Comment on INFLATION, PERSONAL TAXES, AND REAL OUTPUT: A DYNAMIC ANALYSIS, *by Finn E. Kydland*

When Bill Gavin asked me to discuss the Altig-Carlstrom (hereafter AC) paper, he said he was looking for the perspective of real business cycle theory. While I am happy to oblige in that respect, I could also refer to the first study of the role of real shocks with which I was involved (Kydland and Prescott 1980). This was before we thought we could get away with not having monetary shocks in a business cycle model, so the perspective is more balanced. At one point we conclude, based on a few numerical steady-state exercises (p. 174): "More surprising, at least to us, is the large effect that changes in anticipated future inflation rates have upon the capital stock. A change in the average inflation rate from zero to 7 percent more than offsets the effect of a 10 percent investment tax credit, at least for the assumed parameter values. The increase in the average inflation rate that occurred in the seventies may be the principal cause of the low rates of capital accumulation in recent years." I may add that the main mechanism through which inflation played a role for real aggregates in those exercises was through changes in the real value of capital-consumption allowances for tax purposes. I suppose in those days we also had some faith in the role of money for the business cycle. That faith has waned over the years. On the other hand, I have always been sympathetic to the notion that, at least for growth, inflation may be a factor of some importance through interaction with the fiscal tax system. I believe we know little about the role such factors play at cyclical frequencies, and I think this is a very interesting paper on that subject.

The question stated as that to be addressed is (p. 548): "What consequences do interactions between inflation and the nominal taxation of capital income have for the cyclical behavior of the macroeconomy?" To address that question, AC had to choose an appropriate model economy. Their choice appears reasonable, given the propagation mechanism they wish to study. In their theory, inflation plays a role partly through bracket creep that results, under a progressive tax system, from overstating capital income for tax purposes. This feature may affect people differently at different stages of their life cycle. Thus, a model environment in which people work for fifty-five years, and in which there are that many overlapping generations, is an a priori reasonable one, assuming it is tractable.

One of the messages of Auerbach and Kotlikoff's (1987) pathbreaking book is that such models are computationally feasible. We now are beginning to see others follow their lead and use model environments of that type, especially for questions for which heterogeneity may play a significant role. An example is the recent paper

FINN E. KYDLAND *is professor in the Graduate School of Industrial Administration, Carnegie-Mellon University.*

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by Rios-Rull (1990), who studies the implications for aggregate fluctuations of differences in skill distributions over the life cycle and over the business cycle. He makes a quadratic approximation of the economy and then computes the equilibrium for the resulting approximated stochastic economy. The computation of equilibrium is time-consuming, but the subsequent simulations are cheap. AC, in contrast, use equilibrium conditions under certainty. Their simulations are obtained as follows. In every time period a shock occurs. The decision at that point is the first-period part of the path under certainty from that point toward the steady state. Next period, the state of the economy, including the capital stock, has been updated and a new shock occurs. The same procedure is repeated for the required number of time periods. This method surely is faster than Rios-Rull's (assuming the number of simulations is not extremely large), but it remains an open question how accurate the approximation is and whether its use could affect any of the answers.

This paper complements recent research whose aim is to investigate the role of tax policy for cyclical behavior. Examples are Braun (1988), Chang (1988), and McGrattan (1988). In these papers, the representative consumer version of neoclassical growth theory is used as the model environment. Chang, for instance, distinguishes between the differential roles of tax policies for investment in structures and equipment. Inflation is not incorporated in the model, but makes a difference in the data she uses through its effect on effective real tax rates. The work that perhaps comes closest in scope to AC is in Chang (1990). Here, she introduces variations in money growth with associated changes in inflation, and considers the interaction between inflation policy and the fiscal tax system. The way in which that happens is different from AC and the focus is on taxation of capital as well as labor income.

In the following, I shall comment more directly on the paper. My conclusion will be that this is a promising start, but it is surely not the last word on the role of inflation, or, more generally, monetary changes, for the business cycle. I suspect that we are likely eventually to find that inflation plays a substantially greater role than this paper indicates.

Detrending

In contrasting the properties of a model economy with those of the U.S. economy when the question at hand is related to cyclical behavior, it is often useful to detrend time series, resulting in series that one can think of as the cyclical components of those series. AC make the surprising choice of detrending per capita real GNP, consumption, investment, capital stock, and average productivity according to a common trend-growth rate, namely that of consumption. This choice possibly detracts from the clarity of the findings. The problem can be seen in Figure 1. Here, the detrended capital stock stays well below the trend for about a decade. Then, in a matter of about five years, it shoots up to well above the trend and basically stays there for the remaining twenty years or so of the sample period. The problem for some uses is that, in computing correlations between series detrended that way, the correlations may be dominated by behavior that few would associate with business-cycle frequencies.

An alternative detrending method is the Hodrick-Prescott (1980) filter. One of the arguments that can be made for its reasonableness is that the resulting trend is similar to the smooth curve that most students of the business cycle would draw through the picture of the raw series. The curve for the capital stock in Figure 1 clearly does not satisfy that criterion. On the other hand, the picture suggests that alternative detrending methods would not change the sign of the correlation, although the property that capital is more highly correlated with inflation than investment is may be reversed. Indeed, the HP filter yields a capital-inflation correlation of about 0.45, which is larger than that between inflation and investment.

Since we do not have pictures of all the variables, it is not clear what the detrending method does to the other aggregates, or what happens to per capita hours, for example, which here has not been detrended. For investment and hours, the HP filter produces much larger contemporaneous correlations with output than those presented in Table 1, while for productivity it is smaller.

One may argue that problems of the type discussed above do not affect the comparison between the model and the data so long as the same detrending method is used for the time series from the model and the data. A problem with interpretation may arise, however, if, because of the detrending method, a considerable amount of movement is left that takes place at lower than business-cycle frequencies, but the model does not include anything to account for such behavior. Therefore, uncertainty remains in my mind regarding the degree of confidence one can attribute to some of the reported findings.

Calibration

A major reason for using an overlapping generations framework is to permit the human capital of workers to change over their lifetimes. In this model, a generation's skills evolve exogenously. The assumed pattern of productivity endowment is given at the bottom of Table 2. It is hump-shaped with a peak in year 25. Its value in that year is only 8.3 percent higher than in year one. Furthermore, in the last seven years it drops to as much as 5.4 percent below the value in year one. This pattern, which appears much too flat, contrasts with that used by Rios-Rull (1990), who computed it directly from CPS data. His highest value is 78 percent larger than in year one, and the value in period fifty-five still is 15 percent larger than in the first year.

There is evidence for the United States that the cyclical behavior of the labor input is very different from that of aggregate hours of work (Kydland and Prescott 1989). It would be interesting to know whether the model captures some of that difference. Given how little volatility in hours the model produces, however, the labor-input volatility probably could not be much lower.

In my comments at the conference, I was worried that, with growth in per capita output, the depreciation rate of 10 percent was too high, resulting in a capital-output ratio that was too low. In the revised draft, AC mention that they have removed the average growth in the Solow-residual process, evidently to avoid the problem that the model produces a trend in per capita hours, which in the data are essentially without trend. I do not think, however, that this is the preferred way of taking care

of the problem of a trend in per capita hours. As shown in Kydland (1984), within the class of CES utility functions, the special case of unitary elasticity is the one consistent with constant steady-state hours. It seems to me that the appropriate way to proceed is not to remove per capita growth, but to abandon the intratemporally separable utility function stated in equation (1). I cannot see that their assumption buys anything computationally. They do assume larger intertemporal elasticity of substitution in leisure than in consumption, but alternative utility specifications have that property while still being consistent with nearly constant long-run per capita hours.

Findings

The main finding is that the model feature emphasized in this paper contributes little to aggregate fluctuations. There is almost no difference in the behavior of the capital stock with and without taxes or for flat versus progressive taxes. This could change if features such as those considered by Chang (1990) are included. They give a more direct kick to capital accumulation. There is a slightly larger difference in the movement of hours of work. But even this difference is really quite small. The main one is to lower the correlation of hours with the cycle, and the perceived need for this change simply may be a reflection of a misleading detrending method. As Figure 4 indicates, the model produces little variability in hours. To what extent the flat life-cycle human-capital pattern is a factor here remains an open question.

A major discrepancy in the experiments relative to the U.S. statistics in Table 1 are the large contemporaneous correlations between the capital stock and output. I already have mentioned the low correlations between hours and output. These relative magnitudes of comovements between the inputs and output are just the opposite of what we see in the data whether detrended as in AC or using the HP filter.

Exogenous to the model is an estimated second-order autoregressive process for inflation defined as changes in the CPI. The model does not include money explicitly. A real business-cycle model with money can have considerable price-level volatility even with steady money growth. In addition, then, there could be inflation fluctuations associated with variations over time in the growth of the money stock. AC do not distinguish between these sources of measured inflation variation. This may account for the finding that led them to suggest that "the positive correlation between capital and inflation is not due to inflation per se but because of the relationship between inflation and the Solow residual." A property of postwar U.S. data, which is consistent with real business-cycle theory and with the magnitudes of the capital-inflation correlation mentioned earlier, is that both capital stock and inflation lag the cycle by one to two years. Including money explicitly would make it easier to account for these two sources of measured inflation and presumably provide a better model environment for studying its role in many contexts.

Concluding Remarks

This paper represents a fine effort directed toward obtaining answers to a very interesting type of question that deals with the interaction between monetary policy,

as reflected in different inflationary environments, and the fiscal tax system. This is an area of research that I think will attract many researchers in the near future. Furthermore, along with Auerbach and Kotlikoff (1987) and Rios-Rull (1990), the paper demonstrates the tractability of applying these kinds of models that incorporate heterogeneity in interesting ways, which can be important for many questions. Focusing on one particular source of interaction between inflation and the fiscal tax structure has the advantage of bringing out clearly what this feature does quantitatively to aggregate fluctuations. This exercise is interesting whether the resulting quantitative magnitudes are large or, as in this case, small. Thus, we learn a considerable amount even though the authors have not yet included the features that I think carry the greatest potential for generating a role of inflation for the business cycle.

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