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**Searching for Basic Consumption
Patterns**
Is the Engel Elasticity of Housing
Unity?

Abstract:

We estimate Engel elasticities of housing expenditures for each independent cross-section of the Consumer Expenditure Surveys in the period 1986-1998, and find that the elasticity remains close to unity for all years. Its mean over the period is 1.02. Engel and demographic effects for housing are estimated in an errors-in-variables two stage least square regression model using random samples of Norwegian households. We find that given demographic composition household demand for housing seems to increase proportionately with total consumption, in contrast to other categories such as food and transportation. The empirical regularity between housing expenditures and total consumption yields forecasting potential and may represent a basic pattern of consumption.

Keywords: Budget share, consumption pattern, demand for housing, Engel elasticity

JEL classification: D12, R21

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1. Introduction

Household budget shares for expenditures on certain commodities usually change over time. Segal (2001) reports that food's budget share has fallen dramatically in America over the century from 50 percent for poor households and more than 30 per cent from affluent households in 1901 to between 10 and 15 per cent in 1999, depending on whether eating out is excluded or included, a finding that reaffirms Engel's (1895) Law for food.¹ Transportation's budget share, on the other hand, has increased from about 2 per cent to more than 20. However, Segal finds that while American households devoted on average 25 per cent of their budgets to housing in 1901; they continue to spend 27 per cent of the budget on housing today. This remarkable stability of the budget share of housing expenditures hints at an Engel elasticity of magnitude one. This article tests the unity hypothesis on data from Norwegian Consumer Expenditure Surveys in the period 1986-1998 by estimating the demand for housing for each of the 13 independent cross-sections. We find that a fairly stable pattern emerges. The Engel elasticity of housing in Norway is close to unity over the period and the budget share remains close to a quarter, a finding that may re-ignite the search for a regularities resembling Engel's Law.

It would be useful to detect such a pattern for housing expenditures since urban planners and policymakers need to forecast the demand for housing. Knowing that the Engel or income elasticity is stable over time would be convenient. Moreover, an elasticity of unity magnitude is of academic interest since it hints at an intriguing underlying quality of the good. The resolve of why there might be proportionality between housing expenditures and total expenditures might lie in the specific bundling of commodities housing represents. While the demand for foodstuff is primarily connected to the need for calories, and thus clearly is a necessity, and while the demand for transportation is obviously more of a luxury since relocation is less of a priority, the demand for housing combines necessary elements with aspects of luxury. Shelter is necessary, but status is a luxury, and housing offers both. Here, however, we leave speculation aside, and focus attention on sketching an approximate empirical pattern of the Engel curve for housing in Norway. In particular, this article is concerned with establishing whether there is a time trend of such elasticities. While studies of the demand for housing often employ one cross-section in estimating parameter *levels*, and we aim to supplement the literature with repeatedly employing the same model on independent data from different years and thus obtain *time trends of levels*.

¹ Engel's Law is perhaps the most robust empirical pattern in Economics. It has been confirmed for different societies at different times, and has been used e.g. to derive equivalence scales and recently to assess CPI bias.

The estimation of Engel elasticities for several years poses two main sets of problems. First, there are strict requirements that must be brought to the data. The data sets must be comparable, span a substantial period, be of high quality, exhaustively cover expenditure opportunities, and preferably be random samples. Second, the estimation procedure must be convincing. We demand it to be adequate for uncovering the underlying consumption pattern, of such nature that it summarizes that pattern in a few, interpretable parameters, that it be based in consumer theory, and that it handles measurement errors. We choose to use the Norwegian Consumer Expenditure Surveys (CES) to meet the first set of requirements, and we employ a linear errors-in-variables two-stage-least-square model with income sources as instrument variables to handle the second set of demands. Our approach entails using a parsimonious linear model in which latent housing consumption is separated from observable housing expenditures by a measurement error. To control for household size and composition, we include the variables number of children and number of adults in the household. We use income as instrumental variables. Whatever the weaknesses of this approach, let us present some distinct advantages: It easily allows modeling of errors, it offers good approximation to an underlying, true, non-linear relationship, it allows intuitive interpretations, it controls for the most important variables connected to how well-off a household is, it is computationally simple, and it is firmly based in established consumer theory

There is a large literature on and wide interest in housing elasticities. Earlier, estimates of Engel or income elasticities of housing tended to be found to lie below unity. Examples are Leser (1961) and Lee (1964). Such results have come with the corresponding interpretation that housing be classified as a necessity. While some recent studies have found income elasticities below unity; see e.g. Hansen et al. (1996, 1998); other recent studies have challenged the findings of elasticity estimates clearly below unity. Brusewitz (1998) reports an income elasticity of 0.98 and Meen (1996)² finds long-run income elasticity for housing as high as 1.25. Cheshire and Sheppard (1998) estimate the income elasticities of the demand for housing attributes such as square feet, neighborhood, and floors and their estimates range from 1.6 to 3.755 (p. 369). Thus, some housing attributes clearly classify as luxuries. This article finds that the Engel elasticity for housing remains close to unity for the period 1986-1998. Ultimately, it is important to distinguish between what expenditures are housing expenditures and what are not. The different results cited above may largely be due to what is defined as housing expenditures. This article uses the broadest, most conventional definition of housing expenditures that is one of nine main categories of consumer expenditures.

² Reported by Cheshire and Sheppard (1998).

Let us state in advance where we are headed. The next section presents the errors-in-variables model of housing consumption and outlines the estimation procedure. Section 3 tabulates our findings. Section 4 discusses suggestions for future research. Section 5 concludes. In the Appendix, we describe the data and give some estimation details.

2. Theory and Estimation

Let us outline the consumer theory we use. It is closely related to a more involved set-up put forward in Aasness et al. (1993). A household first decides how to allocate its available time between labor and leisure, and from the time devoted to work it obtains through a monetary compensation the available budget for purchases. Adhering to the budget constraint, the household then chooses how much to consume of each of nine main commodity categories, including housing. Let η_h be the resulting unobservable consumption of housing, or demand for housing, in household h , and let ξ_h be the latent total consumption in household h . To make errors tractable, let housing consumption and total consumption be linearly related as in equation (1):

$$(1) \quad \eta_h = \alpha + \beta \xi_h + \gamma_h C_h + \gamma_a A_h + u_h, \quad h \in H,$$

in which C_h represents the number of children in household h , and A_h represents the number of adults in household h . The coefficient β is the Engel coefficient of housing and the coefficient vector γ captures the effects of changes in household size and demographic composition. The set H consists of all households. Notice that both housing consumption, η , and total consumption, ξ , are latent (unobservable) variables. The error term u_h is modeled as a conditionally mean-zero, constant variance, zero-covariance error conditioned on the regressors, and it represents differences between housing consumption and the structural components suggested in equation (1). The purchase expenditure of housing in household h , y_h , is separated from the housing consumption in the same household by a measurement error, ε_h , that is modeled as independent of u_h . This measurement error has conditional expectation zero, has constant variance, and there is zero covariance between measurement error terms of household h and household k , $h \neq k$:

$$(2) \quad y_h = \eta_h + \varepsilon_h, \quad h \in H.$$

$$(3) \quad E(\varepsilon_h | \eta_h) = 0, \quad h \in H,$$

$$(4) \quad E(\varepsilon_h \varepsilon_k | \eta_h, \eta_k) = \sigma_\varepsilon^2, h = k, \quad \text{and } = 0, \text{ otherwise, } h \in H.$$

In this article, housing expenditures, y_h , is shorthand for expenditures on the main category of housing expenditures, called "Housing, fuel, and power". This category includes interest payments on housing loans, housing insurance, charges and rents, maintenance, electricity charges and other fuel and power payments. Again, it is one of nine main categories of consumption, conventionally used by statistical agencies, that cover every way a household may consume; see the Appendix for details. Equations (2)-(4) may be extended to cover all commodity categories in a similar set-up of manifest expenditures and latent consumption, with the additional model assumption of zero covariance between measurement errors of different commodities given household. This implies that there is a difference between observable total purchase expenditure, x , and unobservable total consumption, ξ , consisting of the sum of measurement errors for each category. Thus, total purchase expenditure in a household, x_h , equals the sum of commodity consumption and errors: $\sum_i \eta_{ih} + \sum_i \varepsilon_{ih}$, which equals latent total consumption and the sum of errors: $\xi_h + \sum_i \varepsilon_{ih}$, in which the subscript i refers to commodity category i , $i \in \{1, 2, \dots, 9\}$. This errors-in-variable model gives rise to the two-stage-least-squares approach to estimating the Engel coefficient, β . In consequence, the observable relationship we estimate is the one between observable purchase expenditures on housing expenditures and observable total purchase expenditure, number of children, and number of adults:

$$(5) \quad y_h = \alpha + \beta x_h + \gamma_c c_h + \gamma_a a_h + \omega_h, \quad h \in H,$$

in which the error term ω_h is a collective term of u and ε , conditionally zero-mean, constant variance, and with zero covariance between households. In equation (5), the regressor total purchase expenditure, x_h , is correlated with the collective error term ω_h , so, as is well known, ordinary least squares is not an adequate estimation procedure. In order to obtain estimates on the coefficients, we use in stead the two-stage-least-square method in which we first regress the regressors total purchase expenditure, x , number of children, c , and number of adults, a , onto a space spanned by income variables, number of children, and number of adults. Then in the next stage we regress housing expenditures on the fitted values of the first stage of regressions. In other words, the vector of coefficient estimates is given by:

$$(6) \quad \hat{\beta}^{2SLS} = (\hat{Z}^T \hat{Z})^{-1} \hat{Z}^T Y,$$

in which Y represents the vector of housing expenditures, \hat{Z} is the projection of the right-hand-side variables of equation (5) onto the instrument space, T denotes the transpose, and -1 the inverse. We also report the estimated standard errors derived from computing the variance of the parameter

estimates, given by $\hat{\sigma}^2 (\hat{Z}' \hat{Z})^{-1}$, in which the error variance σ^2 is estimated using the residual sum of squares.

The coefficient estimates of equation (6) are both interesting and interpretable. However, the interpretation is based on monetary units. In order to assist understanding, we also make use of and compute a unitless statistic, the elasticity. We define the Engel elasticity³ by:

$$(7) \quad E_h = \frac{\beta}{y_h/x_h}, \quad h \in H.$$

The Engel elasticity of housing is the relationship between increases in total consumption and increases in housing consumption. The magnitude of the elasticity represents the percentage increase in housing consumption we observe when total consumption increases by 1 per cent.

3. Empirical Results

The mean estimated Engel elasticity of housing expenditures in Norway over the period 1986-1998 is 1.02, remarkably close to unity. The corresponding budget share is close to a quarter over the period, thus in correspondence with Segal's (2001) American findings. Evidence shown below indicates that the Engel curves for each independent cross-section is quite stable, and the underlying human needs and preferences that determine the consumption pattern warrant closer scrutiny and further exploration.

In Table 1, we report the estimation results. We notice that the Engel coefficient β varies, but not more than to be expected in micro data. In fact, its mean is 0.246 and the deviations from it for each year are rather small. The estimated t-values of the Engel coefficient are large and statistically significant. In fact, the t-values are as large as 16.3 for 1988 and no smaller than 4.9, the t-value of the 1995-estimate. The interpretation of a mean Engel coefficient at 0.246 is that 24.6 per cent of each additional Norwegian krone (NOK) of consumption goes towards housing. In other words, on the margin about a quarter of consumption is devoted to housing. Given total consumption, an extra child in the household is seen to increase housing consumption, but an extra adult in the household reduces housing consumption. The mean effects are, respectively, 1 251 NOK and -8 641 NOK, approximately 170 and -1180 USD.

³ The expression in the denominator is the average budget share. An alternative expression for the budget share is the average of each household's individual budget share.

An interesting pattern is tabulated in Table 2. The estimated Engel elasticity fluctuates around unity, and the mean over the 13 years spanning the period 1986-1998 is 1.02. The corresponding standard deviation is 0.181, indicating, as usual, that estimates from micro data varies over cross-sections. Thus, a confidence interval ranging from/to the estimate minus/plus 2 standard deviations will certainly include unity, but it will also span a long interval. Our main interest and emphasis, however, is on the mean elasticity over the period. The interpretation of the elasticity magnitude is that an increase in total consumption of 1 per cent is seen to entail an increase in the demand for housing of 1.02 per cent. The budget share is quite stable and its mean is 0.24, compellingly similar to the finding Segal reported for American households.

Interestingly, there appears to be a downward sloping tendency in the estimated Engel elasticities. The early estimates tend to be above unity, and later estimates tend to be below unity. This pattern may be related to the business cycle, which saw a trough in 1992 and an expansion thereafter. We would be tempted, on the basis of our results, to hypothesize that the pattern of households' housing consumption is such that the luxury component of housing becomes relatively more dominant along with economic expansions while the necessity part becomes dominant when the economy contracts. Thus, since the Engel elasticity is a compact summary of empirical patterns, it would tend to move procyclically.

Table 1: Estimates of Engel Curve Parameters 1986-1998^{a,b} of Housing, Fuel, and Power (t-values)

Year	Intercept	Engel Coefficient	Child Coefficient	Adult Coefficient
1986	13 390 (7.8)	0.217 (15.6)	2 217 (2.9)	-7 591 (-8.2)
1987	11 230 (4.8)	0.267 (13.4)	1 972(1.9)	-9 612 (-7.1)
1988	10 801 (3.9)	0.330 (16.3)	483 (0.4)	-11 994 (-8.1)
1989	6 377 (2.4)	0.324 (16.1)	-43 (-0.0)	-8 580 (-5.3)
1990	9 543 (3.5)	0.303 (14.5)	2 037 (1.7)	-9 106 (-5.8)
1991	17 558 (6.2)	0.265 (13.8)	1 322 (1.0)	-10 171 (-6.3)
1992	13 941 (3.6)	0.259 (12.1)	5 083 (3.8)	-8 659 (-4.6)
1993	12 945 (3.3)	0.297 (12.3)	1 082 (0.7)	-12 729 (-6.3)
1994	23 230 (6.2)	0.243 (10.2)	695 (0.6)	-12 590 (-6.5)
1995	19 534 (3.8)	0.185 (4.9)	1 001 (0.6)	-6 836 (-2.9)
1996	25 410 (7.5)	0.156 (9.7)	1 760 (1.8)	-6 304 (-4.3)
1997	19 401 (3.8)	0.160 (6.3)	1 707 (1.0)	-3 893 (-1.7)
1998	10 705 (2.3)	0.196 (9.3)	-3 058 (-2.0)	-4 271 (-2.0)
Mean	14 928	0.246	1 251	-8 641

Sources: Consumer Expenditure Surveys and Income and Tax Registers. Detailed documentation is available at request from the author. Notes: ^aFor the period 1986-1992, running expenditures are used. For the period 1993-1998 we used expenditures deflated to 1998-prices. ^bFor the period 1993-1998 income after tax from the Income register was used. The income register was not available for the period before 1993. For the period 1986-1992 net income and gross income from tax registers were used instead as instrumental variables.

Table 2: Engel Elasticity for Housing, Fuel, and Power 1986-1998

Year	Engel Elasticity ^a	Budget Share ^b
1986	1.02	0.213
1987	1.16	0.229
1988	1.29	0.255
1989	1.23	0.263
1990	1.15	0.263
1991	1.03	0.257
1992	0.99	0.262
1993	1,18	0,251
1994	0,99	0,246
1995	0,84	0,220
1996	0,71	0,220
1997	0,74	0,215
1998	0,96	0,205
Mean	1.022	0.238
Standard Dev.	0.181	0.022

Sources: Consumer Expenditure Surveys and Income and Tax Registers. Detailed documentation is available at request from the author. Notes: ^aThe Engel elasticity is computed by dividing the estimated Engel coefficient on the estimated budget share. ^bThe budget share is computed by use of non-response weights; an explanation of the scheme for the non-response sampling probability correction may be obtained from the author.

4. Concluding Remarks and Policy Implications

We find that the Engel elasticity of housing, fuel, and power fluctuates around unity for the period 1986-1998 in Norway. Establishing a numerical value of the Engel elasticity may facilitate policymakers with a tool they can use when constructing policy. This article finds that increases in total consumption are observed to correspond to proportionate increases in household spending on housing. Exactly why this is so is a question that has been somewhat neglected in the literature. A neglect that is altogether surprising, given Houthakker's (1961) note four decades ago: "... no explanation [to empirical regularities of elasticities] seems to have been attempted."

We know that Marshall suggested that housing was an opportunity for households to obtain social position in addition to shelter.⁴ In this combination lies the challenge to policymakers. Policymakers often believe that their mandate includes ensuring that everybody has access to necessities such as shelter. At the same time they may maintain that it is outside their mandate to furnish people with means to compete over status. Since housing is a bundle commodity containing both necessary and luxury sub-commodities it becomes difficult for policymakers to identify which is which when they tailor policies. In this article, we do not resolve these issues. But we present a unity estimate for the large commodity category housing, fuel, and power that seems to hold steady over time. Thus, it may allow forecasts. On the basis of the results, it is reasonable to expect expenditures on housing to move parallel with total consumption and permanent income. From this we may deduce that the demand for housing will increase more than the demand for food, but less than the demand for transportation. In fact, it will probably increase as much as total consumption increases. If the supply side of housing is sluggish, we may expect demand to keep pace with income and put pressure on prices. To speculate, in consumer preference for housing lies one source that causes the relation between the business cycle and housing prices.

This is a rich field for exploration, and extensions may be made along dimensions such as functional form and the number of variables. Of course, earlier authors have used different models and looked at other aspects of the demand for housing. This article has suppressed aggregation issues. Certainly, the commodity category housing, fuel, and power is a large one. That category commands a quarter of all expenditures. A more finely-grid and disaggregated system allows more detailed results and discussions. Nevertheless, the present results are intriguing, especially if the elasticity and budget share display persistence at unity and a quarter. Then we do find that one commodity group, namely

⁴ Lee (1961) informs us of this; see Alfred Marshall (1952): *Principles of Economics*, 8th ed., London: Macmillan.

housing, seems to move in tandem with income. This empirical observation of a consumption pattern may peek our curiosity.

References

- Aasness, J., E. Biørn, and T. Skjerpen (1993): Engel Functions, Panel Data, and Latent Variables, *Econometrica*, **61**: 6, pp. 1395-1422.
- Aasness, J. and E. Røed Larsen (2002): Distributional and Environmental Effects of Taxes on Transportation, *Discussion Paper 321*, Oslo: Statistics Norway.
- Brusewitz, U. H. (1998): Self-Selectivity and Kinked Budget Constraints: The Demand for Housing in Sweden, *Journal of Housing Economics*, **7**, pp. 243-273.
- Cheshire, P. and S. Sheppard (1998): Estimating the Demand for Housing, Land, and Neighborhood Characteristics, *Oxford Bulletin of Economics and Statistics*, **60**: 3, pp. 357-377.
- Engel, E. (1895): Die Lebenskosten Belgischer Arbeiter-Familien früher und jetzt, *International Statistical Institute Bulletin*, **9**, 1-74.
- Hansen, J. L., J. P. Formby, and W. J. Smith (1996): The Income Elasticity of Demand for Housing: Evidence from Concentration Curves, *Journal of Urban Economics*, **39**, pp. 173-192.
- Hansen, J. L., J. P. Formby, and W. J. Smith (1998): Estimating the Income Elasticity of Demand for Housing: A Comparison of Traditional and Lorenz-Concentration Curve Methodologies, *Journal of Housing Economics*, **7**, pp. 328-342.
- Houthakker, H. S. (1961): The Present State of Consumption Theory, *Econometrica*, **29**: 4, pp. 704-740.
- Lee, T. H. (1964): The Stock Demand Elasticities for Non-Farm Housing, *The Review of Economics and Statistics*, **53**: 2, pp. 82-89.
- Leser, C. E. V. (1961): Commodity Group Expenditure Functions for the United Kingdom, 1948-57, *Econometrica*, **29**, pp. 24-32.
- Meen, G. P. (1996): Modeling Sustainable Home-Ownership: Demographics or Economics?, Discussion Papers in Urban & Regional Economics, University of Reading, Department of Economics, Reading.
- Segal, J. M. (2001): What We Work for Now, *New York Times*, September 3.
- Statistics Norway (1993): *Survey of Consumer Expenditure*, Official Statistics of Norway NOS C65, Oslo: Statistics Norway.

Consumption Data

We use observations on household purchase expenditures from the Norwegian Consumer Expenditure Surveys in the period from 1986 to 1998; see Statistics Norway (1993). The surveys are conducted continuously by Statistics Norway. Every 14-day period of the year, 1/26 of households report their purchase expenditures. Sample sizes are typically around 1200 households per year. The sampling scheme is a two-stage stratified random sample. Response rates vary around 60 percent, and sampling probability correction weights are available and have been used to compute the average budget share. The commodities are classified into about 800 different items when coding the expenditures in the households accounting books. Standard aggregation levels are 9, 37, 150 and 488 commodity groups. Here we use the most aggregate level of 9 groups. They are: Food; Beverages and Tobacco; Clothes and Shoes; Housing, Fuel, and Power; Furniture and House Equipment; Health Care; Travel and Transportation; Leisure and Education; Other Goods and Services. We do not differentiate between renters and owners, but include both groups in our study. We do, however, differentiate between consumption and investment, and exclude payments on the principal. This study is concerned with housing consumption only, so we limit our attention to the expenditure equivalent of housing.

In order to analyze the effects on increases in income or total consumption it is important to model in some way what determines the material standard of living each member of household experiences. We characterize a household by three salient variables: (latent) total consumption expenditure, the number of children and the number of adults. Assuming that expenditures on each commodity are linear functions of total consumption expenditure, the number of children, and the number of adults in the household entails simplifying a probably complex, non-linear relationship. We do that in order to obtain an easily tractable model of measurement error. The linear model may be a good approximation to non-linear underlying structure; see Aasness (1993) and Aasness and Røed Larsen (2002) for further results and discussion on the use of the same model structure.