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ABSTRACT

We specify a model of municipal labor demand when resource flows available to the municipality are not known with certainty. The model allows us to test the hypothesis that employment decisions are rational in the sense that they incorporate all available information at the time that the decisions are made. We find that for our sample of communities, on the whole one cannot reject the hypothesis that labor demand is consistent with intertemporal utility maximization under uncertainty. However, small and large communities exhibit different behavior. The employment decisions of small communities are consistent with the model, while those of large communities are not.

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1. **Introduction**

State and local governments play an important role in the U.S. labor market. In 1988, about 14 percent of all nonagricultural workers were employed in the state-local sector.[1] There is now a large literature analyzing this market, much of which has been devoted to comparing public and private sector labor with respect to wage setting processes, strike frequency and duration, the impact of unions, etc. (See, for example, Tracy [1988], Gyourko and Tracy [1989], and the survey by Ehrenberg and Schwarz [1986].) A smaller group of papers has focused on the important question of how state and local governments' labor demand responds to changes in their economic environments. Analyses of cross-section, panel, and aggregate time series data all suggest that state and local governments generally react "sensibly"; i.e., their demand curves for labor are downward sloping. (See, for example, Ball, Burkhead and Jump [1980], Hulten [1984], Freeman [1987], and Huckins [1989].)

To date, empirical models of subfederal government labor demand have embodied the implicit assumption that all resource flows available to the government are known with certainty. In contrast, uncertainty seems to pervade the atmosphere in which actual decision-making takes place. Both tax revenues and outside aid fluctuate substantially from year to year, and it appears to be difficult for governments to forecast these variables. (See Feenberg, *et al.* [1989].) Moreover, anecdotal evidence suggests that unanticipated changes in revenue can have important effects on labor demand. In 1986, for example, the Mayor of Houston proposed that 770 workers be laid off due to a $70 million short fall in tax revenues. Similarly, in 1989, Elizabeth, New Jersey laid off 225 city workers in response to an unexpected reduction in aid from the state.[2]

In this paper we formulate a model of community labor demand in the presence of uncertainty, and estimate it using panel data from 1973 to 1980. The model allows us to test the hypothesis that employment decisions are rational in the sense that they incorporate all available information at the time that the decisions are made. One reason why it is important to assess the validity of this hypothesis is that state and federal governments often seek to influence the level of local labor demand by changing the resources available to localities. (This is done directly via grants-in-aid or indirectly via deductions of local taxes on federal and (some) state income tax returns.) The efficacy of such measures depends on whether communities are rational in the sense just described. Specifically, to the extent that the behavior of localities is described by the rational, forward looking model, transitory increases in resources will have a smaller impact on labor demand than permanent increases. More generally, the model provides a different approach to analyzing the underlying decision-making process of local governments. There is a large literature discussing whether local governments conduct their fiscal affairs sensibly (see Inman [1983]); this analysis looks at the issue from a new perspective.

The theoretical model is specified in Section 2. Section 3 discusses the data and econometric issues. We present the results in Section 4. An important finding is that for the sample as a whole, one cannot reject the hypothesis that municipal labor demand is consistent with intertemporal utility maximization under uncertainty. However, when looking at large communities alone, the model fails. Section 5 concludes with a brief summary.

2. Theoretical Framework

In this section we formulate a model in which a local government's demand for labor is the outcome of a rational, forward looking decision process. The model allows us to test the joint hypotheses that government decision-makers are forward looking and face no credit market constraints. The idea that municipal governments act as if they maximize an intertemporal objective function may strike some as clearly implausible. However, our conversations with several local officials have indicated that their time horizons are longer than just a single year budget cycle. Moreover, models assuming "rationality" have had some success in explaining federal government fiscal behavior. (See Poterba and Rotemberg [1990] and Mankiw [1987].) Of course, none of this proves that the model developed here is correct; it simply suggests that the model should not be dismissed out of hand.

The modern empirical literature on intertemporal planning in the face of uncertainty (see Hall [1978]) approaches this problem as follows: Assume that an agent in the municipality maximizes an intertemporal utility function in the presence of uncertainty concerning the future flow of resources. Solve the problem using dynamic programming techniques. The solution places restrictions on the lag distribution of the choice variable (employment). Analyze the time series data on the choice variable to determine whether or not these restrictions are violated. To the extent that the data do not reject the theoretical restrictions, it suggests the presence of rational, forward looking planning. Alternatively, if the restrictions are violated, then myopia, short-run constraints, or backward looking behavior may be present. It is important to stress that this procedure does not produce estimates of a structural model of the determination of the choice variable. It merely tests an important implication of the structural model.

To begin, one must specify an objective function. We assume that the government acts to maximize the expected present value of a utility function that depends upon the flows of after-tax income and government services in the community. We assume that the utility function is separable. This allows us to focus only on government services, so the objective function is

$$E_t \sum_{s=0}^{\infty} \theta^s U(G_{t+s}) \ , \tag{2.1}$$

where E_t denotes expectations taken using information available through the end of period t, $\theta \equiv 1/(1+\pi)$ and π is the pure rate of time preference, G_t is the level of the municipal service provided in period t, and $U(\cdot)$ is the utility function. An attractive feature of this approach is that it does not require us to specify whose preferences are represented by $U(\cdot)$. One possibility is that it is the utility function of a "representative" resident. Alternatively, it might depict the preferences of a bureaucrat whose utility depends on the size of his budget. One possible objection to this formulation is that it assumes that the preference function is stable over time. Might not the identity of the decisive voter or the decision-making bureaucrat change over time? To investigate this possibiity, in the econometric work presented below, we test for time-stability of the parameters that govern labor demand.

We turn now to the constraints facing the decision-maker. Government services are produced using full-time labor, part-time labor, and capital. Given that our focus is on labor demand decisions, we assume that the production function is separable between capital and labor. This assumption is tested below. We also assume that there may be costs to changing the levels of inputs. Following Sargent [1978], we build adjustment costs into the production function by having the current amount of output depend negatively on the discrepancy between the current period's amount of the input and its lag.

To be more specific, let F_t be the number of full-time workers in period t, P_t the number of part-time workers, and K_t the quantity of capital services. Then output, G_t, can be written

$$G_t = f(F_t, \Delta F_t, P_t, \Delta P_t) - g(K_t, \Delta K_t) \tag{2.2}$$

where $\Delta F_t \equiv F_t - F_{t-1}$, $\Delta P_t \equiv P_t - P_{t-1}$, and $\Delta K_t \equiv K_t - K_{t-1}$.

To finance its expenditures, the government raises R_t in own-source revenues and A_t in grants from outside sources. If w_t^f is the wage rate per unit of full-time labor in period t, w_t^p is the wage rate for part-time labor, and q_t is the cost per unit of capital services, then the community's present value budget constraint is

$$NA_{t-1} + \sum_{s=0}^{\infty} D^s (R_{t+s} + A_{t+s} - w_{t+s}^f F_{t+s} - w_{t+s}^p P_{t+s} - q_{t+s} K_{t+s}) = 0 \ , \tag{2.3}$$

where $D \equiv 1/(1+r)$, r is the (constant) real rate of interest, and NA_t is net financial assets at the end of period t. It is assumed that R_t, A_t, q_t, w_t^f and w_t^p are random, but that their realizations in period t are known when decisions are made. Future values of these variables are, of course, uncertain.

The decision-maker's problem is to choose a sequence of planned revenues, labor, and capital so as to maximize (2.1) subject to (2.2) and (2.3). Conventional Euler equation methods suggest that the optimal path for full-time labor is characterized by

$$\frac{E_t\left[\dfrac{\partial U}{\partial G_t}\,\dfrac{\partial G_t}{\partial F_t} + \theta\,\dfrac{\partial U}{\partial G_{t+1}}\,\dfrac{\partial G_{t+1}}{\partial F_t}\right]}{E_t\left[\dfrac{\partial U}{\partial G_{t+1}}\,\dfrac{\partial G_{t+1}}{\partial F_{t+1}} + \theta\,\dfrac{\partial U}{\partial G_{t+2}}\,\dfrac{\partial G_{t+2}}{\partial F_{t+1}}\right]} = \frac{E_t\left[(1+r)w_t^f\right]}{E_t\left[(1+\pi)w_{t+1}^f\right]} \ , \tag{2.4a}$$

and the optimal path for part-time labor is

$$\frac{E_t\left[\dfrac{\partial U}{\partial G_t}\,\dfrac{\partial G_t}{\partial P_t} - \theta\,\dfrac{\partial U}{\partial G_{t+1}}\,\dfrac{\partial G_{t+1}}{\partial P_t}\right]}{E_t\left[\dfrac{\partial U}{\partial G_{t+1}}\,\dfrac{\partial G_{t+1}}{\partial P_{t+1}} + \theta\,\dfrac{\partial U}{\partial G_{t+2}}\,\dfrac{\partial G_{t+2}}{\partial P_{t+1}}\right]} = \frac{E_t\left[(1+r)w_t^p\right]}{E_t\left[(1+\pi)w_{t+1}^p\right]} \quad . \tag{2.4b}$$

The left-hand side of equation (2.4a) is the marginal rate of substitution between full-time labor in adjacent periods; the right-hand side is the present value ratio of the intertemporal prices. Hence, (2.4a) is simply the familiar condition that the marginal rate of substitution equals the price ratio. Similarly, (2.4b) says that the marginal rate of substitution between part-time labor across periods is equal to its price ratio.

Now, from the production function (2.2), we know that $\partial G_t/\partial F_t$ depends upon F_t, F_{t-1}, P_t and P_{t-1}; $\partial G_{t+1}/\partial F_t$ depends on F_{t+1}, F_t, P_{t+1} and P_t; $\partial G_{t+1}/\partial F_{t+1}$ depends on F_{t+1}, F_t, P_{t+1} and P_t; and $\partial G_{t+2}/\partial F_{t+1}$ depends on F_{t+2}, F_{t+1}, P_{t+2} and P_{t+1}. Therefore, assuming that the marginal utility of government services is locally constant, the Euler equation (2.4a) implicitly defines a relationship of the form

$$F_t = h^f(F_{t-1}, F_{t-2}, F_{t-3}, P_t, P_{t-1}, P_{t-2}, P_{t-3}, w_{t-1}^f, w_{t-2}^f, \varepsilon_t^f)\ , \tag{2.5a}$$

where ε_t^f is an expectational error orthogonal to all variables dated t-2 and earlier. Similarly, Euler equation (2.4b) defines a relationship

$$P_t = h^p\left(F_t, F_{t-1}, F_{t-2}, F_{t-3}, P_{t-1}, P_{t-2}, P_{t-3}, w_{t-1}^p, w_{t-2}^p, \varepsilon_t^p\right)\ , \tag{2.5b}$$

where ε_t^p is the analogous expectational error for part-time employment. Equations (2.5) can be viewed as two equations in the two unknowns F_t and P_t. Assume that a unique solution exists. A linear approximation to the solutions gives us

$$F_t = \alpha_0 + \alpha_1 F_{t-1} + \alpha_2 F_{t-2} + \alpha_3 F_{t-3} + \alpha_4 P_{t-1} + \alpha_5 P_{t-2} + \alpha_6 P_{t-3} + \alpha_7 w^f_{t-1} + \alpha_8 w^f_{t-2} + \alpha_9 w^p_{t-1} + \alpha_{10} w^p_{t-2} + \mu^f_t \tag{2.6a}$$

$$P_t = \beta_0 + \beta_1 F_{t-1} + \beta_2 F_{t-2} + \beta_3 F_{t-3} + \beta_4 P_{t-1} + \beta_5 P_{t-2} + \beta_6 P_{t-3} + \beta_7 w^f_{t-1} + \beta_8 w^f_{t-2} + \beta_9 w^p_{t-1} + \beta_{10} w^p_{t-2} + \mu^p_t , \tag{2.6b}$$

where μ^f_t and μ^p_t are linear combinations of ε^f_t and ε^p_t.

Equations (2.6) reveal a testable implication of the assumption that decision-makers use information efficiently. The equations for both full and part-time labor should include no more than three lags of full and part-time labor, and no more than two lags of the wages for both kinds of labor.

An important question is whether any other lagged variables belong on the right-hand side of equation (2.6a). In the presence of adjustment costs, the appropriate value of F_t depends on the costs of adjusting from F_{t-1}; by implication, information from periods t and $t-1$ will affect F_t even after including all the other variables on the right-hand side of (2.6a). However, if decision making is rational, variables from period $t-2$ and earlier (other than F_{t-3} and P_{t-3}) should be excluded from the regression. In particular, other variables from the community's budget constraint, such as own revenues, grants, and net assets dated $t-2$ and earlier should be excludable from equation (2.6a). The same argument applies to equation (2.6b).

Some Special Cases. The form of the Euler equations changes with alternative specifications of the production function (2.2). Two cases are of particular interest:

a. **No increasing marginal adjustment costs.** Recall that adjustment costs enter our model via the presence of ΔF_t and ΔP_t in the production function (2.2). As shown above, this leads to an Euler equation that links F_t to three lags of itself and P_t, and similarly for P_t. On the other hand, if adjustment costs are zero or constant at the margin, then $\partial G_{t+s+1}/\partial F_{t+s} = 0$ and $\partial G_{t+s+1}/\partial P_{t+s} = 0$ for all values of s. In this case, equation (2.4a) implicitly defines a relationship between F_t, F_{t-1}, P_t, P_{t-1}, w_t^f and w_{t-1}^f. Similarly, (2.4b) defines a relationship between F_t, F_{t-1}, P_t, P_{t-1}, w_t^p and w_{t-1}^p. Solving these two equations and linearizing gives us

$$F_t = \alpha_0' + \alpha_1' F_{t-1} + \alpha_2' P_{t-1} + \alpha_3' w_t^f + \alpha_4' w_{t-1}^f + \alpha_5' w_t^p + \alpha_6' w_{t-1}^p + \mu_t^{f'} \tag{2.7a}$$

$$P_t = \beta_0' + \beta_1' F_{t-1} + \beta_2' P_{t-1} + \beta_3' w_t^f + \beta_4' w_{t-1}^f + \beta_5' w_t^p + \beta_6' w_{t-1}^p + \mu_t^{p'} . \tag{2.7b}$$

Comparing (2.7) with (2.6), observe that in the former, only first lags of F_t and P_t appear on the right-hand side, while in the latter, the second and third lags appear as well. This makes intuitive sense because in the absence of increasing marginal adjustment costs, the growth rate for F_t embodied in the intertemporal marginal rate of substitution is independent of past growth rates. Thus, variables dated *t-2* and *t-3* do not matter.

Finally, the dating of the exclusion restrictions differs between (2.7a) and (2.6a). In the absence of increasing marginal adjustment costs, the Euler equation links F_t to at most first lags of itself and other variables. Hence, these lagged variables capture all forecastable information concerning F_t. That is, $\mu_t^{f'}$ is orthogonal to all information available at time period *t-1*. Accordingly, if we estimate regression (2.7a), no other variables lagged *t-1* or earlier should be significantly related to F_t. Exactly the same considerations apply to equation (2.7b) for P_t.

b. **Separability between full and part-time labor**. In this case, the derivatives of G with respect to F do not depend on P, and the derivatives of G with respect to P do not depend on F. Hence, there is no need to solve (2.5a) and (2.5b) simultaneously. Rather, F_t depends only on its lagged values and the lags of w_t^f, and similarly for P_t:

$$F_t = \alpha_0'' + \alpha_1'' F_{t-1} + \alpha_2'' F_{t-2} + \alpha_3'' F_{t-3} + \alpha_4'' w_{t-1}^f + \alpha_5'' w_{t-2}^f + \mu_t^{f''} . \tag{2.8a}$$

$$P_t = \beta_0'' + \beta_1'' P_{t-2} + \beta_2'' P_{t-2} + \beta_3'' P_{t-3} + \beta_4'' w_{t-1}^p + \beta_5'' w_{t-2}^p + \mu_t^{p''} . \tag{2.8b}$$

Our econometric procedure allows us to test whether specification (2.6) or (2.8) is more consistent with the data.

Note that if separability obtains, then the exclusion restrictions are as follows: all variables dated *t-2* and earlier (except for F_{t-3}) should be excludable from (2.8a); and all variables dated *t-2* and earlier (except for P_{t-3}) should be excludable from (2.8b).

Clearly, our Euler equations embody strong predictions concerning the dynamic structure of public sector employment. These predictions are derived from equally strong assumptions concerning the structure of the decision-maker's optimization problem: time separable utility function, no capital market constraints, linear functional form, etc. Nevertheless, as in other contexts, the model provides a useful benchmark and a good starting point for empirical work.

A final issue to be considered is the possibility of heterogeneous community behavior. Our discussion above has implicitly assumed that all of the communities have the same α's and β's. However, the appropriate specification might differ because of different utility or production functions. In addition, some communities' decision-making might not be correctly characterized by the optimizing model.[3] As usual, pooling together observations that are generated by different underlying processes can produce misleading results.

Our data do not allow us to estimate the model separately for each community, so some pooling is inescapable. However, in addition to estimating the model for the entire sample, we divide the sample into two parts based on population size. One might argue that in smaller jurisdictions the decision-makers are more responsive to the wishes of residents, simply because it is easier to "know" their preferences. Indeed, this is one of the main justifications for a federalist fiscal system. Moreover, to the extent that smaller communities are located in suburban settings, they have relatively mobile populations, and the threat of exit can force governments to optimize on behalf of their residents. On the other hand, the threat of such exit may induce decision-makers to focus myopically on the welfare of current residents. In short, while there is reason to believe that behavior in large and small communities may differ, it is hard to say which type is more likely to be "rational" in the sense described above. Dividing the sample on the basis of population allows us to determine the existence and nature of any differences.

3. **Data and Estimation**

In this section we discuss the data, and then turn to the econometric issues that arise in execution of the empirical strategy.

3.1 Data

Our data set is constructed from the employment and finance files of the 1977 Census of Governments, and the Annual Survey of Governments for 1973 to 1976 and 1978 to 1980. A random sample of municipalities was drawn from the 1979 Annual Survey and matching records drawn, when possible, for the remaining years. Only those municipalities that reported nonzero school expenditures were retained.[4] This reduced the possibility that a community's expenditures were underreported because they were in part executed by, for example, a school district, but it cut down the number of available municipalities. After eliminations due to missing data, the result was a panel of 161 municipalities over eight fiscal years.

Nominal values were deflated to 1977 dollars using a region specific consumer price index. End of year holdings of financial assets and liabilities were corrected from par to market value using indices constructed by Eisner and Pieper [1985].[5] The wage rate for full-time workers was computed by dividing the monthly full-time payroll by the number of full-time workers; the part-time wage was found by an analogous procedure.[6] Finally, all variables were converted to per capita terms.

Summary statistics for the sample are provided in Table 1. The relatively large standard deviations suggest the presence of substantial heterogeneity in our sample. As suggested earlier, it is potentially of interest to analyze subsamples of "small" and "large" communities. All communities whose average populations were 50,000 or less during our sample period are classified as "small" and the rest as "large." While this dividing line is essentially arbitrary, it yields a group of 107 small communities and 54 large ones, sufficiently large samples to analyze each independently. Sample statistics for each group are also provided in Table 1. Even within the subsamples, there is considerable dispersion around the mean values of the variables.

3.2 **Econometric Issues**

Several econometric issues arise in the estimation of the Euler equations.

a. **Individual and time effects**. For notational simplicity, our discussion in section 2 ignored the fact that our observations come from different communities. It now becomes important to recognize explicitly that each variable and error term has a subscript, *i*, which indexes the community. Moreover, the demand for labor in community *i* may be affected by an "individual effect," k_i, which captures unobserved and unchanging characteristics that are unique to the community. Incorporating the individual effect into the Euler equation for full-time labor, (2.6a), gives us

$$\begin{aligned} F_{it} = \alpha_0 + \alpha_1 F_{it-1} + \alpha_2 F_{it-2} + \alpha_3 F_{it-3} + \alpha_4 P_{it-1} + \alpha_5 P_{it-2} + \alpha_6 P_{it-3} \\ + \alpha_7 w^f_{it-1} + \alpha_8 w^f_{it-2} + \alpha_9 w^p_{it-1} + \alpha_{10} w^p_{it-2} + k_i + \mu^f_{it} . \end{aligned} \tag{3.1}$$

The correlation of the individual effect with right-hand side variables in (3.1) will lead to inconsistent estimates. Therefore, we take first differences to eliminate k_i:

$$\begin{aligned} \Delta F_{it} = \alpha_1 \Delta F_{it-1} + \alpha_2 \Delta F_{it-2} + \alpha_3 \Delta F_{it-3} + \alpha_4 \Delta P_{it-1} + \alpha_5 \Delta P_{it-2} + \alpha_6 \Delta P_{it-3} \\ + \alpha_7 \Delta w^f_{it-1} + \alpha_8 \Delta w^f_{it-2} + \alpha_9 \Delta w^p_{it-1} + \alpha_{10} \Delta w^p_{it-2} + \Delta \mu^f_{it} . \end{aligned} \tag{3.2}$$

All of our equations are estimated using first differences of the data rather than levels.[7]

In addition to individual effects, we estimate our equations with time effects--year specific intercepts that allow for influences in a given year that affect all of the communities in the same way. *Inter alia*, the year effects control for intertemporal changes in the price of labor that might be induced by modifications in matching rates in federal grant programs. Because changes in federal grant rules are common to all communities, they are captured in the year effects.

b. **Serially correlated errors**. Equation (3.2) illustrates that the process of eliminating the individual effect induces serial correlation in the error term.[8] In the presence of lagged dependent variables, ordinary least squares will result in inconsistent estimates. We employ an instrumental variables estimation procedure suggested by Holtz-Eakin, Newey, and Rosen [1988]. In addition to generating consistent estimates, the procedure produces a chi-square statistic that can be used to perform a variety of specification tests, including tests for parameter stationarity over time.

c) **Heteroskedasticity**. We correct for heteroskedasticity using White's [1980] method.

d) **Functional form**. As stressed above, our estimating equation is based on a linear approximation to the exact Euler equation. If this linearization is inadequate, (say, because the marginal utility of government services is not locally constant), then in effect higher order powers of lagged labor will be grouped with the error term. This situation will induce a correlation between the error term and the instrumental variables, thus violating the orthogonality conditions. Hence, as a specification test, we test the appropriateness of the overidentifying orthogonality conditions.

Another important aspect of the functional specification is the assumption that the parameters are stationary over time. If stationarity is incorrectly imposed, then each time period's error term will contain a component that depends on the true values of the parameters and the right-hand side variables. The latter produces a correlation between the error terms and the instrumental variables and, again, the orthogonality conditions are violated. Thus, the test of the overidentifying orthogonality conditions also serves as a test for parameter stationarity.[9]

4. Results

We start by presenting the results for the entire sample of municipalities, and then for the two subsamples based on population size. In our linearized Euler equations, the coefficients have no natural interpretation. They are complicated amalgams of the utility and production function parameters.[10] For reference, however, we report the coefficients for the pooled sample in the Appendix. Coefficients for the various subsamples are available upon request. The following discussion concentrates on the test statistics for each of the hypotheses discussed above.

4.1 Pooled Sample

To begin, we will discuss the results for full-time employees. Our testing strategy is to estimate an equation which includes as special cases the differenced versions of models with and without increasing marginal adjustment costs (equations (2.6a) and 2.7a)) and models with and without separability between full-time and part-time labor (equations (2.6a) and 2.8a)). Tests of such a model will indicate whether or not increasing marginal adjustment costs and/or separability are present. We then impose the relevant constraints, and test the exclusion restrictions placed on lags of revenues, grants, assets, and debts.

A general equation that contains separability and increasing marginal adjustment costs as special cases is

$$\Delta F_{it} = \gamma_1 \Delta F_{it-1} - \gamma_2 \Delta F_{it-2} - \gamma_3 \Delta F_{it-3} + \gamma_4 \Delta P_{it-1} + \gamma_5 \Delta P_{it-2} + \gamma_6 P_{it-3} - \gamma_7 \Delta w^{P}_{it} + \gamma_8 \Delta w^{P}_{it-1} - \gamma_9 \Delta w^{P}_{it-2} + \gamma_{10} \Delta w^{f}_{it} + \gamma_{11} \Delta w^{f}_{it-1} + \gamma_{12} \Delta w^{f}_{it-2} + \Delta \mu^{f}_{it} . \quad \mathbf{(4.1)}$$

From equation (2.7a), in the absence of increasing marginal adjustment costs, $\gamma_2 = \gamma_3 = \gamma_5 = \gamma_6 = \gamma_9 = \gamma_{12} = 0$. From equation (2.8a), with separability, $\gamma_4 = \gamma_5 = \gamma_6 = \gamma_7 = \gamma_8 = \gamma_9 = 0$.

Our first step is to estimate (4.1) with no restrictions. Line 1 of Table 2 indicates that

Q, the minimized chi-square statistic, is 31.14, with 28 degrees of freedom. At a 0.05 significance level, the critical value of the chi-square distribution is 41.33. Hence, we cannot reject the hypothesis that the parameters are stationary over time. Note that if the preference function and/or the discount rate changed markedly from period to period, or if the linearization embodied in the equation were inadequate, then the data would have rejected parameter stationarity.

We next consider the question of adjustment costs. As just noted, in the absence of increasing marginal adjustment costs, the coefficients on the six variables ΔF_{t-2}, ΔF_{t-3}, ΔP_{t-2}, ΔP_{t-3}, Δw^f_{t-2}, and Δw^p_{t-2} should be zero. When we impose this constraint, the minimized chi-square statistic is 38.61. (See line 2 of Table 2.) The increase in Q, denoted L, is 7.47. With 6 degrees of freedom, the critical value of the chi-square distribution is 12.59. Hence, the data do not reject the hypothesis that increasing marginal adjustment costs are absent.

Conditional on no increasing marginal adjustment costs, is the production function separable between full-time and part-time labor? With separability, the three variables Δw^p_t, Δw^p_{t-1}, and ΔP_{t-1} have zero coefficients in equation (4.1). (Remember, the other lags of Δw^p_t and ΔP_t in (4.1) are already excluded because there are no increasing marginal adjustment costs.) Line 3 of Table 2 indicates that imposing this set of constraints increases the minimized chi-squared statistic by 18.08, a statistically significant amount. The data reject the hypothesis that the municipal production function is separable in full-time and part-time labor.[11]

So far, we have shown that the lag structure is consistent with a technology without increasing marginal adjustment costs and with nonseparability between full and part-time labor. We now turn to the question of whether communities' labor demands are "rational" in the sense of being consistent with the intertemporal utility maximization model of Section 2. As noted there, in the absence of adjustment costs, no lagged variables other than the quantity of labor and the wage rate should appear in the Euler equation. We now test the hypothesis that lagged values of own revenues, grants, and net financial assets can be excluded from the Euler equation. To do so, we first augment the specification from line 3 with three lags each of own revenues, grants, and net assets. We then repeat the exercise with only two lags of these three variables; then with only one lag; and then with none. The results are recorded in lines 4 through 7 of Table 2. They indicate that one cannot reject the hypothesis that all lags of revenues, grants, and net assets can be excluded from the Euler equation. In short, for the sample as a whole, viewing full-time labor demand as a linear, unconstrained, forward looking process is consistent with the data.

An analogous set of results for part-time labor is presented at the right side of Table 2. All the substantive results associated with the analysis of full-time labor are replicated: the parameters are stable over time, there are no increasing marginal adjustment costs, the production function is nonseparable between full and part-time labor, and the path of part-time labor demand is rational in the sense defined above. Importantly, our estimation procedure does *not* impose any constraints that would force the substantive results from the full and part-time equations to be the same. It would have been distressing to find the data indicating that the two series were being generated by two different processes. While the absence of such an anomalous result obviously does not constitute proof that our model is "right," it is still comforting.

4.2 Small versus Large Communities

As suggested earlier, the results for the entire sample may be masking differences across different types of communities. We therefore re-estimated the Euler equations separately for small and large communities. The results are presented in Table 3, which is organized in a fashion parallel to Table 2. The top panel of Table 3 shows that the small community sample mirrors the results for the entire sample: the parameters are stable, there are no increasing marginal adjustment costs, full and part-time labor are not separable, and all lags of own revenues, grants, and net assets are excludable. The similarity is not unexpected; as noted in section 3.1, small communities comprise about two-thirds of the pooled sample.

However, the results for large communities, in the bottom panel of Table 3, do reveal some differences. Like the small communities, the parameters are stable over time, and there are no increasing marginal adjustment costs. However, the results in line 3 indicate that one cannot reject the hypothesis that full and part-time labor are separable in the production function. (The critical chi-square value at a 0.05 significance level is 7.82, which exceeds the value of L, 7.67.) Perhaps more interestingly, line 7 indicates that one can reject the hypothesis that the first lags of own revenues, grants and net assets are zero. Hence, the intertemporal utility maximization model fails to explain the behavior of these communities. As suggested above, this may reflect myopia, liquidity constraints, or backward looking behavior in the determination of labor demand in these communities.[12] One possible explanation is that the presence of public sector unions in large cities may prevent them from responding optimally to changes in economic conditions. An investigation of this topic is an important topic for future research, but beyond the scope of the present paper.

5. Conclusions

This paper has examined the dynamic behavior of local governments' demand for labor. Using panel data on 161 governments during the years 1973-1980, we have obtained the following results:

First, for the sample as a whole, one cannot reject the hypothesis that the path of labor demand is consistent with the maximization of an intertemporal utility function under uncertainty. This result is consistent with the findings of previous investigators like Freeman [1987], whose more informal models have suggested that subfederal government labor demand reacts sensibly to changes in the economic environment.

Second, when the sample is divided into large and small communities, the rational, forward looking model continues to hold for small communities, but it fails for large communities. This is in line with Inman's [1983] view that the fiscal decision-making process of cities is myopic and backward looking. It is also consistent with Holtz-Eakin and Rosen's [1989] analysis of capital spending in a sample of New Jersey municipalities. They found that for relatively small communities, one cannot reject the rational, forward-looking view of capital spending determination. In contrast, this view of capital spending is rejected for large communities. A second difference between the two types of communities is the nature of their production technologies. For small communities, the production function for government services appears to be non-separable in full and part-time labor; for large communities, these two inputs are separable.

Third, for both small and large communities, one cannot reject the hypothesis that increasing marginal adjustment costs are absent from the employment of full and part-time labor. This suggests that communities can rapidly adjust their labor forces in response to changes in their economic environments, at least in comparison to a situation where costs rise steeply with the amount of adjustment.

Thus, our findings suggest that despite its stringent assumptions, the rational forward looking model appears to be consistent with the behavior of at least some communities. However, the heterogeneity we find in our sample indicates that it may be difficult to find a single model that adequately describes the behavior of both large and small municipalities.

Endnotes

1. Computed from *Economic Report of the President*, January 1989, pp. 356-57.

2. Applebome [1986, p. 17] and James [1989, p. B1] describe these events.

3. Our analysis of time series data on aggregate state and local current expenditures suggests that heterogeneity is indeed present--about 38 percent of spending is generated by a permanent income-type model, and 62 percent by a Keynesian-type model. See Holtz-Eakin and Rosen [1990].

4. More precisely, communities with zero or implausibly low levels of school expenditure were excluded.

5. Ideally, one would want to perform a different adjustment for each community, based on the exact maturities of its outstanding debt. Our data do not identify the maturities (debt is classified only as "short-term" or "long-term"); therefore, the same adjustment is made for all communities.

6. The wage and employment variables are the values for each October. We experimented with a payroll variable that included nonwage components of compensation such as health insurance, and found that it left our substantive results unchanged.

7. We estimate each Euler equation using single equation methods, ignoring cross-equation constraints on the coefficients and possible correlation of the errors. While this reduces the efficiency of our estimates, it does not affect their consistency. This procedure has the usual advantages of limited information methods: it is relatively simple computationally, and ameliorates the consequences of specification errors.

8. Following Sargent [1978], identification of the model requires that serial correlation not be due to shocks to preferences.

9. Details of the test are provided in Holtz-Eakin, Newey and Rosen [1988].

10. As Topel [1982] has indicated, the coefficients of dynamic demand equations derived from a set-up similar to ours may have fairly intuitive interpretations in terms of the parameters of the underlying behavioral and technological relations. But this is not the case for Euler equations. For example, in a demand for consumption function, one expects the interest rate to have a negative sign (provided that the substitution effect dominates the income effect). However, as Hall [1978] notes, in an Euler equation for consumption, the interest rate appears with a positive sign because the higher the interest rate, the more that consumption is deferred to the future, and the greater the growth rate of consumption.

11. We also examined whether the production function is separable between capital and labor. To do so, we augmented the specification in line 2 with the first lag of

investment spending. The associated chi-square test with 1 degree of freedom was 0.042. Hence, the data do not reject the hypothesis that lagged capital expenditures can be excluded from the equation; i.e., the production function is separable. The same result was found in all the specifications discussed below.

12. The possibility that liquidity constraints lead to violations of the Euler equations has been investigated by Zeldes [1989] in the context of consumer spending. He does this by estimating separate equations for high- and low-asset individuals. This procedure hinges on the availability of a sufficiently large sample that consistent estimates can be obtained for each subsample. The sample of large communities used here does not meet this requirement.

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TABLE 1

SAMPLE STATISTICS[a]

	Mean	Standard Deviation
Pooled Sample		
Full-Time Employees	0.031	0.009
Part-Time Employees	0.006	0.004
Full-Time Wage	0.046	0.012
Part-Time Wage	0.012	0.044
Own-Source Revenues	548.0	299.8
Grants	233.5	113.0
Net Financial Assets	-353.8	518.8
Large Communities		
Full-Time Employees	0.032	0.007
Part-Time Employees	0.005	0.003
Full-Time Wage	0.013	0.006
Part-Time Wage	0.003	0.002
Own-Source Revenues	489.0	149.1
Grants	254.0	111.1
Net Financial Assets	-388.0	239.5
Small Communities		
Full-Time Employees	0.031	0.009
Part-Time Employees	0.006	0.004
Full-Time Wage	0.062	0.045
Part-Time Wage	0.016	0.013
Own-Source Revenues	577.7	348.5
Grants	223.2	112.6
Net Financial Assets	-336.6	612.7

[a] All variables are in per capita terms. Dollar figures are expressed in 1977 levels.

TABLE 2

POOLED SAMPLE

	Full-Time Labor				Part-Time Labor			
	Q[a]	d.f.	L[b]	d.f.	Q[a]	d.f.	L[b]	d.f.
1. Unconstrained Model	31.14	28	---	---	22.35	28	---	---
2. Zero Adjustment Costs	38.61	34	7.47	6	26.85	34	4.50	6
3. Zero Adjustment Costs plus Separability	36.77	21	18.08	3	33.59	21	16.80	3
4. Zero Adjustment Costs plus 3 lags of $\Delta R_t, \Delta A_t, \Delta NA_{t-1}$	20.52	13	---	---	13.56	13	---	---
5. Zero Adjustment Costs plus 2 lags of $\Delta R_t, \Delta A_t, \Delta NA_{t-1}$	30.61	23	10.09	10	26.66	23	13.10	10
6. Zero Adjustment Costs plus 1 lag of $\Delta R_t, \Delta A_t, \Delta NA_{t-1}$	40.96	33	10.35	10	37.31	33	10.65	10
7. Zero Adjustment Costs plus no lags of $\Delta R_t, \Delta A_t, \Delta NA_{t-1}$	46.17	36	5.21	3	39.64	36	2.33	3

[a] Minimized chi-square statistic.
[b] Change in Q attributed to the restriction.

NOTE: All estimating equations include time effects and individual effects.

Line 1: Instrumental variables are a constant and lags 4 through the longest available lag of F_t, P_t, w_t^f, w_t^p for each year. Years used are 1977-1980.
Line 2: Same as line 1, except years are 1975-1980.

Line 3: Instrumental variables are lags 2 through the longest available lag of F_t, P_t, w_t^f, w_t^p for each year. Years are 1975-1980. Line 3 uses additional instrumental variables because of the finding of no adjustment costs. Hence, the values of *Q* and *L* are not directly comparable to those in lines 1 and 2.

Line 4: Instrumental variables are a constant and the second lag of $F_t, P_t, w_t^f, w_t^p, R_t, A_t, NA_{t-1}$ for each year. Years used are 1977-1980. Again, Q and L are not comparable to lines 1 through 3.
Line 5: Same as line 4, except years 1976-1980.
Line 6: Same as line 4, except years 1975-1980.
Line 7: Same as line 4, except years 1975-1980.

TABLE 3

RESULTS BY COMMUNITY SIZE

	Small Community Sample							
	Full-Time Labor				Part-Time Labor			
	Q[a]	d.f.	L[b]	d.f.	Q[a]	d.f.	L[b]	d.f.
1. Unconstrained Model	19.63	28	---	---	22.52	28	---	---
2. Zero Adjustment Costs	25.18	34	5.55	6	25.97	34	3.45	6
3. Zero Adjustment Costs plus Separability	33.00	21	16.88	3	39.09	21	20.02	3
4. Zero Adjustment Costs plus 3 lags of $\Delta R_t, \Delta A_t, \Delta NA_{t-1}$	19.09	13	---	---	13.11	13	---	---
5. Zero Adjustment Costs plus 2 lags of $\Delta R_t, \Delta A_t, \Delta NA_{t-1}$	29.98	23	10.89	10	24.78	23	11.67	10
6. Zero Adjustment Costs plus 1 lag of $\Delta R_t, \Delta A_t, \Delta NA_{t-1}$	36.72	33	6.74	10	35.22	33	10.44	10
7. Zero Adjustment Costs plus 0 lags of $\Delta R_t, \Delta A_t, \Delta NA_{t-1}$	41.47	36	4.75	3	39.02	36	3.80	3
	Large Community Sample							
1. Unconstrained Model	31.93	28	---	---	25.53	28	---	---
2. Zero Adjustment Costs	34.81	34	2.88	6	30.78	34	5.25	6
3. Zero Adjustment Costs plus Separability	24.05	21	7.67	3	18.05	21	1.78	3
4. Zero Adjustment Costs plus 3 lags of $\Delta R_t, \Delta A_t, \Delta NA_{t-1}$	13.90	13	---	---	18.22	13	---	---
5. Zero Adjustment Costs plus 2 lags of $\Delta R_t, \Delta A_t, \Delta NA_{t-1}$	28.11	23	14.21	10	26.75	23	8.53	10
6. Zero Adjustment Costs plus 1 lag of $\Delta R_t, \Delta A_t, \Delta NA_{t-1}$	28.26	33	0.15	10	33.52	33	6.77	10
7. Zero Adjustment Costs plus 0 lags of $\Delta R_t, \Delta A_t, \Delta NA_{t-1}$	40.51	36	12.25	3	34.39	36	0.87	3

[a,b] See notes to Table 2.

APPENDIX

PARAMETER ESTIMATES FOR POOLED SAMPLES[+]
DEPENDENT VARIABLE

	ΔF_{it}	ΔP_{it}
ΔF_{it-1}	-0.0805 (-1.93)	-0.0060 (-0.09)
ΔP_{it-1}	-0.1965 (-3.22)	0.0957 (1.07)
Δw_{it}^{f}	-0.0925 (-2.90)	0.0843 (2.26)
Δw_{it}^{p}	-0.0020 (-0.05)	-0.0460 (-0.93)
Δw_{it-1}^{f}	-0.0054 (-0.29)	-0.0525 (-1.75)
Δw_{it-1}^{p}	0.0387 (1.51)	-0.0317 (-1.01)

[+] All equations also contained time dummy variables. Asymptotic t-ratios are shown in parentheses.