2 Technology Structure of the Rice Sector of Japanese Agriculture: (I) A Translog Variable Cost (VC) Function Approach

2.1 Introduction

The major objective of this chapter is to execute a comprehensive quantitative investigation on the technology structure of rice production which has still been a most important agricultural product in Japan in many senses. To pursue this objective, a so-called flexible functional model of the cost function will be developed and estimated for the second half of the 20th century, 1956–97, using a pooled cross section of time series data for Tohoku as a representative rice producing region in Japan.

Since the duality theorem, index number theories, and flexible functional forms such as translog, quadratic, generalized Cobb–Douglas, and generalized Leontief models have been developed and promoted extensively, in particular, in the U.S. academic world of economics since around the mid-1950s to the early-1970s, such approaches to empirical economic issues have become popular, and particularly among Japanese researchers not only in the arena of general economics but also in the field of agricultural economics since the late-1970s until recently.

Roughly speaking, however, Japanese researchers in the field of agricultural economics have mainly applied the newly developed methods to empirical analyses of rice production which has been losing its status of the most important product in Japanese agriculture. Figure 1.3 shows that the share of rice production in the total agricultural production has become smaller and smaller since the early-1960s.

For example, Kako (1978) and Kako (1979a, 1979b) focused on estimating the elasticities of demands for and substitutions between factor inputs, scale economies, and technological change biases, respectively,
based on the data obtained for the Kinki agricultural district (Kinki in short hereafter). Chino (1984) made similar researches as executed by Kako. Ito (1989) analyzed for the first time in Japan the effects of public R&D and extension activities on Japanese rice production. Kusakari (1989) analyzed the effects of the set-aside programs for rice production by applying the VP function. Kondo (1991), by estimating the translog cost and profit functions, attacked an important issue of analyzing the effects of the price-support and set-aside programs on rice production.\(^1\)

Although all these studies offer very interesting and important information on the effects of government agricultural policies such as the price-support and set-aside programs, they do not necessarily offer comprehensive and consistent information on the technology or production structure in general for post-war Japanese rice farming. In addition, many previous studies including those mentioned above specified total cost (TC in short hereafter) functions where all factor inputs are assumed to be optimally utilized i.e., to cost-minimizing levels. However, we may argue that the stocks of family labor and land need not be treated as variable factor inputs in the cost or variable profit function models which are estimated using general samples of annual data or pooled cross sections of annual time series data. In reality, farms may need more than one year to adjust their utilization of labor and land. In such a situation, a variable cost (VC) function approach, with labor and land being quasi-fixed factor inputs, may be more appropriate to investigate the technology structure of rice production.\(^2\)

Therefore, this chapter will try to obtain a more comprehensive set of quantitative estimates on the technology structure of post-war rice production for the four decades of the second half of the 20th century, more specifically for the period 1956–97. Accordingly, we will develop and estimate the VC function models for this period, with labor and land being the quasi-fixed factor inputs. Based on the parameter estimates of the VC function models, a set of critical hypotheses on the technology structure will be tested. Furthermore, we will estimate and evaluate important economic indicators: such as, elasticity of demand for and substitution of factor inputs, the degrees of returns to scale, rates and biases of technological change, and the shadow values of the quasi-fixed factor inputs.

The rest of this chapter is organized as follows. Section two presents some background data related to the status of and changes in post-war rice production. Section three lays out in detail the analytical framework. Section four explains the variable processing and the estimation