In Example 16.3, we take the population of interest to be married women who are in the work force (so that equilibrium hours are positive). This excludes the group of married women who choose not to work outside the home. Including such women in the model raises some difficult problems. For instance, if a woman does not work, we cannot observe her wage offer. We touch on these issues in Chapter 17; but for now, we must think of equations (16.19) and (16.20) as holding only for women who have $hours > 0$.

EXAMPLE 16.4

(Inflation and Openness)

Romer (1993) proposes theoretical models of inflation which imply that more "open" countries should have lower inflation rates. His empirical analysis explains average annual inflation rates (since 1973) in terms of the average share of imports in gross domestic (or national) product since 1973—which is his measure of openness. In addition to estimating the key equation by OLS, he uses instrumental variables. While Romer does not specify both equations in a simultaneous system, he has in mind a two-equation system:

$$inf = \beta_{10} + \alpha_1 open + \beta_{11}\log(pcinc) + u_1 \tag{16.22}$$

$$open = \beta_{20} + \alpha_2 inf + \beta_{21}\log(pcinc) + \beta_{22}\log(land) + u_2, \tag{16.23}$$

where *pcinc* is 1980 per capita income, in U.S. dollars (assumed to be exogenous), and *land* is the land area of the country, in square miles (also assumed to be exogenous). Equation (16.22) is the one of interest, with the hypothesis that $\alpha_1 < 0$. (More open economies have lower inflation rates.) The second equation reflects the fact that the degree of openness might depend on the average inflation rate, as well as other factors. The variable log(*pcinc*) appears in both equations, but log(*land*) is *assumed* to appear only in the second equation. The idea is that, ceteris paribus, a smaller country is likely to be more open (so $\beta_{22} < 0$).

Using the identification rule that was stated earlier, equation (16.22) is identified, provided $\beta_{22} \neq 0$. Equation (16.23) is *not* identified because it contains both exogenous variables. But we are interested in (16.22).

QUESTION 16.2

If we have money supply growth since 1973 for each country, which we assume is exogenous, does this help identify equation (16.23)?

Estimation by 2SLS

Once we have determined that an equation is identified, we can estimate it by two stage least squares. The instrumental variables consist of the exogenous variables appearing in either equation.

EXAMPLE 16.5

(Labor Supply of Married, Working Women)

We use the data on working, married women in MROZ.RAW to estimate the labor supply equation (16.19) by 2SLS. The full set of instruments includes *educ*, *age*, *kidslt6*, *nwifeinc*, *exper*, and $exper^2$. The estimated labor supply curve is

$$\begin{aligned}\widehat{hours} = {} & 2{,}225.66 + 1{,}639.56 \log(wage) - 183.75\ educ \\ & (574.56) \quad (470.58) \qquad\qquad (59.10) \\ & - 7.81\ age - 198.15\ kidslt6, \quad -10.17\ nwifeinc\ n = 428, \\ & (9.38) \qquad (182.93) \qquad\qquad (6.61)\end{aligned} \tag{16.24}$$

which shows that the labor supply curve slopes upward. The estimated coefficient on log(*wage*) has the following interpretation: holding other factors fixed, $\Delta\widehat{hours} \approx 16.4(\%\Delta wage)$. We can calculate labor supply elasticities by multiplying both sides of this last equation by 100/*hours*:

$$100\cdot(\Delta\widehat{hours}/hours) \approx (1{,}640/hours)(\%\Delta wage)$$

or

$$\%\Delta\widehat{hours} \approx (1{,}640/hours)(\%\Delta wage),$$

which implies that the labor supply elasticity (with respect to wage) is simply 1,640/*hours*. [The elasticity is not constant in this model because *hours*, not log(*hours*), is the dependent variable in (16.24).] At the average hours worked, 1,303, the estimated elasticity is 1,640/1,303 ≈ 1.26, which implies a greater than 1% increase in hours worked given a 1% increase in wage. This is a large estimated elasticity. At higher hours, the elasticity will be smaller; at lower hours, such as *hours* = 800, the elasticity is over two.

For comparison, when (16.19) is estimated by OLS, the coefficient on log(*wage*) is −2.05 (se = 54.88), which implies no labor supply effect on hours worked. To confirm that log(*wage*) is in fact endogenous in (16.19), we can carry out the test from Section 15.5. When we add the reduced form residuals $\hat{v}_2$ to the equation and estimate by OLS, the *t* statistic on $\hat{v}_2$ is −6.61, which is very significant, and so log(*wage*) appears to be endogenous.

The wage offer equation (16.20) can also be estimated by 2SLS. The result is

$$\begin{aligned}\log(\widehat{wage}) = {} & -.656 + .00013\ hours + .110\ educ \\ & (.338) \quad (.00025) \qquad (.016) \\ & + .035\ exper - .00071\ exper^2, \quad n = 428. \\ & (.019) \qquad (.00045)\end{aligned} \tag{16.25}$$

This differs from previous wage equations in that *hours* is included as an explanatory variable and 2SLS is used to account for endogeneity of *hours* (and we assume *educ* and *exper* are exogenous). The coefficient on *hours* is statistically insignificant, which means that there is no evidence that the wage offer increases with hours worked. The other coefficients are similar to what we get by dropping *hours* and estimating the equation by OLS.

Estimating the effect of openness on inflation by instrumental variables is also straightforward.