CHAPTER TWO
LITERATURE REVIEW AND METHODOLOGY

2.1 Introduction

The theory of demand began with the axiom of utility maximisation. Assuming the consumer is rational, with a given income he will plan his expenditure in a manner which will maximise his satisfaction or utilities (Dahl and Sterner, 1990). Generally, the simple theory of consumer demand explains demand for a commodity or services as a function of its price, assuming other things remain constant. It shows a negative relationship between these two variables. But the explanation itself is misleading mainly because demand is a multivariate function. Furthermore the assumption of other things being constant is unrealistic (Chee, 1981). In an actual situation, aside from prices there are other important determinants of demand. For example, the prices of substitutes and complements, total population and past level of consumption are other factors that affect consumers' demand (Crystal and Lipsey, 1997).

A pragmatic approach was developed in demand analysis. Without reference to consumer behaviour, the demand equation has been formulated directly on the basis of market data (Chee, 1981). The demand function is expressed as multivariate function. It is estimated by various econometric methods. Obviously, the analysis refers to the market behaviour of all the consumers as a group and not the behaviour of a single individual (Metha et al, 1978).

2.2 Gasoline Demand Revisited

A wide variety of models have been estimated, using different functional forms and estimation techniques, covering different time periods and different parts of the globe in the effort to better understand gasoline demand. There are several studies estimating the demand for gasoline in the

industrialised countries. For example, the relationship between gasoline consumption and vehicle stock in Switzerland has been analysed by Wasserfallen and Guntensperger (1988). Baltagi and Griffin (1983) have also analysed the gasoline demand in the Organisation for Economic Co-operation and Development (OECD) countries. Blum et al. (1988) studied the relationship between gasoline demand and other macro-economic variables in Germany. Dahl and Sterner (1990) have provided another survey of the gasoline demand models. Some country-specific studies such as Puller and Greening (1999) for United States, Walls (1996) for Hong Kong and Ramanathan (1999) for India have addressed the issue of estimating the gasoline demand in the case of both developed and developing countries. Particularly, McRae (1994) has used econometric models to estimate the gasoline demand in several developing Asian countries. Closer to home, Chee (1981) has also contributed to the estimation of gasoline demand model in Malaysia using econometric analysis for the year 1971 to 1980.

2.2.1 Estimators in Previous Studies

There has been a wide range of methods used to estimate the demand for gasoline. Ordinary least squares (OLS), generalised least squares (GLS) , maximum likelihood, error components, random coefficients and seemingly unrelated regression models have all been estimated a number of times (Espey, 1998). For example Ramanathan (1999) and Eltony and Al-Mutairi. (1995) used cointegration and error correction techniques for examining the relationship between gasoline demand, national income and price of gasoline in India and Kuwait, respectively. Baltagi and Griffin (1996) used 5 standard pooled estimators including Ordinary Least Squares (OLS), General Least Squares (GLS) and 2 stage Least Squares (2SLS) in their analysis of gasoline demand in United States of America. In their research, Baltagi and Griffin have highlighted that typically the theoretical literature mitigates against some standard estimators on the basis of inconsistency or inefficiency of the estimates. For example, in the popular one way error component model, the standard GLS estimator is often not recommended in a dynamic

model because it yields biased and inconsistent estimators. Nevertheless, the standard GLS estimator as well as the within estimator are frequently applied (Baltagi and Griffin, 1996).

2.2.2 Data Characteristics In Previous Studies

In terms of database, both aggregate and dis-aggregate data were used in previous studies of gasoline demand world-wide. Aggregate data involve national data for example Gross Domestic Product (GDP), Gross National Product (GNP), total vehicle stock and etc. Dis-aggregate data is data based on state or provincial level data. Studies that have used disaggregate data have found gasoline demand to be fairly inelastic (Puller and Greening, 1999). Data characteristics of previous works can be classified into 4 categories by Epsey (1998) : (1) Quantity measure - per household/capita and per vehicle, (2) Time interval - monthly, quarterly and yearly, (3) cross sectional and lastly (4) time series data.

These literature also differentiate each other in number of independent variables. Most of them used price and income as independent variables, whilst some also included stock of vehicles and fuel efficiency in their demand models. This will be further discussed in the following section.

2.2.3 Results of Previous Estimates

All literature suggest that price and income are statistically significant to the dependent variable i.e. gasoline consumption (Ramanathan, 1999; Greening and Puller, 1999; Epsey, 1998; Baltagi and Griffin, 1996; McRae, 1994; Dahl and Sterner, 1991; Chee, 1981). Gasoline demand is relatively inelastic to price changes, both in the long and short terms. (Ramanathan, 1999). According to Dahl and Sterner, for the price elasticity, the average of various studies places the short run price elasticity at -0.26 and the long run at -0.86. Epsey (1998) concluded that the range of short run and long run price elasticity estimates for the demand for gasoline range from 0 to -1.36, averaging -0.26 with a median of -0.23 for the studies conducted

internationally. Long run price elasticity estimates range from 0 to -2.72, averaging -0.58 with a median of -0.43 (Epsey, 1998). Nonetheless, Greening and Puller (1999) in their gasoline demand analysis based on 9 years US household survey data estimated that price elasticities range from -0.44 to -1.33 with most estimating inelastic demand. Ramanathan (1999) in his recent research on gasoline demand in India found that the long run price elasticity is -0.319, indicating relative inelasticity which is consistent with other findings. McRae (1994) in the study of gasoline elasticity estimates across a number of Asian countries found that the price elasticity range from -0.13 to -0.50, of which estimate for Malaysia using data in between 1973 - 1987 reported the lowest price elasticity. This indicates that Malaysia has relatively inelastic gasoline demand towards changes in gasoline price. The results is relatively close to Chee's (1981) study on local gasoline demand which reported -0.11 and -0.14 for short and long run price elasticities, respectively. In general, all literature suggested that long run price elasticities are larger than short run price elasticities.

In terms of income elasticities, it has been found that gasoline demand is likely to increase significantly for a given increase in the national income, and the increase will be larger in the long run (2.682) than in the short run (1.178) (Ramanathan, 1999). In the estimation of the income elasticity of the demand for gasoline by Epsey (1998), the inclusion of some measurement of vehicle ownership and of vehicle characteristics significantly influences the results. Those models that include some measure of vehicle ownership estimate the income elasticity of the demand for gasoline to be significantly lower , in both short run and the long run, than those models that exclude vehicle ownership. This statement is reinforced by findings from Baltagi and Griffin(1997), "models explicitly introducing the vehicle stock show average long run elasticities in the 0.6 to 0.87 range, whereas specifications omitting the vehicle stock estimate the income elasticity in the 1.3 range". The income elasticities implied by the various pooled estimators are generally positive and statistically significant in the short run, but frequently insignificant in the long

run, suggesting that income effects primarily impact short term utilisation. Most studies indicate much higher long run income elasticities but the stock of cars is frequently absent from such a regression (Baltagi and Griffin, 1997). In local environment, income elasticites are estimated at 0.57 (McRae, 1994) and 0.006 to 0.008 (Chee, 1981) for short and long run.

2.3 Basic Models

In a recent survey of gasoline demand models, Ramanathan (1999) have found that income and price to be the main parameters in determining gasoline demand. On the other hand, Epsey (1998) suggested that gasoline demanded is also affected by distance driving, the number of vehicles being driven and the fuel efficiency of those vehicles. Some researchers like Baltagi and Griffin assume that the stock of energy using equipment to be fixed in the short run, and its utilisation is a function of normal economic influences. However, Epsey (1998) concludes that "*...models that include some measure of vehicle ownership and fuel efficiency capture the 'shortest' short run elasticities by effectively measuring the influence of price and income changes on driving only. Models that omit one or both of these variables would measure changes in consumption through driving as well as through changes in vehicle ownership and/or fuel efficiency (all implicitly), hence measuring an intermediate or long run elasticity.....*".

The above statement is also supported by Ramanathan (1999). They argue that because stock and efficiency are not included, such models measure long run responses to prices and income. However, since responses to fuel price or income changes can take a decade or more to be reflected through turnover of the vehicle stock, if the data only covers a few years and includes only one country or countries with similar prices and incomes, the data might not reflect the full long run response, and hence elasticity estimates might be better classified as short run or medium run (Epsey, 1998).

In this study, we assume that the inclusion of vehicle stock in the model as short run elasticity estimates. The justification to this assumption is that adjustment of demand pattern in respond to changes in price of gasoline and income level require much longer time than change in number of vehicles. For instance, the effect on gasoline consumption in the short run would not be significant should gasoline price decreased as there are constraints on fuel conversion, vehicle usage and etc. In contrary, changes in gasoline consumption is significant when there is increase in vehicle stock though in short period. In the short run, fuel efficiency is fixed and consumers vary their utilisation of the auto fleet in response to current prices, income and cars per capita. But over time, as income augments the auto stock, adjustment to the latter variable is found less. As pointed out in a recent study by Epsey (1998), models that include vehicle ownership resulted in less elastic long run estimates. Utilisation of vehicles is essentially a short run decision (Baltagi and Griffin, 1996).

There are two types of model used in the literature : static and dynamic model. For instance, Ramanathan (1999) used only static model in his analysis. Chee (1981) and Baltagi and Griffin (1996) used both static and dynamic models. Static model is a homogenous function of degree zero (Chee, 1981). Dynamic model, on the other hand, includes the lagged endogenous and/or exogenous variables (Baltagi and Griffin, 1996). It is based on notion that current consumption is influenced by past behaviour. The relationship between past and present indicates that current behaviour depends on past levels of income and past levels of demand (Chee 1981). For a non-durable commodity such as food, past purchases reflect a habit which is acquired by buying and consuming the commodity in the past. Past purchase influence the decision of current consumption. For a durable commodity, past consumption constitutes a stock effect (Espey, 1998). Theoretically, static models represent long run behaviour whilst dynamic models explains intermediate to short run demand pattern. In this study, only static model is considered hence the elasticities are taken as long run

elasticities for the model that excludes vehicle stock. The inclusion of vehicle stock, as explained earlier, will be assumed as short run to intermediate scenarios.

Several studies analysing gasoline demand using econometric analysis (Baltagi and Griffin, 1996; Chee, 1981) have used the following model, which will also be used in the present study :

$$G_t = \alpha_0 + \beta_1 Y_t + \beta_2 P_t + \beta_3 SPV_t, \quad t = 1,2,.....T$$

where : G is the per capita gasoline consumption in tonnes per capita;

Y, the real income per capita;

P, the real gasoline price;

SPV, number of vehicle stock per capita and

α_0, is the constant of the equation

$\beta_{1,2,3}$ represent elasticity for each of the variable

In consistent to other literature (Ramanathan 1999; Baltagi and Griffin 1996; Chee 1981), demand elasticity in this study is defined as the change of an independent variable over the change of the dependent variable, i.e. the coefficient of the variable in the regression.

2.4 Data

The research is conducted based on secondary data collection from the year of 1990 to 1998. This sample period is selected as unleaded gasoline was introduced in mid-1990 and the tax incentive on unleaded gasoline was only implemented in 1994. Most data are aggregated in terms of national and industry units for example, gasoline consumption, income level, stock of petrol driven vehicle and etc. Besides government agencies and published statistics, these data are obtained through various channels including that from oil companies and motor associations. The government bodies involved are the Department of Statistics and Ministry of Domestic Trade and Consumer Affairs. The published reports used include The

Yearbook of Statistics, various issues of Economic Reports from 1990/91 to 1998/99, Consumer Asia, Yearbook of Transport Statistics and etc. This paper also includes literature search and review on the previous relevant publications and studies, conference papers, newspapers and journals.

Unfortunately, the study is constrained by types of data obtained due to confidentiality of some data for example sales of gasoline by company and etc. Besides, it is also impossible to obtain demand schedule for this product. Another limitation in data collection is unavailability of actual numbers of petrol-driven vehicles. To counter the above problems, some assumptions are made. For example, it is assumed that motorcars and motorcycles are the two main constituents of petrol driven vehicles, as 90% of the passenger vehicles are petrol driven (Yearbook of Transport Statistics, 1996). As such, only data for total registrations of motorcars and motorcycles are taken as stock of passenger vehicles. In order to obtain general price level of gasoline for the country, an weighted average of each gasoline consumption to its price is taken to examine general gasoline demand model.

2.5 Methodology

Gasoline demand models in this study is analysed using linear regression method. The statistic software used is SPSS for Windows version 9.05. The first step involves data cleaning using frequency analysis in order to detect errors and outliers. The models are then examined using regression analysis. As the demand model is multivariate in nature, multiple regression is selected. Multiple regression analysis is an dependence method of analysis because it attempts to explain or predict the dependent variable on the basic of 2 or more independent variables. Theoretically, the value of R^2 from enter regression and Adjusted R^2 should fall within 0 - 1. The higher the number of R^2 to 1, the higher the percentage of variation explainable by the regression model (Zikmund, 1997). The results for elasticities from various literature are also compiled for comparison.

There are three cases for examination : (1) nominal versus real data (adjusted to Consumer Price Index of year 1990 as reference), (2) inclusion and exclusion of vehicle stocks and (3) demand model for each type of gasoline i.e. Leaded and Unleaded Gasoline of which cross elasticities between these two products will also be analysed.

On top of quantitative analysis, qualitative analysis on other determinant factors for example legislation, consumer preference and other environmental and sociological effects, will also be conducted and discussed. In order to achieve the above, an interview with the Assistant Principle Director - Account of Ministry of Domestic Trade and Consumer Affairs (MDTCA) was held for a better understanding of the government's involvement especially in price control mechanism for gasoline.