

**A CLARIFICATION: USING THE GROWTH MODEL
TO ACCOUNT FOR FLUCTUATIONS***
Reply to James Heckman

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There is apparently considerable confusion as to what has been learned from the research reported in the paper "Time to Build and Aggregate Fluctuations" and from the subsequent research that developed this line. These efforts are best viewed as accounting exercises. We are determining to what extent the postwar fluctuations of the United States economy can be accounted for by the equilibrium stochastic growth model. Following Solow (1957), changes in output not accounted for by changes in inputs are interpreted as being technological shocks. Using shocks of the same magnitudes and with similar serial correlation properties as those residuals, we found that they, along with an extended growth model, accounted for most of the fluctuations in aggregate United States output and employment.

We learned that simple naive versions of the stochastic growth model account for too little of aggregate fluctuations, especially hours' variability. Using a standard time-separable utility function, about two-thirds of the fluctuations in the data were accounted for. If households are assumed to value leisure more if they have consumed less leisure in the past, the growth model explained nearly all.

There are, of course, other possible explanations. For example, we could have increased the weight on leisure in the utility function as explained in Section IV. This is a route that Eichenbaum, Hansen, and Singleton (1984) took. We rejected that route because that specification was inconsistent with average relations in aggregate data as well as with microfindings on households' average time allocation to market activity as discussed in our paper.

There is substantial evidence, both at the macro- and microlevel, that

*To the extent that this reply deals with those of Heckman's comments that are also directed at the joint paper with Edward Prescott, it has received extensive input from Prescott. This note was written while I was visiting the Hoover Institution.

leisure is valued more relative to contemporaneous consumption the less leisure has been consumed in the recent past. Lucas and Rapping (1969) suggested this as an explanation of the large aggregate labor-supply elasticities they found. Hotz, Kydland, and Sedlacek (1982), using the Panel Study of Income Dynamics, estimated the parameters of non-time-separable utility functions from the first-order conditions for utility maximization for prime-age males who worked in every year of the sample period. Because there are surely large measurement errors in wage rates in this data set as discussed in Section II of my paper, we devised a method for estimating the parameters without using the intertemporal leisure condition, thus not requiring the use of wage data. The estimated weights on past leisure in current utility are positive and fairly large, considering the fact that the data are annual.

It is obvious that much of the employment fluctuation has taken the form of females (and also youths) moving in and out of the labor force. But, just as concentrating on males gives a distorted picture of the variation, we cannot consider only females, either. It is reasonable to think of the household as the relevant decision unit, and to my knowledge the joint movements of male and female hours of work have not been extensively studied. At the individual level, there is a surprising degree of volatility in annual hours worked even by prime-age males. It is simply not the case that they are bunched around 2000 hours a year. This is clear from the PSID, which is the only dataset of this type that I am aware of in which multiple jobs and moonlighting are included. I computed the standard deviation of hours for each male over the twelve-year sample period and then averaged the resulting figures. The ages in the last year were between 34 and 60. If we exclude those who reported zero hours in at least one out of the twelve years, the average of 593 individual standard deviations is 312, or more than one-eighth of the overall mean of annual hours.¹ The wage rate fluctuates relatively less, and, to me at least, this surprisingly high figure suggests that there is substantial variability in hours even among men who work every year.

¹ I excluded those individuals who reported working more than 4380 hours in any year and also those whose highest real wage in any of the twelve years was more than five times as large as the lowest. Leaving these observations in would have made the variation even larger. As another example, selecting only those who work more than 500 hours in every year lowers the average standard deviation to 302 for 576 individuals, which is still more than one-eighth of the mean.

The evidence of heterogeneity of workers is clearly overwhelming. The importance for the stand-in household is less clear, however. I thought my Section VII made it clear that I think investigating the importance of entry and exit, say with fixed costs, is a potentially interesting research topic, and that it may very well turn out that a representative consumer with non-time-separable utility is partly a stand-in for that phenomenon. I do not see how anybody can as yet claim to know the answer. The recent work of Rogerson (1984) should bring us closer to an answer.

Turning now to Heckman's comments on adjustment costs, insofar as such costs are important, they imply smaller response of the labor input to shocks. This is true whether there be one capital good or many (we had five). Adjustment costs, if significant, spread out the effects of shocks, reducing their effect at any point and thereby reducing the variation in output accounted for by any given shock, whether it be technological or monetary. The microevidence for the time-to-build assumption is also overwhelming. It is hardly controversial that expansion in capacity requires allocation of resources over more than one quarter. Mayer's (1960) survey, for example, supports this. Taylor (1982) found that Swedish data are consistent with this investment technology.² The microevidence is inconsistent with adjustment cost as discussed in Kydland and Prescott (1982).

Heckman relies on Altug's estimates as key support for his position. Considering the fact that her model is different from the one Prescott and I used, this hardly seems warranted. She assumes a one-parameter specification of the relative weight distribution on current and past leisure choices in the utility function. Except for an unlikely special case, this formulation, as I showed in Section IV, is a very different utility function. Furthermore, Altug does not include our indicator shock but instead assumes that the aggregate variables are subject to measurement errors that are independent over time. Especially for hours worked, my paper indicates that this is an unrealistic assumption. With regard to productive technology, she has the problem one usually runs into when formally estimating production functions, namely, that the output

²Taylor looked only at investment in structures. In an interesting version of her model, Altug (1983) distinguishes between investment in structures and equipment.

elasticity of labor input becomes near one.³ Average relations in the model, such as the inventory-output ratio or the ratio of investment in structures and equipment for the model in which they are treated separately, differ from those in the data by factors of more than ten. It is hard for me to see, then, how these estimates give any basis for firm conclusions about the appropriateness of time-to-build versus cost-of-adjustment investment technology, or about intertemporally nonseparable versus separable utility functions, for that matter.

We do not view our efforts as the definitive numbers--just the best that are currently available. Better measurement of the economic time series may significantly alter the numbers. Any measurement improvement which makes hours less variable and GNP more variable increases the amount accounted for by the growth model. Measurement improvements with opposite effects, of course, reduce the fraction explained. Besides measurement considerations, features from which we abstracted may also prove to be important. Perhaps permitting hours to increase by employing capital more hours in a given week with the same number of workers rather than fixing the work-week of capital would make an important difference. Perhaps introducing human capital acquisition associated with production is a significant consideration. In other periods or in other countries, one may find less or more of the fluctuations accounted for by technological shocks. There is no shortage of candidates to account for the residual. Monetary and fiscal shocks come to mind first, as do shocks to the household technology. We have been concerned with peacetime cycles. Wartime shocks may affect the economy differently, and so may foreign-trade shocks. These are a few of the questions that warrant investigation.

³See Lucas (1970) for a possible explanation.

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