

first-stage estimation. The model can also be extended to allow for other covariates both within and between villages, it can be expanded into a system of demand functions with many goods and many prices — [Deaton and Grimard (1992)]¹ — and a simple theory of quality shading can be appended to the model so as to allow θ and ρ to be separately identified, [Deaton (1988)].

2.1.9. Selection models

Selection bias occurs in many different forms; one very general formulation is due to Heckman (1990) and is useful for thinking about a number of issues that arise in development practice. Heckman's formulation has three equations, two regression equations, and a switching equation that governs which of the two determines behavior. The regressions are:

$$y_{it} = \beta_0 + \beta_1 x_{it} + u_{it} \quad (36)$$

The dichotomous switch variable d_i takes values 1 or 0 and satisfies $d_i = 1(z_i + u_i)$

$$d_i = 1(z_i + u_i) \quad (37)$$

where the "indicator function" $1(\cdot)$ is defined to take the value 1 when the statement in brackets is true, and 0 otherwise. The dependent variable y_i is thus determined by

$$y_i = \beta_0 + \beta_1 x_i + u_i + d_i(z_i + u_i) \quad (38)$$

There are several cases in the development literature that use the model in essentially this form. In van der Gaag, Stelcner, and Wijverberg (1989) and Stelcner, van der Gaag and Wijverberg (1989), (36) are wage equations for the formal and informal sectors in Peru, while (37) is the equation determining choice of sector. Pitt and Surnodiningrat (1991) look at the adoption of high yielding versus traditional variety rice in Indonesia, so that the equations (36) are variety specific profit functions, and (37) is the profit maximizing choice between them. Bell, Srinivasan and Udry (1992) model credit markets in the Punjab using a demand equation, a supply equation, and a condition that enforces a ration whenever the supply is less than the demand. In the appropriate notation, all of these fall within the general framework of the previous paragraph. Various special cases of Heckman's model occur even more frequently in development practice.

Consider first setting both β_1 , and the variance of u_i , to be zero in the second equation in (36). Given this, we have the Tobit model when the right hand side of the first equation in (36) coincides with the argument of the indicator