Primal-Dual Links to Spatial Equilibrium Market Model for Palm Oil in Nigeria

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ABSTRACT

Distribution of agricultural produce is undertaken to bridge the gap between production and consumption arising due to spatial separation between areas of surplus and deficit. An investigation of primal-dual links to spatial equilibrium model and integration of palm oil markets in Nigeria was carried out using transportation model. Two-stage sampling technique was used to collect data from 3 markets and 276 distributors. Data were analyzed using linear programing model. Average cost of transportation per mode was bus (N17,173), truck (N10,357) and lorry (N5,831) respectively. Total transportation cost of N347,809,600.6k was observed compared to a minimized objective cost of N142,536,800.30k produced by the program. Highest optimal allocation to the destination markets using the different mode of transportation were Port Harcourt–Lagos by lorry (103,200 MT), Owerri–Maiduguri by truck (21,200 MT) and Ondo–Lagos by bus (19,800 MT) respectively. Subsidized cost of public transport facilities will reduce high cost of transportation.

KEYWORDS

Market Integration, Nigeria, Optimal Allocation, Palm Oil, Primal-Dual, Transportation Cost

INTRODUCTION

The distinguishing characteristics of spatial price equilibrium model lies in their recognition of the importance of space and transportation costs associated with shipping a commodity from a supply market to a demand market Nagurney (2002). This model is perfectly competitive partial equilibrium model, in that it assumes that there are many producers and consumers involved in the production and consumption of one or more commodities. The primary purpose for developing a spatial equilibrium model is to determine equilibrium values for prices, quantities and trade flows between spatially
(and/or temporally) separated regions or markets (Batterham & Macaulay, 1994). In the simplest form of the model the assumption of perfect competition between regions is adopted and supply, demand and transport costs between each of the regions are assumed to be known. A two-region, single-commodity model can be solved graphically (see Bressler & King 1970 or Tomek & Robinson 1981). Slightly more complex models can be solved algebraically using the concepts of consumer and producer surplus (Samuelson1952). As noted in Takayama & Judge (1971) and Takayama & MacAulay (1991), distinct model formulations are needed, in particular, both quantity and price formulations depending on the availability and format of the data.

In the spatial price equilibrium problem, one seeks to compute the quantity supply prices, demand prices, and trade flows satisfying the equilibrium condition that the demand price is equal to the supply price plus cost of transportation, if there is trade between the pair of supply and demand markets. If the demand price is less than the supply price plus the transportation cost, then there will be no trade. In other words, spatial price equilibrium is obtained if the supply price at a supply market plus the cost of transportation is equal to the demand price at the demand market. In the case of trade between the pair of markets; if the supply price plus the cost of transportation exceeds the demand price, then the commodity will not be shipped between the market pairs. In this model, a path represents a sequence of trade or transportation link; one may also append links to the network to reflect steps in the production process. It is the primal-dual character of the model that permits the connection of market models with the spatial model by linking the output of the commodity modelled at the market level to both price and quantity variables for the same commodity in the spatial equilibrium model.

Thus, there is a simultaneous determination of equilibrium prices and quantities in the market and spatial models. The result of this simultaneous solution is that if a higher price is generated for the commodity modelled in the spatial equilibrium model this price is transmitted to the market model. The market model solution will simultaneously generate a larger amount of the commodity since relative prices in the market component of the model will have changed in favour of the higher priced commodity. However, the market solution will be subject to the input-output coefficients and resource constraints so that with a price rise for the commodity, the imputed shadow values on the effective market resource constraints will also rise.

To incorporate the market models into a primal-dual spatial equilibrium model so as to replace the supply functions in the standard spatial equilibrium model, it is necessary that the market models be in a primal-dual form also. The market models can be transformed to dual models in the standard way using the method described in Baumol (1977). The rows become the columns and the right hand side the objective function, and the dual objective function is subtracted from the primal objective function. If the primal-dual form of the market models are solved as models in their own right then, as is the case with the spatial equilibrium model, the optimum value of the objective function is zero.

In spatial terms, the classical paradigm of the law of one price, as well as the predictions on market integration provided by the standard spatial price determination models (Enke, 1951; Samuelson, 1952; Takayama & Judge, 1972) postulate that price transmission is complete with equilibrium prices of a commodity sold on competitive foreign and domestic markets differing only by transfer costs. If we interpret primal linear program as classical “resource allocation problem, its dual can be interpreted as a resource valuation problem. These models predict that changes in supply and demand conditions in one market will affect trade and therefore prices in other markets as equilibrium is restored through spatial arbitrage. Thus this paper investigates the market model link to the spatial equilibrium model in two ways, by quantity through the primal part of the spatial equilibrium model, and by price through the dual part of the model.
Simulation-Based Scheduling of Waterway Projects Using a Parallel Genetic Algorithm