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A solution method for consumption decisions in a dynamic stochastic general equilibrium model

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Abstract

In this paper we describe a numerical solution of the consumer's life-cycle problem based on value function iteration. The advantage of our approach is that it retains the versatility of the value function iteration approach and achieves a high degree of accuracy without resorting to the very computationally burdensome task of calculating a very fine grid. There are two innovations, the first is not to discretise the state space but effectively to allow the states to take any value on the real line by using two different third-order interpolation algorithms: bicubic spline for extrapolation and interpolation on the edge of the grid and the faster cubic convolution interpolation for inside the grid. The second is to compute a pair of nested grids, one coarse and one fine. The fine grid is used to calculate the consumption paths of the majority of individuals, and the coarse grid to catch only the few with very high incomes. We shall discuss our approach in relation to those already in the literature. We shall argue that value function iteration approach is probably the most flexible and robust way to solve these problems. We shall show that our implementation achieves a high degree of accuracy, using a modified den Haan and Marcet simulation accuracy test, without comprising significantly on speed. © 2000 Elsevier Science B.V. All rights reserved.

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1. Introduction

In this paper we describe a numerical solution of the consumer's life-cycle problem based on value function iteration. The advantage of our approach is that it retains the versatility of the value function grid approach: it can easily accommodate increasing complexities such as liquidity constraints, margins between interest rates on lending and borrowing, means-tested benefits, uncertain life length etc. At the same time it achieves a high degree of accuracy without resorting to the computationally burdensome (and therefore time-consuming task) of calculating a very fine grid. The motivation for solving this consumer problem efficiently and accurately is to be able to solve a general equilibrium model with as near as possible a continuum of consumers.

We have made two innovations to the basic value function iteration approach as described in Taylor and Uhlig (1990, p. 2). The first is effectively to allow the states of the problem to lie anywhere on the real line rather than at a set of discrete grid points by using two different third-order interpolation algorithms: bicubic spline for extrapolation and interpolation on the edge of the grid and the faster cubic convolution interpolation for inside the grid. The second is to compute a pair of nested grids; a coarse one and a fine one. The fine grid is used to calculate the consumption paths of the majority of individuals, and the coarse grid to catch the few very wealthy, or productive or just plain lucky ones.

Any numerical solution algorithm must be assessed according to its accuracy, speed, flexibility and robustness. We discuss in detail these concepts and show how the performance of other algorithms in the literature can be assessed according to these criteria. We argue that our algorithm compromises slightly on speed, but gains in both flexibility and robustness. We assess its accuracy in detail by using the den Haan and Marcet test of simulation accuracy. This is a powerful test which has been used previously by Den Haan and Marcet (1994) and Campbell and Koo (1997) to rank solutions to stochastic steady-state problems according to their accuracy. We have adapted this test slightly so that now its results also include an absolute measure of accuracy as well as a comparative one. These tests all suggest that our solution algorithm attains a very high degree of accuracy.

The structure of the paper is as follows. Section 2 describes the model we wish to solve. Section 3 discusses our assessment criteria and discuss the other solution algorithms in the literature with reference to these criteria. Section 4 describes in detail our algorithm and discusses its speed, flexibility and