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Fuel price determination in transportation sector using predicted energy and transport demand

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Abstract

This study determines fuel price based on estimated sectoral energy and transport demand using pumping prices. Three approaches are first used for estimating energy and transportation demand based on linear time series, polynomial time series and genetic algorithm based (GATEDE and GATDETR), as multi-parameter, models. Then, future fuel prices and marginal costs of the energy consumption are obtained. Transport demand-based energy efficiency methods are also developed. The fuel prices (FP) are analyzed under two scenarios: *Linear* and *exponential price* scenarios. Results showed that if the FP increases linearly, the marginal cost will slightly decreases from current trend, but will increases if demand increases exponentially. Results also showed that the demand-based pricing policy would help to develop a new pricing policy for fuel use in order to control fast growing demand on this sector. The exponential price increase would also help to locate financial sources to create environmentally friendly transportation systems.

Keywords: Energy demand; Transport demand; Fuel price

1. Introduction

Energy plays a vital importance in daily life and it may be considered as one of the lifelines for the humanity. It affects the living standards in the community. In addition to the energy importance, the transportation is also vital importance for community. But, energy, especially fuel as being a scarce sources and non-renewable, needs to carefully be planned. Over consumption of energy sources may lead to decrease scarce sources and also pollutes our environment. Therefore, the planning of the energy and transport demand needs to be investigated to control growing demand to meet future needs of humanity to achieve sustainable objectives. In order to lessen the environmental affect of energy consumption, the Kyoto protocol is singed some countries in 1990.

Total energy consumption increased 500% and the petroleum and natural gas consumption increased about 900%, while the world population growth increased 200% between 1945 and 1985 (Haldenbilen, 2003). Thus, there is a huge demand to energy and transport.

Transportation is one of the biggest sectors to use non-renewable energy sources as fuel. The energy consumption in this sector covers both private and commercial vehicles. Per capita sectoral energy consumption in European Union (EU) was about 0.4 tone equivalent petrol (TEP) in 1970 and was increased to a level of 0.77 TEP in 1995 (Banister et al., 2000). The energy consumption in this sector was increased from 0.1 to 0.2 TEP between 1970 and 2000 in Turkey as well. While there is a decrease on energy consumption per vehicle-km, there is an increase on demand per capita (Haldenbilen, 2003). The reason for is that the improvement of the vehicle technology will cause to reduce the energy consumption. In 1970, the energy consumption on rural roads was 0.52 kilogram equivalent petrol (KEP)/veh-km and decreased to a level of

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0.28 KEP/veh-km in 2000 (Haldenbilen and Ceylan, 2005a, b).

The efficient use of energy is generally justified with pricing policy and technological improvements, but the demand for gasoline is inelastic with price changes according to State Planning Organization (SPO, 2001). The report indicated that the changes on fuel price did not affect the growing demand for transportation for the period of 1990–2000. The fuel tax increased from 56% to 72% in same period and reached to a level of EU average.

The high tax rate and the price on fuel will subsidize the national budget and they are not used for managing and planning energy sources. The price for operating private vehicles are relatively decreased when it is compared with public transport, for instance, the increase on operating public transport in terms of fuel cost increased by about 53% while on private transport it decreased by about 38% including insurance, service, road tax costs (Banister et al., 2000).

Designing efficient and cost effective energy and transport systems that meet environmental conditions is one of the foremost challenges that engineers face. In the world with scarce natural resources and large energy demands, modeling becomes increasingly important to understand the mechanisms that degrade energy and resources and to develop systematic approaches for improving systems and, thus, also reducing the impact on the environment. Moreover, fuel price and marginal cost analysis help to identify the components where inefficiencies occur. Improvements should be done to these components to increase their efficiency. However, estimation of fuel price and marginal cost analysis of energy and transport demand is quite new. Thus, this study investigates relations between the fuel price (FP), energy and transport demand. Also demand-based marginal cost analysis is proposed.

The main objective of this study is to investigate the cost of the energy consumption and transportation cost as a fuel price. For this aim, the transport and energy demand is forecasted first, and then the fuel price is analyzed under two different pricing trends. The relationship between the fuel price and transport demand (TD), and also energy demand (ED) are evaluated based on marginal cost (MC).

2. FP

The FP in Turkey, as one of a developing country, has been increasing and the tax on fuel is also increasing. The FPs is given in Fig. 1 for the period of 1990–2004. The effect of economic crisis, which hit Turkey two times, can clearly be seen for which the prices decreased due to the big variations on the value of money, but the general trend followed the trends of the developed world. The fuel price per liter was about 0.50$/lt in 1990 and it increased to a level of 1.8$/lt. As figure indicates there is an increasing trend in dollar basis. The prices are given in the middle of month for each year, where the National Statistics (NS, 2005) records data on midterm basis.

The tax that is taken from fuels is very high about 75%, which supports the National Budget (NB) about 10% in Turkey. Tax rates, which are taken from motorized vehicles, are given in Table 1 as a proportion of the NB, where FT is the fuel tax, MOT is the motor vehicle tax, and the PT is the purchase tax (Ministry of Finance, MF, 2003). An average of 12% of the NB comes from road transport taxes. However, the revenues collected from road transport are not fully used in transportation sector although there is a growing demand. General Directorate of Turkish Highways (GDTH) budget has been decreasing when it is compared with the NB even though the road tax revenues are increasing to a level of 11% in 2000 (GDTH, 2004). The highest share is in 1960 that can be the political reasons and one of the critical stages in that

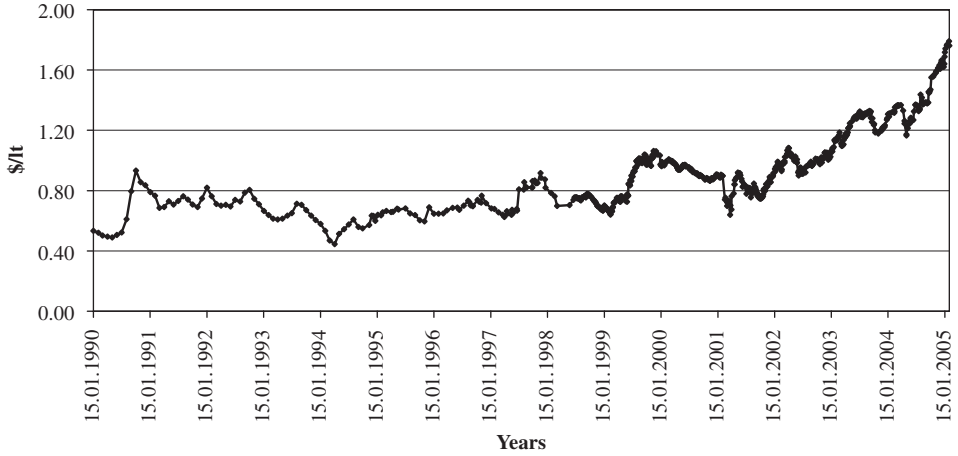

Fig. 1. Gasoline pumping prices (NS, 2005).