Lecture 5

Intertemporal Labor Supply (continued)

References

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a. Recap; More on the Relation of Intertemporal and Static Responses

Last time we laid out the prototypical setup: consumption in period t is c_t, hours of work are h_t, the wage is w_t. Individuals have flow utility $u(c_t, h_t; a_t)$ that is concave in (c, h), and an intertemporal budget contraint:

$$A_{t+1} = (1 + r_t)(A_t + y_t + w_t h_t - c_t).$$

The Bellman equation is

$$V_t(A_t) = \max_{c_t, h_t} u(c_t, h_t; a_t) + \beta E_t[V_{t+1}((1 + r_t)(A_t + y_t + w_t h_t - c_t))]$$

After defining $\lambda_t \equiv V_t'(A_t)$ we get the f.o.c. (assuming an interior solution for h_t) :

$$\begin{aligned} u_c(c_t, h_t; a_t) &= \lambda_t \\ u_h(c_t, h_t; a_t) &= -w_t \lambda_t \end{aligned}$$

and the intertemporal optimum condition:

$$\lambda_t = \beta(1 + r_t)E_t[\lambda_{t+1}].$$

Define the Frisch demands as the solutions to these f.o.c., given (w_t, λ_t) and the preference shocks:

$$\begin{aligned} c_t &= c^F(w_t, \lambda_t, a_t) \\ h_t &= h^F(w_t, \lambda_t, a_t) \end{aligned}$$

Let's log-linearize the Frisch demands:

$$\begin{aligned} \log h_t &= A_t + \eta \log w_t + \delta \log \lambda_t \\ \log c_t &= B_t + \theta \log w_t + \kappa \log \lambda_t. \end{aligned}$$

Differentiating the f.o.c. we get

$$\begin{pmatrix} dc \\ dh \end{pmatrix} = \begin{bmatrix} U_{cc} & U_{ch} \\ U_{hc} & U_{hh} \end{bmatrix}^{-1} \begin{bmatrix} 1 & 0 \\ -w & -\lambda \end{bmatrix} \begin{bmatrix} d\lambda \\ dw \end{bmatrix}$$

So

$$\begin{aligned} \frac{\partial h^F}{\partial w} &= \frac{-\lambda U_{cc}}{\Delta} \\ \frac{\partial h^F}{\partial \lambda} &= \frac{-wU_{cc} - U_{hc}}{\Delta} \\ \frac{\partial c^F}{\partial \lambda} &= \frac{wU_{ch} + U_{hh}}{\Delta} \\ \frac{\partial c^F}{\partial w} &= \frac{\lambda U_{ch}}{\Delta} \end{aligned}$$

where $\Delta = U_{cc}U_{hh} - U_{ch}^2 > 0$. Note that

$$w\frac{\partial h^F}{\partial w} - \lambda\frac{\partial h^F}{\partial \lambda} = \frac{\partial c^F}{\partial w}$$

and dividing by h we get

$$\frac{w}{h}\frac{\partial h^F}{\partial w} - \frac{\lambda}{h}\frac{\partial h^F}{\partial \lambda} = \frac{c}{wh}\frac{w}{c}\frac{\partial c^F}{\partial w}$$

or in terms of the elasticities of the log-linearized system,

$$\eta - \delta = \frac{c}{wh}\theta.$$

On average $c \approx wh$ (other than for trust-fund babies), so this says that $\eta - \delta \approx \theta$. In particular, in the separable case $U_{ch} = 0$ which implies:

$$\begin{aligned} \eta &= \delta = \frac{U_h}{hU_{hh}} \\ \kappa &= \frac{U_c}{cU_{cc}} \\ \theta &= 0 \end{aligned}$$

The separable case is a useful benchmark. You may think on a priori grounds that $U_{ch} > 0$: if this is true, when you work more the marginal utility of (cash-based) consumption goes up. In that case $\theta > 0$ and $\eta > \delta$.

It useful to relate δ and κ to the more familiar income effects in static labor supply models. To do this consider the static labor supply problem with the same preferences

$$\max_{c,h} U(c,h) \quad s.t. \quad c = y + wh$$

The f.o.c. for this problem are

$$\begin{aligned} U_c(c,h) - \lambda &= 0 \\ U_h(c,h) + \lambda w &= 0 \\ -c + wh + y &= 0. \end{aligned}$$

Differentiating these we get

$$\begin{bmatrix} dc \\ dh \\ d\lambda \end{bmatrix} = \begin{bmatrix} U_{cc} & U_{ch} & -1 \\ U_{hc} & U_{hh} & w \\ -1 & w & 0 \end{bmatrix}^{-1} \begin{bmatrix} 0 & 0 \\ -\lambda & 0 \\ -h & -1 \end{bmatrix} \begin{bmatrix} dw \\ dy \end{bmatrix}$$

and we can show

$$\begin{aligned} \frac{\partial c}{\partial y} &= \frac{-U_{ch}w - U_{hh}}{\Delta'} \\ \frac{\partial h}{\partial y} &= \frac{U_{cc}w + U_{ch}}{\Delta'} \end{aligned}$$

where Δ' is the determinant of the bordered Hessian. Note that the numerators of these expressions are the same as the numerators of $\frac{\partial c^F}{\partial \lambda}$ and $\frac{\partial h^F}{\partial \lambda}$ respectively (with a sign change). Thus:

$$\frac{\frac{\partial h^F}{\partial \lambda}}{\frac{\partial c^F}{\partial \lambda}} = \frac{\frac{\partial h}{\partial y}}{\frac{\partial c}{\partial y}}.$$

This is useful because we know $\frac{\partial c}{\partial y} = 1 + mpe$ and $w\frac{\partial h}{\partial y} = mpe$, where mpe is the marginal propensity to earn out of non-labor income, and is thought to be a number like -0.1 or so. Thus

$$\frac{w\frac{\partial h^F}{\partial \lambda}}{\frac{\partial c^F}{\partial \lambda}} = \frac{mpe}{1 + mpe}.$$

Converting to elasticities, we get:

$$\frac{wh\frac{\lambda}{h}\frac{\partial h^F}{\partial \lambda}}{c\frac{\lambda}{c}\frac{\partial c^F}{\partial \lambda}} = \frac{wh}{c}\frac{\delta}{\kappa} = \frac{mpe}{1 + mpe}$$

implying that

$$\frac{\delta}{\kappa} = \frac{c}{wh}\frac{mpe}{1 + mpe}.$$

This says that the ratio of the elasticities of labor supply and consumption with respect to λ is (roughly) the same as the ratio of mpe to $(1 + mpe)$, which is generally thought to be a number like -0.1.

In the additively separable case we can use this ratio to think about a likely magnitude for η. Specifically, in the separable case $\kappa = \frac{U_c}{cU_{cc}}$ is the negative of the inverse of the coefficient of relative risk aversion defined over gambles. Define

$$R = -c\frac{U_{cc}}{U_c}.$$

The $\kappa = -1/R$. So if $R = 1$ and $mpe = -0.1$, then $\delta \approx 0.1$, implying $\eta = 0.1$ (since in the separable case $\eta = \delta$). To get a larger value for η we need to have a "big" value for θ, the elasticity of $c^F(w, \lambda)$ w.r.t w, or a small value for R. This is understood by RBC macroeconomists, who normally assume that θ is large.

The relationship between the coefficient of relative risk aversion and the Frisch elasticity of labor supply is developed nicely in Chetty's 2006 *AER* paper.

b. "Reduced Form" Evidence on Intertemporal Labor Supply Elasticities

Following the development from Lecture 4, we start with the log-linearized labor supply and consumption equations:

$$\begin{aligned} \log h_t &= A_t + \eta \log w_t + \delta \log \lambda_t \\ \log c_t &= B_t + \theta \log w_t + \kappa \log \lambda_t. \end{aligned}$$

Focusing on hours, we can difference over time:

$$\Delta \log h_t = \log h_t - \log h_{t-1} = \Delta A_t + \eta \Delta \log w_t + \delta(\log \lambda_t - \log \lambda_{t-1}).$$

Next, use the fact that $\lambda_{t-1} = \beta(1 + r_{t-1})E_{t-1}[\lambda_t]$. Thus

$$\log \lambda_{t-1} = \log[\beta(1 + r_{t-1})] + \log E_{t-1}[\lambda_t]$$

Now define

$$\phi_t = \log E_{t-1}[\lambda_t] - E_{t-1} \log[\lambda_t]$$

and define the innovation in the log marginal utility of income as ξ_t where:

$$\log \lambda_t = E_{t-1} \log[\lambda_t] + \xi_t.$$

Combining all these terms we get

$$\log \lambda_{t-1} = \log[\beta(1 + r_{t-1})] + \log \lambda_t - \xi_t + \phi_t.$$

If we write $\beta = (1 + \rho)^{-1}$ and approximate $\log[(1 + r_{t-1})/(1 + \rho)] = r_{t-1} - \rho$ we get a very useful expression for the evolution of the log marginal utility of income:

$$\log \lambda_t = \log \lambda_{t-1} - (r_{t-1} - \rho) - \phi_t + \xi_t$$

So

$$\Delta \log h_t = \Delta A_t + \eta \Delta \log w_t + \delta \xi_t - \delta(r_{t-1} - \rho) - \delta \phi_t. \tag{1}$$

And following the same steps:

$$\Delta \log c_t = \Delta B_t + \theta \Delta \log w_t + \kappa \xi_t - \kappa(r_{t-1} - \rho) - \kappa \phi_t. \tag{2}$$

Estimation Based on Equation (1)

When wages are uncertain equation (1) cannot be estimated by OLS because $\Delta \log w_t$ is correlated with ξ_t. For example, Pistaferri (2003) writes an approximating model (also used by MaCurdy, 1981) of the form

$$\delta\xi_t = \delta[\log \lambda_t - E_{t-1} \log[\lambda_t]] = \sum_{j=0}^{T-t} \gamma_j [E_t \log[w_{t+j}] - E_{t-1} \log[w_{t+j}]]$$

(The coefficients γ_j are negative). If wages follow an AR(1) process

$$\log w_t = \lambda \log w_{t-1} + \zeta_t$$

then

$$E_t \log[w_{t+j}] - E_{t-1} \log[w_{t+j}] = \lambda^j \zeta_t$$

and

$$\delta\xi_t = \sum_{j=0}^{T-t} \gamma_j \lambda^j \zeta_t = \Gamma(t, T, \lambda)\zeta_t.$$

The update to $\log \lambda_t$ is some coefficient Γ (which depends on (t, T, λ)) times the wage innovation. Note that the$\gamma_j' s$ should also depend on age and current wealth, which introduces even more heterogeneity into the coefficient Γ.

One approach to estimation is to find instruments that predict wage growth, that are orthogonal to the "surprise" component in wages (and therefore in $\log \lambda_t$) and that also do not enter in ΔA_t (the preference shock). MaCurdy (1981) used experience: according to the simplest Mincer model

$$\log w_t = b_1 x(t) + b_2 x(t)^2 + ...$$

where $x(t)$ is experience at time t. Since $x(t) = x(t-1) + 1$ predicted wage growth is a simple linear function of experience in year $t-1$. In fact experience works as a predictor of wage growth, though the "first stage" is often weak. Estimates of η based on this approach tend to be small - on the order of 0.1 to 0.3 (see MaCurdy's orginal analysis and Altonji (1986, Table 2) for a variety of estimates based on the MaCurdy approach)**. A concern is that experience may have some direct effect on preferences. This, coupled with the a priori belief that η "must be relatively large" has led to ongoing interest in other approaches.

**An interesting feature of Altonji's paper is that he reports the first stage equations, so you can judge the power of the instruments, though his paper was written before the "weak instruments" critique was well understood (and before the cluster option made it easy to account for serial correlation within the data for each person over time).

Altonji (1886) tried using consumption as a proxy for the (unobserved marginal utility of wealth). This is easiest to understand in the within-period separable case: then the system of interest is

$$\log h_t = A_t + \eta \log w_t + \eta \log \lambda_t + e_{1t}$$
$$\log c_t = B_t + \kappa \log \lambda_t + e_{2t}$$

where I have added measurement errors e_{1t} and e_{2t}. This implies

$$\log h_t = (A_t - \frac{\eta}{\kappa} B_t) + \eta \log w_t + \frac{\eta}{\kappa} \log c_t + e_{1t} - \frac{\eta}{\kappa} e_{2t}.$$

If the $e'_{jt}s$ are really measurement errors the "only" remaining problems with this specification are that $\log c_t$ is correlated with e_{2t} and any unobserved components of B_t, and that $\log w_t$ is measured with error. [It is also possible, as in a static labor supply model, that the unobserved parts of A_t are correlated with $\log w_t$]. The main advantage is that we don't have to first difference – so there is a lot of variation left and many potential instruments for $\log w_t$ and $\log c_t$. Altonji (1986) used a second measure of wages (collected at the interview in the PSID, and representing the "point-in-time" wage on the job at the time of the interview), the mean wage observed in other years, and various demographic factors (e.g. spouse's education, parental education/income). His estimates (Altonji (1986, Table 4)) for η are between 0.1 and 0.2.

The main concern with Altonji's approach is that preferences may not be separable. If

$$\log c_t = B_t + \theta \log w_t + \kappa \log \lambda_t + e_{2t}$$

then solving for $\log \lambda_t$ and substituting into the hours equation (with a coefficient δ for $\log \lambda_t$ that is potentially different from η) leads to an hours model:

$$\log h_t = (A_t - \frac{\eta}{\kappa} B_t) + (\eta - \theta \frac{\delta}{\kappa}) \log w_t + \frac{\delta}{\kappa} \log c_t + e_{1t} - \frac{\delta}{\kappa} e_{2t}.$$

Notice that the coefficient on $\log w_t$ in this case is

$$\eta - \theta \frac{\delta}{\kappa} \approx \eta - \theta \frac{mpe}{1 + mpe}$$

using the result presented earlier that $\frac{\delta}{\kappa} \approx \frac{mpe}{1+mpe}$. Assuming $mpe \approx -0.1$, this implies that the estimate obtained using Altonji's procedure is an estimate of $\eta + 0.11\theta$. Assuming $\theta \geq 0$ we get an upward-biased estimate for η, though the magnitude of the bias is arguably small.

Pistaferri (2003) presents an interesting addition to this literature, using information on wage growth expectations that is collected in the Bank of Italy's Survey of Household Income and Wealth (SHIW). Pistaferri assumes that individual wages follow a random walk:

$$\log w_t = \log w_{t-1} + \zeta_t$$

and adopts the assumption (presented above) that the (scaled) innovation in the log marginal utility of wealth follows

$$\delta\xi_t = \delta[\log\lambda_t - E_{t-1}\log[\lambda_t]] = \sum_{j=0}^{T-t}\gamma_j[E_t\log[w_{t+j}] - E_{t-1}\log[w_{t+j}]].$$

With the unit root assumption $E_t\log[w_{t+j}] - E_{t-1}\log[w_{t+j}] = \zeta_t$ and

$$\delta\xi_t = \sum_{j=0}^{T-t}\gamma_j\zeta_t = \Gamma\zeta_t.$$

With this substitution, equation (1) becomes

$$\begin{aligned}\Delta\log h_t &= \Delta A_t + \eta\Delta\log w_t + \delta\xi_t - \delta(r_{t-1}-\rho) - \delta\phi_t \\ &= \Delta A_t + \eta E_{t-1}[\Delta\log w_t] + (\eta+\Gamma)\zeta_t - \delta(r_{t-1}-\rho) - \delta\phi_t \quad \text{(3a)}\end{aligned}$$

(which is Pistaferri's equation (13)). In the SHIW people are asked directly their expected rate of growth of earnings over the next year. Letting $y_t = w_t h_t$, this means that we observe $E_{t-1}[\Delta\log y_t]$ in the year $t-1$ survey. This means we have to translate the labor supply model into a model of hours and earnings. Using the definition of earnings we get

$$E_{t-1}[\Delta\log w_t] = E_{t-1}[\Delta\log y_t] - E_{t-1}[\Delta\log h_t]$$

and taking expectations of (3) and substituting we get

$$E_{t-1}[\Delta\log h_t] = \frac{1}{1+\eta}\{\Delta A_t + \eta E_{t-1}[\Delta\log y_t] - \delta(r_{t-1}-\rho) - \delta\phi_t\}.$$

Finally, if we define

$$\psi_t = \Delta\log y_t - E_{t-1}[\Delta\log y_t]$$

as the innovation in log earnings, and use the fact that $\Delta\log h_t - E_{t-1}[\Delta\log h_t] = (\eta+\Gamma)\zeta_t$ (from equation (3)) we get

$$\begin{aligned}\zeta_t &= \psi_t - (\eta+\Gamma)\zeta_t \Rightarrow \zeta_t = \frac{\psi_t}{1+\eta+\Gamma} \\ &\Rightarrow \Delta\log h_t - E_{t-1}[\Delta\log h_t] = \frac{(\eta+\Gamma)}{1+\eta+\Gamma}\psi_t.\end{aligned}$$

Thus we can write the labor supply equation in terms of expected earnings changes and the innovation in earnings as:

$$\Delta\log h_t = \frac{1}{1+\eta}\Delta A_t + \frac{\eta}{1+\eta}E_{t-1}[\Delta\log y_t] - \frac{\delta}{1+\eta}(r_{t-1}-\rho) - \frac{\delta}{1+\eta}\phi_t + \frac{(\eta+\Gamma)}{1+\eta+\Gamma}\psi_t \quad (4)$$

(As a final step, Pistaferri solves for ϕ_t in terms of the variance in the earnings forecast, under the assumption of log-normality, but we will leave that aside).

Notice that if we observe expected and realized earnings then we can estimate this model taking $E_{t-1}[\Delta \log y_t]$ and ψ_t as observed variables. This procedure will yield estimates for η and Γ. Morever, Pistaferri uses the relatively short time period in his panel to get variation in the real interest rate, providing an estimate of δ. His estimates are

$$\begin{aligned} \eta &= 0.70\ (0.09) \\ \Gamma &= -0.20\ (0.09) \\ \delta &= 0.59\ \ (0.29) \end{aligned}$$

which look pretty large in magnitude. As discussed in his paper, one (plausible) explanation for this is that the true wage process is more like:

$$\begin{aligned} \log w_t &= z_t + \epsilon_t \quad \text{where} \\ z_t &= z_{t-1} + \zeta_t \end{aligned}$$

and ϵ_t and ζ_t are i.i.d. This says wages are a combination of a component with a unit root ("permanent" wages) and a serially uncorrelated component ("transitory wages"), and implies that

$$\log w_t = \log w_{t-1} + \zeta_t + \epsilon_t - \epsilon_{t-1}$$

which is an ARIMA(0,1,1) model. Now the innovation in log wages is $\zeta_t + \epsilon_t$, but only the permanent part is expected to persist, so holding constant the (observed) innovation in current wages (or, in Pistaferri's case, earnings) the apparent response in labor supply is bigger than it would be if the entire wage innovation persisted (which is what is being assumed in equation (3). Preferences are being credited for a labor supply response that is due in part to the "temporary" nature of the wage innovation, so there is an upward bias in the estimate of η.

Some simple evidence on the right statistical model for wages is presented in Card (1994): there I used data on a sample of male household heads from the PSID observed continuously over an 8-year period to fit a model of the form

$$\log w_{it} = \omega_i + v_t + u_{it} + \mu_{it}$$

where

$$u_{it} = \alpha u_{it-1} + \xi_{it}$$

and ξ_{it} and μ_{it} are mutually uncorrelated, the innovations in the AR(1) component are uncorrelated (but allowed to have differenent variances in different years), and ξ_{it} and μ_{it} are uncorrelated with the random effect. Pistaferri (effectively) assumes $\alpha = 1$ and $var(\mu_{it}) = 0$. The estimates are reported in Table 2.3 of my paper and show that: (1) such a model fits relatively well; (2) $\alpha \approx 0.9$; (3) about 50% of the variance in wages is attributed to ω_i, 16% to the transitory component μ_{it} and 34% to the serially correlated component u_{it}.

Arguably, Pistaferri's assumption of a pure random walk model for wages is too restrictive.

Problems with Estimation Based on Equation (1)

There are a number of criticisms of evidence based on the simple model based on equation (1). Here we briefly discuss a few of these issues,which are a topic for ongoing research. In the next lecture we will discuss some of these points in more depth.

Extensive margin

Most estimates ignore the "extensive margin" – workers who don't work for a year are dropped. This is potentially important for understanding aggregate movements in hours because:

(a) there are substantial numbers of people who move in/out of employment

(b) the "elasticity" of participation w.r.t. wages can be relatively high, even if η is small.

A simple approach to this problem is to go back to the first order conditions defining the Frisch labor supply/consumption choices, and define a "reservation wage" in each period (or more generally a selection equation determining whether the individual works in period t. For an example of this see J. Kimmel and T. Kniesner, "New Evidence on Labor Supply" Employment vs Hours Elasticities by Sex and Marital Status." Journal of Monetary Econ 42 (1998).

Manoli and Weber (2011) is a very recent attempt to look at one of the important "extensive margins" : variation in the length of time people work. This paper uses an RD design to study the effects of a benefit that is paid to workers who retire after certain tenure "milestones". Since workers start jobs at different ages, there is a smooth distribution of people across the tenure distribution at different ages, and Manoli and Weber find strong evidence that some workers appear to delay retirement to get the benefits. However, the implied responsiveness is relatively small (elasticities on the order of 0.3 or smaller). An earlier paper by Krueger and Pischke (Journal of Labor Economics, 1992) looked at the effect of a revision in the indexing formula for Social Security, which sharply lowered the benefits to people born in 1917-1921 relative to those born 1915-1916 (who got very high benefits as a result of an error in the indexing formula). As shown in their figures:

(1) people born in 1918-20 suffered a sharp drop in benefits to earliest possible retirement (age 62)

(2) people born in 1914-1916 had unusually high incentives to delay retirement to age 68

(3) BUT LFPR's trended pretty smoothly down across these cohorts

Nevertheless, the "extensive margin" (EM) is an area of active research interest. One (serious) difficulty with studying EM responses is that wages are only observed for workers. So it becomes necessary to impute "shadow wages" (or make other assumptions) to correlate changes in participation with changes in wages.

"Involuntary" Unemployment

In an older macro/labor literature, researchers attempted to estimate labor supply functions, assuming that desired labor supply might not equal actual supply. Ashenfelter and Ham (1979) introduce a simple intertemporal labor supply model based on Stone Geary preferences. In this model (similar to the one adopted by Imbens et al in their study of lottery winners) desired hours of individual i in period t are given by:

$$w_{it}h_{it}^{*} = \gamma_h w_{it} + (\frac{1+r}{1+\rho})^t F_i$$

where F_i is a fixed effect for each individual that depends on discounted wealth. They then assume that actual hours may be less than desired hours, and that the gap is reflected in reported unemployment:

$$h_{it} = h_{it}^{*} - \theta u_{it}$$

They then estimate the labor supply model and the coefficient θ. (which they estimate to be in the range of 0.8 to 0.9. The idea that actual and desired labor supply can differ is surprisingly controversial, and largely fell out of favor in the 1980s and 1990s. (If you are interested, a more recent paper in this area is John Ham and Kevin Reilly AER, 2002, which also looks at the implications of an implicit contracting relationship model.) Instead people have tried to explain hours choices as movements in desired supply, and ignored reported unemployment.

Ham and Reilly build on an earlier paper by Ham (ReStud, 53 (4), 1986) which asks whether "signals" from the demand side affect hours, controlling for wages and other factors. In a simple neoclassical model "market model"

$$\begin{aligned} h &= h^d(w,x) \\ &= h^s(w,y) \end{aligned}$$

where h^d and h^s are the demand and supply functions for hours (by some group of workers), and x and y represent demand and supply shocks. The effect of demand shocks on supply choices works through w: the two sides of the market both make independent decisions, taking w as given. Thus, a test of the standard model is to fit the supply function and include x directly in the estimating equation. This requires that there be instruments for w in addition to the demand shock variables - so one interpretation of their test is that they are testing whether one set of demand shock variables affect supply, when wages are instrumented with other variables.

Formally, H-R consider two specifications. Their first set of models use first differenced labor supply model of the type we presented in Lecture 5:

$$\Delta \log h_t = \Delta A_t + \eta \Delta \log w_t + \delta \xi_t - \delta(r_{t-1} - \rho) - \delta \phi_t. \quad (5)$$

Their idea is to include an extra set of explanatory variables: the changes in the unemployment rates for the industry and occupation that the agent was working in in the base year ($\Delta UR^{ind}, \Delta UR^{occ}$). These are treated as potentially "endogenous" because they may reflect the "news" shocks incorporated in the innovation in the log marginal utility of consumption, ξ_t. They also present models with future wage changes ($\Delta \log w_{t+1}$) included on the right hand side, as a potential way to incorporate non-separable preferences (basically, if people forsee high wages ahead they may work more or less this period) See Table 1 of their paper.

H-R's second specification builds on Altonji's idea of controlling directly for consumption. Recall from Lecture 5 that the baseline specification is:

$$\log h_t = (A_t - \frac{\eta}{\kappa} B_t) + (\eta - \theta\frac{\delta}{\kappa}) \log w_t + \frac{\delta}{\kappa} \log c_t + e_{1t} - \frac{\delta}{\kappa} e_{2t}.$$

In this case they augment the model with (UR^{ind},UR^{occ}), and include specifications with future wages. See tables 2 and 3, which use PSID and CES data.

Their key finding is that predictable movements in ΔUR^{ind} and ΔUR^{occ} (or in the levels of UR^{ind},UR^{occ}),have a lot of explanatory power. They interpret this as evidence that wages are not "fully sufficient" to translate all the necessary information about the state of the demand side to the worker.