

Capital Vintages and Technology Diffusion in Global Models

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Abstract

This paper provides an examination of the implications associate with different types of technological change for the operation of recursive dynamic CGE models. The analyses contrast the implications of different types of technical changes – Hicks, Harrod and Solow neutral – for model performance and analyses the importance of tracking capital vintages to ensure that capital services as opposed to capital stocks are used in the model's production functions. In addition it is noted that the interpretation of technical change in most CGE models does not coincide with the interpretation in the productivity literature; the adjustments necessary to calibrate recursive dynamic models are identified.

Keywords: capital vintages; dynamic CGE models; model calibration.

JEL classification:

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Introduction

The treatment of technological change and its interaction with capital accumulation in dynamic CGE models is arguably crude. It is common in (recursive) dynamic models to assume a high degree of separability between capital accumulation and technology change and to assume, implicitly, that any technological change that effects the productivity of capital impacts upon all capital, i.e., existing and new capital. This approach has obvious attractions; it avoids the modeler having to track capital in both ‘natural’ and efficiency units and simplifies treatment of technological change by facilitating the imposition of Hicks neutral technological change at some, usually unspecified, level of the production system. However both the technological change and economic growth literatures suggest that this common approach is poorly grounded in economic theory. In particular Hicks neutral technological change is not consistent with steady state growth while it is common for new technology to be associated with new capital investments, Solow neutral technological change.

This study uses a recursive dynamic variant of the GLOBE model to analyse the implications of departing from the assumption of ‘pure’ Hicks neutral technological change in two ways. First, it is assumed that new technologies are, to a greater or lesser extent, embedded in new capital stocks – Solow neutral technological change. This requires that the model tracks the vintages of capital stocks so that a separation can be maintained between capital stocks in ‘natural’ and ‘efficiency units. The approach developed in this application is to assume that once capital is invested in an activity it cannot be relocated to another activity; the model therefore only allows capital stocks by activity to reduce through depreciation and/or early retirement and to increase through only through investment. And second, that the ‘calibrated’ rate of technological change, aka “the measure of our ignorance”, derived when determining the baseline is, predominately, Harrod neutral, i.e., manifest as increases in the efficiency of labour.

The exploration of the specification of technological change in CGE models also demonstrates that the interpretation of the efficiency parameters in CGE models is not consistent with their interpretation in the measured productivity growth literature, i.e.,

productivity growth that originates within an activity. This transpires to be an important difference since it is common for (recursive) dynamic CGE models to assume uniform rates of productivity growth whereas the imposed rates of measured productivity growth differ widely across sectors. The model includes a method to ensure that the imposed and measured productivity growth changes are (approximately) the same.

The implications of using capital vintages with Solow neutral and Harrod neutral technical changes are examined using an energy variant of the GLOBE model. The model simulations analyse the transition from ‘high’ to ‘low’ carbon technologies in electricity generation in a developing and developed regions. Preliminary results demonstrate that (i) the vintage capital approach reduces the rate at which carbon emissions are reduced for any given level of carbon tax, (ii) the assumption of Harrod neutrality for calibration of the ‘residual’ is associated with non-trivial differences in structural change, and (iii) that uniform rates of measured productivity reduce the rates at which costs in agricultural and service activities decline relative to the conventional approach.

2. Capital and Technology Diffusion in CGE Models

2a. Capital Mobility

2b. Technological Change and Efficiency Gains

3. Measured and Imposed Productivity Growth in dynamic CGE

Models

4. Data and Model

5. Experiments

6. Results and Analyses

7. Concluding Comment

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