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Incorporating commodity stockholding into a general equilibrium model of the global economy

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Abstract

Applied General Equilibrium (AGE) models are increasingly used for short-run commodity market analysis, although they are generally not designed for such purposes. This study remedies a key shortcoming of such work by incorporating a commodity stockholding model into a short-run global AGE model. An approach to calibrating and validating the model is demonstrated for the staple grains sector. Its historical weather-induced supply shocks form a natural vehicle for reconciling model outcomes with observed behavior. The stockholding model, in conjunction with a Gaussian Quadrature approach to characterizing supply-side uncertainty, will prove useful to researchers seeking to conduct short-run analysis of commodity market policy in an AGE context.

JEL classification: C15; C68; D58

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1. Introduction

Applied General Equilibrium (AGE) models are increasingly used for short-run policy analysis of international commodity markets (OECD, 2001; Burfisher and Jones, 1998; Martin and Winters, 1997; Francois and Shiells, 1994). However, most AGE models are not designed with such a purpose in mind. Comparative-static models, for example, are typically oriented towards a "medium run" scenario of 2 to 3 years, depending on the factor market assumptions employed. Dynamic AGE models focus on long-run growth effects, not short-run dynamics. In turn, stockholding is typically missing from AGE models, yet this is a principal means of accommodating short-run volatility in international commodity markets (Williams and Wright, 1991). In developing an AGE model, changes in commodity stocks are typically eliminated in the initial data, or subsumed into aggregate investment. For these reasons, standard AGE models are of limited usefulness for short-run commodity market analysis. However, 1 year or less is usually the time frame many policy analysts have in mind.

The purpose of this paper is to bridge the divide between short-run trade policy analysis, and AGE models, by incorporating stockholding behavior into a widely used AGE model of the global economy. The first step is to develop a model of commodity stockholding from first principles, and incorporate this into the Global Trade Analysis Project (GTAP) model. GTAP is a relatively conventional, multi-region AGE model that plays a role in commodity market analysis in dozens of institutions worldwide, including: national ministries of trade and agriculture, as well as international public agencies concerned with trade and development and academic research centers (Hertel, 1997). In addition to incorporating stockholding, the model's closure (i.e., classification of variables into exogenous and endogenous) is adapted to short-run analysis.

The paper's next steps are to demonstrate how the stockholding function can be parameterized. This is demonstrated for "staple grains," which is an amalgam of wheat, rice, maize, and other grains (Appendix Table A3). Staple grains are particularly useful for illustrative purposes because it has a volatile supply, is widely traded, and is stored over time. This is also a composite commodity that receives considerable attention from the UN Food and Agriculture Organization (FAO), as well as the World Bank.

One approach to parameterizing the stockholding model is econometric estimation, and this is carried out for a country–commodity combination that offers reliable and extensive time-series data (U.S. wheat). There are substantial challenges in this work, however, including a lack of time-series data on non-price determinants of stockholding behavior, and how to correct for the simultaneous determination of price and stock changes. Another concern is that estimation of the stockholding model as a distinct entity may not be appropriate for use in the rather different environment represented by the AGE model (Browning et al., 1999). Ideally, one would simultaneously estimate all elasticities and share parameters using time-series data in conjunction with the full general equilibrium model. However, AGE studies that attempt this are often plagued by lack of data, and face other significant conceptual and computational difficulties (Arndt et al., 2002). Therefore, the sub-systems of the AGE model typically have to be estimated separately, instead of incorporating the full set of cross-equation equilibrium restrictions in the procedure (Jorgenson, 1984; McKitrick, 1998).