Computational economics is rapidly changing the types of problems economists can feasibly solve. In particular, advances in non-linear solving algorithms have allowed macroeconomists to create dynamic, multi-objective optimization (MOO) models that can be applied to growth theory. The research presented will show how Microsoft Excel's built-in Solver function can be utilized to create and test a growth model.

Base Model and Motivation

The work of Messrs. Kendrick and Mercardo (3/30/2004) creates the base of the growth model used. Over nine periods, optimal consumption levels are chosen such that the combined utility is maximized, while simultaneously reaching a final target capital level:

The model is constrained by limits on consumption set by the level of production; consumption must be greater than zero; and the interrelationship between capital, production, and consumption:

Excel is subsequently charged with altering consumption levels at each period such that the maximum total utility is reached. The model is also given static variables that represent the depreciation rate , the discount factor , the sensitivity of production to capital , and a variable used in correlating the consumption and utility . These variables can be altered to run parametric studies on how perturbations will affect consumption patterns in each period. A sample study on how increases in the discount factor—effectively a measure of how patient actors are—will shift consumption further into the future can be seen in **Figure 1**. The model matches well with expected results: consumption is smoother (has a flatter slope) when the discount rate is close to unity. This implies that agents are willing to sacrifice present consumption so that future production—a function of current capital—will be higher in future periods, and therefor overall utility will be as well. This fits established analytic models of future value which obey the relationship:

where is the real interest rate:

Improving the Model

While the proposed model owes a great deal to the foundation laid by Kendrick and Mercardo, some improvements have been made to align it both with known economic and sociological models as well as patterns observed in the real world. Mainly, the production function used by Kendrick and Mercardo is the Neoclassical Growth Model as proposed by Harrod and Domar (1946), not the expanded model of Robert Solow (1956) in which labor factors into growth. The original, continuous formula described by Solow has been modified to a finite, period based one.

The proposed model incorporates a population that grows each period in accordance to the model proposed by John Vandameer (2010). Vandameer's model posits that populations grow in a bounded exponential fashion, where the current population density serves as a negative feedback mechanism. This model suggests that populations will grow at an exponential rate until the population density approaches some maximum level, after which population growth will plateau. In the proposed model, population density has been replaced with a predefined population cap . This population growth function has the properties of an increasing population and, after a number of periods, a negative second derivative, implying a slowing growth rate as seen in **Figure 2**.

In addition to omitting the labor force, the base model assumes that technology , is a constant throughout all periods. The proposed model instead incorporates an exponential growth in technology, as described by:

**Figure 1: Consumption v. Time as a Function of Discount Factor**