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Energy use by apartment tenants when landlords pay for utilities

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Abstract

Energy costs are included in the rent for many US apartments, giving tenants little incentive to conserve. This apparent market failure has two explanations: the tenants value the utility-included rental contracts more than they value the extra energy they consume, or the landlords value the contracts more than the cost of that extra energy. We use the Residential Energy Consumption Survey and the American Housing Survey to estimate energy consumption and rent premiums for utility-included apartments. While rents are higher than for comparable metered apartments, the difference is smaller than the cost of the energy used, a finding that supports landlord-side explanations.
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1. Introduction

More than one-fourth of rental apartments in the US 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 therefore raises two questions that we address

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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 the apparent inefficiency, that retrofitting old buildings and individual metering are costly, cannot be the entire story. Many newly built, 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, 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% of US energy consumption,[1] 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.[2] 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."[3] 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.

Another policy implication involves the so-called "energy paradox"—the surprisingly slow adoption of cost-effective residential energy-conservation technologies.[4] Common 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.

Finally, 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 may increase economic welfare while reducing energy consumption and pollution.

In what follows, we use data on apartment rental configurations and utility use to examine competing explanations for utility-included rents. We first assess 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

[1] Authors' calculations using data for 1997 from the 1999 Energy Information Agency's *Annual Energy Outlook*, US Department of Energy, Washington, DC.

[2] PURPA did not, however, prohibit utility-included rental contracts, and some new, individually metered, electrically heated apartments are rented with utilities included. See Munley et al. (1990).

[3] 1998 Code of Federal Regulations, Title X, part 435.106.

[4] See for example, Hausman (1979), Jaffe and Stavins (1994), and Hassett and Metcalf (1995, 1999).

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 brief, we find that tenants living in utility-included apartments set their thermostats between one and three degrees (°F) warmer during winter months when they are absent from the premises, all else equal. This temperature difference translates into approximately half to three-quarters of a percent increase in fuel expenditures. While the increase in fuel costs is small, there are several reasons to believe that it may be an underestimate. Moreover, given the size of the rental housing market, even a tiny increase in fuel use amounts to a considerable absolute increase. Finally, we find that the rent differential between metered and heat-included apartments is significantly less than even this small cost of the extra fuel use, and argue that this outcome points to landlord-side explanations for the heat-included rental contracts.

2. Deadweight loss and explanations for utility-included apartments

Fig. 1 depicts one tenant's consumption choices between heat, H, and all other goods except rent, 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 ab represents the tenant's budget constraint, excluding rent costs, where the tenant pays his own utility bill, and the price of heat is a/b. A utility-maximizing tenant will choose H^1 units of heat and x^1 other goods, spending $(a - x^1)$ 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 (H^2, x^2) in Fig. 1 satisfies this condition,

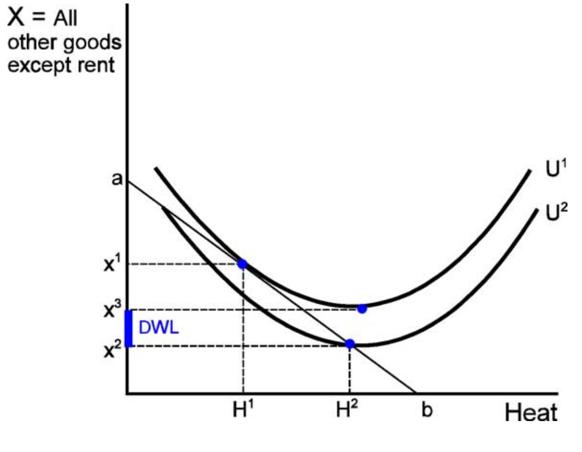

Fig. 1. Deadweight loss.

resulting in a rent increase of $(a - x^2)$, an increase in combined housing and heating costs to the tenant of $(x^1 - x^2)$, and a lower level of utility U^2. The compensating variation, the amount the tenant would be willing to pay to have heat included in his rent is $(a - x^3)$, but the increased costs to the landlord are $(a - x^2)$. The difference, $(x^3 - x^2)$, 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, and costless metering of energy use, landlords would demand $(a - x^2)$ in higher rents in order to include utilities, and tenants would only be willing to pay $(a - x^3)$. 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% of apartments in the US are rented with utilities included.

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.

Fig. 2 depicts a tenant in an unmetered apartment, consuming H^1 and paying $(a - x^1)$ in extra rent to cover the utility bill. The tenant would be willing to pay as much as $(a - c)$ in extra base rent to have an individually metered apartment. If the metering costs are higher than $(a - c)$, the landlord will not benefit from converting to individual meters. If the metering costs are less than $(a - c)$, 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

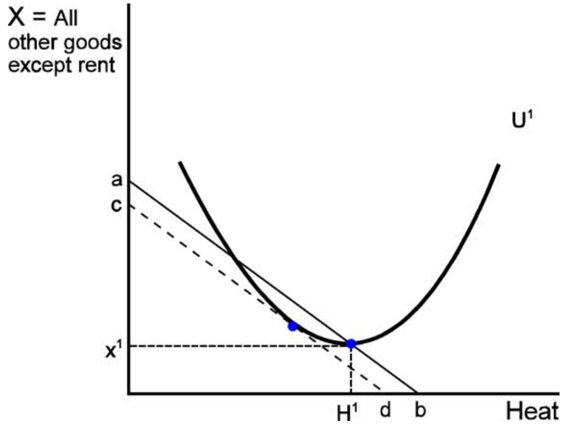

Fig. 2. Metering costs.

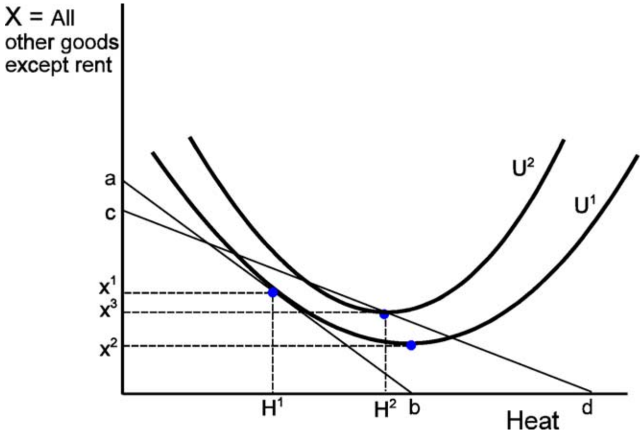

Fig. 3. Economies of scale.

difference between metered and heat-included apartments will be less than $(a - x^1)$, the observed cost of the utilities consumed.[5]

Though the metering cost story may be the most obvious explanation for utility-included apartments, it is not the only explanation. 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 newly constructed, electrically heated apartments include heat in their rents. Eleven percent of apartments with electric heat in 1993 had heat included, as did 8% of apartment buildings less than 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 landlord-side 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 Fig. 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. The landlord needs to charge only $(a-x^3)$ 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.

[5] Note that metering costs might include more than just the extra capital cost of outfitting individual apartments with meters. One cost might be the risk that individually metered tenants set thermostats so low that pipes freeze and burst in the winter. Another might be the risk that individually metered tenants cause fire damage by using space-heaters improperly.

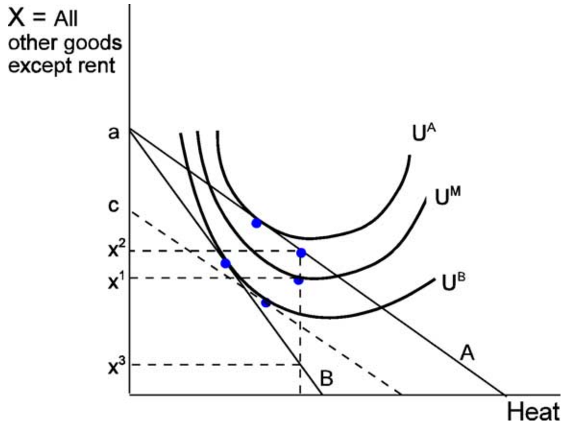

Fig. 4. Signaling.

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. However, prospective tenants do not know the energy consumption habits of past tenants, and may attribute low bills to excessive conservation, or absenteeism. Another, perhaps more convincing, way for landlords to convey energy efficiency information would be to offer to pay the utility costs up front in exchange for higher rent.

Fig. 4 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.[6] If identical risk-neutral tenants cannot discern in advance apartments of types A and B, they have some intermediate utility (denoted by U^{M}).[7] 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 incurred by landlords of type-A insulated apartments would be $(a - x^2)$. The difference, $(x^2 - x^1)$, 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

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

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

energy cost incurred by landlords of type-B uninsulated apartments would be $(a - x^3)$, and no such apartments will be leased with utilities included.[8]

A key stylized fact emerges from all of these landlord-side explanations, metering costs, economies of scale, 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 energy they use.[9]

Similarly, risk-averse tenants may prefer utility-included apartments. When tenants sign a lease, they cannot forecast the year's weather or fuel prices. As with any insurance, tenants may be willing to pay a risk 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 Fig. 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.[10]

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 insufficient to compensate landlords for their extra utility costs, then the landlord-side explanations must be part of the explanation. Unfortunately, all of the data necessary for both sides of the question—energy use 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.

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[8] If landlords develop reputations for leasing inefficient apartments, or if tenants can move without cost, this asymmetric information problem will be ameliorated. To the extent that tenants are immobile, and reputations are imperfect, however, there will be room for a signaling equilibrium.

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

[10] There may also be institutional constraints. In states that prohibit resale of electricity, utilities have no incentive to retrofit buildings with individual meters. The PURPA clause requiring individual metering resolves this issue as of 1978.

3. 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 temperature settings.[11]

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 of the apartments in the US. 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.[12,13]

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 97% of the apartments, and prices for other fuels are not in the RECS.

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)

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

The marginal cost of heating, C, is determined by several factors. If heat is included in rent, the marginal cost is 0. If the tenant pays for heating, the marginal cost of turning up the

[11] We also considered conducting this analysis using summer indoor temperatures as a proxy for air conditioning use. However, the RECS only reports AC use as a categorical variable (often, sometimes, never . . .), not as a thermostat setting or indoor temperature.

[12] Of course, the causality could run in the other direction. Landlords with individually metered buildings may skimp on energy efficiency investments. In the empirical work that follows, we attempt to disentangle these effects.

[13] The prevalence of heat-included rental contracts varies by region, and by building size and age (see Appendix A Table A.1). 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.

Table 1
Comparison of RECS apartments with and without heat included in rent[a] (means weighted to represent all US apartments)

Variable	Heat included		Heat not included	
	Mean	S.D.	Mean	S.D.
Winter indoor temperature (°F) when home	70.68	4.52	70.25	4.62
Winter indoor temperature (°F) when gone[b]	68.60	5.51	66.35	6.23
Heated floor space (ft^2)	834	467	1073	587
Heating-degree-days (base 60)	4833	1841	3805	2150
Building age	37	19	30	20
Units in building	38	70	10	38
Well insulated[c]	0.34	0.47	0.24	0.42
Poorly insulated[c]	0.21	0.41	0.32	0.47
Number of windows	7	5	9	6
Natural gas furnace[c]	0.69	0.46	0.49	0.50
Electric furnace[c]	0.12	0.33	0.44	0.50
Fuel oil furnace[c]	0.18	0.38	0.04	0.20
LPG furnace[c]	0.01	0.09	0.03	0.18
AC uses same fuel as furnace[c]	0.09	0.29	0.35	0.48
Income	20305	18624	25310	21598
Education of household head[d]	12.63	2.95	13.02	2.85
Number of persons in household	2.02	1.25	2.47	1.46
Children under 1 year in household[c]	0.02	0.15	0.05	0.22
Children under 12 years[c]	0.20	0.40	0.32	0.47
Persons over 65 year[c]	0.23	0.42	0.12	0.32
Sample size	1364		3549	

Source: US Energy Information Administration, 1987, 1990, 1993 and 1997 Residential Energy Consumption Survey.

[a] Differences between the heat-included apartments and the metered apartments are all statistically significant at 5%.

[b] Temperature when gone, only observed for 1213 heat-included apartments and 2716 metered apartments.

[c] Denotes dummy variables.

[d] 1987–1993 only. Education was dropped from the RECS after 1993, so the analyses that follow do not control for education. We have estimated all of the models using only data for 1993 and earlier, and included education, with virtually identical results.

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

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

where $I = 1$, if heat is included in rent and 0 otherwise, and P is the price of heating fuel. We estimate a reduced-form version of Eq. (2)

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

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.[14] The remaining variation in fuel prices is due to differences across regions, over time, and within regions across different energy suppliers. 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.[15] Similarly, structural characteristics have both direct and indirect effects that make signing the reduced-form coefficients 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 income of the household, household size, and indicators for the presence of household members under 5 years or over 65 years old.

As a benchmark, Table 2 presents ordinary least squares estimates of Eq. (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. The second column estimates Eq. (3) where the dependent variable, *T*, is the winter indoor temperature when someone is home. The third column uses the temperature when nobody is home. In both cases, the coefficient on the heat-included dummy variable is positive and statistically significant. Also, as one might expect, the effect is larger in the case when no one is home.

Table 2 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 both columns, the estimated coefficients (−0.069 and −0.209) are small and statistically insignificant.

The coefficients on the heat-included indicators 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

[14] 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 0, relative to the log–normal distribution.

[15] 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 Eq. (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.

Table 2
Winter indoor temperature OLS estimates

Variable	Mean (S.D.)	Temperature (°F) when home	Temperature (°F) when gone
Cost of heating included in rent		0.749* (0.167)	2.74* (0.24)
ln(heating fuel price)		−0.226** (0.116)	−0.119 (0.160)
ln(heating fuel price) × metered apartment		−0.069 (0.142)	−0.209 (0.201)
Heating-degree-days	4257 (2155)	−0.00315* (0.0033)	−0.0425* (0.0050)
Heated floor space	1010 (576)	−0.0013 (0.0134)	0.0469* (0.0191)
Building well insulated	0.27 (0.44)	−0.155 (0.162)	−0.173 (0.238)
Building poorly insulated	0.30 (0.46)	−0.110 (0.156)	−0.570* (0.234)
Number of windows	8.2 (5.7)	−0.028** (0.0014)	−0.054* (0.021)
Building age	32 (20)	−0.0068** (0.0038)	−0.0028 (0.0055)
Fuel Oil furnace	0.09 (0.29)	−1.30* (0.24)	−0.70* (0.33)
Electric furnace	0.34 (0.47)	−0.399* (0.162)	−0.000 (0.248)
LPG furnace	0.03 (0.17)	−0.884* (0.400)	−0.699 (0.590)
ln (household income in $1000US)	23085 (20920)	−0.076 (0.077)	0.204** (0.114)
Number of persons in household	2.43 (1.44)	0.135* (0.066)	0.293* (0.101)
Infants in household	0.047 (0.211)	0.623** (0.321)	0.908** (0.484)
Children aged 1–12 years in household	0.31 (0.46)	0.362** (0.192)	−0.303 (0.287)
Persons over 65 years in household	0.14 (0.35)	1.46* (0.20)	1.92* (0.29)
Intercept		71.8* (0.34)	66.7* (0.53)
R^2		0.055	0.075
Sample size	4913	4913	3929

Standard errors in parentheses.
* Statistically significant at 5%.
** Statistically significant at 10%.

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:[16]

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

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.[17] Z_i is a vector of landlord and tenant variables.

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

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

where T_i^{I} is the winter indoor temperature in apartments whose rents include heat, T_i^{N} is the winter indoor temperature in apartments whose rents do not include heat, and $\lambda_i^{\mathrm{I}} = \Phi(\eta Z_i)/(1 - \Phi(\eta Z_i))$ and $\lambda_i^{\mathrm{N}} = -\Phi(\eta Z_i)/\Phi(\eta Z_i)$ are the selection correction terms.[18] The selection probit (Eq. (4)) uses the entire sample, the top heating equation in Eq. (5) uses only the observations for which heat is included in rent ($I = 1$), and the bottom heating equation in Eq. (5) uses only the observations where heat is not included ($I = 0$). The increase in temperature resulting from heat being included in rent is $T_i^{\mathrm{I}} - T_i^{\mathrm{N}}$ using predicted values of T_i^{I} and T_i^{N} from Eq. (5).

Table 3 gives the coefficients from the first-stage probit, Eq. (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 Eq. (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

[16] This type of model is described by Heckman (1976).

[17] 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 Eq. (4) combines the decisions of both landlords and tenants.

[18] See, for example, Maddala (1983), Chapter 9.

Table 3
Selection model first stage probit (dependent variable = heat included in rent)

Variable	Coefficient (S.E.)	Marginal effect (S.E.)
Number of units in building[a]	0.0052* (0.0005)	0.0015 (0.0001)
AC uses same fuel as furnace[a]	−0.1164 (0.1471)	−0.0330 (0.0407)
Cooling-degree-days (CDD)[a]	0.0130* (0.0060)	0.0038 (0.0017)
CDD × AC uses same fuel as heat[a]	−0.0068 (0.0059)	−0.0020 (0.0017)
New England[a]	0.269* (0.103)	0.084 (0.035)
West North Central[a]	−0.296* (0.097)	−0.077 (0.022)
East South Central[a]	−0.296* (0.097)	−0.067 (0.028)
West South Central[a]	−0.253* (0.119)	−0.114 (0.024)
Mid-Atlantic[a]	0.435* (0.091)	0.141 (0.032)
South Atlantic[a]	0.083 (0.101)	0.025 (0.031)
Mountain[a]	−0.236* (0.099)	−0.063 (0.024)
Pacific[a]	−0.513* (0.118)	−0.128 (0.025)
Urban	0.230* (0.048)	0.066 (0.014)
Price of heat (normalized)	−0.126* (0.029)	−0.036 (0.009)
Heating degree days	0.0087* (0.0025)	0.0025 (0.0007)
Heated floor space	−0.0415* (0.0050)	−0.0120 (0.0014)
Building well insulated	0.220* (0.054)	0.066 (0.017)
Building poorly insulated	−0.299* (0.055)	−0.082 (0.014)
Number of windows	−0.053* (0.005)	−0.015 (0.002)
Electric furnace	−0.928* (0.096)	−0.235 (0.021)
Fuel oil furnace	0.375* (0.085)	0.121 (0.030)

Table 3 (*Continued*)

Variable	Coefficient (S.E.)	Marginal effect (S.E.)
LPG furnace	−0.443* (0.158)	−0.106 (0.030)
Building age	0.0049* (0.0013)	0.0014 (0.0004)
Household income ($1000 US)	−0.00609* (0.00129)	−0.00177 (0.00037)
Number of persons in household	−0.0145 (0.0240)	−0.0042 (0.0070)
Infant in household	−0.257* (0.122)	−0.067 (0.028)
Child aged 1–12 years in house	−0.082 (0.069)	−0.023 (0.019)
Person over 65 years in household	0.219* (0.064)	0.067 (0.021)
Intercept	−0.181 (0.215)	
Number of observations	4913	

Standard errors are reported in parentheses.
[a] Exclusion restriction.
* Statistically significant at 5%.

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, evidence for both landlord and tenant-side explanations can be seen in Table 3. On the landlord side, variables associated with higher metering costs, such as building age and heating costs, are positively associated with heat being included in rent. On the other hand, heating-degree-days has a positive coefficient, supporting the signaling-cost landlord-side story. On the tenant side, poorer tenants and tenants over 65 years are more likely to opt for heat included apartments. Of the variables included in this selection equation but excluded from second stage, the regional indicators, building size, and cooling-degree-days are statistically significant. Although the dummy for air conditioning using the same fuel as heat has the expected large negative coefficient, it is statistically insignificant.[19]

[19] 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 building age to the exclusion restrictions by dropping it from the second stage. The key results that follow in Table 4 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 0 could be rejected in all cases except for the test with the air conditioning variables.

Table 4 shows the results for the second-stage regressions. Consistent with our intuition, fuel price has 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 5 we compare the predicted values from Tables 2 and 4. The top panel displays the difference between predicted temperature settings when somebody is home. Column (2) 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. Column (3) uses only metered apartments, making out-of-sample predictions for temperature settings in those apartments if heat were included. And column (1) 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 °F. The middle panel of the table shows that same difference when nobody is home, about 2 °F.[20] The estimated effects are each smaller in magnitude than the OLS estimates from Table 2 (0.74 and 2.82 °F, respectively), suggesting that tenants who prefer warmer temperatures self-select into heat-included apartments.

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 translation 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. We regressed the log heating fuel expenditures on log temperature when home, log temperature when gone, and apartment characteristics, using only the RECS observations where heat is *not* included in rent.[21] Unsurprisingly, higher temperature settings correspond to higher fuel use. We then used the coefficients to predict fuel expenditures for each apartment, both for the case when the landlord pays for heating and the out-of-sample cases when the tenant pays. The bottom panel of Table 5 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 1%.[22]

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 (CREST), home heating costs fall by 2% for every degree the temperature is

[20] The differences between heat-included and heat-not-included thermostat settings are statistically significantly different from 0 when the tenants are away, but not when they are home.

[21] Because the metered apartments are less well insulated, this procedure overstates the fuel cost per degree of temperature for heat-included apartments. Detailed results are available separately from the authors.

[22] Note that tenants in heat-included apartments may opt to crank up the heat and open the windows. In that case, our estimate of the additional fuel costs will be an underestimate. In the end, we are going to show that the hedonic rent differences between heat-included and metered apartments is smaller than even these underestimated fuel cost differences.

Table 4
Selection model final stage regressions

Variable	Winter temperature (°F) when home		Winter temperature (°F) when gone	
	Heat not included	Heat included	Heat not included	Heat included
ln(heating fuel price)	−0.381* (0.084)	−0.167 (0.122)	−0.375* (0.131)	−0.114 (0.152)
Heating-degree-days	−0.045* (0.004)	−0.020* (0.007)	−0.051* (0.007)	−0.050* (0.010)
Heated floor space	0.016 (0.016)	0.059** (0.034)	0.085* (0.024)	0.121* (0.043)
Building well insulated	−0.341** (0.198)	−0.205 (0.305)	−0.786* (0.309)	0.147 (0.389)
Building poorly insulated	0.022 (0.183)	0.160 (0.345)	−0.467 (0.290)	0.313 (0.438)
Number of windows	−0.002 (0.018)	0.030 (0.037)	−0.009 (0.028)	0.059 (0.047)
Building age	−0.0063 (0.0044)	−0.0190* (0.0076)	−0.0129** (0.0069)	0.0012 (0.0096)
Electric furnace	−0.186 (0.227)	0.658 (0.562)	0.929* (0.359)	1.08 (0.76)
Fuel oil furnace	−1.22* (0.36)	−1.91* (0.41)	−1.28* (0.52)	−1.82* (0.51)
LPG furnace	−0.416 (0.431)	−0.74 (1.25)	−0.142 (0.669)	0.40 (1.56)
ln(household income in $1000 US)	−0.084 (0.093)	0.199 (0.148)	0.310* (0.147)	0.289 (0.188)
Number of persons in household	0.216* (0.073)	−0.151 (0.149)	0.353* (0.119)	0.189 (0.191)
Infant in household	0.817* (0.348)	0.356 (0.816)	0.992** (0.557)	1.75** (1.02)
Children aged 1–12 years in household	0.269 (0.214)	1.05* (0.43)	−0.077 (0.338)	−0.64 (0.55)
Persons over 65 years in household	1.27* (0.25)	1.06* (0.35)	2.04* (0.40)	0.96* (0.44)
Selectivity regressor (λ)	−1.79* (0.45)	−1.11* (0.52)	−2.26* (0.68)	−2.80* (0.68)
Intercept	70.9* (0.49)	72.2* (0.70)	65.1* (0.79)	70.7* (0.91)
R^2	0.068	0.048	0.059	0.050
Observations	3549	1364	2716	1213
Pagan and Vella (1989) test for normality	$F(3, 3529) = 1.08$ Probability > $F = 0.36$	$F(3, 1345) = 3.46$ Probability > $F = 0.02$	$F(3, 2696) = 1.80$ Probability > $F = 0.14$	$F(3, 1193) = 1.37$ Probability > $F = 0.25$

Standard errors are reported in parentheses. The Pagan and Vella (1989, p. S51) test fails to reject the hypothesis that the error terms in the two-step estimator are distributed normally in every case but column (2).

* Statistically significant at 5%.

** Statistically significant at 10%.

Table 5
Average predicted winter indoor temperature (°F)

Variable	All apartments (column (1))		Apartments with heat included (column (2))		Apartments with heat not included (column (3))	
	Mean	S.E.	Mean	S.E.	Mean	S.E.
Mean predicted temperature (°F) when home						
Heat included	70.74[a]	0.56	70.65	0.49	70.77[b]	0.59
Heat not included	70.29[a]	0.31	70.49[b]	0.37	70.21	0.29
Difference (temperature change)	0.45		0.17		0.56	
OLS estimated difference	0.75					
Mean predicted temperature (°F) when gone						
Heat included	67.99[a]	0.73	68.53	0.64	67.75[b]	0.77
Heat not included	66.19[a]	0.49	66.28[b]	0.57	65.15	0.47
Difference (temperature change)	1.80		2.25		1.60	
OLS estimated difference	2.74					
Predicted percent increase in fuel expenditures from including heat in rent[c]						
Selection adjusted estimate	0.705		0.574		0.752	
OLS estimate	1.12					

Note: For each observation in the data set, we obtained a predicted value for each case (heat included or not), using the sampling weights in the RECS. In the OLS specification, the dummy variable was set to either one or zero, depending on the case. In the selection model, the coefficients from the heat included case were used for the prediction in the "heat included" rows, and the coefficients from the heat not included case were used in the "heat not included" rows. Column (2) uses only the apartments where the entire data set, making in-sample predictions for apartments where heat is included in the rent, and out-of sample predictions for metered apartments. Column (3) uses only the metered apartments, making out-of-sample predictions for apartments where rent includes heat. Column (1) uses all apartments, making some out-of-sample predictions in each case.

[a] Partly out-of-sample prediction.

[b] Out-of-sample prediction.

[c] Applies predicted fuel expenditures from a regression of log(annual fuel expenditures) on winter temperature when home and away, and apartment characteristics. (Available separately from the authors.)

lowered.[23] Additionally, the US Department of Energy claims that for each degree thermostats are lowered over an 8 h period, heating costs fall 1%.[24] Based on these figures, we estimate that energy costs are 1.7% higher in heat-included apartments than they would be if these same apartments, with the same tenants, were individually metered.[25]

As we suggested in the Section 1, 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

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

[24] US Department of Energy, Energy Efficiency and Renewable Energy Network (http://www.eren.doe.gov/erec/factsheets/thermo.html).

[25] The average temperature of heat-included apartments is 70.7 °F. We estimate that such apartments are 0.46° warmer when the tenants are home, and 1.87° warmer when tenants are gone. Using the CREST estimate for the savings, and assuming tenants are gone for 8 h each day, this translates to a 2.8% higher energy cost in apartments where heat is included in rent.

Table 6
Selected means for AHS apartments with and without heat-included in rent means weighted to represent all US apartments in 1985, 1987, 1989, 1991, and 1993

Variable	Apartments with heat included		Apartments with heat not included	
	Mean	S.D.	Mean	S.D.
Monthly rent (1993 $US)	533	213	530	219
Air conditioning in rent*	0.24	0.42	0.005	0.070
Number of bedrooms*	1.43	0.79	1.90	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	17
Central city*	0.61	0.49	0.58	0.49
Located in cold climate*	0.50	0.50	0.28	0.45
Observations	6780		24513	

Source: American Housing Survey, 1985, 1987, 1989, 1991, 1993, 1995, and 1997.
* Difference of means (or proportions) statistically significant at 5%.

explanations, we next examine data on the rent differences between utility-included and metered apartments.

4. 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 1985–1997 national core samples, limited to apartments not subject to rent control and for which metropolitan area is identified.[26] The sample contains 31,293 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 6 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.[27]

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

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

[27] 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 (details available separately). However, building size, age, and region do not explain all of the variation in metering arrangements. The RECS and the AHS differ substantially, as can be seen by comparing Tables 2 and 6. The principal difference is that the AHS contains only apartments in metropolitan areas (SMSAs).

outlined by Rosen (1974). We estimate

$$\text{Rent}_i = \beta_0 + \beta_1' X_i + I_i(\beta_2 + \beta_3' X_i) + \beta_4' Z_i + \varepsilon_i \quad (6)$$

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.

Table 7 presents two different specifications of Eq. (6): 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. At the bottom of Table 7, we calculate the average premium for heat-included rents. 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 7, calculated at the average values in the data, predict that including heat in utilities raises rent by about 4%, or US$ 17 per month.

Because hedonic models are typically estimated for individual cities, rather than a national sample, we have also estimated models similar to Table 7 separately for the 14 metropolitan areas most heavily represented in the AHS.[28] 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 8 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 7 provides the implicit price for including utilities, and the RECS-based analysis in Table 4 provides the increased energy use when heat is included in rent.

The top line of Table 8 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

[28] Results available separately from the authors.

Table 7
Hedonic rent model dependent variable = monthly rent

Variable	Means	OLS	Log–linear
Heat included in rent	0.22	−14.09 (13.29)	−0.030 (0.032)
Heat included × cold climate	0.11	13.28* (4.33)	0.023* (0.010)
Heat included × building age	8.6	−0.006 (0.192)	−0.00004 (0.00046)
Heat included × rooms	0.79	6.40* (2.80)	0.015* (0.007)
Window AC included in rent	0.021	−8.83 (12.12)	−0.008 (0.029)
Window AC included × number of AC units	0.025	11.15 (12.87)	−0.007 (0.031)
Window AC included × units × hot climate	0.0027	29.8* (15.0)	0.049 (0.036)
Window AC included × units × building age	1.10	0.311 (0.205)	0.00072 (0.00049)
Central AC included in rent	0.035	133.0* (18.5)	0.132* (0.044)
Central AC included × hot climate	0.015	−12.90 (9.88)	0.039 (0.024)
Central AC included × age	0.86	1.19* (0.30)	−0.0013 (0.0007)
Central AC included × rooms	0.13	−10.98* (4.20)	−0.013 (0.010)
Hot water included in rent	0.21	11.5 (10.0)	0.024 (0.024)
Hot water included × age	8.3	−0.211 (0.192)	−0.0001 (0.0005)
Hot water included × bedrooms	0.31	−1.00 (4.02)	−0.0090 (0.0096)
Cold water included in rent	0.82	−22.5* (6.4)	−0.010 (0.015)
Cold water included × bedrooms	1.35	10.2* (2.7)	0.011 (0.006)
Bedrooms	1.80	35.7* (2.4)	0.078* (0.006)
Bathrooms	1.24	68.7* (2.4)	0.104* (0.006)
Other rooms	1.12	10.8* (1.3)	0.023* (0.003)

Table 7 (*Continued*)

Variable	Means	OLS	Log–linear
Floor of apartment building	0.92	4.28*	0.006*
		(0.83)	(0.002)
Single family home	0.14	44.4*	0.050*
		(3.5)	(0.008)
Single family home (attached)	0.061	13.1*	0.00008
		(3.8)	(0.00902)
Building age	32.4	−2.63*	−0.0048*
		(0.17)	(0.0004)
Building age squared	1580	0.023*	0.000035*
		(0.002)	(0.000005)
Near a park	0.16	−4.18	−0.012*
		(2.38)	(0.006)
Near a body of water	0.040	28.8*	0.052*
		(4.5)	(0.011)
Near abandoned buildings	0.048	−49.0*	−0.121*
		(4.1)	(0.010)
Bars on nearby windows	0.15	−22.0*	−0.046*
		(2.7)	(0.006)
Exterior in poor condition	0.17	−4.19	−0.0112*
		(2.4)	(0.0057)
Walls or floor in poor condition	0.11	−18.3*	−0.039*
		(2.8)	(0.007)
Water leaks in	0.12	−0.33	−0.0022
		(2.58)	(0.0062)
Number of units in building	13.5	0.451*	0.00088
		(0.063)	(0.00015)
Number of stories in building	2.66	7.19*	0.013*
		(1.05)	(0.003)
Washer/dryer	0.29	26.5*	0.055*
		(2.3)	(0.005)
Dishwasher	0.43	62.7*	0.123*
		(2.4)	(0.006)
Free garage parking	0.33	48.4*	0.110*
		(3.1)	(0.007)
Free off street parking	0.47	16.3*	0.047*
		(2.8)	(0.007)
Porch or patio	0.61	3.12*	0.0079
		(1.94)	(0.0046)
Fireplace	0.14	57.6*	0.092*
		(2.8)	(0.007)

Table 7 (*Continued*)

Variable	Means	OLS	Log–linear
Central AC	0.38	40.9* (3.1)	0.113* (0.008)
Window AC	0.30	8.1* (2.4)	0.021* (0.006)
Central city	0.56	−12.6* (2.1)	−0.034* (0.005)
Dummies for years (7) and metropolitan areas (148)	Not reported		
Predicted rent premium for heat included, based on averages for climate, age, and rooms		+17.08	+0.041
R^2		0.551	0.448
Observations		31293	31293

Heteroskedasticity-consistent standard errors in parentheses. Includes dummy variables for 148 metropolitan areas and year of survey.

* Statistically significant at 5%.

Table 8
Average monthly cost of utilities in metered apartments vs. implicit hedonic price of free utilities[a]

Apartment type	Utility cost	Cold climate		Moderate climate		Hot climate	
		Mean (US$)	S.E.	Mean (US$)	S.E.	Mean (US$)	S.E.
One-bedroom apartments	Average cost of utilities in metered apartments	68	1.0	56	0.7	65	0.8
	Estimated cost of utilities in inclusive apartments[b]	69		57		66	
	Estimated hedonic price	74	11.1	61	9.3	59	10.4
Two-bedroom apartments	Average cost of utilities in metered apartments	91	0.9	74	0.6	92	1.0
	Estimated cost of utilities in inclusive apartments[b]	93		75		94	
	Estimated hedonic price	79	11.3	66	9.6	65	10.8
Three-bedroom apartments	Average cost of utilities in metered apartments	123	1.7	110	1.4	126	1.9
	Estimated cost of utilities in inclusive apartments[b]	126		112		128	
	Estimated hedonic price	85	11.6	71	10.2	70	11.3
Four+ bedroom apartments	Average cost of utilities in metered apartments	140	4.1	139	3.8	151	6.2
	Estimated cost of utilities in inclusive apartments[b]	143		142		154	
	Estimated hedonic price	90	13.2	77	9.9	76	11.1

[a] Utility costs and hedonic prices include electricity, natural gas, and heating oil, but exclude water, sewer, and trash.

[b] Assuming a 2% increase in consumption, as estimated for heating using the RECS, and footnote 23.

average utility bill inflated by 2%, a rough estimate of the increase in usage from the RECS survey, and the engineering estimates in footnote 23. The third line presents the hedonic price of having all utilities included in rent, calculated from Table 7.

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% increase, and for three- and four-bedroom apartments the differences are statistically significant. 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 in master-metering, or because their energy efficiency investments cannot otherwise be passed through to uncertain renters.

5. Conclusion

The intuition outlined in Fig. 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. So, while we cannot rule out the presence of tenant demand for heat-included arrangements, some of the explanation for the persistence of heat-included rental contracts must come from landlord-side explanations: metering costs, economies of scale, or signaling costs.

However, Fig. 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.

Policies that encourage the inclusion of energy costs in base rents would be appropriate if having landlords responsible for utilities led to greater *efficiency*, via investments in energy-efficient construction. However, some 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 is 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. 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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Appendix A. Table A.1

Percentage of apartments with heat included in the rent by age, census region, and building size

Region	Built before 1950			Built 1950–1979			Built after 1979		
	Small building	Medium-sized building	Large building	Small building	Medium-sized building	Large building	Small building	Medium-sized building	Large building
Northeast	40.4	89.7	98.7	52.0	63.8	85.1	7.0	18.0	45.8
Midwest	29.6	72.7	94.4[a]	28.7	62.9	86.9	8.1	40.5	58.3
South	14.5	75.0	40.0[a]	18.6	27.6	73.5	8.8	3.1	10.7
West	20.1	33.9	12.5[a]	15.9	33.2	32.2	7.3	1.8	8.3

Source: Energy Information Administration, 1987, 1990, 1993 and 1997 Residential Energy Consumption Survey. Small: eight or fewer apartments; medium: 9–29 apartments; and large: 30+ apartments.

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

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