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A co-integration analysis of the price and income elasticities of energy demand in Turkish agriculture

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ABSTRACT

Agriculture has an important role in every country's development. Particularly, the contribution of agriculture to development and competitiveness is increasing with agricultural productivity growth. Productivity, in turn, is closely associated with direct and indirect use of energy as an input. Therefore, the importance of energy in agriculture cannot be denied as one of the basic inputs to the economic growth process. Following the importance of energy in Turkish agriculture, this study aims to estimate the long- and short-run relationship of energy consumption, agricultural GDP, and energy prices via co-integration and error correction (ECM) analysis. Annual data from 1970 to 2008 for diesel and electricity consumptions are utilized to estimate long-run and short-run elasticities. According to ECM analysis, for the diesel demand model, the long-run income and price elasticities were calculated as 1.47 and −0.38, respectively. For the electricity demand model, income and price elasticities were calculated at 0.19 and −0.72, respectively, in the long run. Briefly, in Turkey, support for energy use in agriculture should be continued in order to ensure sustainability in agriculture, increase competitiveness in international markets, and balance farmers' income.

1. Introduction

Energy is an important input for production, conversion, processing, and commercialization activities. The importance of energy has increased in every field as one of the basic inputs to economic development. On the other hand, energy consumption is rising as the world population increases and technology advances. Energy's limited supply leads to price increases (especially for oil) in light of increasing demand, international instabilities, crises, and wars. These increased oil prices directly or indirectly translate into higher production costs for farmers—which in turn exercises a negative impact on farmers' income.

In Turkey, energy use in agriculture has increased because agricultural production became more mechanized and the use of land substitutes (such as fertilizers) increased. During the last 30 years, diesel consumption in agriculture has increased annually by 5.35%. In the case of electricity, this rise was 21.81% (MENR, 2009). The reason for a slower pace in diesel consumption is the fact that Turkey ranks fifth among the most expensive diesel-consuming countries. In fact, in the same period, the diesel prices increased annually by 22.27% (TurkStat, 2009a).

In Turkish agriculture, direct energy inputs are mainly based on fuels, and indirect inputs are dominated by fertilizer use. In crop production, the share of direct energy input varies between 30% and 60%. Depending on the crop, the diesel cost share in production expenses varies between 10% and 20% (Dellal et al., 2007).

These trends in agricultural energy consumption and prices, as well as the share of costly energy inputs in production costs, deliver severe implications for future energy policies for the agricultural sector. First, high energy prices and costs reduce energy consumption in agriculture, and this lowers the productivity. Low productivity thus impairs economic growth. In addition, high prices that make agricultural production more expensive cause deterioration in Turkey's competitiveness. Turkish farmers earning a low income and receiving less support are less competitive, compared to developed countries such as the European Union (E.U.) and the United States in terms of price paid to diesel. Therefore, estimating the energy demand is an important issue to increase Turkish agriculture's sustainability and competitiveness and raise Turkish farmers' income.

Following the importance of energy in Turkish agriculture, the present study aims to estimate the long-run relationship of energy consumption, agricultural GDP, and energy prices via co-integration and error correction (ECM) analysis. Estimating the relationships for energy in Turkish agriculture is important not only for the sector but also from the standpoint of the overall

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economy and environment. Annual data from 1970 to 2008 for diesel and electricity consumptions are utilized to estimate long-run and short-run elasticities.

The co-integration and ECM framework have been used for modeling energy demand in a number of studies, e.g., modeling energy demand in Mexico (Galindo, 2005), road energy demand for Greece (Polemis, 2006), coal demand in China (Chan and Lee, 1997) and India (Kulshreshtha and Parikh, 2000), the UK's final user energy demand (Fouquet et al., 1997), gasoline demand in the United States (Park and Zhao, 2010), in Fiji (Rao and Rao, 2009), in India (Ramanathan, 1999), in Brazil (Alves and Bueno, 2003), in South Africa (Akinboade et al., 2008), and to estimate electricity demand in Sri Lanka (Amarawickrama and Hunt, 2008). Studies on energy demand functions predominantly estimated the price and income elasticities of demand. Most estimates of price and income elasticities do not provide a consensus on the short- and long-run elasticity estimates. Alves and Bueno (2003) found low long- and short-run income elasticities (0.122 and 0.122) for Brazil. They found price elasticities close to the estimates of Ramanathan (1999) in India. Akinboade et al. (2008) confirms the existence of a co-integrating relationship, and the estimated long-run price and income elasticities were −0.47 and 0.36, respectively. Park and Zhao (2010) found that price and income elasticities are time varying but very low in the United States. Rao and Rao (2009) estimated the gasoline demand for Fiji using five alternative time series methods and found close estimates of the long-run parameters in all five methods. Amarawickrama and Hunt (2008) estimated electricity demand functions for Sri Lanka using six econometric techniques and found that the preferred specifications differ somewhat. Amarawickrama also discovered a wide range in the long-run price and income elasticities—with the estimated long-run income elasticity ranging from 1.0 to 2.0 and the long-run price elasticity from 0 to −0.06.

The remainder of this paper is organized as follows: Section 2 gives information about energy polices applied in Turkish agriculture. Section 3 presents the method used in this paper. Section 4 presents the data. Section 5 discusses the results of the co-integration analysis. The last section concludes.

2. Support policies for energy in Turkish agriculture

Agriculture in Turkey holds the promise of making a major contribution to the country's economic development. The principal objectives of the Turkish agricultural policy are set out in successive five-year development plans. These are as follows: (i) to establish an organized, highly competitive, and sustainable agricultural sector; (ii) to provide adequate and stable incomes for those working in agriculture; (iii) to meet the nutritional needs of a growing population considering food safety as the most important issue; (iv) to stabilize agricultural prices to enhance productivity by ensuring the utilization of high-quality seeds and seedlings, training farmers, strengthening producer organizations, supporting R&D activities, increasing competitiveness of agricultural holdings, and improving the marketing framework; (v) to develop rural areas, preventing large stocks and keeping and stabilizing producer income levels; and (vi) to promote the application of modern agricultural techniques and develop the export potential of agriculture.

The agricultural sector in Turkey was orientated with short-term price support policies rather than structural measures until the end of the 1990s. The scope of support policies and price levels has been determined with sometimes economic but mostly political concerns rather than internal and external demand conditions. Production of some items has been encouraged without concern for market conditions. Budget burden, ineffectiveness of the policy, and inequality in income distribution revived a change in agricultural policies. The new adjustments in Turkish agricultural policy significantly changed due to the above-stated internal factors and commitments arising from the World Trade Organization (WTO) Agreement on Agriculture—as well as developments in the E.U. Common Agricultural Policy (CAP), World Bank (WB), and International Money Fund (IMF).

In 2001, the Agricultural Reform and Implementation Project (ARIP) supported by a loan from the WB launched to help implement the Turkish government's agricultural reform program, aimed at reducing government subsidies and implementing a new support system. Within this project, instead of price incentives and input supports, Direct Income Support (DIS) for farmers is implemented to set up a mechanism to identify farmers eligible for payments and deliver those payments. Other important components of the Agricultural Reform and Implementation Project are as follows:

(i) the Farmer Transition Support aims to help farmers make the switch to alternative activities as governmental supports are reduced and
(ii) the Agricultural Sales Cooperatives and Agricultural Sales Cooperatives Unions Restructuring project aims to take necessary measures and policies for the provision of sustainability.

DIS is not contingent on input use or output production decisions of the farmer. According to DIS, the farmers are eligible to receive a fixed amount (about $100/ha for a year) of payment for up to 50 ha of cultivated land (Dellal et al., 2007). Besides compensation of producer income losses by giving up the old agricultural support system, this method aims to convey support payments directly to farmers who really need assistance.

However, the subsidies applied in the old system for some agricultural inputs were not abandoned with the new agricultural support policy because they contribute a small share in total agricultural support payments. These subsidized inputs are electricity, natural gas, and water for irrigation. At later stages, in addition to these inputs, diesel support was also added (Sayin et al., 2005).

In Turkey, the support payment for diesel used in agricultural production by farmers began in 2003 due to the excessive rises in oil prices. Another reason is that the proportion of diesel input in the total production cost (as emphasized previously) is very high. In 2003, 39 TL/ha was paid as diesel support to registered farmers. An average of 8 l/da is accepted for all products. Given that the average diesel price was TL 1.4 in 2003, in order to raise 1 ha agricultural product, TL 112 is required as diesel cost and TL 39 of this cost was paid to farmers as support. In this case, the diesel support rate was 34.8% in 2003.

The second diesel support was given in 2005. Different from the 2003 support, the new diesel support amount was calculated according to different product groups. The diesel support amount was calculated based on the following:

- 5 lt/da for vegetables, fruits, ornamental plants, meadow pasture, and forest land;
- 8 lt/da for cereals, fodder crops, legumes, and tuber crops; and
- 15 lt/da for oilseeds and industrial crops.

In 2005, 15% of the diesel used by farmers was supported. This rate increased to 16.3% in 2007.

Electricity consumption in agricultural production is supported by the government. Since 1997, low electricity tariffs were applied for some limited areas such as irrigation, aquaculture, and