Survey, 1985, 1987, 1989, 1991, and 1993.

* Difference of means statistically significant at 5 percent.

Table 9

Percentage of Apartments with Heat Included in the Rent By Age, Census Region, and Building Size[1]

	Built Before 1950			Built 1950-1979			Built after 1979		
Region	**Small Building**	**Medium-Sized Building**	**Large Building**	**Small Building**	**Medium-Sized Building**	**Large Building**	**Small Building**	**Medium-Sized Building**	**Large Building**
Northeast	32.1%	66.0%	78.8%	31.9%	53.1%	75.3%	3.3%	25.5%	53.8%
Midwest	16.3%	39.2%	68.6%	19.8%	38.4%	55.5%	4.0%	7.9%	28.4%
South	10.8%	46.4%	47.8%	9.3%	15.2%	17.1%	1.1%	0.9%	11.0%
West	12.4%	28.1%	54.1%	6.8%	15.6%	22.6%	4.1%	2.3%	16.7%

Source: American Housing Survey 1985, 1987, 1989, 1991, and 1993.

[1] Small = 8 or Fewer Apartments; Medium = 9 - 29 Apartments; Large = 30+ Apartments.

Table 10

Hedonic Rent Model
Dependent Variable = Monthly Rent

Variable	Means	OLS	Log Linear
Heat included in Rent	0.22	-14.08	-0.040
		(17.65)	(0.045)
Heat Included × Cold Climate	0.11	18.34 *	0.032 *
		(5.48)	(0.013)
Heat Included × Building Age	8.6	-0.096	0.00020
		(0.240)	(0.00151)
Heat Included × Rooms	0.81	7.80 *	0.017
		(3.86)	(0.010)
Window AC Included in Rent	0.020	-9.35	-0.00083
		(15.0)	(0.03490)
Win. AC Incl. × Number AC units	0.023	23.87	0.026
		(16.83)	(0.033)
Win. AC Incl. × Units × Hot Climate	0.0030	14.24	0.0043
		(13.50)	(0.0466)
Win. AC Incl. × Units × Bld. Age	0.94	0.220	0.0003
		(0.297)	(0.0007)
Central AC Included in Rent	0.032	110.01 *	0.094
		(30.98)	(0.068)
Central AC Incl. × Hot Climate	0.013	-15.38	0.049
		(13.52)	(0.032)
Central AC Incl. × Age	0.72	-0.850	-0.0010
		(0.519)	(0.0013)
Central AC Incl. × Rooms	0.12	-8.702	-0.010
		(6.406)	(0.015)
Hot Water Included in Rent	0.22	12.26	0.041
		(12.52)	(0.029)
Hot Water Incl. × Age	8.2	-0.143	0.00034
		(0.240)	(0.00051)
Hot Water Incl. × Bedrooms	0.31	-1.39	-0.0097
		(5.55)	(0.0133)
Cold Water Included in Rent	0.80	-19.7 *	0.0039
		(8.49)	(0.0202)
Cold Water Incl. × Bedrooms	1.32	7.77 *	0.0031
		(3.76)	(0.0083)

(continued)

(Table 10 continued)

Bedrooms	1.82	39.70 * (3.74)	0.090 * (0.008)
Bathrooms	1.23	60.57 * (5.45)	0.087 * (0.009)
Other Rooms	1.14	7.39 * (1.79)	0.018 * (0.004)
Floor of Apartment Building	0.89	2.93 * (1.11)	0.0032 (0.0026)
Single Family Home	0.16	46.84 * (4.33)	0.058 * (0.010)
Single Family Home (Attached)	0.065	16.24 * (4.13)	0.014 (0.010)
Building Age	32.0	-2.35 * (0.19)	-0.0043 * (0.0005)
Building Age Squared	1552	0.019 * (0.002)	0.000026 * (0.000005)
Near a Park	0.14	-7.24 * (2.58)	-0.021 * (0.006)
Near a Body of Water	0.029	24.85 * (5.91)	0.039 * (0.014)
Near Abandoned Buildings	0.047	-50.93 * (4.78)	-0.129 * (0.013)
Bars on Nearby Windows	0.14	-19.35 * (3.20)	-0.042 * (0.008)
Exterior in Poor Condition	0.18	-1.63 (2.66)	-0.0075 (0.0064)
Walls or Floor in Poor Condition	0.12	-17.23 * (2.99)	-0.039 * (0.008)
Water Leaks In	0.13	-1.31 (2.96)	-0.007 (0.007)
Number of Units in Building	13.0	0.611 * (0.070)	0.0012 (0.0002)
Number of Stories in Building	2.70	6.947 * (1.23)	0.012 * (0.003)
Washer/Dryer	0.29	26.01 * (2.63)	0.056 * (0.006)
Dishwasher	0.42	61.65 * (2.96)	0.117 * (0.006)

(continued)

(Table 10 continued)

Free Garage Parking	0.33	51.38 *	0.115 *
		(3.71)	(0.009)
Free Off Street Parking	0.46	17.88 *	0.047 *
		(3.18)	(0.007)
Porch or Patio	0.61	5.41 *	0.0089
		(2.13)	(0.0052)
Fireplace	0.14	59.82 *	0.095 *
		(3.41)	(0.007)
Central AC	0.35	45.06 *	0.126 *
		(3.58)	(0.009)
Window AC	0.30	9.08 *	0.021 *
		(2.84)	(0.007)
Central City†	0.58	-14.20 *	-0.038 *
		(2.33)	(0.005)
Cold Climate†	0.334		
Hot Climate†	0.207		
1985 Sample		-2.65	-0.024 *
		(2.88)	(0.007)
1987 Sample		13.07 *	0.0153 *
		(2.84)	(0.0070)
1989 Sample		15.50 *	0.0093
		(2.71)	(0.0070)
1991 Sample		4.63	0.0059
		(2.64)	(0.0063)
Constant		348.31 *	5.852 *
		(12.26)	(0.028)
Predicted rent premium for heat included, based on averages for climate, age, and rooms.		+21.67	+0.042
R^2		0.592	0.483
Observations		26,332	26,332

Heteroskedasticity-consistent standard errors in parentheses.
* Statistically significant at 5 percent.
Includes dummy variables for 148 metropolitan areas.
† Based on 30 year average heating and cooling degree days.
Coldest: > 7,000 HDD and < 2,000 CDD; Cold: 5,500-7,000 HDD and < 2,000 CDD;
Cool: 4,000-5,500 HDD and < 2,000 CDD; Mild (Omitted): > 4,000 HDD and > 2,000 CDD;
Mixed: 2,000-4,000 HDD and > 2,000 CDD; Hot: < 2,000 HDD and > 2,000 CDD.

Table 11

Hedonic Rent Models for Individual Cities

City	Heat Included Coeff. (S.E.)	AC Included Coeff. (S.E.)	R^2	N	Percent with Heat Included in Rent	Percent with AC Included in Rent
Anaheim [1]	-2.90 (20.90)	---	0.451	599	13%	5%
Boston	36.31 * (19.41)	42.99 (35.92)	0.348	604	41%	7%
Chicago	51.48 * (10.93)	-41.69 (26.96)	0.382	1259	32%	3%
Dallas	46.55 (33.76)	-7.57 (35.89)	0.469	654	17%	15%
Detroit [1]	19.09 (13.88)	---	0.607	570	27%	2%
Houston	28.36 (30.02)	27.18 (32.90)	0.490	707	13%	11%
Los Angeles	-5.49 (15.62)	12.89 (28.24)	0.506	1762	9%	2%
New York [2]	-8.23 (10.95)	51.31 * (25.71)	0.289	1727	63%	4%
Philadelphia	35.21 * (14.66)	-22.74 (29.14)	0.526	667	34%	6%
Washington, DC	-4.36 (16.87)	37.56 * (18.96)	0.616	578	53%	37%
Miami					8%	4%
Minneapolis [1]	6.61 (11.10)	---	0.723	438	41%	2%
Milwaukee [1]	32.28 * (17.68)	---	0.617	266	26%	0%
Buffalo [1]	19.37 (22.90)	---	0.504	207	28%	5%

*Statistically significant at 5 percent.

[1] Indicator variable for AC Included in rent excluded because landlord pays bill for very few apartments.
[2] Indicator variable for water included in rent excluded because tenants pay bill for very few apartments.

Table 12

Average Monthly Cost of Utilities in Metered Apartments vs. Implicit Hedonic Price of Free Utilities

Type of Apartment	Utility Cost	All Climates	Cold Climate	Moderate Climate	Hot Climate
1 Bedroom Apartments	Average Cost of Utilities in Metered Apartments	$87	$95	$81	$93
	Estimated Cost of Utilities in Inclusive Apartments*	89	97	83	95
	Estimated Hedonic Price	91	106	74	86
2 Bedroom Apartments	Average Cost of Utilities in Metered Apartments	117	128	108	124
	Estimated Cost of Utilities in Inclusive Apartments*	119	131	110	126
	Estimated Hedonic Price	98	114	81	92
3 Bedroom Apartments	Average Cost of Utilities in Metered Apartments	145	151	137	152
	Estimated Cost of Utilities in Inclusive Apartments*	148	154	140	155
	Estimated Hedonic Price	102	116	90	98
4+ Bedroom Apartments	Average Cost of Utilities in Metered Apartments	170	164	166	184
	Estimated Cost of Utilities in Inclusive Apartments*	173	167	169	188
	Estimated Hedonic Price	108	121	95	104

* Assuming a 2 percent increase in consumption, as estimated for heating using the RECS, and footnote 17.

Figure 1: Deadweight loss.

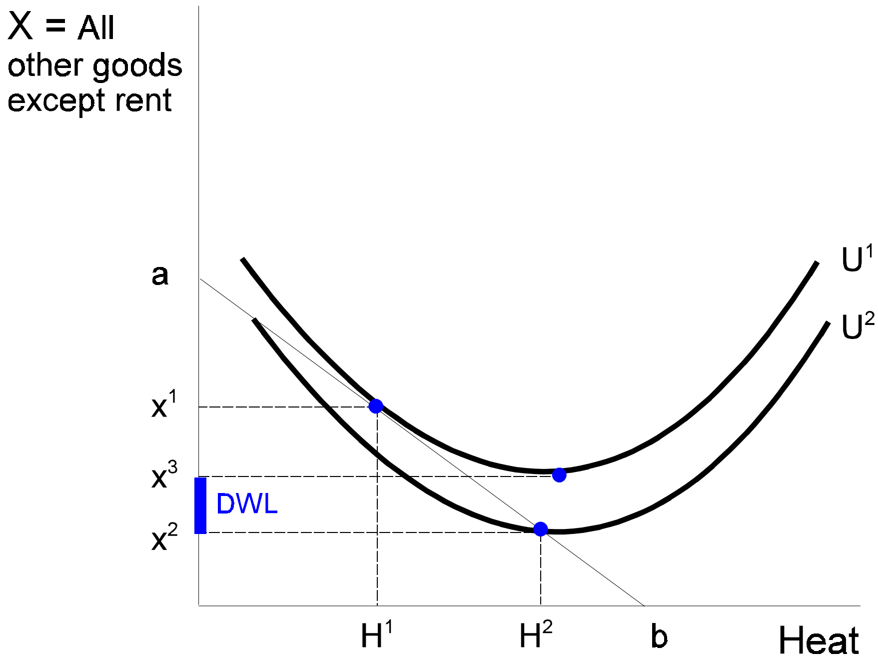

Figure 2: Metering costs.

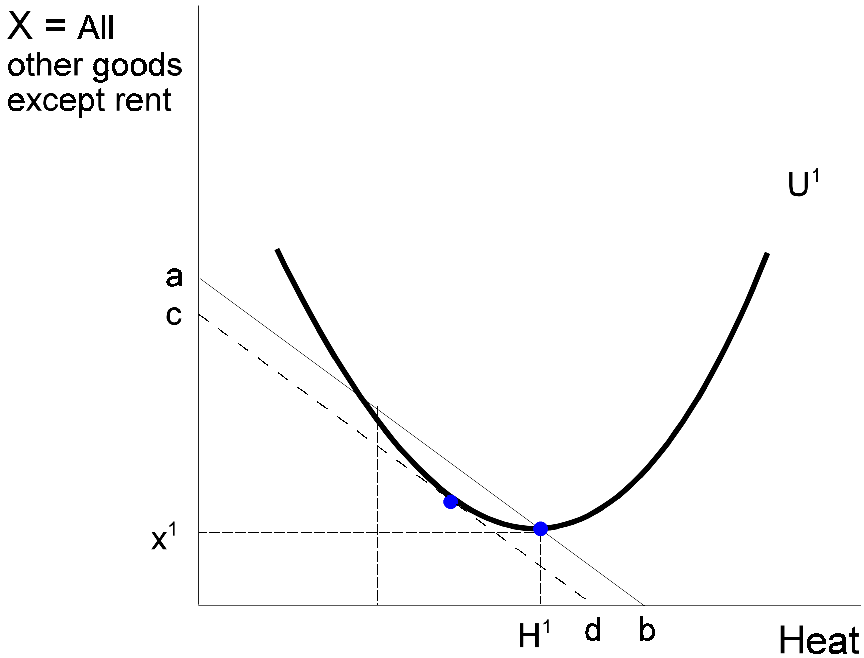

Figure 3: Economies of scale.

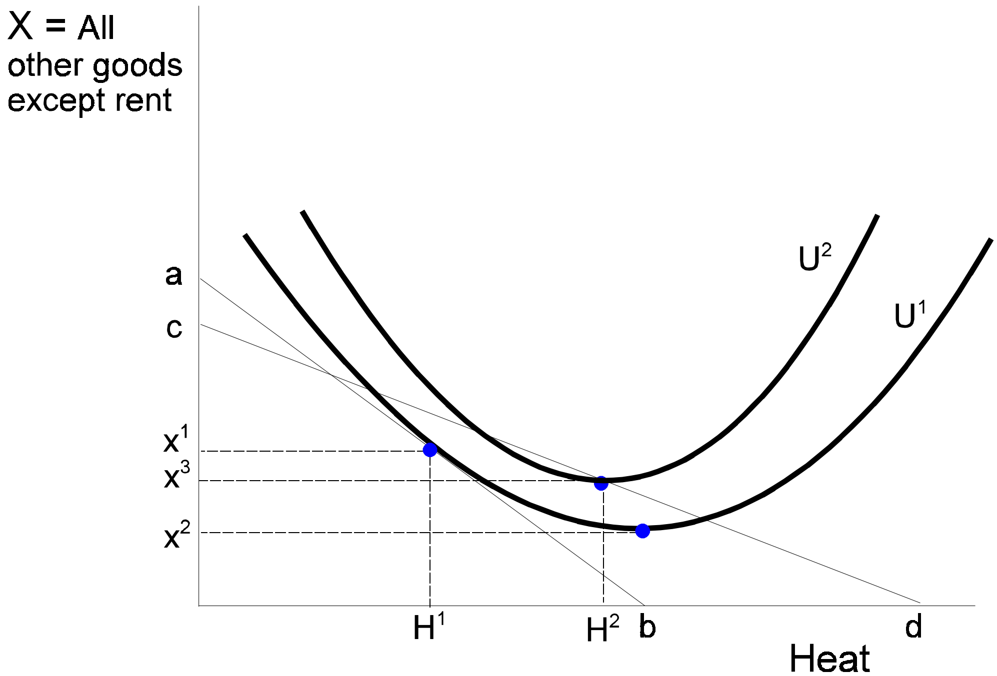

Figure 4: Taxes.

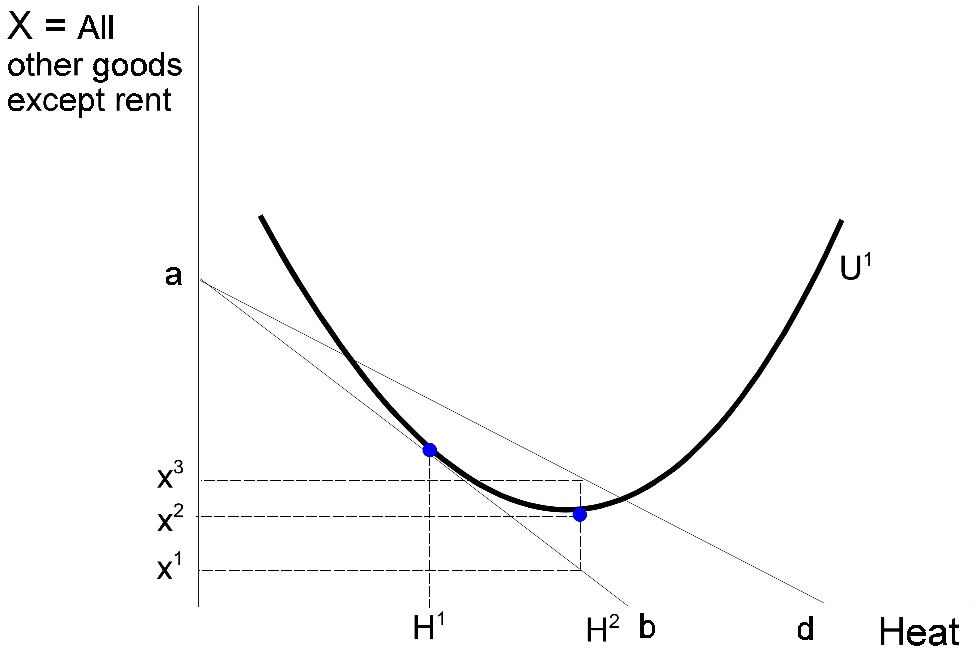

Figure 5: Signaling.