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IN MODELS OF HOUSING DEMAND

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ABSTRACT

"Permanent" income has for some time been recognized as the appropriate income variable for models of housing demand. This note examines a recently-developed model wherein "permanent" and "transitory" income are considered to be the fitted and residual components, respectively, of a regression of actual income on several household characteristics. An important caveat for these models is pointed out. One logical remedial strategy is shown to result in underidentification for the coefficient on permanent income. However, the technique uncovers a tangential result which summarizes why an alternative class of models can be expected to underestimate income elasticities.

PERMANENT AND TRANSITORY INCOME IN MODELS OF HOUSING DEMAND

I. INTRODUCTION

Ever since Muth [5] emphasized the importance of Friedman's [1] concept of "permanent" income as the appropriate income variable for explaining the demand for housing, researchers have been grappling with the problem of how to construct such a variable. The comprehensive comparison study by Polinsky and Ellwood [8] is probably the best recent summary of various attempts, and of the different income elasticity estimates which result. However, in two more-recent articles, Goodman and Kawai (GK) [2, 3] have postulated that both permanent and transitory components of current income have substantial and separate effects upon housing demand. This paper examines their estimation procedure and emphasizes an important caveat which should accompany their model. One suggested remedy for the problem exposes a hitherto unrecognized property of an alternative class of housing demand models which, in turn, provides a succinct explanation for their tendency to underestimate income elasticities.

II. ESTIMATED REGRESSORS

In order to distinguish the separate effects of permanent and transitory income, GK propose a two-stage estimation procedure. To illustrate, I will adopt a simplified version of their notation. The first stage consists of an ordinary least

squares regression for actual current income, Y:

$$Y = \phi H + \psi N + \varepsilon \quad (1)$$

where H is a vector of human capital variables (such as education, age, etc.) and N is a vector of non-human capital variables. The systematic portion of the fitted regression is considered to be "permanent income," \hat{Y}^P . The residual is deemed to be transitory income $\hat{Y}^T = Y - \hat{Y}^P = Y - \hat{\phi}H - \hat{\psi}N$. In the second stage, both fitted values enter into a housing demand equation:

$$Q = \beta_0 + \beta_1 P + \beta_2 \hat{Y}^P + \beta_3 \hat{Y}^T + \eta \quad (2)$$

This demand model is therefore afflicted by the problem of "generated regressors" discussed in detail by Pagan [7]. The GK approach is Pagan's Model 4, which is a generalization of models in the "rational expectations" literature such as those proposed by Sargent [9], and Ouliaris [6], wherein (for example) the anticipated and unanticipated parts of some variable, such as inflation, are presumed to have differing effects upon consumption.

Pagan's Theorem 7 shows that the OLS standard error estimate for β_2 is only consistent if the null hypothesis to be tested is $\beta_2 = 0$, i.e. that permanent income has no influence upon housing demand. However, the intent of these papers is not to assess whether permanent income elasticity is non-zero. This is generally conceded. More interest revolves around the magnitude of this elasticity. Permanent income elasticity at the means of the data is a function of the means and the β_2 coefficient. For

accurate hypothesis testing regarding the precise magnitude of this elasticity, then, we need to accommodate null hypotheses regarding non-zero values of β_2 . Pagan shows that for hypotheses other than $\beta_2 = 0$, the OLS estimator for the variance of $\hat{\beta}_2$ is generally inconsistent, and the t-statistics derived from the second-stage OLS estimates will generally overstate the true values. As a consequence, specific hypotheses about the magnitude of permanent income elasticity will be too readily rejected. (On the positive side, Pagan's Theorem 7 argues that the OLS standard error for $\hat{\beta}_3$, the coefficient on transitory income, is perfectly acceptable under any null hypothesis.)

Fortunately, however, a consistent estimator for the true variance of $\hat{\beta}_2$ (under null hypotheses with $\beta_2 \neq 0$) can be found by using a two-stage least squares algorithm. At the very least, the residuals

$$\eta^* = Q - \beta_0 - \beta_1 P - \beta_2 Y \quad (3)$$

(rather than the second-stage OLS residuals) must be used for estimating the appropriate residual variance for deriving coefficient standard errors.

Objectively, failure to acknowledge this difficulty is probably not a fatal oversight for GK. In both of their papers, the coefficients appear (at least) to be very strongly significantly different from zero. Nevertheless, we cannot be certain that correction of the standard error estimates would not affect the outcomes of more-specific hypothesis tests regarding β_2 . In other applications, if the usual null hypotheses were

only marginally rejected, use of simple OLS standard error estimates certainly could jeopardize conclusions about the magnitude of permanent income elasticities. Since the GK innovation seems to have become quite popular in models of housing demand, it is important that potential users of the technique be aware of its shortcomings.

One further caveat should be mentioned. In order for OLS to be consistent, a necessary assumption is that ϵ and η are uncorrelated. GK must therefore be making the implicit assumption that when transitory income is positive, for example, housing demand will not also tend to be larger than the predicted value from the regression in equation (2). This implies some very strong assumptions about orthogonality between "transitory income" and the whole array of potential explanatory variables omitted from the housing demand equation. These assumptions should be addressed and defended.

III. A SINGLE-EQUATION MODEL

In lieu of a two-stage least squares approach, another method for overcoming the difficulties inherent in the GK procedure might be to embed the first equation explicitly into the second. However, this strategy brings out a fundamental problem with the GK approach. (We will ignore the fact that the price and quantity variables are also stochastic.) By making the appropriate substitutions, it is possible to embed the income equation (1) into the demand equation (2), thereby respecifying the demand equation in a manner which ought to allow ϕ , ψ , and the β -coefficients (and their unconditional standard errors) to

be estimated simultaneously. The alternative specification makes Q a non-linear function of the full set of parameters:

$$Q = \beta_0 + \beta_1 P + \beta_2 (\phi H + \psi N) + \beta_3 (Y - \phi H - \psi N) + \epsilon' \quad (4)$$

$$= \beta_0 + \beta_1 P + (\beta_2 - \beta_3) \phi H + (\beta_2 - \beta_3) \psi N + \beta_3 Y + \epsilon' \quad (4')$$

However, if we redefine the coefficients as follows:

$$Q = \alpha_0 + \alpha_1 P + \alpha_2 H + \alpha_3 N + \alpha_4 Y + \epsilon' \quad (5)$$

it becomes clear that equation (4) is not identified. In particular, there is no way to solve directly for β_2 without assuming that either ϕ or ψ is known. Some type of restriction is necessary. GK implicitly impose the assumption that both ϕ and ψ are known constants. While there are a variety of alternative a priori restrictions concerning parameters or error variances which can be imposed (see Judge [4], p. 537), they are equally as difficult to justify.

IV. A USEFUL ARTIFACT

While the joint estimation procedure thus seems to bring us to a dead end, its specification in equations (4') and (5) brings to light a very interesting point. The coefficient α_4 provides a consistent estimate of β_3 , the coefficient on the transitory income variable, and we have already argued that the OLS standard error for this coefficient will be correct. This result has important implications for the interpretation of empirical studies of housing demand using formulations in the class of equation (5). If we agree with the interpretations of GK, then variations in the H and N variables will capture the

explanatory power of variations in "permanent" income and α_4 reflects only the influence of transitory income.

GK argue correctly that in theory, α_4 is a weighted average of the true coefficients, β_2 and β_3 , which would result if Y^P and Y^T were observable. If variations in current income can be attributed to variations in both permanent and transitory income, they conclude that α_4 will always underestimate β_2 and overestimate β_3 . Only if variations in current income are due totally to variations in transitory income will α_4 be a consistent estimate of the coefficient of transitory income. But this is exactly the condition that GK impose by assuming that the systematic component of income from the regression in (1) can be interpreted as permanent income. Thus GK are not strictly correct in their claim that previous models using equations such as (5) (they cite Stevens [10]), "cannot distinguish between permanent and transitory components of measured income." Indeed, these models cannot explicitly address permanent income, but they yield consistent estimates of the responsiveness of housing demand to the transitory component of income, as it has been defined by GK.

V. RELEVANT STANDARDS OF COMPARISON

As their basic specification, GK [3] focus on housing demand equations with price and income as the only explanatory variables. They judge models like equation (2) against a standard of comparison using only current income:

$$Q = \gamma_0 + \gamma_1 P + \gamma_2 Y + \epsilon \quad (6)$$

They conclude that for models like (6), "the estimated income coefficient...overestimates the transitory income coefficient." But this is simply because the H and N variables, which appear implicitly in (2), play no part whatsoever in equation (6). If the standard of comparison had instead been the model in (5), we have already seen that the coefficient α_4 would have been a consistent estimator for the same underlying parameter as β_3 .

VI. "CURRENT" VERSUS "PERMANENT" INCOME ELASTICITIES

Polinsky and Ellwood [8], provide a thorough discussion of the distinction between income elasticity estimates derived using "micro" data with individual current incomes, and "grouped" data using averaged incomes (where the transitory components of individual current incomes presumably cancel out across group members). For the selection of studies they cite, the permanent income elasticity estimates from grouped data are approximately 50 percent higher than the estimates from the micro equations. They attribute the difference to the likelihood that micro current income is probably a poor approximation to permanent income. The pervasive empirical finding is that if the income measure has not been completely purged of its transitory component, the income elasticity which results will be a downward-biased estimate of the true elasticity with respect to permanent income.

Equations (4') and (5) suggest that when researchers opt to use single-equation housing demand models such as (5), we would expect to see a low estimate of "income" elasticity because we are actually estimating transitory income coefficients and

multiplying these smaller coefficients by mean current income in the process of generating elasticity estimates. Hence, the "income" elasticity estimates obtained from these models are neither current income elasticities nor transitory income elasticities (such a concept is difficult to define because mean transitory income is zero), but some conglomeration of the components of each.

VII. CONCLUSIONS

In sum, researchers contemplating use of the GK technique should be aware of the hazards of using estimated quantities as explanatory variables. The OLS standard error for the coefficient on permanent income in the demand equation will be invalid in general and cannot be used for rigorous testing of hypotheses about the relative importance of permanent income as a determinant of housing demand. Furthermore, one remedial procedure--embedding the first equation into the second equation in order to estimate all parameters simultaneously--results in a more fundamental problem: the permanent income coefficient cannot be identified. However, the coefficient on transitory income in a GK model can be estimated consistently by the coefficient on total current income in single-equation models employing the same non-income variables. The implication: these alternative models generate low estimates for "income" elasticities of housing demand because they unwittingly estimate the coefficients for transitory income, rather than for permanent income.

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