RAMSEY PRICING IN TURKISH POSTAL SERVICES

A THESIS SUBMITTED TO
THE GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES
OF
THE MIDDLE EAST TECHNICAL UNIVERSITY

BY

ÖZGÜR ÖZUĞUR

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF
MASTER OF SCIENCE
IN
THE DEPARTMENT OF INDUSTRIAL ENGINEERING

SEPTEMBER 2003

Approval of the Graduate School of Natural and Applied Sciences.

Prof. Dr. Canan ÖZGEN
Director

I certify that this thesis satisfies all the requirements as a thesis for the degree of Master of Science.

Prof. Dr. Çağlar GÜVEN
Head of Department

This is to certify that we have read this thesis and that in our opinion it is fully adequate, in scope and quality, as a thesis for the degree of Master of Science.

Prof. Dr. Çağlar GÜVEN
Supervisor

Examining Committee Members

Assist. Prof. Dr. Müge AVŞAR

Assoc. Prof. Dr. Sinan KAYALIGİL

Prof. Dr. Erol ÇAKMAK

Assoc. Prof. Dr. Levent KANDİLLER

Prof. Dr. Çağlar GÜVEN

ABSTRACT

RAMSEY PRICING IN TURKEY POSTAL SERVICES

ÖZUĞUR, Özgür
M.S., Department of Industrial Engineering
Supervisor: Prof. Dr. Çağlar Güven

September 2003, 93 pages

This study aims to provide an empirical investigation of Postal Services pricing in Turkey by way of computing Ramsey prices and examining the sensitivity of Ramsey prices to changes in demand and cost parameters. In this study, the Ramsey pricing problem is stated as maximizing a welfare function subject to the Post Office attaining a certain degree of profitability.

The conditions necessary for the Post Office to be able to price efficiently have implications for Ramsey pricing. We estimate demand functions and cost structure of letters and express mail using data from Turkish Postal Services. The robustness of the Ramsey rule is assessed under alternative estimates of demand and similarly, in the absence of reliable data, under alternative intervals of marginal cost.

Ramsey prices for two letter categories and welfare gains of moving from the existing pricing structure to Ramsey are determined and examined. Sensitivity analysis indicates that the existing policy is not Ramsey optimal and that this is a fairly robust result.

Keywords: Ramsey Pricing, Economics of Postal Service, Postal Demand Estimation, Turkish Postal Services, Welfare Maximization.

ÖZ

TÜRKİYE POSTA SERVİSLERİNDE RAMSEY FİYATLANDIRMA METODU

ÖZUĞUR, Özgür
Yüksek Lisans Tezi, Endüstri Mühendisliği Bölümü
Tez Yöneticisi: Prof. Dr. Çağlar Güven

Eylül 2003, 93 sayfa

Bu çalışma Ramsey fiyatlarını hesaplayarak ve Ramsey fiyatlarının talep ve maliyet parametrelerindeki değişikliklere duyarlılıklarını analiz ederek Türkiye'deki Posta Servislerinin fiyatlandırılması üzerine sayısal bir inceleme ortaya koymayı amaçlamaktadır. Bu çalışmada Ramsey fiyatlandırma metodu, sosyal refahı ençoklayacak ve posta hizmetlerinin belirli bir derecede karlılığını sürdürebileceği şekilde tanımlanır.

Posta Ofisi'nin doğru bir fiyatlandırma yapabilmesi için gerekli koşullar Ramsey fiyatlandırma metodu ile paralellikler taşımaktadır. PTT verileri kullanılarak mektup ve acil posta hizmetinin talep fonksiyonları ve maliyet yapıları tahmin edilmiştir. Ramsey metodunun güvenilirliliği çeşitli talep tahminleri ve benzer şekilde, sağlıklı veri yokluğunda, çeşitli marjinal maliyet aralıklarında belirlenmiştir.

İki mektup grubu için Ramsey fiyatları ve mevcut fiyatlandırma yapısından Ramsey'e geçişte sosyal refah kazanımları hesaplanmış ve

irdelenmiştir. Duyarlılık analizleri mevcut fiyatlandırma politikasının Ramsey optimal olmadığını ve bunun sağlıklı bir sonuç olduğunu göstermektedir.

Anahtar Kelimeler: Ramsey Fiyatlandırma Metodu, Posta Servislerinin Ekonomisi, Posta Talep Tahmini, Türk Posta Servisleri (PTT), Sosyal Refah Ençoklaması.

To My Supervisor; Prof. Dr. Çağlar Güven

and

To My Cousin; Sitare Kalaycı

ACKNOWLEDGEMENTS

I would like to thank my supervisor Prof. Dr. Çağlar Güven for his insightful comments and suggestions throughout this study. That guided me in the development of this thesis. Especially, I will never forget his trust in a successful completion of this work.

I would like to thank to examining members for their contributions and helpful comments.

Finally, many thanks to my cousins and family for all their sacrifices in raising me and for their unshakable faith in me.

TABLE OF CONTENTS

LIST OF TABLES

TABLE

LIST OF FIGURES

FIGURE

CHAPTER 1

INTRODUCTION

Pricing is a complex problem involving many parties and variables, all of which interact in complicated ways. Effective product pricing is both a science and an art and the manager who is in charge of setting prices always faces a complex decision.

Formulating a pricing strategy is complicated for at least three reasons. The first is the difficulty in formulating and validating the necessary demand and cost functions. The second reason is that analysis must be restricted to situations when the demand is price-elastic. Thirdly, changes that take place in demand and costs over time and the effects of other marketing variables must somehow be considered. A large variety of pricing models have been developed with the purpose of capturing the dynamic interrelationship between cost and demand related factors, effects of competitive actions, effects of price discounts, the role of price in individual choice decisions and the relationship of price with other variables of the marketing. Further difficulties are faced, previous-period's cost and demand functions enter the models endogenously when competing products and the marketing-mix variables of other products affect the product's price. Therefore, complexity and difficulty is due to the large number of variables affecting the decision and the interrelationships among them.

In order to be able to analyze alternative pricing decisions, the price setter must estimate the amount that will be demanded at each alternative price. Hence demand analysis is an essential part of pricing. Sellers often enjoy a certain degree of monopoly power. A monopolist being the only supplier is a price maker. It is possible for a monopolist to sell more units only if it lowers price. In a monopolist's mind there is always the idea whether the tradeoff between a lower price and a larger quantity demanded will increase or decrease profits.

Like demand, costs are also important for effective pricing. If a manager understands his costs, he knows more than their levels; he knows how his costs will change with the changes in sales that result from pricing decisions. So sufficient knowledge about price sensitivity and competition is important for pricing strategy. Costs may not determine price but they are important as price sensitivity in formulating a pricing strategy.

Finally, price discrimination refers to the practice of charging different markups over marginal cost to different customers. Different prices might legally be charged to non-competing customers, raising issues and implications for efficiency and social welfare.

In this study, Ramsey pricing is investigated for efficient pricing of Turkish Postal Services. For this purpose, a demand model for both letters and express mail is estimated over the period 1987-1999, keeping in mind various potential substitutes like for instance courier, telephone, telex, facsimile, TV. Very little is known about the factors which determine the demand for inland mail categories in Turkey. There is no statistical study of demand for Post Office products. In spite of these difficulties and limited available data, we make an attempt to study the factors which determine demand using multiple regression analysis. In order to estimate the relationship between different measures of postal volume and variables such as postal prices, phone charges, national, household and business income and delivery standards, annual data was collected for the period 1987 to 1999. All prices and income series were converted into constant prices. All equations were estimated using the OLS multiple regression model incorporating various test statistics. Whilst it would be desirable to construct an all embracing model of the simultaneous demand for all communication services, that is outside the scope of this study given the attendant data limitations and technical difficulties.

Thus, the most suitable pricing principle for the postal industry would seem to be the Ramsey principle dictating that prices for services with independent demands should diverge from direct marginal costs by a proportion varying inversely with the own-price elasticity of demand for the particular postal product. This is useful especially when the aim is to minimize the total deadweight loss or equivalently to maximize total welfare, while covering total fixed costs, given that demands are independent.

The aim of this study is to present an empirical investigation of letters and express mail traffic and the cost structure, which is followed by a discussion of the Ramsey pricing principle. The empirical and theoretical discussions are then combined to yield estimates of Ramsey prices for the two mail categories and the reductions in deadweight losses from moving to a Ramsey pricing structure.

The rest of this report is organized as follows. Chapter 2 reviews the literature on Ramsey pricing in detail. Some mathematical background is provided to explain the implications of Ramsey pricing for the Turkish Postal Service. Chapter 2 also points out the welfare maximization considerations for postal service regulation. Chapter 3 provides an econometric analysis of demand functions for letters and express mail. Issues such as multicollinearity, autocorrelation, heteroscedasticity, choice of functional form, etc. are addressed and all computations are undertaken using Excel. Chapter 4 then applies Ramsey pricing and reports the results of the sensitivity analysis for the Turkish Postal Service. Chapter 5 summarizes the results and conclusions of the study as a whole and points out further investigation that seems promising.

CHAPTER 2

PRICING THEORY AND PUBLIC UTILITY PRICING

Postal service economics has received considerably less attention in the literature than other traditional public utilities. The motivation for this study partly derives from the recognition that postal service is facing important challenges, arising out of the increasingly high-tech nature of postal service, the entry of competition into the business, and new attitudes on the part of government to postal service. In the United Kingdom and Germany, for example, the increased interest in privatization and recognition of the benefits of competition are considered to have an impact on postal service. These challenges mean that postal managers must learn new ways of doing business, not just in successfully introducing new hardware and in new internal operating procedures, but also in the development of new pricing and costing methodologies.

The history of pricing policy as it applies to postal service dates back to 1840, when Rowland Hill (1837) proposed pricing reforms in England. He argued that uniform pricing should be applied to distribution between major cities based on the fact that distribution costs were inelastic with regard to distance. Coase (1947) reinforces this argument but notes that uniform pricing tends to result in one class of service with one resulting level of service quality. The implication is that those consumers willing to pay higher prices for better quality cannot achieve their desired service quality level, while those consumers preferring lower quality service find this uniform price too costly. Postal services respond to these consumer preferences by offering service-differentiated classes of mail, differentiated prices. This pricing mechanism also allows postal services to contend with peak-loads. Although time-differentiated pricing is commonly used to smooth demand over peak and off-peak hours for public utilities, traditional time of day pricing is neither technologically nor politically feasible as a means in reducing fluctuations in demand for postal services (Crew, 1990). Instead, service-differentiated pricing is utilized, and accomplishes similar smoothing effects through the deferral of low priority mail during peak times.

Coase (1947), Sherman and George (1979), and Wattles (1973) all consider the issue of postal pricing, although none of these early analyses considers the issue of service standards and service reliability. Activity-based costing (ABC) methods have been considered, although limitations in ABC methodologies suggest that errors would be obtained if utilized in postal pricing systems (Bradley, 1993). Baumol (1987) advocates marginal cost concepts as the basis for postal rate setting. More recently, Boronico (1997) considers the impact that service quality and reliability have on marginal cost pricing as it applies to postal services through the incorporation of service quality constraints within a welfare-maximization framework.

Although there has been some work on the general principles of postal pricing (e.g. Sherman and George [1979], Crew, Kleindorfer and Smith [1990]) and empirical work on the postal services in the United States (e.g. Stephenson [1976], Scott [1986]), economics of Turkish postal system remains largely unexplored.

2.1. The Economics of Postal Service

Many of the problems facing postal service are similar to those facing traditional public utilities. Therefore, in this study of the economics of postal service, we draw upon essentially the same theoretical framework as the welfare economics of natural monopoly. Postal service has traditionally been and with few exceptions, still is provided by public enterprise, raising concern over welfare economic foundations of public policy decisions.

The net social welfare worth is traditionally defined as the sum of consumers' and producers' surpluses. Historically, the use of consumers' and producers' surplus as a measure of welfare was proposed by Jules Dupuit (1844) in connection with the evaluation of public works projects. Alfred Marshall (1890) developed and extended the concept, and Hotelling (1932 and 1938) used it as a basis for his proposals on public utility pricing. Although there have been detractors, the use of consumers' and producers' surpluses are now broadly accepted as appropriate for welfare analysis in public utility economics.

This suggests that the problem of public utility pricing is one of second best, in which different and interdependent sources of welfare loss have to be taken into account simultaneously. According to the welfare criterion of maximizing consumer surplus plus firm profits, it appears that setting price equal to marginal cost will maximize welfare. This is illustrated in Figure 2.1 for the case of a single product natural monopoly.

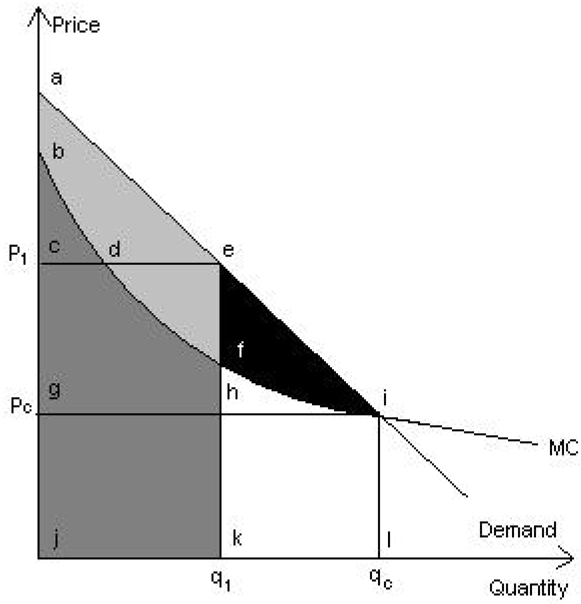

Figure 2.1 Welfare Maximization

Social benefit (area *aehg*) is measured as consumer surplus (area *aec*) plus profits (area *eih*; profit equals revenue minus cost). In Figure 2.1, consider first the effect of setting an arbitrary price p_1; consumers choose to purchase q_1, and clearly at this output level, price is not equal to marginal cost. Consumer surplus is the area above the price line (area *ace*) and firm revenues are the marginal cost line (*bfkj*). So profit, i.e. revenue minus costs, is the area def minus the area *bcd*. Summing profit plus consumer surplus gives the area *aefb*. That is, economic welfare amounts to the difference between willingness to pay (WTP, costs (the area below the demand curve-area aekj) and costs (the area under the marginal cost curve, area *bfkj*). Under marginal cost pricing, welfare is equal to areas *aig*. To see this, note that price is Pc = MC, output is Qc, and consumer surplus is given by area *aig*, whilst profit is zero (since price equals marginal cost for each unit sold). It is important that when moving from the monopoly price to marginal cost pricing, there is a dead-weight welfare losses. The existence of a welfare loss under profit maximizing monopoly pricing provides the fundamental insight of Ramsey pricing.

Thus, welfare can be expressed either as willingness to pay minus costs, or as consumer surplus plus profits:

$W = CS + \prod = WTP$ – costs.

Thus maximum attainable welfare is given as the area *aib*. To get this level of welfare requires the firm to charge the price p_c (the marginal cost price). It should also be that consumers do very well out of this marginal cost pricing solution, gaining consumer surplus CS=*aig*, while the firm makes a loss equal to area *big*.

There are two approaches to measuring the incidence of benefits among customers. One method relies on an explicitly parameterized model of customers' types that specifies directly the net benefit each type obtains. Consequently, the firm's profit contribution and customers' benefits can be aggregated by summing these amounts pertinent to each customer. The second, indirect method uses the demand profile to infer the number of customers purchasing each increment. This enables the firm's profit contribution and the consumers' surplus to be obtained by aggregating over increments, surplus measurement via parameterized models.

The traditional measure of welfare employed in evaluating public utility policies has been the following:

$$W = TR + S - TC, \tag{2.1}$$

where W=net social benefit, TR=total revenue, S=consumers' surplus and TC=total costs. In the case of a single product, the net benefits of (2.1) occurs at a given output level x may be expressed as

$$W = \int_0^x P(y)dy - C(x), \tag{2.2}$$

where P(x) is the inverse demand function and C(x) is the total cost function. Now, we can easily compute from (2.2) that dW/dx = 0 implies P(x)=dC/dx, i.e. maximizing W in (2.2) leads to price = marginal cost, or marginal cost pricing.

The use of the consumers' surplus to measure benefit is widespread in applied welfare economics, for example Mishan (1971 and 1981). Further justification for its use has been provided by Willig (1976) who demonstrated that consumers' surplus closely approximates the consumers benefit in money terms. Accordingly we will continue the tradition of using consumer surplus as a measure of benefit in this study.

2.1.1. Ramsey Pricing

In natural monopolies, as for example public utilities or postal services, marginal cost pricing causes the firm to fail attaining break-even; and even when publicly compensated, such results distort the original, or "first-best" welfare optimum. Attention in such situations has therefore focused on "second-best" solutions.

Some of the early contributors on second-best, Lipsey and Lancaster (1956) for example, argue that there are just no general rules for optimality in second-best situations. Later developments, however, have been more positive. Farrell (1958) argued that the second-best optimum is likely to be close to the first-best optimum, implying that price should be set at least equal to marginal cost, and in the case of substitutes, above marginal cost. Davis and Whinston (1965) indicate that where there is little or no interdependence between sectors, enforcing competitive prices in the competitive sector may be appropriate. Textbooks on industrial organization, like Scherer (1970) and Sherman (1974), also reflect a more positive attitude towards second-best problems. Two alternatives which have served as the focus for discussing the issue of decreasing costs have been fair rate-of-return regulation and welfare optimal break-even pricing. Let us consider these two approaches briefly.

Consider first a profit-maximizing monopolist producing the two commodities $x = (x_1,x_2)$, with total cost $C(x)$ and faced with "willingness to pay" (i.e. inverse demand) functions $P_1(x)$, $P_2(x)$. Such a monopolist would set price and output so as to

$$Max_{x\geq 0}\sum_{i=1}^{2} x_i P_i(x) - C(x). \tag{2.3}$$

This leads to the familiar solution that marginal revenue is equated to marginal cost, i.e. $\partial R(x)/\partial x_i = \partial C(x)/\partial x_i$, where $R(x) = \sum x_i P_i(x)$, then:

$$x_i\, \partial P_i/\partial x_i + x_j\, \partial P_j/\partial x_i + P_i(x) = \partial C(x)/\partial x_i\ , \tag{2.4}$$

where $j\neq i$; $i,j = 1,2$. Depending on the sign of $\partial P_j/\partial x_i$ various possibilities result in, but the usual presumption is that own effects dominate cross effects so that the first term in (2.4), which is negative since $\partial P_i/\partial x_i < 0$, dominates the second, leading to higher prices $P_i(x)$ and lower output x than would be obtained under marginal-cost pricing. In order to limit the resulting welfare losses due to monopoly pricing we might attempt to regulate the level of profits to some 'fair' level which is high enough to pay competitive rates to the various factor used in producing x.

A second approach, which owes much to Ramsey (1927), Boiteux (1956) and the recent synthesis by Baumol and Bradford (1970), is to deal directly with the problem of deficits by allowing departures from marginal-cost pricing in order to break even and avoid a deficit. The best departure from marginal-cost pricing can be found by optimizing some welfare function subject to an explicit break-even constraint. If all goods in the economy are brought under the umbrella of this welfare optimization, the Lipsey-Lancaster second-best formulation results. If only some goods are brought under the optimization umbrella, we still speak of a second-best solution. For the case at hand where the postal sector produces $x=(x_1,x_2)$, this second-best problem can be stated from the book called "The Economics of Public Utility Regulation" of M.A.Crew and P.R.Kleindorfer as follows

$$Max_{x\geq 0}W(x) = \int_0^x \sum_{i=1}^{2} P_i(y)dy_i - C(x), \quad (2.5)$$

Subject to:

$$\Pi(x) = \sum_{i=1}^{2} x_i P_i(x) - C(x) \geq \Pi_0, \quad (2.6)$$

where $\prod_0$ is the required profit level. Associating the Lagrange multiplier μ with (2.6), we form the Lagrangian

$$L(x, \mu)=W(x)+ \mu(\sum_{i=1}^{2} x_i P_i(x) - C(x) - \Pi_0), \quad (2.7)$$

and consider the Kuhn-Tucker conditions $\partial L/\partial x_i=0$ (assuming $x_i>0$) and $\partial L/\partial \mu=0$ (assuming (2.6) holds as an equality at optimum). This yields $\prod(x)= \prod_0$ and

$$P_i(x)-MC_i(x)+\mu(MR_i(x)-MC_i(x))=0, \qquad i=1,2. \quad (2.8)$$

where $MR_i=\partial R/\partial x_i$, $MC_i=\partial C/\partial x_i$. From (2.8), then, deviations (p_i-MC_i) of price from marginal cost should be proportional to the difference between marginal revenue and marginal cost. In the case of independent demands $P_i(x)=P_i(x_i)$ so that (2.8) may be rewritten as

$$\frac{P_i(x_i) - MC_i(x)}{P_i(x_i)} = -\frac{\lambda}{(1+\lambda)}\frac{1}{\eta_i}, i = 1,2. \quad (2.9)$$

where $\eta_i=[(P_i(x_i)/x_i)(1/P'_i(x_i))]$ is the price elasticity of demand and where $\lambda / (1+\lambda)$ is the 'Ramsey Number', when equal to unity results in the profit-maximizing solution. This last is the so-called inverse elasticity rule; it says that the percentage deviation of price from marginal cost should be inversely proportional to elasticity. Also when the Ramsey number is zero reduces to the marginal cost pricing rule. It is important also to note that if Ramsey number is one, then it is the profit-maximizing third-degree price discrimination rule. In other words, for the social welfare problem $\lambda=0$ and Ramsey number is equal to zero; for the monopoly problem $\lambda=\infty$ and Ramsey number is equal to one. If we assume that profit maximization more than achieves the profit target, then clearly the optimal level of the constant Ramsey number will lie strictly between zero and unity. Then, the optimal Ramsey prices will lie between marginal cost and the profit-maximizing price discrimination level.

This intuitive and important result holds as long as the demand for each product is independent. Where demands are interdependent, some modifications are required in this rule. In view of the importance of interdependent demands in natural monopolies, so that Ramsey optimality with interdependent demands may be rewritten for two product case as

$$\sum_{j=1}^{2}\left[\frac{p_j^*-c_j^*}{p_j^*}\right]\left[\frac{p_j^*x_j^*}{p_i^*x_i^*}\right]\eta_{ji}^* = -\left[\frac{\lambda^*}{1+\lambda^*}\right], \qquad i=1,2 \qquad (2.10)$$

where λ^* denotes the value of the Lagrange multiplier associated with constraint. $c_j^*=\partial C(x^*)/\partial x_j$, the marginal cost for the jth product and cross-price elasticity ($\eta_{ji}=(\partial x_j/\partial p_i)(p_i/x_j)$) is evaluated at (p^*,x^*).

As noted by Philips and Roberts (1985), $\eta i=[(P_i(x_i)/x_i)(1/P'_i(x_i))]$ is own price elasticity of demand. Equation (2.9) is called as inverse elasticity rule; it says that the deviation of price from marginal cost should be inversely proportional to elasticity. The intuitive rationale for this rule is that in achieving a required level of profit in a welfare optimal fashion, those prices ought to be raised the most which will least distort the resulting output pattern from the socially efficient pattern obtainable thorough marginal-cost pricing. This suggests that contributions toward covering the public enterprise deficit resulting from marginal cost pricing should be extracted more from products with inelastic demands than from those which are price sensitive. If own-price effects dominate ($|\eta_{ii}|>|\eta_{ji}|$ for $i\neq j$), then it reduces to the standard inverse elasticity rule as (2.9) when η_{ji}=0 for all j≠i and that (for both the Ramsey problem and the profit-maximizing problem):

1. If products 1 and 2 are substitutes (η_{ij}>0 for i≠j), then $P_i \geq C_i$, i=1,2 with $p_i > C_i$, i=1,2 except at the unconstrained welfare optimum.
2. If products 1 and 2 are complements (η_{ij}<0 for all i,j), then $p_i < C_i$ is possible at optimum for one of the two products.

Returning to the two-product case, given the assumption that $|\eta_{ii}|>|\eta_{ji}|$ and yet $(p_1-C_1)/p_1>(p_2-C_2)/p_2$, which is contrary to the simple inverse elasticity rule of (2.9) which would imply prices always greater than or equal to marginal cost. If the product of R_1/R_2 and η_{12} were sufficiently large, this could easily happen. Thus the combination of x_1 providing a large share of the total revenue and being a strong complement with x_2 would imply a significant divergence from the simple inverse elasticity rule. Product 2, in this case, could actually be subsidized (sold below marginal cost) because of the beneficial effects it had on sales of product 1. However, as interdependencies in demand are reduced, optimal pricing approaches the simple inverse elasticity rule (2.9).

In concluding this discussion of Ramsey pricing, Ramsey prices which maximize welfare subject to attaining the target profit level feature a similar pattern to the prices that a profit-maximizer would charge. That is, the highest mark-ups are on the more inelastic (least price sensitive) products, whilst low prices are charged to the elastic (price sensitive) segments. Thus a utility practising price discrimination could be consistent with that firm actually pursuing an objective of welfare maximization (subject to financial constraints) or of profit maximization. Clearly, price discrimination in itself is not evidence of profit maximization. However, to test whether the firm is indeed maximizing profits, or is setting prices below such information regarding not only demand elasticities across the market segments, but also the firm's marginal cost of production. In our study, Ramsey pricing was applied to the Turkish Post Office for letters and express mail. A recent study (Dobbs and Cutherbertson 1996) suggested that the price differential applied in recent years could be justified from the perspective of Ramsey pricing.

2.2. Postal Demand and Cost Analysis

The data must be sufficient to provide estimates of how demands will change as prices change. Furthermore, for a profit-maximizing firm setting a uniform price, it may be sufficient to use aggregated market data to estimate the aggregate demand function-or perhaps only the price elasticity of this demand function to examine whether a price change would be profitable. Otherwise, for regulated firms and public enterprises, postal service in our study, this finer information is necessary to assess the distribution of benefits among customers, which is a matter of special concern to regulatory agencies.

In our study, we have not chosen a tightly defined theoretical demand model, given the data limitations, but have attempted to combine theory with statistical results to produce a model that is acceptable. Empirical studies on the demand for postal services are relatively scarce. The approach taken by many of these studies has been to consider postal demand as a function of postal prices, incomes and telephone charges (as a substitute). Most studies segment the market between first and second class mail.

Some empirical studies on the demand estimation of postal services are as follows: Izutsu and Yamaura (1997) studied the Japan Post Office using double log ordinary least squares estimation technique from 1972 to 1995's postal data. Their dependent variables were total regular delivery mail, standard sized first class mail, non-standard first class mail and second class mail and their independent variables were real prices, real incomes and facsimile numbers. They found that own price elasticity of total, standard first, non-standard first and second are -0.2, -0.3, -0.52 and -0.12, respectively. In the meantime, Nikali (1997) set out a study for Finland Postal Service by modeling a double log ordinary least squares estimation technique. His dependent variables are again first and second class mail volumes and his independent variables are real first and second class prices, real GDP, a business cycle variable (number of building permits), the number of facsimile machines and a dummy for changes in mail composition. His key findings were that the own price elasticity of demand for first class mail was -0.52 and with own price being first class price divided by second class price. Three years ago from these studies in 1994, Ohya and Albon had studied Japan Postal business by accounting postal data from 1968 to 1993. They used double log, maximum likelihood technique as an estimation technique and also used normal sized first class mail under 50 grams, abnormal sized first class mail and first class over 50 grams and second class mail as dependent variables and real postal prices for each category, real per capita GDP, a time trend to represent communications advances and telephone prices as independent variables. In this study all own price elasticities were highly inelastic and normal first, abnormal first and second class mail elasticities are -0.25, -0.40 and -0.08, respectively. Telephone prices were found to be insignificant. In 1990, Adie examined the United States postal service. He set out a linear and double log ordinary squares estimation model to estimate the postal data from 1977 to 1982. Seasonally adjusted monthly first class mail volumes were used as dependent and real postal prices, real personal income, real long distance telephone prices and US population were used as independent variables in Adie's study. Adie found that the own price elasticity of demand was -0.23 and the telephone price was only significant at the 90 per cent level. Another study on postal demand estimation in 1989 belongs to Albon who examine United Kingdom postal services' data from 1976 to 1986 by setting an ordinary least squares estimation method. In this study, a traffic index for total volume and actual first and second class mail volumes were used as dependent variables. The independent variables were real postal prices, real telephone usage prices, real GDP, first and second class delivery standards, real GDP, household income, business income and delivery standards. The findings in this study are own price elasticities with total -0.638, first -0.86, second -0.89 and telephone prices insignificance. The earliest study about estimation of postal demand was done in 1975 by Neary. Neary used a linear and log-linear ordinary least squares estimation technique and examined the Ireland postal business. In the same way, Neary used total mail, first class and second class mail volumes per head per week as dependent; but real postal prices, real consumer expenditure, real telephone prices, number of telephones and a time trend for independent variables. The key findings on Neary's study are the own price elasticity for first class mail was about -0.3 and second class was less certain but appeared to be very low.

The study by Cutherbertson and Richards (1990) has valuable contributions to our study. Unlike other estimation techniques, Cutherbertson and Richards' estimation method is static double-log demand function with error correction by assuming fixed communications budget and imposed demand regularity conditions. But like other studies, first and second class mail volumes are used as dependent variables and its independent variables are first and second class mail prices, telephone prices, prices for other communications services, real expenditure and first and second class delivery standards. This study's findings are that own price declined over the sample period; first class from -2.2 to -1.8, second class from -1.2 to -.0.8 but telephone prices had little impact.

During our study, we had very little information about the factors which determine the demand and cost for inland mail categories in Turkey. The Post Office has not undertaken any proper study of demand and cost for its product. Moreover, the Post Office was unable to comment on the cross-price elasticity between letters and express mails as it was difficult to estimate partly because there are other factors like the quality of service. In our study, in order to estimate the relationship between different measures of postal volume and variables such as postal prices; national, household and business income; and delivery standards, annual data were collected for the period 1987 to 1999. All equations were estimated using the OLS multiple regression model incorporating various test statistics. In the absence of any strong argument to the contrary, the relationship between dependent and explanatory variables were assumed to be linear. Our first task was to get some idea of the aggregate relationship between consumption of postal services and overall postal prices, telephone usage prices, real gross domestic product.

The Postal Service is a natural monopoly. Prior to the late 1970s this claim was interpreted to mean that economies of scale exist in the production of postal services. Empirical studies of the postal system, some of which are reviewed by Miller and Sherman (1980, p59), have not supported that claim. Recent developments in the theory of the multi-product firm have added a new direction to the discussion. Papers by Baumol, Bailey and Willig (1977), Panzar and Willig (1977), Sappington and Shepherd (1982), have shown that the existence of economies of scope may also create the situation where a single firm is the low-cost producer of a group of products. Wattles (1973), found some evidence of economies scope for the Postal Service, but did not estimate a multi-product cost function using econometric techniques.

Postal costs fall between those that can be attributed to the provision of particular services ('direct costs') and those that cannot ('overhead costs'). For the purposes of this study we require figures on direct costs for each of the two mail categories and the aggregate of overhead costs. The Post Office is reluctant to release data on its cost structure so that glimpses of this are rare.

Since, in postal service practise, cost allocation procedures are used to estimate marginal costs, it is important to determine how accurately such measures reflect real marginal costs. The Postal Service uses a system known as the "In-Office Cost System (IOCS)" to allocate costs between the various categories of mail. In the IOCS procedure, a labor-time weighted average of total costs is used to allocate costs to demand classes. This allocated class cost is then divided by the overall demand in the class to yield an estimate of marginal cost.

The traditional approach to postal pricing is one where all costs of provision of the service are retrieved through direct user charges. Unlike pricing of telecommunications, there has been no resource to a communication of access charges and usage charges. Postal pricing does not lend itself to access charging for technical reasons and fixed costs have, instead, been covered by marking-up unit costs. However, the mark-ups have usually been set on the basis of criteria other than minimizing the deadweight loss of departing from marginal cost pricing.

Pricing according to the Ramsey (1927) rule, where demands are independent, minimizes the deadweight losses from pricing above marginal costs. The appropriate rule is derived by, for example, Brown and Sibley (1986). By taking any pair of products, say 1 and 2, and defining proportional mark-ups (as a ratio of the new price) on marginal costs, the inverse elasticity rule is obtained.

In the present case where direct marginal costs are assumed constant, this rule is simpler to interpret than where the cost base depends on output levels and, therefore on prices. Where demands are not independent, the rule must be modified to take into account cross-price effects.

CHAPTER 3

DEMAND ESTIMATION

This chapter provides the estimation of postal demand using data collected from PTT Statistics year books. We develop log-linear and linear demand models for understanding the factors affecting postal demand and for forecasting postal demand in Turkey.

In order to estimate the relationship between different measures of postal volume and variables such as postal prices; telephone charges, number of telephone subscribers, number of televisions in use, Gross Domestic Product Index (GDP) and Consumer Price Index as an inflation indicator, annual data were collected for the period 1987 to 1999. No reliable data is available older than 1987. Furthermore, the economical crisis at year 2000 in Turkey enforces us to exclude data for the year 2000,2001 and 2002. All prices and variable series were converted into constant prices using the consumer price index with base 1987 = 100. We use stepwise regression to help us select the independent variables to be included in the model. It is also note that instead of incorporating the population, number of internet users and usage of facsimile, we use the number of telephone subscribers and the number of televisions as an index of others in stepwise regression.

All equations were estimated using the OLS multiple regression. Turkish Postal prices and volumes of letter and express mail per year is documented in

Appendix A. Average prices for one minute long distance telephone call between 1987-2002 are presented in Appendix B. Consumer price index table is given in Appendix C. Gross Domestic Product index is given (GDP) Appendix D. Telecommunication and Postal Services Indexes are in Appendix E. Bedides, all price tariffs for letter and express mail are provided in Appendix F and G, respectively.

Since for the implementation of the Ramsey pricing we need to estimate the demand functions, some statistical tests are performed on the data set in order to decide whether demand models are reasonable on statistical and economical grounds. Most of the statistical issues such as multicollinearity, autocorrelation, heteroscedasticity, choice of functional form, etc. are undertaken using Excel in our study. These analyses are presented in this chapter.

In this study, we have 13 observations from years from 1987 to 1999. It is important to keep the number of the explanatory variables associated with the model at significantly less than the number of the observations. According to the our initial model after stepwise, for example, even introducing just one lag would lead to 9 parameters, whereas there are only 13 observations. In the light of this, the model does not feature lagged values. It can be said that tha available data does not allow the use of a more general form than that given in study.

3.1. Demand Estimation of Turkish Inland Letters

This section illustrates the process of the econometric analysis of the letter demand estimation. All data for the study comprise the average figures for each year over a period of 13 years and the related data collected from PTT Statistical year books are given in the following Table 3.1.

Table 3.1: Postal Data For Letters Demand

Postal Data								
t	q_{let}	p_{let}	p_{exp}	TEL_t	CPI_t	p_{let}/CPI_t	p_{exp}/CPI_t	TEL_t/CPI_t
1987	685913	50	1000	187.50	100.00	50.00	1000.00	187.50
1988	838485	75	1500	295.14	174.00	43.10	862.07	169.62
1989	816812	175	1800	418.75	284.00	61.62	633.80	147.45
1990	822072	300	2000	525.00	455.00	65.93	439.56	115.38
1991	840753	500	3500	826.39	754.00	66.31	464.19	109.60
1992	850153	625	7750	1400.00	1283.00	48.71	604.05	109.12
1993	785267	1500	10500	2200.00	2131.00	70.39	492.73	103.24
1994	660908	3500	25000	4733.33	4396.00	79.62	568.70	107.67
1995	714035	7500	75000	6400.00	8266.00	90.73	907.33	77.43
1996	682123	15000	115000	9052.00	14908.00	100.62	771.40	60.72
1997	661315	30000	250000	19826.67	27694.00	108.33	902.72	71.59
1998	568322	65000	350000	34833.33	51122.00	127.15	684.64	68.14
1999	616361	125000	550000	50666.67	84313.00	148.26	652.33	60.09
Postal Data (log real prices)								
t	$ln\ q_{let}$	$ln\ p_{let}$	$ln\ p_{exp}$	$ln\ TEL_t$	$ln\ CPI_t$	$ln(p_{let}/CPI_t)$	$ln(p_{exp}/CPI_t)$	$ln(TELt/CPIt)$
1987	13.439	3.912	6.908	5.234	4.605	-0.693	2.303	0.629
1988	13.639	4.317	7.313	5.687	5.159	-0.842	2.154	0.528
1989	13.613	5.165	7.496	6.037	5.649	-0.484	1.847	0.388
1990	13.620	5.704	7.601	6.263	6.120	-0.417	1.481	0.143
1991	13.642	6.215	8.161	6.717	6.625	-0.411	1.535	0.092
1992	13.653	6.438	8.955	7.244	7.157	-0.719	1.798	0.087
1993	13.574	7.313	9.259	7.696	7.664	-0.351	1.595	0.032
1994	13.401	8.161	10.127	8.462	8.388	-0.228	1.738	0.074
1995	13.479	8.923	11.225	8.764	9.020	-0.097	2.205	-0.256
1996	13.433	9.616	11.653	9.111	9.610	0.006	2.043	-0.499
1997	13.402	10.309	12.429	9.895	10.229	0.080	2.200	-0.334
1998	13.250	11.082	12.766	10.458	10.842	0.240	1.924	-0.384
1999	13.332	11.736	13.218	10.833	11.342	0.394	1.875	-0.509

Table 3.1 gives the data for the volume of delivered inland letters, denoted by q_{let}, the prices of letters and express mails, p_{let}, p_{exp}, an average price for one minute long distance telephone call TEL_t, and an index of consumer price index CPI_t. Real prices and log real prices are also given in Table 3.1.

At the end of the study, a comparison of a linear and log-linear demand function for letter demand will be considered, but we will start with the general-to-specific methodology applied to the log-linear model which we determined after stepwise analysis. So, the initial demand model for the letter is

$$\ln q_{let} = \beta_0 + \beta_1 \ln p_{let} + \beta_2 \ln p_{exp} + \beta_3 \ln TEL_t + \beta_4 \ln CPI_t + \varepsilon_t . \qquad (3.1)$$

To perform log-linear regression, we first constructed data as variables are log-values and appropriate data set is given Table 3.1. In this demand estimation study

n: number of observations which equals 13 that is sample size,

k: parameters estimated which equals 5,

df: degrees of freedom which equals 8 that is n – k.

3.1.1. Reported Statistics

- R-Square

Running regression analysis for the model (3.1), we have observed the Table 3.2 as a regression output. From Table 3.2, R^2 = 0.86187; it says that %86.2 of the variation in the dependent variable is explained by variation in the independent variables.

Table 3.2: Regression Output; log-linear model, nominal prices, equation (3.1)

SUMMARY OUTPUT						
Regression Statistics						
Multiple R	0.9283723					
R Square	0.86187513					
Adjusted R^2	0.7928127					
Standard Error	0.06082388					
Observations	13					
ANOVA						
	df	*SS*	*MS*	*F*	*Significance*	
Regression	4	0.18467613	0.046169	12.47965	0.001618838	
Residual	8	0.029596359	0.0037			
Total	12	0.214272489				
	Coefficients	*Stand. Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper95%*
Intercept	14.0785549	0.29497801	47.72747	4.11E-11	13.39833392	14.75878
ln plet	-0.333649	0.136738771	-2.44005	0.040562	-0.6489694	-0.01833
ln pexp	-0.1273667	0.068454623	-1.8606	0.099839	-0.28522344	0.03049
ln TELt	-0.3951482	0.168164383	-2.34977	0.046698	-0.7829362	-0.00736
ln CPIt	0.80170453	0.218988549	3.660943	0.006393	0.296715703	1.306693

- The F-Statistics

The reported value of the F-Statistic in Table 3.2 can be used to test the overall significance of the regression for letter demand estimation. The F-statistic can be summarized as:

H_0: $\beta_0=\beta_1=\beta_2=\beta_3=\beta_4=0$, against the alternative hypothesis;

H_1: at least one of β_i is significantly different from zero.

The F-statistics is given in the ANOVA (analysis of variance) section in Table 3.2; the calculated value is F^{calc} = 12.48, whilst the critical value at 5% level of significance, with k-1, n-k = 4,8 degrees of freedom, is obtained from table as $F_{4,8}$=3.84. Hence, we reject H_0, that is at least one of the β_i is significantly different than zero. We can also arrive at the same answer by noting that the summary information actually reports the significance level of the F-statistics. This also means that the null hypothesis would be rejected, at least one of β_i is significantly different from zero.

- Standard Errors And t-Statistics

The standard errors in Table 3.2 can be used to see the indication of how tightly individual slope coefficients are estimated. So, the reported t-statistics can be used to test formally whether individual coefficients are significantly different from zero. If $|t_{calc}| > t_{crit}$, where t_{crit} is the critical value for the t-statistic, then it means that coefficient is significantly different from zero. Thus, Table 3.3 illustrates whether each coefficient is significantly different from zero or not that is null hypothesis (H_0:β_i=0) accepted or not. For instance, the absolute value of the calculated t-statistic for letter price (p_{let}) is greater than the critical value of t-statistic (2.306), so the null hypothesis should rejected for that coefficient. That is, p_{let} is significantly different from zero.

Table 3.3: t-Statistics for Coefficients

	Coefficients	*Standard Error*	$\lvert t_{calc}\rvert$	t_{crit}=2.306
Intercept	14.0785549	0.29497801	47.72747	Rejected
ln plet	-0.333649	0.136738771	-2.44005	Rejected
ln pexp	-0.1273667	0.068454623	-1.8606	Accepted
ln TELt	-0.3951482	0.168164383	-2.34977	Rejected
ln CPIt	0.80170453	0.218988549	3.660943	Rejected

According to Table 3.3, except the coefficient of express mail price, all other variables are significantly different from zero. In parallel with t-statistic, the same conclusions can be inferred by checking the 95% confidence intervals. It is only to check whether the value of the parameter under the null hypothesis is included within the confidence interval or not. If it is in confidence interval, then this means that the null hypothesis cannot be rejected. If it is not, the null is rejected. Thus, all coefficients and their 95% confidence intervals are as follows:

Table 3.4: Confidence Intervals Checking

	Lower 95%	*Upper 95%*	*Null Hypothesis For β_i=0*
Intercept	13.39833392	14.75878	Rejected
ln pexp	-0.6489694	-0.01833	Rejected
ln plet	-0.28522344	0.03049	Accepted
ln TELt	-0.7829362	-0.00736	Rejected
ln CPIt	0.296715703	1.306693	Rejected

- Other Information

The most important information about this regression is that the very small p-values of variables leaves little doubt. Other information of use in computing some test statistics in the ensuing analysis are as follows: the standard error of the regression is 0.06082, the sum of squared errors SSE (or residuals) is 0.02959 and the portion of the total squared deviations explained by the regression, SSR, is 0.18467.

3.1.2. Non-Reported Statistics

In this section we set out time-series analyses in particular.

- Testing For Autocorrelation

The Durbin-Watson Statistic d is a useful measure of the degree of first-order autocorrelation. It is defined as

$d = \frac{\sum_{t=2}^{n}(e_t - e_{t-1})^2}{\sum_{t=1}^{n} e_t^2}$, in fact its calculation from residuals in Table 3.5 that the list of residuals, e_t, t=1,…,13 and the series which comprises the squared residuals are also given.

Table 3.5: The Durbin-Watson Statistic (d)

Durbin-Watson d=2,83541677			
Observation	*Residuals*	*(e_t)2*	*(e_t-e_{t-1})2*
1	-0.07885571	0.006218223	0
2	0.04413103	0.001947548	0.015125739
3	0.06932729	0.004806273	0.000634851
4	-0.01950798	0.000380561	0.007891705
5	0.01900425	0.000361161	0.001483191
6	-0.01202879	0.000144692	0.000963049
7	0.01118101	0.000125015	0.000538695
8	-0.04580322	0.002097935	0.003247202
9	0.03869111	0.001497002	0.007139291
10	-0.05713089	0.003263938	0.009181855
11	0.05536418	0.003065193	0.012655141
12	-0.06410827	0.00410987	0.014273666
13	0.03973597	0.001578947	0.010783626

Hence, the Durbin-Watson statistic d is 2.83541. Under the null hypothesis of no autocorrelation, it takes the value d ≈ 2. Positive autocorrelation is associated with a value for d of less than 2 and negative autocorrelation with a value greater than 2. Therefore, in our model, it is 2.8354. It seems that there is no autocorrelation but it may be a little problem from negative autocorrelation.

- Testing For Multicollinearity

We know that regression does not say anything about multicollinearity. To test for autocollinearity, we have to generate the correlation matrix for the independent variables. The correlations in Table 3.6 between the log-variables are all very high. This indicates that there may be a problem with multicollinearity in regression.

Table 3.6: Correlation Matrix For Log Nominal Prices

Correlation Matrix for Log Nominal Prices				
	ln plet	ln pexp	ln TELt	ln CPIt
Ln plet	1			
Ln pexp	0.991116	1		
Ln TELt	0.996839	0.993215	1	
Ln CPIt	0.998749	0.992915	0.998284	1

- Testing For Heteroscedasticity

Heteroscedasticity is the problem that the variance of the error term is not constant from observation to observation. In order to test for heteroscedascitiy, we use the Breusch-Pagan (BP) statistic. In order to implement this test, it is necessary to construct an hypothesis as to what the determinants of variance are. That is, for the initial model (3.1), instead of assuming that the disturbance term has constant variance σ^2, it can be hypothesized that it varies across observations as $\sigma_t^2 = \alpha_0 + \alpha_1 \ln p_{let} + \alpha_2 \ln p_{\exp} + \alpha_3 \ln TEL_t + \alpha_4 \ln RPI_t$, then the null hypothesis is that the error variance is really constant. That is, H_0: $\alpha_1 = \alpha_2 = \alpha_3 = \alpha_4 = 0$. This is tested against the alternative hypothesis that at least one of these parameters is significantly different from zero. We know that the squared residuals give estimates for σ_t^2. Hence, we simply take the residuals e_t, t=1,...,13 from the original regression equation, square them and then run the regression for the (3.2). The results for this regression are given in Table 3.7.

$$e_t^2 = \alpha_0 + \alpha_1 \ln p_{let} + \alpha_2 \ln p_{\exp} + \alpha_3 \ln TEL_t + \alpha_4 \ln RPI_t + \mu_t \qquad (3.2)$$

Table 3.7: Analysis of Heteroscedasticity

SUMMARY OUTPUT						
Regression Statistics						
Multiple R	0.837079					
R Square	0.700702					
Adjusted R2	0.551052					
Standard Error	0.001291					
Observations	13					
ANOVA						
	Df	*SS*	*MS*	*F*	*Significance*	
Regression	4	3.12E-05	7.81E-06	4.682293	0.030516	
Residual	8	1.33E-05	1.67E-06			
Total	12	4.46E-05				
	Coefficients	*Stand.Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	0.000595	0.006262	0.095089	0.926583	-0.01385	0.015036
Ln plet	0.007265	0.002903	2.502683	0.036788	0.000571	0.013959
Ln pexp	0.004471	0.001453	3.07687	0.015189	0.00112	0.007823
Ln TELt	0.004168	0.00357	1.167506	0.276623	-0.00406	0.0124
Ln CPIt	-0.01652	0.004649	-3.5533	0.007473	-0.02724	-0.0058

Then, the Breusch-Pagan statistic is formulated if μ_t has a normal distribution as $BP = \frac{SSR}{2(\sum_{i=1}^{n} e_t^2 / n)^2} \approx \chi^2(v)$, that is, for large samples, the BP statistic has an approximate chi-square distribution with degrees of freedom V, where V is the number of variables in the estimating regression, in our case V=4. In summary, it turns out that, for large samples, the statistic $nR^2 \approx \chi^2(v)$. In our model, the sample involved here 13 is small, however, the magnitude of the BP or nR^2 statistic still gives some idea of the extent of heteroscedasticity that may be present. According to the table, nR^2= 13 x 0.7007 = 9.1091. There are four variables in the estimating equation, so the critical value is $\chi^2(4) = 9.49$ at the 95% level of significance. The calculated value would have to exceed 9.49 for there to be significant heteroscedasticity, but not in our case. Clearly, it is worth emphasizing that there is no heteroscedasticity or any other anomaly in our model, so the process of testing down should begin.

3.1.3. The Process of Testing Down

The process of testing down begins with the initial equation (3.1), given here for convenience.

$$\ln q_{let} = \beta_0 + \beta_1 \ln p_{let} + \beta_2 \ln p_{exp} + \beta_3 \ln TEL_t + \beta_4 \ln CPI_t + \varepsilon_t . \qquad (3.3)$$

- The Unconstrained Log-Linear Model (3.3): Table 3.2

The regression for this model as a whole is significant at $R^2 = 0.862$, 4 of 5 parameters are significantly different from zero and the correlation matrix in Table 3.6 suggests fairly high correlations between explanatory variables. As a general criticism of this model, nominal prices on the right side are not stationary. Furthermore, imposing the homogeneity in effect, demand is modeled as a function of real rather than nominal prices. Real prices are more likely to be stationary (i.e. not trending over time). The homogeneity restriction is that;

$\beta_1 + \beta_2 + \beta_3 + \beta_4 = 0$. In our unconstrained model;

$\widehat{\beta}_1 + \widehat{\beta}_2 + \widehat{\beta}_3 + \widehat{\beta}_4$ = -0.33365-0.12737-0.39515+0.80171 = -0.05446.

This is too close to zero, but it is useful to check homogeneity in the unconstrained model. Now, we have to impose homogeneity restriction.

- The Constrained Log-Linear Model: Table 3.8

To implement the homogeneity restriction, we have constructed the real price variables and run the regression. This formulation is formally equivalent to imposing restriction.

$$\ln q_{let} = \beta_0+\beta_1 \ln(p_{let}/CPI_t)+\beta_2 \ln(p_{exp}/CPI_t)+\beta_3 \ln(TEL_t/CPI_t)+ \varepsilon_t \quad (3.4)$$

The results of the Ordinary Least Squares (OLS) estimation of (3.4) are given in Table 3.8 with R-Square=0.82 and F-statistic=13.77.

Table 3.8:Regression output (3.4);log-linear model, real prices

SUMMARY OUTPUT						
Regression Statistics						
Multiple R	0.90614063					
R Square	0.82109085					
Adjusted R2	0.76145446					
Standard Error	0.06526468					
Observations	13					
ANOVA						
	Df	*SS*	*MS*	*F*	*Significance*	
Regression	3	0.175937179	0.058646	13.76829	0.00103563	
Residual	9	0.03833531	0.004259			
Total	12	0.214272489				
	Coefficients	*Stand. Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	13.6735877	0.142290327	96.0964	7.26E-15	13.35170442	13.99547
ln(plet/CPIt)	-0.457717	0.118426009	-3.865	0.003818	-0.72561541	-0.18982
ln(pexp/CPIt)	-0.1576492	0.070344188	-2.24111	0.051749	-0.31677892	0.001481
ln(TELt/CPIt)	-0.2013166	0.119360528	-1.68663	0.125952	-0.47132903	0.068696

Imposing the homogeneity restriction increases the degrees of freedom from 8 to 9, but this reduces the values of the correlation coefficients, in Table 3.9 so it says that multicollinearity may be less of a problem in this model.

Table 3.9: Correlation Matrix for Log Real Prices

	$\ln(p_{let}/CPI_t)$	$\ln(p_{exp}/CPI_t)$	$\ln(TEL_t/CPI_t)$
$\ln(p_{let}/CPI_t)$	1		
$\ln(p_{exp}/CPI_t)$	0.053068	1	
$\ln(TEL_t/CPI_t)$	-0.90674	-0.0031	1

In the same way, the DW statistic d in this model takes the value d = 2.4949, so it indicates no significant negative autocorrelation.

Now, we test multiple linear restrictions on parameters, an F-test was used, especially, the sum of squared errors (SSE) which measures the goodness of fit of the regression. The F-statistic for simultaneously testing J equality restrictions amongst the parameters is

$$F = ((SSE_R - SSE_U)/J)/(SSE_U/(n-K)) \qquad (3.5)$$

where n is the number of observations, K is the number of parameters estimated in the unrestricted regression, and SSE_U the unrestricted sum of squared residuals, whilst SSE_R denotes the restricted sum of squared residuals. The worse the fit of the restricted model, the larger SSE_R will be, and so the larger the value of the calculated F-statistic. In our case, there is just a single restriction that is J=1 and from Table 3.2, SSE_U = 0.029596, whilst from Table 3.8, SSE_R = 0.038335. Therefore,

$$F=((0.038335-0.029596)/1)/(0.029596/(13-5)) = 2.362211.$$

The critical value, at the 5% level of significance, is $F_{1,8} = 5.32$. Here, clearly the null hypothesis (homogeneity) should be accepted, since the calculated value is smaller than the critical value. We can say in this condition that the constrained log-linear model with imposing homogeneity can be more appropriate for the model.

Here, we can say something by checking confidence intervals or comparing t_{calc} and t_{crit} = 2.306. According to the t_{calc}, the coefficients on $\ln(p_{let}/CPI_t)$ and $\ln(p_{exp}/CPI_t)$ are still significant, but other parameter -$\ln(TEL_t/CPI_t)$- doesn't seem so significant. Thus, we can go further on our model by setting this parameter to zero.

- Dropping TEL, Log-Linear Model: Table 3.10

Our model after dropping the variable $\ln(TEL_t/CPI_t)$ is as follows:

$$\ln q_{let} = \beta_0 + \beta_1 \ln(p_{let}/CPI_t) + \beta_2 \ln(p_{exp}/CPI_t) + \varepsilon_{t,} \qquad (3.6)$$

Rerunning the regression for the (3.6), we have the results in Table 3.10

We can use the F-test of the restriction (that the coefficient on $\ln(TEL_t/CPI_t)$ is zero) to check the quality of fit of the last restricted model with respect to previous model (3.4). The F-statistic is

$$F=((0.050452 - 0.038335)/1)/(0.038335/(13-4)) = 2.844737,$$

whilst the critical value at 5% is $F_{1,9} = 5.12$. That is, the calculated F-statistic is small against to critical F value but not too small. It means that the dropping TEL

Table 3.10: Regression output (3.6); log-linear model, real prices, TEL dropped

SUMMARY OUTPUT						
Regression Statistics						
Multiple R	0.874381					
R Square	0.764542					
Adjusted R2	0.71745					
Standard Error	0.07103					
Observations	13					
ANOVA						
	Df	*SS*	*MS*	*F*	*Significance*	
Regression	2	0.16382	0.08191	16.23516	0.000724	
Residual	10	0.050452	0.005045			
Total	12	0.214272				
	Coefficients	*Stand. Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	13.74694	0.147448	93.23247	4.93E-16	13.41841	14.07548
Ln(plet/CPIt)	-0.27638	0.05404	-5.11438	0.000454	-0.39679	-0.15597
Ln(pexp/CPIt)	-0.17033	0.076119	-2.23771	0.049195	-0.33994	-0.00073

variable to zero restriction could not be rejected and the other variables are highly significant. As a result, we can say that some explanatory power is lost in setting the coefficient on TEL variable to zero. Furthermore, R-Square decreases from 0.82 in model (3.4) to 0.7645 in model (3.6). Therefore, we should not prefer dropping TEL variable.

Now, we may conclude with some economic implications for our last model. The own-price elasticity of letter demand is elastic at -0.45772, as is the cross-price elasticity with respect to express mail is highly inelastic at -0.15765. If both letters and express mail prices are raised by %1 the net effect on sales is -0.61537%. So, the overall effect of increasing prices is that demand falls very much. This is the fact that the own-price elasticity is very important parameter in pricing postal services.

We have very good estimated letter demand equation but it is necessary to have a linear formulation of the demand approximately, because we will use linear approximations of letter demand in Ramsey optimality study in Chapter 4.

- Linear Model: Table 3.11

Now, we will discuss the functional forms, linear versus log-linear. Taking equivalent linear model of our initial log-linear model,

$$q_{\text{let}} = \gamma_0 + \gamma_1 (p_{\text{let}}/\text{CPI}_t) + \gamma_2 (p_{\text{exp}}/\text{CPI}_t) + \gamma_3 (\text{TEL}_t/\text{CPI}_t) + \varepsilon_t , \qquad (3.7)$$

Then, again SSE is our measure of goodness of fit. In order to compare models, we will compare the SSE's of each model. But residuals are not directly comparable. According to the Box and Cox (1964), SSEs are comparable if we calculate an adjusted sum of squared residuals for the linear model, defined as SSE_{lin}/q_G, where q_G is the geometric mean of the independent variable in the linear model. Particularly, whichever of these is smaller can be viewed as the SSE of the better model. Then, the following statistic is distributed as $\chi^2_{(1)}$(chi-square with one degree of freedom):

$$\chi^2_{(1)} = (n/2)\ \ln(\text{the larger SSE/the smaller SSE}) \qquad (3.8)$$

To apply this test, we should calculate $q_{G,}$ (compute the average value for the log-dependent variable and then take the exponential of this). For postal data,

$$q_G = \exp\{1/13)\ \Sigma \ln(q_i)\} = 728107.3449.$$

The log-linear model's $SSE_{\text{log-lin}}$ is 0.050452 from Table 3.10. Running the regression for the linear model (3.7), we have the following results in Table 3.11

with R-Square = 0.79 and F-statistics = 11.34. The linear model's SSE_{lin} is 23100000000 from Table 3.11. Then, the adjusted SSE for linear model is 23100000000 / $(728107.3449)^2$=0.04357. Thus, the linear model fits the data better because its adjusted $SSE_{adj\text{-}lin}$ (0.04357) is smaller than log-linear model $SSE_{log\text{-}lin}$ (0.050452). The test statistic χ^2_{calc} is, from (3.8), given as

$$\chi^2_{calc} = (13/2)\ \ln(0.050452/0.04357) = 0.95295.$$

At 5% level of significance, $\chi^2_{(1)}$ = 3.84. Thus, I could not say that there is significant difference between the linear and log-linear functional forms, we found the χ^2_{calc} (3.84) < $\chi^2_{(1)}$ (0.95). Therefore, depending on our purposes, we prefer both the linear (3.7) and log-linear (3.4) functional models in our pricing study. Then, our linear model of letter demand is as follows:

$$q_{let} = 1157322\text{-}3131.1(p_{let}/CPI_t)\text{-}136.125(pexp/CPI_t)\text{-}690.713(TELt/CPI_t).$$

Table 3.11: Regression output (3.7); linear model, real prices

SUMMARY OUTPUT						
Regression Statistics						
Multiple R	0.88931					
R Square	0.790872					
Adjusted R2	0.721163					
Standard Error	50640.42					
Observations	13					
ANOVA						
	Df	*SS*	*MS*	*F*	*Significance*	
Regression	3	8.73E+10	2.91E+10	11.3453	0.00206	
Residual	9	2.31E+10	2.56E+09			
Total	12	1.1E+11				
	Coefficients	*Stand. Error*	*T Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	1157322	128652	8.995755	8.57E-06	866290.8	1448353
Plet/CPIt	-3131.1	866.4606	-3.61366	0.005627	-5091.17	-1171.03
Pexp/CPIt	-136.125	86.4225	-1.57512	0.149683	-331.627	59.37596
TELt/CPIt	-690.713	685.3196	-1.00787	0.339844	-2241.01	859.5889

3.1.4. The Final Demand Equation for Letters

We began the letter demand estimation by considering alternative source of data for the estimation of demand relationships; then focused on econometrics and the application of econometrics to demand estimation (including issues such as testing the whole regression, testing individual parameters for significance, testing the choice of functional forms, etc.), and also testing for violations of basic assumptions, such as autocorrelation and heteroscedasticity. A general-to-specific approach was applied in our study. Then, we concluded with ultimate log-linear, homogeneity imposed demand equation from Table 3.8 as:

lnq_{let}=13.674–0.4577ln(p_{let}/CPI_t)–0.1576ln(p_{exp}/CPI_t)–0.20ln(TEL_t/CPI_t) (3.9)

with the own-price elasticity of letter is elastic at – 0.45772, as is the cross-price elasticity with respect to letters is poor elastic at -0.1576 and so it is assumed zero in pricing study.

3.2. Demand Estimation of Turkish Inland Express Mail

This section illustrates the process of the econometric analysis of the express mail demand estimation which is similar to the estimation of letter demand. All data for the study comprise the average figures for each year over a period of 13 years and the related data collected from PTT Statistical year books are given in the following Table 3.12.

Table 3.12: Postal Data For Express Mail Demand

Postal Data								
t	q_{exp}	p_{let}	p_{exp}	TEL_t	CPI_t	p_{let}/CPI_t	p_{exp}/CPI_t	TEL_t/CPI_t
1987	1880	50	1000	187.50	100.00	50.00	1000.00	187.50
1988	2548	75	1500	295.14	174.00	43.10	862.07	169.62
1989	3158	175	1800	418.75	284.00	61.62	633.80	147.45
1990	5000	300	2000	525.00	455.00	65.93	439.56	115.38
1991	7725	500	3500	826.39	754.00	66.31	464.19	109.60
1992	8345	625	7750	1400.00	1283.00	48.71	604.05	109.12
1993	9979	1500	10500	2200.00	2131.00	70.39	492.73	103.24
1994	9058	3500	25000	4733.33	4396.00	79.62	568.70	107.67
1995	8637	7500	75000	6400.00	8266.00	90.73	907.33	77.43
1996	8429	15000	115000	9052.00	14908.00	100.62	771.40	60.72
1997	9901	30000	250000	19826.67	27694.00	108.33	902.72	71.59
1998	11746	65000	350000	34833.33	51122.00	127.15	684.64	68.14
1999	14261	125000	550000	50666.67	84313.00	148.26	652.33	60.09
Postal Data (log real prices)								
t	$\ln q_{exp}$	$\ln p_{let}$	$\ln p_{exp}$	$\ln TEL_t$	$Ln\ CPI_t$	$\ln(p_{let}/CPI_t)$	$\ln(p_{exp}/CPI_t)$	$\ln(TELt/CPIt)$
1987	7.539	3.912	6.908	5.234	4.605	-0.693	2.303	0.629
1988	7.843	4.317	7.313	5.687	5.159	-0.842	2.154	0.528
1989	8.058	5.165	7.496	6.037	5.649	-0.484	1.847	0.388
1990	8.517	5.704	7.601	6.263	6.120	-0.417	1.481	0.143
1991	8.952	6.215	8.161	6.717	6.625	-0.411	1.535	0.092
1992	9.029	6.438	8.955	7.244	7.157	-0.719	1.798	0.087
1993	9.208	7.313	9.259	7.696	7.664	-0.351	1.595	0.032
1994	9.111	8.161	10.127	8.462	8.388	-0.228	1.738	0.074
1995	9.064	8.923	11.225	8.764	9.020	-0.097	2.205	-0.256
1996	9.039	9.616	11.653	9.111	9.610	0.006	2.043	-0.499
1997	9.200	10.309	12.429	9.895	10.229	0.080	2.200	-0.334
1998	9.371	11.082	12.766	10.458	10.842	0.240	1.924	-0.384
1999	9.565	11.736	13.218	10.833	11.342	0.394	1.875	-0.509

Table 3.12 gives the data for the volume of delivered inland express mail, denoted q_{exp}, the prices of letters and express mails, p_{let}, p_{exp}, an average price for one minute long distance telephone call TEL_t, and an index of consumer price index CPI_t. Real prices and log real prices are also given in Table 3.12.

At the end of the study, a comparison of a linear and log-linear demand function for express mail demand will be considered, but I will start with the general-to-specific methodology is applied to the log-linear model that we determined after stepwise analysis. So, the initial demand equation for the express mail is

$$\ln q_{exp} = \beta_0 + \beta_1 \ln p_{let} + \beta_2 \ln p_{exp} + \beta_3 \ln TEL_t + \beta_4 \ln CPI_t + \varepsilon_t . \qquad (3.10)$$

To perform log-linear regression, we first constructed data as variables are log-values and appropriate data set is given Table 3.12. In this demand estimation study;

n: number of observations which equals 13 that is sample size,
k: parameters estimated which equals 5,
df: degrees of freedom which equals 8 that is n – k.

3.2.1. Reported Statistics

Running regression analysis for the model (3.12), we have the Table 3.13.

- R-Square

From Table 3.13, R^2 = 0.9627; it says that %96.3 of the variation in the dependent variable is explained by variation in the independent variables.

Table 3.13: Regression Output (3.10); log-linear model, nominal prices

SUMMARY OUTPUT						
Regression Statistics						
Multiple R	0.981206					
R Square	0.962766					
Adjusted R2	0.944149					
Standard Error	0.147504					
Observations	13					
ANOVA						
	Df	*SS*	*MS*	*F*	*Significance*	
Regression	4	4.500649	1.125162	51.71401	9.32E-06	
Residual	8	0.174059	0.021757			
Total	12	4.674708				
	Coefficients	*Stand.Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	7.309988	0.715351	10.21875	7.22E-06	5.660385	8.959591
ln plet	-0.99962	0.331605	-3.01448	0.016699	-1.7643	-0.23493
ln pexp	-0.91111	0.166009	-5.48828	0.000582	-1.29392	-0.52829
ln TELt	-0.25949	0.407815	-0.6363	0.542352	-1.19992	0.68093
ln CPIt	2.54565	0.531069	4.793448	0.001367	1.321003	3.770298

- The F-Statistics

The reported value of the F-Statistic in Table 3.13 can be used to test the overall significance of the regression for express mail demand estimation. The F-statistic was defined in letter demand estimation study (3.1.1.2). The F-statistics is given in the ANOVA (analysis of variance) section in Table 3.13; the calculated value is F^{calc} = 51.71, whilst the critical value at the 5% level of significance, with k-1, n-k = 4,8 degrees of freedom, is obtained from table as $F_{4,8}$=3.84. Hence, we reject H_0, that is at least one of the β_i is significantly different zero. We can also arrive the same answer by noting that the summary information actually reports the significance level of the F-statistics. This also means that the null hypothesis would be rejected, at least one of the βi is significantly different from zero.

- Standard Errors And t-Statistics:

The standard errors in Table 3.13 can be used to see the indication of how tightly individual slope coefficients are estimated. Thus, Table 3.14 illustrates whether each coefficient is significantly different from zero. For instance, the absolute value of the calculated t-statistic for express mail price (p_{exp}) is greater than the critical value of t-statistic (2.306), so we can infer that the coefficient is significantly different from zero.

Table 3.14: t-Statistics for Coefficients

	Coefficients	*Standard Error*	$\|t_{calc}\|$	$t_{crit}=2.306$
Intercept	7.309988	0.715351	10.21875	Rejected
ln plet	-0.99962	0.331605	-3.01448	Rejected
ln pexp	-0.91111	0.166009	-5.48828	Rejected
ln TELt	-0.25949	0.407815	-0.6363	Accepted
ln CPIt	2.54565	0.531069	4.793448	Rejected

According to the Table 3.14, except the coefficient of TEL price, all other variables are significantly different from zero. In parallel with t-statistic, the same conclusions can be inferred by checking the 95% confidence intervals. Thus, all coefficients and their 95% confidence intervals are as follows:

Table 3.15: Confidence Intervals Checking

	Lower 95%	*Upper 95%*	*Null Hypothesis For* $\beta_i=0$
Intercept	5.660385	8.959591	Rejected
Ln pexp	-1.7643	-0.23493	Rejected
Ln plet	-1.29392	-0.52829	Rejected
Ln TELt	-1.19992	0.68093	Accepted
ln CPIt	1.321003	3.770298	Rejected

- Other Information:

In this regression the observed significance level or p-values is also very small. Other statistics in the ensuing analysis are as follows: the standard error of the regression is 0.147504, the sum of squared errors SSE (or residuals) is 0.174059 and the total squared deviations, SSR, is 4.500649.

3.2.2. Non-Reported Statistics

Again, we set out time-series analyses in this section. These are as follows:

- Testing For Autocorrelation

The Durbin-Watson Statistic d is a useful measure of the degree of first-order autocorrelation. The DW-statistic was defined in letter demand estimation study (3.1.2.1). In fact its calculation from residuals in Table 3.16 that the list of residuals, e_t, t=1,…,13 and the series which comprises the squared residuals are also given.

Table 3.16: The Durbin-Watson Statistic (d)

Durbin-Watson	2,50617263		
Observation	*Residuals*	*(et)2*	*(et-et-1)2*
1	0,06823701	0,00465629	0
2	-0,14526774	0,021102716	0,045584278
3	-0,07393497	0,005466379	0,005088364
4	-0,12079744	0,014592021	0,002196091
5	0,16665453	0,027773731	0,082628631
6	-0,02520292	0,000635187	0,036809279
7	0,13108682	0,017183755	0,024426483
8	0,02711217	0,00073507	0,010810729
9	0,21313487	0,045426471	0,034604444
10	-0,14024091	0,019667513	0,124874439
11	0,04798557	0,002302615	0,035429209
12	-0,1159265	0,013438953	0,026867167
13	-0,03284049	0,001078498	0,006903285

Hence, the Durbin-Watson statistic d is 2.50617. Under the null hypothesis of no autocorrelation, it takes the value $d \approx 2$. Positive autocorrelation is associated with a value for d of less than 2 and negative autocorrelation with a value greater than 2. Therefore, in our model, it is (d) 2,50617. It can be said that there is no autocorrelation but it may be little evidence of negative autocorrelation.

- Testing For Multicollinearity

We know that regression does not say anything about multicollinearity. The correlations in Table 3.17 between the log-variables are all very high. This indicates that there may be a problem with multicollinearity in regression.

Table 3.17: Correlation Matrix For Log Nominal Prices

	ln plet	*ln pexp*	*ln TELt*	*ln CPIt*
ln plet	1			
ln pexp	0.991116334	1		
ln TELt	0.996838547	0.99321506	1	
ln CPIt	0.998748677	0.99291516	0.998283903	1

- Testing For Heteroscedasticity

The details of heteroscedasticity was defined in letter demand estimation study (3.1.2.3). Hence, we simply take the residuals e_t, t=1,...,13 from the original regression equation, square them and then run the regression for the (3.11).

$$e_t^2 = \alpha_0 + \alpha_1 \ln p_{let} + \alpha_2 \ln p_{\exp} + \alpha_3 \ln TEL_t + \alpha_4 \ln RPI_t + \mu_t \qquad (3.11)$$

The results for this regression are given in Table 3.18.

Table 3.18: Analysis of Heteroscedasticity

SUMMARY OUTPUT						
Regression Statistics						
Multiple R	0.549125					
R Square	0.301539					
Adjusted R2	-0.04769					
Standard Error	0.01349					
Observations	13					
ANOVA						
	df	*SS*	*MS*	*F*	*Significance*	
Regression	4	0.000629	0.000157	0.863437	0.525056	
Residual	8	0.001456	0.000182			
Total	12	0.002084				
	Coefficients	*Stand. Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	0.087491	0.065423	1.337324	0.21789	-0.06337	0.238356
ln plet	0.004305	0.030327	0.141946	0.890632	-0.06563	0.074239
ln pexp	0.01174	0.015182	0.773247	0.46161	-0.02327	0.046751
ln TELt	-0.06802	0.037297	-1.82381	0.105634	-0.15403	0.017984
ln CPIt	0.039882	0.048569	0.821147	0.435348	-0.07212	0.151883

Then, the Breusch-Pagan statistic is formulated if μ_t has a normal distribution as: $BP = \frac{SSR}{2(\sum_{i=1}^{n} e_t^2 / n)^2} \approx \chi^2(v)$, that is, for large samples, the BP statistic has an approximate chi-square distribution with degrees of freedom V, where V is the number of variables in the estimating regression, in our case V=4. According to the regression results, nR^2= 13 x 0.3015 = 3.9195. There are 4 variables in the estimating equation, so the critical value is $\chi^2(4) = 9.49$ at the 95% level of significance. The calculated value would have to exceed 9.49 for there to be significant heteroscedasticity, but not in our case. Clearly, it is worth emphasizing that in our model heteroscedasticity is not present, so the process of testing down begins.

3.2.3. The Process of Testing Down

The process of testing down begins with the initial equation (3.10), given here for convenience.

$$\ln q_{\exp} = \beta_0 + \beta_1 \ln p_{let} + \beta_2 \ln p_{\exp} + \beta_3 \ln TEL_t + \beta_4 \ln CPI_t + \varepsilon_t . \qquad (3.12)$$

- The Unconstrained Log-Linear Model (3.12): Table 3.13

The regression for this model as a whole is significant at 96.3%, 4 of 5 parameters are significantly different from zero and the correlation matrix in Table 3.17 suggests fairly high correlations between explanatory variables. Then, imposing the homogeneity in effect, demand is modeled as a function of real rather than nominal prices. Real prices are more likely to be stationary (i.e. not trending over time). In our unconstrained model;

$$\hat{\beta}_1 + \hat{\beta}_2 + \hat{\beta}_3 + \hat{\beta}_4 = -0.99962-0.91111-0.25949+2.54565 = 0.37543.$$

This is close to zero, but it is useful to check homogeneity in the unconstrained model. Now, we have to impose homogeneity restriction.

- The Constrained Log-Linear Model: Table 3.8

To implement the homogeneity restriction, I have constructed the real price variables and run the regression. This formulation is formally equivalent to imposing restriction.

$$\ln q_{exp} = \beta_0+\beta_1 \ln(p_{let}/CPI_t)+\beta_2 \ln(p_{exp}/CPI_t)+\beta_3 \ln(TEL_t/CPI_t)+ \varepsilon_t \quad (3.13)$$

The results of the Ordinary Least Squares (OLS) estimation of (3.13) are given in Table 3.19.

Table 3.19: Regression output (3.13);log-linear model, real prices

SUMMARY OUTPUT						
Regression Statistics						
Multiple R	0.934838					
R Square	0.873922					
Adjusted R2	0.831896					
Standard Error	0.255903					
Observations	13					
ANOVA						
	df	*SS*	*MS*	*F*	*Significance*	
Regression	3	4.085331	1.361777	20.79481	0.00022	
Residual	9	0.589378	0.065486			
Total	12	4.674708				
	Coefficients	*Stand.Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	10.10176	0.557921	18.10609	2.18E-08	8.839659	11.36387
ln(plet/CPIt)	-0.14431	0.464349	-0.31079	0.76304	-1.19474	0.906118
ln(pexp/CPIt)	-0.70234	0.27582	-2.54638	0.03138	-1.32629	-0.07839
ln(TELt/CPIt)	-1.59574	0.468013	-3.4096	0.007755	-2.65446	-0.53702

Imposing the homogeneity restriction increases the degrees of freedom by from 8 to 9, but this reduces the values of the correlation coefficients, in Table 3.20 so it says that multicollinearity may be less of a problem in this model.

Table 3.20: Correlation Matrix for Log Real Prices

	ln(plet/CPIt)	*ln(pexp/CPIt)*	*ln(TELt/CPIt)*
ln(plet/CPIt)	1		
ln(pexp/CPIt)	0.053068274	1	
ln(TELt/CPIt)	-0.90673658	-0.00310061	1

In the same way, the DW statistic d in this model takes the value d = 1.5013, so there is no evidence of significant positive autocorrelation.

This homogeneity regression with high R-square and F-statistic implies that all coefficients except for ln(Plet/CPIt) are highly significant. So, we do not go further on our model by setting TEL parameter to zero.

Now, we may conclude some economic implications for our last meaningful model (3.13). The own-price elasticity of express mail demand is highly elastic at -0.70234, as is the cross-price elasticity with respect to letters is inelastic at -0.14431. If both letters and express mail prices are raised by %1 the net effect on sales is from own elasticity of express mail. This is the fact that the own-price elasticity is important parameter in pricing postal services.

- Linear Model: Table 3.22

Now, we will discussed the functional forms, linear versus log-linear. Taking equivalent linear model of our initial log-linear model. It is as follows:

$$q_{exp} = \gamma_0 + \gamma_1 (p_{let}/CPIt) + \gamma_2 (p_{exp}/CPIt) + \gamma_3 (TEL_t/CPIt) + \varepsilon_t . \qquad (3.15)$$

Then, again SSE is our measure of goodness of fit. In order to compare models, we will compare the SSE's of each model. According to the Box and Cox (1964), we have to calculate adjusted SSEs for the linear model, defined as SSE_{lin}/q_G, where q_G is the geometric mean of the independent variable in the linear model. Particularly, whichever of these is smaller can be viewed as the SSE of the better model. Then, we also know from the letter demand analysis that the following statistic is distributed as $\chi^2_{(1)}$(chi-square with one degree of freedom):

$$\chi^2_{(1)} = (n/2) \ln(\text{the larger SSE}/\text{the smaller SSE})$$

To apply this test, we should calculate $q_{G,}$ (compute the average value for the log-dependent variable and then take the exponential of this). For postal data,

$$q_G = \exp\{1/13) \Sigma \ln(q_i)\} = 6684.672.$$

The log-linear model's $SSE_{log-lin}$ for homogeneity imposed model is 0.589378 from Table 3.19. Running the regression for the linear model (3.15), we have the following results in Table 3.21.

Table 3.21: Regression output (3.15); linear model, nominal prices

SUMMARY OUTPUT						
Regression Statistics						
Multiple R	0.922097					
R Square	0.850263					
Adjusted R2	0.800351					
Standard Error	1638.865					
Observations	13					
ANOVA						
	Df	*SS*	*MS*	*F*	*Significance*	
Regression	3	1.37E+08	45754312	17.03514	0.000471	
Residual	9	24172905	2685878			
Total	12	1.61E+08				
	Coefficients	*StandError*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	11435.72	4163.538	2.746635	0.022601	2017.134	20854.3
plet/CPIt	46.38107	28.04108	1.65404	0.132507	-17.0523	109.8144
pexp/CPIt	-3.50343	2.796873	-1.25262	0.241911	-9.8304	2.823542
TELt/CPIt	-47.3669	22.17885	-2.13568	0.061452	-97.5389	2.805227

The linear model's SSE_{lin} is 24172905 from Table 3.21. Then, the adjusted SSE for linear model is 24172905 / $(6684.672)^2$=0.540964. Thus, the log-linear model fits the data better because linear's adjusted $SSE_{adj-lin}$ (0.540964) is smaller than log-linear model $SSE_{log-lin}$ (0.589378). The test statistic χ^2_{calc} is, from (3.8), given as

$$\chi^2_{calc} = (13/2)\ \ln(0.589378/0.540964) = 0.556.$$

At 5% level of significance, $\chi^2_{(1)}$ = 3.84. Thus, we could not say that there is significant difference between the linear and log-linear functional forms, we found the χ^2_{calc} (3.84) > $\chi^2_{(1)}$(0.556). Therefore, depending on our purposes, we prefer both linear (3.15) and the log-linear (3.13) functional models in our pricing study. Then, our linear model of letter demand is as follows:

q_{exp}=11435,72-46,38107(p_{let}/CPI_t)-3.50343(pexp/CPI_t)-47,3669(TELt/CPI_t).

3.2.4. The Final Demand Equation For Express Mail

We began the express mail demand estimation by considering alternative source of data for the estimation of demand relationships; then focused on econometrics and the application of econometrics to demand estimation (including issues such as testing the whole regression, testing individual parameters for significance, testing the choice of functional forms, etc.), and also testing for violations of basic assumptions, such as autocorrelation and heteroscedasticity. A general-to-specific approach was applied in our study. Then, we concluded ultimate demand equation as log-linear homogeneity imposed model (3.13), then from Table 3.19 model is

$$\ln q_{exp}=10.1017-0.14431\ln(p_{let}/CPI_t)-0.70234\ln(p_{exp}/CPI_t)-1.5957(TEL_t/CPI_t) \quad (3.16)$$

with the own-price elasticity of express mail demand is highly elastic at –0.70234, as is the cross-price elasticity with respect to letters is inelastic at -0.14431 and hence it is assumed zero in our study.

CHAPTER 4

RAMSEY PRICING AND SENSITIVITY ANALYSIS

In this chapter we describe the application of Ramsey pricing and report the results of sensitivity runs for Turkish Postal Service. First, we consider Post Office costs and then set out Ramsey pricing in detail together with the approach to sensitivity analysis. Sensitivity analysis is carried out using computer based iterative search method using estimates of costs and elasticities.

Demand equations including own-price and cross-price eleasticities are available from Chapter 3. But determining cost equations was not possible. Not only in practice marginal costs are not known with any great precision, but also the Post Office does not want to release data on its cost structure. Therefore, for the purposes of this study as discussed in Chapter 2, we parametrise marginal costs over a range of values. In this way we generate optimal prices and welfare gains from estimated demands and marginal costs.

4.1. Cost Consideration

Postal costs are classified as either attributable, assignable, or residual. A cost element should be attributed if it can be causally linked with a volume-related mail characteristic that can be used as a distribution key (for example, weight). A cost should be reasonably assigned if (i) it can be causally linked with a non-volume related mail characteristic (for example, delivery service standards) and (ii) a suitable distribution key can be developed for allocating the functional cost to classes and services. A cost should be treated as residual if either (i) it cannot be causally linked with any specific mail characteristic or (ii) a suitable distribution key simply cannot be developed (PRC[1981, p116]).

Postal costs can be divided between those that can be attributed to the provision of particular services ('direct costs') and those that cannot ('overhead costs'). If full cost recovery is to occur from user charges, there must be set to cover the total of direct and overhead costs. The data we have for inland letters in Turkey is not sufficient for suggesting some rate or value for overhead and direct costs. Given that there have been no significant changes in the underlying procedures and conditions, it was expected that scaling up these figures at the rate of increase of postal prices would yield a reasonable approximation of the 1987-1999 cost differences. Estimates derived in this way seem reasonable in the light of recently released data from the Post Office cost analysis.

The Postal Service's costs correspond roughly to short-run average variable costs. In succeeding cases the cost variability time horizon has been lengthened and the percent of total costs either attributed or assigned has increased significantly, so that the cost data in our study gets much closer to the theoretically appropriate measure to use, that is, long-run marginal costs.

Two primary considerations are that the overall level of prices must generate enough revenue to permit the Postal Service to break even and that each class of mail must cover the direct and indirect postal costs attributable to the class, plus a portion of the remaining institutional costs. Each class of mail or type of service bear all the direct and indirect costs attributable to the class or service. The Postal Service has been examined that much of its costs are institutional and cannot be directly attributed to specific classes or services.

Although it is possible to use published data to assess marginal and overhead/fixed costs, there are problems with trying to identify what is variable/fixed and indeed what is allocated to the letters part of the overall Post Office business. One of the important features of the formulation of the constraint is that it facilitates analysis of segments of a Post Office's overall business without any need to be concerned with the complex problem of deciding what the profitability of that segment actually is.

4.2. Application of Ramsey Pricing

We have a two-product Ramsey problem at hand. Assume that letter demand is x_1, and express mail demand is x_2. Then, Post Office has two services in quantities $x=(x_1,x_2)$ and sells these services at prices $p=(p_1,p_2)$, letter and express mail prices respectively. The current output and prices are $\tilde{x}$ and $\tilde{p}$. However, the Post Office cost function, C(x), may feature economies of scale; we do not have the detailed structure of this function. Cost structures for a multi-product firm are difficult to estimate in precision. Therefore, our pricing methodology assumes only that there is a range for marginal cost estimates. This is defined by vectors for lower, $\underline{c}=(\underline{c}_1, \underline{c}_2)$ and upper bound marginal cost, $\bar{c}=(\bar{c}_1, \bar{c}_2)$. That is,

$$C(x^*), C(\tilde{x}) \in (\underline{c}, \bar{c}). \tag{4.1}$$

For the present, the long-run linear demand functions from Chapter 3 can be written as in the form $x_i = g^i(p)$, i=1,2. (4.2)

$q_{let} = 1157322\text{-}3131{,}1(p_{let}/CPI_t)\text{-}136{,}125(pexp/CPI_t)\text{-}690{,}713(TELt/CPI_t)$

t-Stat (8.99) (-3.61) (-1.57) (-1.00)

$R^2=0.79$ F=11.34

and

$q_{exp}=11435{,}72\text{-}46{,}38107(p_{let}/CPI_t)\text{-}3.50343(pexp/CPI_t)\text{-}47{,}367(TELt/CPI_t)$

t-Stat (2.75) (1.65) (-1.25) (-2.13)

$R^2=0.85$ F=17.03

The equations have the expected sign on all the variables and the relationship is highly significant from own price and TEL. The R^2's are satisfactory and there is no evidence of first-order autocorrelation. The own price elasticities are -0.46 and -0.7 for letter and express mail, respectively. Furthermore, the cross-price effects (-0.144 and -0.157, respectively) were found to be insignificantly different from zero but it implies that these products are complements of each other. Since cross-price elasticities are poor elastic, we neglect cross-price effects in our calculations.

The Ramsey pricing solution for the case where C(x) is known is examined; for a given price vector p, profits are

$$\pi = px - C(x) \tag{4.3}$$

where x is given by (4.2). Current prices are $\tilde{p}$. Long-run demands at current prices are written as

$$\tilde{x} = g^{i}(\tilde{p}) \qquad i=1,2. \tag{4.4}$$

and current long-run profits are

$$\tilde{\pi} = \tilde{p}\,\tilde{x} - C(\tilde{x}). \tag{4.5}$$

The Ramsey pricing problem involves choosing the price vector p to maximize the sum of consumers' surplus plus profits:

$$\text{Maximize } \int_{p}^{p_{ch}} \sum_{i=1}^{2} x_i \, dp_i + \pi \tag{4.6}$$

$$\text{subject to } \pi \geq \tilde{\pi} \tag{4.7}$$

Here, p_{ch} stands for the price at which the quantity demanded of a good is equal to zero. That is, at any price equal to or above the choke price, no goods are demanded. As discussed in Chapter 2, given the current long-run profit level of the Post Office, welfare could be raised by changing pricing policy. This constrained optimization problem can be rewritten using (4.3) and (4.5) as

$$\text{Maximize } \int_{p}^{p_{ch}} \sum_{i=1}^{2} x_i \, dp_i + px - C(x) \tag{4.8a}$$

$$\text{subject to} \qquad px - C(x) \geq \tilde{p}\,\tilde{x} - C(\tilde{x}) \tag{4.8b}$$

where x, $\tilde{x}$ are given by (4.2), (4.4) respectively. Notice that the right hand side, $\tilde{p}\,\tilde{x} - C(\tilde{x})$ is a constant; (4.8b) is thus a standard Ramsey problem. The optimal solution to this model is, p^*, with outputs x^*. We assume that the demand and cost functions are such that the Kuhn-Tucker conditions associated with this problem identify a unique global maximum (strict quasi-concavity of the objective function and the constraint is a sufficient condition). The Kuhn-Tucker conditions for p* to be a solution to this problem are the constraint (4.8b) holding with equality and that

$$\sum_{j=1}^{2}\left[\frac{p_j^* - c_j^*}{p_j^*}\right]\left[\frac{p_j^* x_j^*}{p_i^* x_i^*}\right]\eta_{ji}^* = -\left[\frac{\lambda^*}{1+\lambda^*}\right], \qquad i=1,2 \qquad (4.9)$$

where λ^* denotes the value of the Lagrange multiplier associated with constraint (4.8b), $x_i^* = g^i(p^*)$, $c_j^* = \partial C(x^*)/\partial x_j$, the marginal cost for the jth product and $\eta_{ji} = (\partial x_j/\partial p_i)(p_i/x_j)$ evaluated at (p^*, x^*). But, empirically, we have insignificant cross-price elasticities empirically, then we assume that $\eta_{ji} = 0$ and $\eta_{ij} = 0$ in our case.

As discussed in Chapter 2, we do not have the detailed knowledge of C(x) which would be required to find a numerical solution for (4.8a and 4.8b). For any given choice of $\tilde{c} = (\tilde{c}_1, \tilde{c}_2) \in (\underline{c}, \bar{c})$, it is easy to compute the solution for this range of marginal costs.

We can now consider the null hypothesis that current prices $\tilde{p}$ are Ramsey optimal ($p^* = \tilde{p}$), it is straightforward to verify the optimal conditions from (4.8a and 4.8b). Thus, the Ramsey prices, p^*, are also Ramsey optimal if $p^* = \tilde{p}$. Moreover, if current prices $\tilde{p}$ are not equal to the Ramsey optimal prices p^*, thus the null hypothesis that current prices are Ramsey optimal can be tested by simply solving problem (4.8a and 4.8b) to determine whether the solution p^* diverges from the existing prices $\tilde{p}$. Even if marginal costs do vary with output, p^* will remain optimal as long as marginal costs do not vary significantly as output changes. An important practical advantage of this way of solution of Ramsey pricing is that it can be solved without any knowledge of C(x) other than the levels of marginal costs. The only inputs required are the current prices $\tilde{p}$, the forecast long-run outputs at these prices, $\tilde{x}$, and the range within which actual marginal costs are in $[\underline{c}, \bar{c}]$.

4.3. Sensitivity Analysis Using Computer Based Search Procedure

In this section, Ramsey pricing principles are applied to Turkey letter business in the light of knowledge of previous works. As a result, letter and express mail volumes denoted by x_1, x_2 and given the own-price elasticities (cross-price elasticities are zero) set out in Chapter 3; the Ramsey pricing rule equation (inverse elasticity rule) can be written when assuming the cross-price effects are insignificant as

$$[(p^*-c) / p^*]\, \eta_{11} = -\lambda / (1+\lambda) \tag{4.10}$$

if cross-price affects are not all zero, then the Ramsey optimal condition will give the cross-price restriction like

$$[(p_i^* - c_i^*) / p_i^*]\, (\eta_{ii} - \eta_{ji}) = [(p_j^* - c_j^*) / p_j^*]\, (\eta_{jj} - \eta_{ij}). \tag{4.11}$$

Since we will be using a range for marginal costs, we will conduct sensitivity analysis by using computer based iterative search method. This computer program, written in Microsoft Visual Basic 6.0, will be used to determine the optimal Ramsey prices which satisfy the Ramsey rule (4.15) and the constraint (4.8) with equality.

The Ramsey pricing rule may be derived from the maximization of a general social welfare function; this approach does not require any restrictions on cross-price derivatives for the aggregate demand equations (see e.g. Sherman and George [1979]). To find optimal Ramsey prices, welfare must be measurable at different sets of prices and the cross-price restriction is omitted for a well-defined welfare measure.

Now, we outline the computer program in detail. We give some mathematical derivations used in the program for Ramsey pricing. The aim of these derivations is to make it easy to understand program source code. These derivations are based on previous section that sets out Ramsey theory.

It is important to note that we develop our program such that it can support cross-price effects. Since computer program can also support cross-price restriction, we simplified and altered the program such that it can support both cross-price restriction and inverse elasticity rule. Here, we gave the derivation details of cross-price restriction. The program with cross-price restriction is in Appendix J. The other one with inverse elasticity rule we used to calculate the Ramsey prices given in Appendix H and its output example for year 1999 prices and range of marginal costs is in Appendix I.

Let's assume that our long-run demand equations are in the linear forms as follows:

(i) $x_1 = \alpha_0 + \alpha_1 p_1 + \alpha_2 p_2$

(ii) $x_2 = \beta_0 + \beta_1 p_1 + \beta_2 p_2$

where $\alpha_2=\beta_1$(cross-price restriction) and Ramsey rule equation, namely

(iii) $[(p_1-c_1)/p_1] (\eta_{11}- \eta_{21}) = [(p_2-c_2)/p_2] (\eta_{22}- \eta_{12})$.

But, we will use Ramsey rule without cross-price restriction as

$[(p_1-c_1)/p_1] \eta_{11} = - \lambda / (1 + \lambda)$.

We know that

(iv) $\eta_{ij}= (\partial x_i/\partial p_j)(p_j/x_i)$

Then, the four elasticity equation we have

⇨ $\eta_{11}= (\partial x_1/\partial p_1)(p_1/x_1) = \alpha_1 p_1/x_1$

⇨ $\eta_{21}= (\partial x_2/\partial p_1)(p_1/x_2) = \beta_1 p_1/ x_2$ from $\alpha_2=\beta_1$ its value = $\alpha_2 P_1/ x_2$

⇨ $\eta_{22}= (\partial x_2/\partial p_2)(p_2/x_2) = \beta_2 p_2/ x_2$

⇨ $\eta_{12}= (\partial x_1/\partial p_2)(p_2/x_1) = \alpha_2 p_2/ x_1$

Then replace elasticities in (iii) with the above four equations appropriately. We have

⇨ $[(p_1-c_1)/p_1]\ [(\alpha_1 p_1/x_1)-(\alpha_2 p_1)/x_2)] = [(p_2-c_2)/p_2]\ [(\beta_2 p_2/x_2)-(\alpha_2 p_2)/x_1)]$, then

(v) $(p_1-c_1)(\alpha_1 x_2- \alpha_2 x_1) = (p_2-c_2)(\beta_2 x_1-\alpha_2 x_2)$

For the left side of the equation (v):

⇨ $(p_1-c_1) (\alpha_1 (\beta_0 + \alpha_2 p_1 + \beta_2 p_2) - \alpha_2 (\alpha_0 + \alpha_1 p_1 + \alpha_2 p_2))$

⇨ $(p_1-c_1) (\alpha_1\beta_0 + \alpha_1\alpha_2 p_1 + \alpha_1\beta_2 p_2 - \alpha_2\alpha_0 - \alpha_2\alpha_1 p_1- \alpha_2^2 p_2)$

⇨ $(\alpha_1\beta_0p_1+\alpha_1\alpha_2p_1^2+\alpha_1\beta_2p_2p_1-\alpha_2\alpha_0p_1-\alpha_2\alpha_1p_1^2-\alpha_2^2p_2p_1-\alpha_1\beta_0c_1-\alpha_1\alpha_2p_1c_1-$
$\alpha_1\beta_2p_2c_1+\ldots$

⇨ $\ldots\alpha_2\alpha_0c_1+\alpha_2\alpha_1p_1c_1+\alpha_2^2p_2c_1)$

In the last expression, 2. & 5. terms and 8. & 11. terms are eliminated. we have

⇨ $(\alpha_1\beta_0p_1+\alpha_1\beta_2p_2p_1-\alpha_2\alpha_0p_1-\alpha_2^2p_2p_1-\alpha_1\beta_0c_1-\alpha_1\beta_2p_2c_1+\alpha_2\alpha_0c_1+\alpha_2^2p_2c_1)$

For the right side of the equation (v):

⇨ $(p_2-c_2)\,(\beta_2\,(\alpha_0+\alpha_1p_1+\alpha_2p_2)-\alpha_2\,(\beta_0+\alpha_2p_1+\beta_2p_2)$

⇨ $(p_2-c_2)\,(\beta_2\alpha_0+\beta_2\alpha_1p_1+\beta_2\alpha_2p_2-\alpha_2\beta_0-\alpha_2^2p_1-\alpha_2\beta_2p_2)$

⇨ $(\beta_2\alpha_0p_2+\beta_2\alpha_1p_1p_2+\beta_2\alpha_2p_2^2-\alpha_2\beta_0p_2-\alpha_2^2p_1p_2-\alpha_2\beta_2p_2^2-\beta_2\alpha_0c_2-\beta_2\alpha_1p_1c_2-\ldots$

⇨ $\ldots\beta_2\alpha_2p_2c_2+\alpha_2\beta_0c_2+\alpha_2^2p_1c_2+\alpha_2\beta_2p_2c_2)$

In the last expression, 3. & 6. terms and 9. & 12. terms are eliminated. we have

⇨ $(\beta_2\alpha_0p_2+\beta_2\alpha_1p_1p_2-\alpha_2\beta_0p_2-\alpha_2^2p_1p_2-\beta_2\alpha_0c_2-\beta_2\alpha_1p_1c_2+\alpha_2\beta_0c_2+\alpha_2^2p_1c_2)$,

then from the equality in (v);

⇨ $(\alpha_1\beta_0p_1+\alpha_1\beta_2p_2p_1-\alpha_2\alpha_0p_1-\alpha_2^2p_2p_1-\alpha_1\beta_0c_1-\alpha_1\beta_2p_2c_1+\alpha_2\alpha_0c_1+\alpha_2^2p_2c_1)=\ldots$

⇨ $\ldots(\beta_2\alpha_0p_2+\beta_2\alpha_1p_1p_2-\alpha_2\beta_0p_2-\alpha_2^2p_1p_2-\beta_2\alpha_0c_2-\beta_2\alpha_1p_1c_2+\alpha_2\beta_0c_2+\alpha_2^2p_1c_2)$

After eliminating 2. terms both from left side and right hand side of the equation and also eliminating 4. terms both from left side and right hand side of the equation, we have

⇨ $\alpha_1\beta_0p_1-\alpha_2\alpha_0p_1-\alpha_1\beta_0c_1-\alpha_1\beta_2p_2c_1+\alpha_2\alpha_0c_1+\alpha_2^2p_2c_1=\ldots$

⇨ $\ldots\beta_2\alpha_0p_2-\alpha_2\beta_0p_2-\beta_2\alpha_0c_2-\beta_2\alpha_1p_1c_2+\alpha_2\beta_0c_2+\alpha_2^2p_1c_2$

Here, 1. & 2. terms on the left side are organized under common parenthesis of p_1 as $p_1(\alpha_1\beta_0-\alpha_2\alpha_0)$, 3. & 5. terms on the left side are organized under common parenthesis of c_1 as $c_1(\alpha_2\alpha_0-\alpha_1\beta_0)$, 4. & 6. terms in the left are organized under common parenthesis of p_2c_1 as $p_2c_1(\alpha_2^2-\alpha_1\beta_2)$. The same arrangements are implied to right side of the equation. Then, 1. & 2. are organized under common parenthesis of p_2 as $p_2(\beta_2\alpha_0-\alpha_2\beta_0)$, 3. & 5. are organized as $c_2(\alpha_2\beta_0-\beta_2\alpha_0)$, 4. & 6. are organized under common parenthesis of p_1c_2 as $p_1c_2(\alpha_2^2-\beta_2\alpha_1)$. Rearranging all these terms; we have following new equation:

(vi) $p_1(\alpha_1\beta_0-\alpha_2\alpha_0)+c_1(\alpha_2\alpha_0-\alpha_1\beta_0)+p_2c_1(\alpha_2^2-\alpha_1\beta_2)=p_2(\beta_2\alpha_0-\alpha_2\beta_0)+\ldots$
$\ldots c_2(\alpha_2\beta_0-\beta_2\alpha_0)+p_1c_2(\alpha_2^2-\beta_2\alpha_1)$

By taking first and last terms in the equation into p_1 common parenthesis and 3. term in the left and first term in the right side of the equation into p_2 common parenthesis; then taking p2 alone in the left hand side of the equation; we have the following equation.

(vii) $p_2=[c_2\alpha_2^2-c_2\beta_2\alpha_1+\alpha_2\alpha_0-\alpha_1\beta_0)p_1-(c_1(\alpha_2\alpha_0-\alpha_1\beta_0)+c_2(\beta_2\alpha_0-\alpha_2\beta_0))]/\ldots$

$\ldots c_1(\alpha_2^2-\alpha_1\beta_2)+\alpha_2\beta_0-\beta_2\alpha_0$

Here we have a form like $p_2 = \{\Psi_1 p_1 - \Psi_2\} / \Psi_3$, where

$\Psi_1 = c_2\alpha_2^2 - c_2\beta_2\alpha_1 + \alpha_2\alpha_0 - \alpha_1\beta_0,$

$\Psi_2 = c_1(\alpha_2\alpha_0 - \alpha_1\beta_0) + c_2(\beta_2\alpha_0 - \alpha_2\beta_0),$

$\Psi_3 = c_1(\alpha_2^2 - \alpha_1\beta_2) + \alpha_2\beta_0 - \beta_2\alpha_0.$

Programmatically, the optimal Ramsey solution is determined from (vii) by iterative search on p_1. For any p_1, a new p_2 is evaluated. For actual prices, $\tilde{p}$, from equations (i), (ii) we have the associated long-run demands as $(\tilde{x}_1, \tilde{x}_2)$. For the determined marginal cost vector $c=(c_1,c_2)$, the exact Ramsey pricing solution involves an iterative search over price space until $p^*= (p_1^*, p_2^*)$ is found which satisfies (4.11) and the constraint (4.9) with equality.

The calculation of optimal discrete prices is based on computing welfare. So, it is necessary to have inverse demand equations as follows:

(viii) $p_1 = \theta_0 + \theta_1 x_1 + \theta_2 x_2$

(ix) $p_2 = \varphi_0 + \varphi_1 x_1 + \varphi_2 x_2$

From (i),

(x) $p_1 = (x_1 - \alpha_0 - \alpha_2 p_2) / \alpha_1$

From (ii),

(xi) $p_2 = (x_2 - \beta_0 - \alpha_2 p_1) / \beta_2$

Then, replacing p_2 in (x) with (xi), we have

⇨ $p_1 = (x_1 - \alpha_0 - \alpha_2 [(x_2 - \beta_0 - \alpha_2 p_1) / \beta_2]) / \alpha_1$, by reorganizing the terms;

⇨ $p_1 \beta_2 \alpha_1 = x_1 \beta_2 - \alpha_0 \beta_2 - \alpha_2 x_2 + \alpha_2 \beta_0 + \alpha_2^2 p_1$, by regrouping p_1's,

(xii) $p_1 = [(\alpha_2 \beta_0 - \beta_2 \alpha_0) + \beta_2 x_1 - \alpha_2 x_2] / (\beta_2 \alpha_1 - \alpha_2^2)$.

Then, replacing p_1 in (xi) with (x), we have

⇨ $p_2 = (x_2 - \beta_0 - \alpha_2 [(x_1 - \alpha_0 - \alpha_2 p_2) / \alpha_1]) / \beta_2$, by reorganizing the terms;

⇨ $p_2 \alpha_1 \beta_2 = x_2 \alpha_1 - \alpha_1 \beta_0 - \alpha_2 x_1 + \alpha_2 \alpha_0 + \alpha_2^2 p_2$, by regrouping p_2's,

(xiii) $p_2 = [(\alpha_2 \alpha_0 - \alpha_1 \beta_0) - \alpha_2 x_1 + \alpha_1 x_2] / (\beta_2 \alpha_1 - \alpha_2^2)$.

The (xii) with (viii) and (xiii) with (ix) have the same forms, then;

$$\mu = (\beta_2 \alpha_1 - \alpha_2^2)$$

$$\theta_0 = (\alpha_2 \beta_0 - \beta_2 \alpha_0) / \mu,\ \theta_1 = \beta_2 / \mu,\ \theta_2 = -\alpha_2 / \mu.$$

$$\varphi_0 = (\alpha_2 \alpha_0 - \alpha_1 \beta_0) / \mu,\ \varphi_1 = -\alpha_2 / \mu,\ \varphi_2 = \alpha_1 / \mu.$$

The linearised cost function is as

(xiv) $C(x) = F + c_1x_1 + c_2x_2$

where c_1, c_2 are the marginal costs and F is the fixed cost. Thus, welfare is given by (see e.g. Mohring [1971]);

(xv) $$W(\text{elfare}) = \int_0^{x_1} (\theta_0 + \theta_1 \tau)\, d\tau + \int_0^{x_2} (\varphi_0 + \varphi_1 x_1 + \varphi_2 \tau)\, d\tau - c_1x_1 - c_2x_2 - F$$

$$= [\theta_0 + (\theta_1 x_1/2)]\, x_1 + [\varphi_0 x_2 + \varphi_1 x_1 x_2 + (\varphi_2/2)\, x_2^2] - c_1x_1 - c_2x_2 - F$$

This welfare formulation gives us a chance to compute W + F given the demand parameters and values for c_1, c_2, p_1, p_2. This means that W + F and hence W is maximized at the optimal exact prices p^* subject to the constraint (4.9). For each set of prices, both W + F and the constraint (4.9) is evaluated. Then, the optimum is found easily by simply selecting the price combination which both satisfies the constraint and gives the largest value of welfare (W). All things explained in this section were programmed and this program source code is in Appendix J.

It is important to note that it is trivial in our program to replace the long-run profitability target (4.7) by the constraint $\pi \geq \tilde{\pi} + \Delta\tilde{\pi}$ where $\Delta\tilde{\pi}$ illustrates some specified variation in the target profit level. If $\Delta\tilde{\pi} \neq 0$, current prices are not be Ramsey optimal. By this program, optimal Ramsey pricing solutions are obtained for a wide range of values for letter and express mail marginal costs centered on about half of the associated base prices.

Now, we can compute welfare gains and Ramsey prices by calculating optimal Ramsey number (λ) for each year prices. For example, we can check whether the prices of letter and express mail in year 1999 are Ramsey optimal or not. For this, we should remember the linear demand estimation equations of letter and express mail, firstly.

q_{let} = 1157322-3131.1(p_{let}/CPI_t)-136.125(p_{exp}/CPI_t)-690.713($TELt/CPI_t$)

q_{exp}=11435.72-46.38107(p_{let}/CPI_t)-3.50343($pexp/CPI_t$)-47.3669($TELt/CPI_t$).

Then, we must convert this linear equation to this form "$q_{let} = a_0 - a_1(p_{let}/CPI_t)$" and "$q_{exp} = b_0 - b_1(p_{exp}/CPI_t)$" by substituting p_{let}/CPI_t , p_{exp}/CPI_t and $TELt/CPI_t$ real prices with values (148.26, 652.33, 60.09) in year 1999. Then, we have

q_{let} = 1030694.01 – 3131.1(p_{let}/CPI_t), with a_0 = 1030694.01.

q_{exp} = 15465.90042 – 3.50343(p_{exp}/CPI_t), with b_0 = 15465.90042.

All these coefficients are entered as parameter to the computer program. Then, the program is ready for calculating optimal Ramsey prices given marginal cost range and given base prices. For being test the year 1999 prices, we must input base prices as 150≈148.26 for letter and 650≈652.33 for express mail. We also assume that fixed costs as 36.000.000 MTL. After having input marginal cost ranges, program gives the optimal Ramsey number and its corresponding Ramsey optimal prices in million of TL with their welfare gains where demands are in thousands of letter. Table.4.1 summarizes the results of Ramsey pricing for year 1999 with given range of marginal cost values.

Table 4.1: Welfare Gains and Ramsey Prices At MClet=50, MCexp=200

Ramsey Optimality: λ= 0.30; MC_{let}=50 TL, MC_{exp}=200 TL					
Mail Category	*Real Base Prices*	*Real Ramsey Price*	*Actual Demand*	*Ramsey Demand*	*Welfare Gain*
Letter	150	100	561044	716543	*12,025,984*
Express Mail	650	298	13191	14422	

From Table 4.1, when marginal cost of letters is 50 and marginal cost of express mail is 200 the optimum demand for letters and express mail will be 716543 and 14422, respectively. At these optimum price and demand, gained welfare will be about 12 MTL.

Table 4.2: Welfare Gains and Ramsey Prices At MClet=50, MCexp=300

Ramsey Optimality: λ= 0.29; MC_{let}=50 TL, MC_{exp}=300 TL					
Mail Category	*Real Base Prices*	*Real Ramsey Price*	*Actual Demand*	*Ramsey Demand*	*Welfare Gain*
Letter	150	98	561044	724508	*12,258,451*
Express Mail	650	442	13191	13919	

From Table 4.2, it can be seen that increasing marginal cost of express mail causes a small increased in welfare gain.

Table 4.3: Welfare Gains and Ramsey Prices At MClet=60, MCexp=250

Ramsey Optimality: λ= 0.27; MC_{let}=60 TL, MC_{exp}=250 TL					
Mail Category	*Real Base Prices*	*Real Ramsey Price*	*Actual Demand*	*Ramsey Demand*	*Welfare Gain*
Letter	150	112	561044	681401	*8.778,041*
Express Mail	650	359	13191	14209	

But, from Table 4.3 a small increase in the marginal cost of letters results in a huge loss of welfare.

Table 4.4: Welfare Gains and Ramsey Prices At MClet=60, MCexp=450

Ramsey Optimality: λ= 0.26; MC_{let}=60 TL, MC_{exp}=450 TL					
Mail Category	*Real Base Prices*	*Real Ramsey Price*	*Actual Demand*	*Ramsey Demand*	*Welfare Gain*
Letter	150	109	561044	690007	*8.958,803*
Express Mail	650	638	13191	13233	

Again, it is possible to see the small increase in welfare at Table 4.4 because of the increase in the marginal cost of express mail.

Table 4.5: Welfare Gains and Ramsey Prices At MClet=70, MCexp=300

Ramsey Optimality: λ= 0.25; MC_{let}=70 TL, MC_{exp}=300 TL					
Mail Category	Real Base Prices	Real Ramsey Price	Actual Demand	Ramsey Demand	Welfare Gain
Letter	150	124	561044	642932	*5.669,351*
Express Mail	650	420	13191	13996	

Then, the result in Table 4.5 concludes that letter mail generates big part of all postal service revenues and small changes in the letter prices produce big changes in welfare.

Table 4.6: Welfare Gains and Ramsey Prices At MClet=80, MCexp=300

Ramsey Optimality: λ= 0.24; MC_{let}=80 TL, MC_{exp}=300 TL					
Mail Category	*Real Base Prices*	*Real Ramsey Price*	*Actual Demand*	*Ramsey Demand*	*Welfare Gain*
Letter	150	138	561044	598267	*2.575,734*
Express Mail	650	415	13191	14015	

As can be seen above tables, Ramsey number for Turkish Postal Service (λ) ranges from 0.24 to 0.30 under our assumptions. It can also be said from these tables that applying Ramsey pricing to Turkish Postal Services at 1999 indicates some welfare gains about 2000 to 12000 BTL. The most valuable result which can be easily inferred is the dramatic decreases in welfare gains as a response to the small increases in the marginal cost of the letter. Express mail does not seem Ramsey optimal at all and Ramsey prices also varies rapidly with changes in marginal cost of express because of high variable cost of express mail. All results holds over a large range of marginal cost levels. Welfare gains from changing prices are fairly high for quite wide ranges of marginal cost and marginal cost differentials.

This table shows only the small part of the program output, but it is possible to check Ramsey optimality for any base prices, any range of marginal cost and fixed cost variations as well. This program gives you the ability the simulate for wide ranges of values of base prices and cost ranges. As can be seen, program reports all details of iteration from initial values of demand to optimal Ramsey prices found. For example, complete output for the year 1999 is in the Appendix I.

CHAPTER 5

CONCLUSION

In this study, Ramsey pricing methodology is investigated in the context of the Turkish postal services for efficient pricing. The outcomes of moving from current pricing structure to Ramsey are evaluated in order to be able to compare the two pricing scheme.

Ramsey pricing is based on the idea that in the public sector, prices should be chosen so as to maximize welfare rather than profits. From this perspective, marginal cost pricing is unlikely to be welfare-optimal because it leads to deficits. The idea of Ramsey pricing is to contribute a maximum level of welfare subject to the Post Office earning a given target level of profitability.

In this study, most of the data about postal services have been obtained from PTT. In addition, the opinions of some postal experts in Turkish Post Office have been considered.

The two mail groups were selected for investigation because it is thought that their prices may be related with each other. Demand equations for each mail group are estimated using the OLS multiple regression model. The statistical tests and calculations are undertaken using Microsoft Excel.

In the absence of the reliable cost data, we have determined some ranges for the marginal cost values of selected mail groups. This gives us the ability to apply Ramsey pricing methodology under various marginal cost scenarios. This also gives us a chance to understand how sensitive is the price to changes in the cost structures of the Post Office.

According to the results obtained, Ramsey optimal prices for letters are not much affected from different marginal cost values, but welfare gains are very sensitive to marginal cost of letters. This result seems to occur primarily because letter mail generates big part of all postal service revenues and small changes in the letter prices produce big changes in revenues. Ramsey optimal prices varies rapidly with changes in marginal cost of express mail because of its high variable cost.

Perhaps the most striking result of this study is that there are substantial welfare gains to be expected from Ramsey pricing in Turkish Postal Services. However, dramatic decreases are observed in welfare gains with small increases in the marginal cost of letters. This calls for a further and more detailed investigation of the cost structure before reaching definite conclusions.

In view of the fact that all results hold over a wide interval of marginal cost and that substantial welfare gains can be expected from Ramsey pricing, it is possible to state consequently that the current pricing structure seems to be far away from being optimal.

As an extension of this study; the general issue of reliability-constraint and service-differentiated pricing is of great interest since postal services are a large and still growing sector in most economies and are currently facing increased competition. The adoption of new technologies that will automate most sorting and other mail processing will introduce significant costs making peak-load pricing more important. Similarly, as postal services face increased competition worldwide, pose a significant and clearly an important area for further research.

The pursuit of further research regarding capacity planning, service quality of service, increased competition and adoption of new technologies will help increase efficiency of service provided by Turkish Postal Services while increasing the welfare of end users and providing fair and equitable prices for services.

REFERENCES

1. Ian Dobbs, Managerial Economics; firms, markets, and business decisions, Oxford University Press 2000.

2. M.D.Intriligator, Econometric Models, Techniques and Applications, Advanced Textbooks in Economics 1978.

3. Robert Wilson, Nonlinear Pricing, Oxford University Press 1993.

4. Michael A. Crew, Paul R.Kleindorfer, The Economics of Postal Service, Kluwer Academic Publishers 1992.

5. Stephen G.Nash, Ariela Sofer, Linear and Nonlinear Programming, McGraw-Hill 1996.

6. Mokhtar S. BAZARAA , Hanif D. SHERALI, C. M. SHETTY, Nonlinear Programming, Theory and Algorithms, John Wiley & Sons 1979.

7. William MENDENHALL, Terry SINCICH, A Second Course in Statistics, Regression Analysis, Prentice Hall 1996.

8. Peter B. PASHIGIAN, Price Theory and Applications, Irwin McGraw-Hill 1998.

9. John R.BIRGE, François LOUVEAUX, Introduction to Stochastic Programming, Springer 1997.

10. David BESANKO, David DRANOVE, Mark SHANLEY, The Economics Of Strategy, John Wiley & Sons 1996.

11. Robert E. McCORMICK, Managerial Economics, Prentice Hall .

12. Stephen L. MONTGOMERY, Profitable Pricing Strategies, McGraw-Hill Book Company 1988.

13. Thomas T. NAGLE, The Strategy and Tactics of Pricing, A Guide To Profitable Pricing, Prentice Hall 1987.

14. Kent B. MONROE, Pricing Making Profitable Decisions, McGraw-Hill 1990.

15. Alfred R. OXEFELDT, Pricing Strategies, American Management Associations 1975.

16. Timothy M. DEVINNEY, Issues in Pricing, Theory And Research, Lexington Books 1988.

17. Fred R. DAVID, Concepts of Strategic Management, Prentice Hall International1997.

18. Henry MINTZBERG, James Brian QUINN, Strategy Process, Concepts, Contexts, Cases, Prentice Hall 1996.

19. Thomas L. WHEELEN, J. David HUNGER, Strategic Management And Business Policy, Entering 21st Century Global Society, Addison-Wesley 1998.

20. Richard G. LIPSEY, Paul N. COURANT, Douglas D. PURVIS, Peter O. STEINER, ECONOMICS, HarperCollinsCollegePublishers 1993.

21. Christopher T. MAY, Nonlinear Pricing, Theory & Applications.

22. Lous PHLIPS, The Economics of Price Discrimination.

23. Keith CUTHBERTSON and Ian DOBBS, A Robust Methodology for Ramsey Pricing with an Application to UK Postal Services, The Journal of Industrial Economics-September 1996, Vol.XLIV, pp.229-247.

24. Michael A. CREW, Paul R. KLEINDORFER And Marc A. SMITH, Peak-Load Pricing In Postal Services, The Economic Journal-September 1990, pp.793-807.

25. D. Mark KENNET, David J. GABEL, Fully Distributed Cost Pricing, Ramsey Pricing, and Shapley Value Pricing: A Simulated Welfare Analysis for the Telephone Exchange, Review of Industrial Organization 1997, pp.485-499.

26. Marcelo RESENDE, Ramsey and Regulator's Social Welfare Weights: An Emprical Application, Review of Industrial Organization 1997, pp.413-416.

27. William B. Tye, Measurement of Volume Variability for Mail Delivery Costs, Logistic and Transportation Review, Vol. 21, Number 4, pp.337-351.

28. Nissan LEVIN, Jacob ZAHAVI, Price Discrimination in Third Class Postal Rates in the Database Marketing Industry: The Single-User Case, Journal of Direct Marketing-Spring 1997, Vol.11, Number 2, pp.36-45.

29. Jess S. BORONICO, Ratemaking for Postal Services: A Stochostic Marginal Cost Pricing Model, Journal of Product & Brand Management 1998, Vol.7, No.4, pp.342-353.

30. Jess S. BORONICO, Reliability-Constrained Pricing, Capacity, and Quality: An Illustration of Economic Concepts to Postal Services, Production and Operations Management Society 1999, pp.92-107.

31. Robert ALBON, Some Observation on the Efficiency of British Postal Pricing, Applied Economics 1989, Vol.21, pp.461-473.

32. Keith CUTHBERTSON and Paul Richards, An Econometric Study of The Demand for First and Second Class Inland Letter Services, The Review of Economics and Statistics 1990, pp.640-648.

33. Roger SHERMAN, Anthony GEORGE, Second-Best Pricing for the U.S. Postal Service, pp.685-695.

34. BAUMOL, W. and BRADFORD, D., 1970, Optimal Departures from Marginal Cost Pricing, American Economic Review, Vol.60, pp.809-822.

35. Frank A. SCOTT, Assessing USA Postal Ratemaking: An Application of Ramsey Prices, The Journal of Industrial Economics-March 1986, Vol.XXXIV, No.3, pp.279-290.

36. NEARY, P., 1975, An Econometric Study of Irish Postal Services, The Economic and Social Research Institute, Paper No.80, Dublin.

37. Jess S. BORONICO, Postal Service Pricing Subject to Reliability Constraints on Service Quality, Pricing Strategy & Practise 1997, Vol.5, No.2, pp.80-93.

38. RAMSEY, F.P., 1927, A contribution to the Theory of Taxation, Economic Journal, Vol.48, pp.561-577.

39. Jess S. BORONICO, An Extension of Ramsey-Boiteaux Pricing to Services Offering Limited Deferability Subject to Reliability Constraints and Fuzzy Demand Functions, Managerial Finance-1997, Vol.23, No.6, pp.1-13.

40. Jess S. BORONICO, Mathematical Optimization in the Management of Services, The UMAP Journal 1997, pp.15-34.

41. Lionel THOMAS, Optimal Non-Linear Pricing with Indirect Prior Beliefs, Economic Letters 61 1998, pp.321-325.

42. Lionel THOMAS, Technological Change In Optimal Non–Linear Pricing, Economic Letters 63 1999, pp.55-59.

43. Leonard J. MIRMAN, Optimal Nonlinear Prices For Multi Product Monopolies

44. David E. M. SAPPINGTON, David S. SIBLEY, Strategic Nonlinear Pricing under Price – Cap Regulation, RAND Journal of Economics Spring 1997, Vol. 23, No.1, pp.1-19.

45. Paulo Klinger MONTEIRO, Frank H. PAGE JR., Nonlinear Pricing with A General Cost Function, Economic Letters 52 1996, pp.287-291.

46. W.A.BROCK and W.D.DECHERT, Dynamic Ramsey Pricing, International Economic Review October 1985, Vol.26, No.3, pp.569-589.

47. Nitzan WEISS and Phil LEE, Sustainability of the Multiproduct Monopoly and Ramsey-optimal Pricing, Journal of Institutional and Theoretical Economics 142, 1986, pp.473-492.

48. Egbert DIERKER, The Optimality of Boiteux-Ramsey Pricing, Econometrica January 1991, Vol.59, No.1, pp.99-121.

49. Kevin M.CURRIER, An Algorithm for Ramsey Pricing by Multiproduct Public Firms Under Incomplete Information, Journal of Economic Dynamics and Control 1989, pp.282-300.

50. Jun-ji SHIH, Edgeworth's Contribution to the Theory of "Ramsey Pricing", History of Political Economy 1989, pp.345-349.

51. Leonard J.MIRMAN and David SIBLEY, Optimal Nonlinear Prices for Multiproduct Monopolies, The Bell Journal of Economics, pp.659-669.

52. Albert L.DANIELSEN and David R.KAMERSCHEN and Donald C.KEENAN, Third-Best Pricing Rules for Regulated Utilites, pp. 628-637.

53. Michael SHEEHAN, Why Ramsey Pricing is Wrong: The Case of Telecommunications Regulation, Journal of Economic Issues March 1991, Vol.XXV, No.1, pp.21-31.

APPENDIX A

TURKISH POSTAL DATA

Table A: Price and Traffics For Inland Letters and Express Mails Between 1987-1999

Years	*Inland Letters*		*Inland Express Mails*	
	Price	*Traffic*	*Price*	*Traffic*
1987	50	685913	1000	1880
1988	75	838485	1500	2548
1989	168,75	816812	1800	3158
1990	258,33	822072	1800	5000
1991	500	840753	5250	7725
1992	625	850153	7750	8345
1993	1125	785267	12500	9979
1994	2166,66	660908	31250	9058
1995	4125	714035	57500	8637
1996	20833,33	682123	115000	8429
1997	32500	661315	250000	9901
1998	57500	568322	350000	11746
1999	112500	616361	550000	14261
2000	200000	637606	1000000	11118
2001	229166	638342	1300000	10218

APPENDIX B

TURKISH TELECOMMUNICATION DATA

Table B: Average Prices for One Minute Long Distance Telephone Call Between 1987-1999 (T : Stands For One Counter Change Period In Seconds)

Years	January		February		March		April		May		June		July		August		September		October		November		December		Average
	T	Kontör	T	Kontör	T	Kontör	T	Kontör	T	Kontör	T	Kontör	T	Kontör	T	Kontör	T	Kontör	T	Kontör	T	Kontör	T	Kontör	
1987	18	50	18	50	18	50	18	50	18	50	18	50	18	60	18	60	18	60	18	60	18	60	18	75	187,50
1988	18	75	18	75	18	75	18	75	18	75	18	75	18	100	18	100	18	100	18	100	18	100	20	125	295,14
1989	20	125	20	125	20	125	20	125	20	125	20	150	20	150	20	150	20	150	20	150	20	150	20	150	418,75
1990	20	150	20	150	20	150	18	160	18	160	18	160	18	160	18	160	18	160	18	175	18	175	18	175	525,00
1991	18	175	18	200	18	200	18	200	18	200	18	200	15	250	15	250	15	250	15	250	15	250	15	250	826,39
1992	15	350	15	350	15	350	15	350	15	350	15	350	15	350	15	350	15	350	15	350	15	350	15	350	1400,00
1993	15	350	15	350	15	350	15	350	15	500	15	500	15	500	15	500	15	800	15	800	15	800	15	800	2200,00
1994	15	800	15	850	15	850	15	1300	15	1300	15	1300	15	1300	15	1300	15	1300	15	1300	15	1300	15	1300	4733,33
1995	15	1600	15	1600	15	1600	15	1600	15	1600	15	1600	15	1600	15	1600	15	1600	15	1600	15	1600	15	1600	6400,00
1996	15	2000	15	2000	15	2000	15	2000	15	2000	15	2000	15	2000	15	2180	15	2376	15	2600	15	3000	15	3000	9052,00
1997	15	3160	15	3370	15	3600	15	3750	15	4000	15	4000	15	4000	15	6000	15	6300	15	6700	15	7100	15	7500	19826,67
1998	15	8000	15	8000	15	8000	15	8000	15	8000	15	8000	15	8000	15	9500	15	9500	15	9500	15	10000	15	10000	34833,33
1999	15	11500	15	11500	15	12000	15	12000	15	12500	15	12500	15	12500	15	12500	15	12500	15	12500	15	15000	15	15000	50666,67

APPENDIX C

CONSUMER PRICE INDEX

Table C: Consumer Price Index (1987=100)

if 1987 = 100 then			*if 1994=100 then*		*if 1991=100 then*	
Modified	*Index*	*(%)Change*		*Index*	*Modified*	*Index*
(1987=100)	100		(1994=100)	100	(1990=100)	100
1988	174	73,7	1995	188	1991	166
1989	284	63,3	1996	339	1992	282
1990	455	60,3	1997	630	1993	469
1991	754	66,0	1998	1163	1994	967
1992	1283	70,1	1999	1918	1995	1818
1993	2131	66,1	2000	2970	1996	3280
1994	4396	106,3	2001	4586	1997	6092
1995	8266	88,0			1998	11246
1996	14908	80,4			1999	18548
1997	27694	85,8			2000	28725
1998	51122	84,6			2001	44352
1999	84313	64,9				
2000	130576	54,9				
2001	201609	54,4				
Source: SIS.						

APPENDIX D

GROSS DOMESTIC PRODUCT BY EXPENDITURES

Table D: Gross Domestic Product By Expenditures (At 1987 Prices, Billion TL)

Years	*Index*	*(%)Change*
1987	74.722	
1988	76.306	2,1
1989	76.498	0,3
1990	83.578	9,3
1991	84.353	0,9
1992	89.401	6,0
1993	96.590	8,0
1994	91.321	-5,5
1995	97.888	7,2
1996	104.745	7,0
1997	112.631	7,5
1998	116.114	3,1
1999	110.646	-4,7

Source: SIS.

APPENDIX E

TELECOMMUNICATION AND POSTAL SERVICES AND INDEXES

Table E.1: Telecommunication and Postal Services

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Telephone subscribers (000)	3702	4921	5877	6862	8147	9472	11020	12306	13227	14286	15744	16959	18054	18395
Letters (Million)	1251	1490	1507	1432	1485	1511	1459	1233	1261	1312	1290	1031	1045	1025
Number of Television (000) (*)	10736	11185	11854	12988	14525	16000	17284	18006	18958	20589	23019	24341	26962	29791
(*) : After 1985, figures have been obtained by using commodity flow method														

Table E.2: Telecommunication and Postal Services - Indexes (1987=100)

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Telephone subscribers (000)	100	133	159	185	220	256	298	332	357	386	425	458	488	497
Letters (Million)	100	119	120	114	119	121	117	99	101	105	103	82	84	82
Number of Television (000) (*)	100	104	110	121	135	149	161	168	177	192	214	227	251	277
(*) : After 1985, figures have been obtained by using commodity flow method														

APPENDIX F

POSTAL PRICE TARIFFS

Table F: Postal Price Tariffs

	Letters		Post Cards		Printed Matters		Small Packets		Greeting Cards		Registered Articles	
DATE	Inland	International	Inland	International	Inland	International	Inland	International	Inland	International	Inland	International
01.09.1939	6 Kr.		3 Kr.									
01.07.1940		10 Kr		6 Kr								
01.06.1942	6.75 Kr.		4.5 Kr.									
01.03.1944	9 Kr.											
01.11.1946		20 Kr		12 Kr.								
01.04.1947	15 Kr.		10 Kr.			4 Kr.						
01.07.1948						8 Kr.		40 Kr.				
15.08.1955	20 Kr		15 Kr.		3 Kr.		50 kr.					
01.09.1955		30 Kr.		18 Kr.		12 Kr.		60 Kr.				
01.10.1958		75 Kr.		45 Kr.		30 Kr		150 Kr.				
15.06.1959	30 Kr.		25 Kr.		5 Kr.		50 kr.					
01.03.1963	50 Kr.	100 Kr.	30 Kr.	60 Kr.	10 kr.	40 kr.	100 kr.	200 kr.				
05.05.1971	100 Kr.	200 Kr.	50 Kr.	125 Kr.	25 kr.	75 kr.	100 kr.	200 kr.			100 kr.	
01.01.1976		400 Kr.		250 Kr.		125 kr		350 kr.		125 kr.	100 kr.	
20.09.1977	250Kr.	500 Kr.	100 Kr.	350 kr	50 kr	250 kr	250 kr	550 kr	50 kr.	250kr	250kr	
17.09.1979		10 TL		7.5 TL.		5 TL		10 TL			250 kr	
01.02.1980		20 TL	2.5 TL.	15 TL	1.5 TL	7.5 TL.	10 TL	20 TL	2.5 TL	7.5 TL	250 Kr.	
01.12.1980	10 TL.		7.5 TL.		2.5 TL		15 TL		2.5 TL		10 TL	
01.07.1981		30 TL		20 TL		15 TL		35 TL		15 TL	50 TL	
01.04.1983	15 TL	50 TL	10 TL	35 TL	5 TL	25 TL	30 TL	50 TL			50 TL	
06.04.1984	20 TL	70 TL	15 TL	50 TL	10 TL	40 TL	40 TL	80 TL			70 TL	
16.01.1985	20 TL	100 TL		70 TL		50 TL		110 TL			100 TL	
16.02.1987	50 TL	200 TL	30 TL	150 TL	20 TL	100 TL	100 TL	200 TL	20 TL	100 TL	250 TL	
08.07.1988	100	400	100	300	50	200	200	400	50	200	500	800

POSTAL PRICE TARIFFS (continued)

Table F: Postal Price Tariffs (continued)

01.12.1988	150	600	100	450	75	300	300	600	75	300	750	1.200
01.06.1989	175	700	125	500	100	350	350	700	100	350	825	1.400
15.09.1989	200	700	150	500	100	400	400	700	100	400	800	1.400
01.05.1990	300	1.000	200	700	150	500	400	1.100	150	500	1.200	2.000
01.02.1991	500	1.500	300	1.000	250	800	700	2.000	250	800	2.000	3.000
20.12.1991											3.000	4.500
01.09.1992	1.000	3.000	600	2.500	500	1.500	1.500	4.000	500	1.500	4.000	7.000
12.09.1993	1.500	5.000	1.500	5.000	1.000	3.500	3.000	7.000	1.000	3.500	6.000	11.000
05.04.1994	2.500	8.500	2.500	8.500	1.500	6.000	5.000	12.000	1.500	6.000	10.000	18.500
22.12.1994	3.500	15.000	3.500	15.000	2.000	15.000	6.500	22.500	2.000	15.000	14.000	30.000
21.07.1995	5.000	30.000	5.000	30.000	3.000	15.000	10.000	40.000	3.000	20.000	20.000	60.000
27.12.1995	10.000	40.000	10.000	40.000	6.000	25.000	20.000	55.000	6.000	25.000	40.000	80.000
03.05.1996	15.000	50.000	15.000	50.000	10.000	35.000	30.000	75.000	10.000	35.000	60.000	100.000
17.12.1996	25.000	70.000	25.000	70.000	15.000	50.000	60.000	100.000	15.000	50.000	120.000	140.000
07.06.1997	40.000	100.000	40.000	100.000	25.000	70.000	75.000	150.000	25.000	70.000	150.000	200.000
17.12.1997		150.000		125.000		100.000		200.000		100.000		250.000
19.06.1998	75.000	175.000	75.000	150.000	50.000	125.000	150.000	250.000	50.000	125.000	200.000	300.000
14.12.1998		200.000		175.000		150.000		300.000		150.000		
01.07.1999	150.000	250.000	150.000	225.000	100.000	200.000	250.000	375.000	100.000	200.000	300.000	400.000
21.12.1999		300.000		275.000		250.000		450.000		250.000		500.000
24.12.1999	200.000	300.000	200.000	275.000	125.000	250.000	350.000	450.000	125.000	250.000	400.000	500.000
15.12.2000		350.000		325.000		275.000		525.000		275.000		600.000
17.04.2001		500.000		450.000		425.000		750.000		425.000		750.000
01.05.2001	300.000	500.000	300.000	450.000	175.000	425.000	525.000	750.000	175.000	425.000	500.000	750.000
09.01.2002	400.000	600.000	400.000	500.000	250.000	450.000	750.000	900.000	250.000	450.000	600.000	900.000
03.05.2002	400.000	600.000	400.000	500.000	250.000	450.000	750.000	900.000	250.000	450.000	600.000	900.000
29.06.2002		700.000		600.000		500.000		1.050.000		500.000		1.000.000
19.09.2002	450.000	700.000	450.000	600.000	300.000	500.000	850.000	1.050.000	300.000	500.000	700.000	1.000.000
16.11.2002	500.000	700.000	500.000	600.000	300.000	500.000	1.000.000	1.050.000	300.000	500.000	750.000	1.000.000

APPENDIX G

PRICE TARIFF FOR EXPRESS MAIL SERVICE

Table G: Price Tariff For Express Mail Service

	Express Mail Service			*Eexpress Mail Service*	
DATE	*INLAND*			*INTERNATIONAL*	
	Up to 250 gr	*Up to 1 kg*	*Successor 1 kg*	*Up to 500 gr*	*Successor 500 gr*
16.02.1987	1.000 TL	2.200 TL			
08.07.1988	2.000 TL	5.000 TL			
01.12.1988	1.800 TL	3.000 TL	1.000 TL	35.000 TL	7.000 TL
01.05.1990	1.800 TL	3.000 TL	1.000 TL	40.000 TL	8.000 TL
01.02.1991	3.500 TL	6.000 TL	3.000 TL	70.000 TL	10.000 TL
20.12.1991	7.000 TL	12.000 TL	6.000 TL		
01.07.1991				120.000 TL	20.000 TL
01.09.1992	10.000 TL	18.000 TL	7.000 TL	180.000 TL	25.000 TL
12.09.1993	20.000 TL	36.000 TL	14.000 TL	250.000 TL	40.000 TL
05.04.1994	35.000 TL	63.000 TL	25.000 TL	350.000 TL	60.000 TL
18.07.1994				830.000 TL	140.000 TL
22.12.1994	45.000 TL	80.000 TL	35.000 TL	890.000 TL	150.000 TL
21.07.1995	75.000 TL	150.000 TL	50.000 TL	1.100.000 TL	185.000 TL
27.12.1995	100.000 TL	200.000 TL	50.000 TL	1.400.000 TL	200.000 TL
03.05.1996	120.000 TL	250.000 TL	75.000 TL	2.100.000 TL	400.000 TL
17.12.1996	200.000 TL	400.000 TL	100.000 TL	2.750.000 TL	550.000 TL
07.06.1997	300.000 TL	600.000 TL	250.000 TL	3.400.000 TL	800.000 TL
17.12.1997				4.500.000 TL	1.100.000 TL
19.06.1998	400.000 TL	1.000.000 TL	500.000 TL	5.000.000 TL	1.250.000 TL
14.12.1998				5.500.000 TL	1.750.000 TL
01.07.1999	700.000 TL	1.750.000 TL	1.000.000 TL	8.500.000 TL	2.750.000 TL
24.12.1999	1.000.000 TL	2.250.000 TL	1.250.000 TL	11.000.000 TL	3.500.000 TL
15.12.2000				12.000.000 TL	5.000.000 TL
17.04.2001				20.000.000 TL	9.000.000 TL
01.05.2001	1.500.000 TL	3.500.000 TL	2.000.000 TL	28.000.000 TL	12.500.000 TL

APPENDIX H

VISUAL BASIC SOURCE CODE FOR RAMSEY PRICING UNDER ZERO CROSS-PRICE ELASTICITY

```
Option Explicit

Public Const ICHECK As Integer = 0
Public C1 As Double, C2 As Double
Public Target As Double
Public P10 As Double, P20 As Double
Public P1 As Double, P1A As Double, P1B As Double, P1Z As Double, P2 As Double, P2A As Double, P2B As Double, P2Z As Double
Public PA As Double, PIA As Double, PB As Double, PIB As Double, PIZ As Double
Public AL0 As Double, AL1 As Double, AL2 As Double
Public BE0 As Double, BE1 As Double, BE2 As Double
Public Q1 As Double, Q2 As Double, F As Double, TC As Double
Public Q1A As Double, Q2A As Double
Public G1 As Double, G2 As Double, G3 As Double, G4 As Double, G6 As Double, G7 As Double
Public PS0 As Double, PS1 As Double, PS2 As Double
Public TH0 As Double, TH1 As Double, TH2 As Double
Public C As Double
Public PI As Double, PI0 As Double
Public B As Double, B0 As Double, BZ As Double, DELB As Double, DELBZ As Double, DB As Double
Public XX As Double
Public PDIF As Double, CDIF As Double
Public DBA As Double, DP1 As Double, DP2 As Double, P1R As Double, P2R As Double, PP1 As Double, PP2 As Double
Public IZA As Integer, IZB As Integer
```

```
Public LMB As Double, E1 As Double, E2 As Double
Public Sub Ben(B, PI, P1, P2)
        Q1 = AL0 + AL1 * P1
        Q2 = BE0 + BE1 * P2
        C = (C1 * Q1 + C2 * Q2) + F
        PI = ((P1 * Q1) + (P2 * Q2)) - C
        '  Benefits measured from demand curves with prices and quantities.
        B = (((TH0 + Q1 * TH1 / 2) * Q1) + ((PS0 + Q2 * PS1 / 2) * Q2)) - C
End Sub

Option Explicit
Dim cnt As Integer
Public i As Integer, j As Integer

Private Sub Command1_Click()
  Screen.MousePointer = vbHourglass
  txtDebug.Text = ""
  For i = txtC1(0).Text To txtC1(1).Text Step 20
    For j = txtC2(0).Text To txtC2(1).Text Step 50
    '  Marginal Cost first class and second class
       C1 = i 'Int(txtC1(0).Text)
       C2 = j 'Int(txtC2(0).Text)
       txtDebug.Text = txtDebug.Text & "Marginal Costs C1= " & C1 & "; C2= " & C2
& vbNewLine
    '  Profit Target
       Target = CDbl(txtTarget)
       txtDebug.Text = txtDebug.Text & "Profit Target= " & Target & vbNewLine
    '  Initial Prices
       P10 = Int(txtIP1.Text)
       P20 = Int(txtIP2.Text)
       txtDebug.Text = txtDebug.Text & "Base Prices IP1= " & Int(txtIP1.Text) & ";
IP2= " & Int(txtIP2.Text) & vbNewLine
    '  Q1 & Q2 are the estimated quantities at the initial prices
       Q1 = AL0 + AL1 * P10
       Q2 = BE0 + BE1 * P20
```

```
        'txtDebug.Text = txtDebug.Text & vbNewLine
        txtDebug.Text = txtDebug.Text & "Initial Quantities Q1= 0" & Format(Q1, ".000000E+00") & "; Q2= 0" & Format(Q2, ".000000E+00") & vbNewLine
    '   F = Profit + Fixes Costs implied.
        F = P10 * Q1 + P20 * Q2 - C1 * Q1 - C2 * Q2 '- 48000000
    '   F is now updated to include the profit increase/decrease
        F = F + Target
    '   Compute inverse demand equations
        TH0 = -AL0 / AL1
        TH1 = 1 / AL1
        PS0 = -BE0 / BE1
        PS1 = 1 / BE1
        'txtDebug.Text = txtDebug.Text & "Marginal Costs and Base Prices>> C1= " & C1 & "; C2= " & C2 & "; IP1= " & P10 & "; IP2= " & P20 & vbNewLine
    '   Subroutine Ben calculates welfare benefits and the profit change from the status quo position
        Call Ben(B, PI, P10, P20)
    '   B0 is the initial level of welfare
        B0 = B
        cnt = 0
    '   PI is Profit - (Profit at initial prices)
    '   Thus at initial prices this is zero - PI0 = 0, But F = F + Target, That is PI = -Target
        'PI0 = PI
        'txtDebug.Text = txtDebug.Text & "Initial Profit >> " & Format(PI, "#########") & vbNewLine
        txtDebug.Text = txtDebug.Text & "Initial Welfare>> B0= " & Format(B0, "#########") & vbNewLine
    '   P1 & P2 are Ramsey prices and are calculated given values of own-elasticity, marginal cost and lambda.
        LMB = 0.01
RamseyRule:
        P1 = ((LMB + 1) * C1 * E1) / (E1 + E1 * LMB + LMB)
        P2 = ((LMB + 1) * C2 * E2) / (E2 + E2 * LMB + LMB)
        cnt = cnt + 1
        Call Ben(B, PI, P1, P2)
```

```
            DELB = B - B0
        '   Since fixed costs are unknown, Welfare cannot be measured in absolute terms;
        '   however, it is possible to measure the change in welfare from that at the initial prices;
        '   DELB is this.
            If PI >= 0 Then GoTo RamseyEnd
            PA = P1
            LMB = LMB + 0.01
            PIA = PI
            GoTo RamseyRule
RamseyEnd:
            PDIF = P1 - P2
            CDIF = C1 - C2
            txtDebug.Text = txtDebug.Text & ">>Optimal Ramsey Pricing Found At " & cnt & " iteration." & vbNewLine
            txtDebug.Text = txtDebug.Text & "     Welfare Gain= " & Format(DELB, "#########") & vbNewLine
            txtDebug.Text = txtDebug.Text & "   Profit Level= " & Format(PI, "#########") & vbNewLine
            txtDebug.Text = txtDebug.Text & "    Letter Ramsey Price= " & Format(P1, "###") & vbNewLine
            txtDebug.Text = txtDebug.Text & "     Express Mail Ramsey Price= " & Format(P2, "###") & vbNewLine
            txtDebug.Text = txtDebug.Text & "   Letter Demand at Ramsey Optimum= " & Format(Q1, "######") & vbNewLine
            txtDebug.Text = txtDebug.Text & "     Express Mail Demand at Ramsey Optimum= " & Format(Q2, "######") & vbNewLine
            txtDebug.Text = txtDebug.Text & "   Ramsey Number Lambda= " & LMB & vbNewLine
            txtDebug.Text = txtDebug.Text & "**************************" & vbNewLine
        Next j
    Next i
    Screen.MousePointer = vbDefault
End Sub
```

```
Private Sub Form_Load()
'   Demand parameter values
    AL0 = 1030694
    AL1 = -3131
    AL2 = 0
    BE0 = 15466
    BE1 = -3.5
    BE2 = 0
    E1 = -0.46
    E2 = -0.7
End Sub
```

APPENDIX I

RAMSEY OPTIMALITY RESULTS FOR YEAR 1999

Ramsey Optimality: λ= 0.30; MC_{let}=50 TL, MC_{exp}=200 TL					
Mail Category	*Real Base Prices*	*Real Ramsey Price*	*Actual Demand*	*Ramsey Demand*	*Welfare Gain*
Letter	150	100	561044	716543	12,025,984
Express Mail	650	298	13191	14422	

Ramsey Optimality: λ= 0.29; MC_{let}=50 TL, MC_{exp}=250 TL					
Mail Category	*Real Base Prices*	*Real Ramsey Price*	*Actual Demand*	*Ramsey Demand*	*Welfare Gain*
Letter	150	98	561044	724508	*12,334,847*
Express Mail	650	368	13191	14177	

Ramsey Optimality: λ= 0.29; MC_{let}=50 TL, MC_{exp}=300 TL					
Mail Category	Real Base Prices	Real Ramsey Price	Actual Demand	Ramsey Demand	Welfare Gain
Letter	150	98	561044	724508	*12,258,451*
Express Mail	650	442	13191	13919	

Ramsey Optimality: λ= 0.29; MC_{let}=50 TL, MC_{exp}=350 TL					
Mail Category	Real Base Prices	Real Ramsey Price	Actual Demand	Ramsey Demand	Welfare Gain
Letter	150	98	561044	724508	*12,188,847*
Express Mail	650	516	13191	13661	

Ramsey Optimality: λ= 0.29; MC_{let}=50 TL, MC_{exp}=400 TL					
Mail Category	*Real Base Prices*	*Real Ramsey Price*	*Actual Demand*	*Ramsey Demand*	*Welfare Gain*
Letter	150	98	561044	724508	*12,126,035*
Express Mail	650	589	13191	13404	

Ramsey Optimality: λ= 0.29; MC_{let}=50 TL, MC_{exp}=450 TL					
Mail Category	*Real Base Prices*	*Real Ramsey Price*	*Actual Demand*	*Ramsey Demand*	*Welfare Gain*
Letter	150	98	561044	724508	*12,070,014*
Express Mail	650	663	13191	13146	

Ramsey Optimality: λ= 0.27; MC_{let}=60 TL, MC_{exp}=200 TL					
Mail Category	*Real Base Prices*	*Real Ramsey Price*	*Actual Demand*	*Ramsey Demand*	*Welfare Gain*
Letter	150	112	561044	681401	*8.859,907*
Express Mail	650	287	13191	14461	

Ramsey Optimality: λ= 0.27; MC_{let}=60 TL, MC_{exp}=250 TL					
Mail Category	*Real Base Prices*	*Real Ramsey Price*	*Actual Demand*	*Ramsey Demand*	*Welfare Gain*
Letter	150	112	561044	681401	*8.778,041*
Express Mail	650	359	13191	14209	

Ramsey Optimality: λ= 0.27; MC_{let}=60 TL, MC_{exp}=300 TL					
Mail Category	*Real Base Prices*	*Real Ramsey Price*	*Actual Demand*	*Ramsey Demand*	*Welfare Gain*
Letter	150	112	561044	681401	*8.703,259*
Express Mail	650	431	13191	13958	

Ramsey Optimality: λ= 0.27; MC_{let}=60 TL, MC_{exp}=350 TL					
Mail Category	*Real Base Prices*	*Real Ramsey Price*	*Actual Demand*	*Ramsey Demand*	*Welfare Gain*
Letter	150	112	561044	681401	*8.635,563*
Express Mail	650	503	13191	13707	

Ramsey Optimality: λ= 0.27; MC_{let}=60 TL, MC_{exp}=400 TL					
Mail Category	*Real Base Prices*	*Real Ramsey Price*	*Actual Demand*	*Ramsey Demand*	*Welfare Gain*
Letter	150	112	561044	681401	*8.574,953*
Express Mail	650	574	13191	13455	

Ramsey Optimality: λ= 0.26; MC_{let}=60 TL, MC_{exp}=450 TL					
Mail Category	*Real Base Prices*	*Real Ramsey Price*	*Actual Demand*	*Ramsey Demand*	*Welfare Gain*
Letter	150	109	561044	690007	*8.958,803*
Express Mail	650	638	13191	13233	

Ramsey Optimality: λ= 0.26; MC_{let}=70 TL, MC_{exp}=200 TL					
Mail Category	*Real Base Prices*	*Real Ramsey Price*	*Actual Demand*	*Ramsey Demand*	*Welfare Gain*
Letter	150	127	561044	633226	*5.284,635*
Express Mail	650	284	13191	14473	

Ramsey Optimality: λ= 0.25; MC_{let}=70 TL, MC_{exp}=250 TL					
Mail Category	*Real Base Prices*	*Real Ramsey Price*	*Actual Demand*	*Ramsey Demand*	*Welfare Gain*
Letter	150	124	561044	642932	*5.742,676*
Express Mail	650	350	13191	14241	

Ramsey Optimality: λ= 0.25; MC_{let}=70 TL, MC_{exp}=300 TL					
Mail Category	*Real Base Prices*	*Real Ramsey Price*	*Actual Demand*	*Ramsey Demand*	*Welfare Gain*
Letter	150	124	561044	642932	*5.669,351*
Express Mail	650	420	13191	13996	

Ramsey Optimality: λ= 0.25; MC_{let}=70 TL, MC_{exp}=350 TL					
Mail Category	*Real Base Prices*	*Real Ramsey Price*	*Actual Demand*	*Ramsey Demand*	*Welfare Gain*
Letter	150	124	561044	642932	*5.603,376*
Express Mail	650	490	13191	13751	

Ramsey Optimality: λ= 0.25; MC_{let}=70 TL, MC_{exp}=400 TL					
Mail Category	*Real Base Prices*	*Real Ramsey Price*	*Actual Demand*	*Ramsey Demand*	*Welfare Gain*
Letter	150	124	561044	642932	*5.544,751*
Express Mail	650	560	13191	13506	

Ramsey Optimality: λ= 0.25; MC_{let}=70 TL, MC_{exp}=450 TL					
Mail Category	*Real Base Prices*	*Real Ramsey Price*	*Actual Demand*	*Ramsey Demand*	*Welfare Gain*
Letter	150	124	561044	642932	*5.493,476*
Express Mail	650	630	13191	13261	

Ramsey Optimality: λ= 0.25; MC_{let}=80 TL, MC_{exp}=200 TL					
Mail Category	*Real Base Prices*	*Real Ramsey Price*	*Actual Demand*	*Ramsey Demand*	*Welfare Gain*
Letter	150	142	561044	587537	*2.085,604*
Express Mail	650	280	13191	14486	

Ramsey Optimality: λ= 0.24; MC_{let}=80 TL, MC_{exp}=250 TL					
Mail Category	*Real Base Prices*	*Real Ramsey Price*	*Actual Demand*	*Ramsey Demand*	*Welfare Gain*
Letter	150	138	561044	598267	*2.648,388*
Express Mail	650	346	13191	14257	

Ramsey Optimality: λ= 0.24; MC_{let}=80 TL, MC_{exp}=300 TL					
Mail Category	*Real Base Prices*	*Real Ramsey Price*	*Actual Demand*	*Ramsey Demand*	*Welfare Gain*
Letter	150	138	561044	598267	*2.575,734*
Express Mail	650	415	13191	14015	

Ramsey Optimality: λ= 0.24; MC_{let}=80 TL, MC_{exp}=350 TL					
Mail Category	*Real Base Prices*	*Real Ramsey Price*	*Actual Demand*	*Ramsey Demand*	*Welfare Gain*
Letter	150	138	561044	598267	*2.510,553*
Express Mail	650	484	13191	13773	

Ramsey Optimality: λ= 0.24; MC_{let}=80 TL, MC_{exp}=400 TL					
Mail Category	*Real Base Prices*	*Real Ramsey Price*	*Actual Demand*	*Ramsey Demand*	*Welfare Gain*
Letter	150	138	561044	598267	*2.452,843*
Express Mail	650	553	13191	13531	

Ramsey Optimality: λ= 0.24; MC_{let}=80 TL, MC_{exp}=450 TL					
Mail Category	*Real Base Prices*	*Real Ramsey Price*	*Actual Demand*	*Ramsey Demand*	*Welfare Gain*
Letter	150	138	561044	598267	*2.402,606*
Express Mail	650	622	13191	13289	

Ramsey Optimality: λ= 0.24; MC_{let}=90 TL, MC_{exp}=200 TL					
Mail Category	*Real Base Prices*	*Real Ramsey Price*	*Actual Demand*	*Ramsey Demand*	*Welfare Gain*
Letter	150	155	561044	544214	*-710,886*
Express Mail	650	276	13191	14498	

Ramsey Optimality: λ= 0.23; MC_{let}=90 TL, MC_{exp}=350 TL					
Mail Category	*Real Base Prices*	*Real Ramsey Price*	*Actual Demand*	*Ramsey Demand*	*Welfare Gain*
Letter	150	152	561044	555897	*-184,023*
Express Mail	650	478	13191	13794	

Ramsey Optimality: λ= 0.24; MC_{let}=100 TL, MC_{exp}=250 TL					
Mail Category	*Real Base Prices*	*Real Ramsey Price*	*Actual Demand*	*Ramsey Demand*	*Welfare Gain*
Letter	150	173	561044	490161	*-4,082,518*
Express Mail	650	346	13191	14257	

Ramsey Optimality: λ= 0.24; MC_{let}=100 TL, MC_{exp}=400 TL					
Mail Category	*Real Base Prices*	*Real Ramsey Price*	*Actual Demand*	*Ramsey Demand*	*Welfare Gain*
Letter	150	168	561044	503142	*-3,358,324*
Express Mail	650	546	13191	13556	

APPENDIX J

VISUAL BASIC SOURCE CODE FOR RAMSEY PRICING UNDER NONZERO CROSS-PRICE ELASTICITY

```
Option Explicit

Public Const ICHECK As Integer = 0
Public C1 As Double, C2 As Double
Public Target As Double
Public P10 As Double, P20 As Double
Public P1 As Double, P1A As Double, P1B As Double, P1Z As Double, P2 As Double, P2A As Double, P2B As Double, P2Z As Double
Public PA As Double, PIA As Double, PB As Double, PIB As Double, PIZ As Double
Public AL0 As Double, AL1 As Double, AL2 As Double
Public BE0 As Double, BE1 As Double, BE2 As Double
Public Q1 As Double, Q2 As Double, F As Double
Public Q1A As Double, Q2A As Double
Public G1 As Double, G2 As Double, G3 As Double, G4 As Double, G6 As Double, G7 As Double
Public PS0 As Double, PS1 As Double, PS2 As Double
Public TH0 As Double, TH1 As Double, TH2 As Double
Public C As Double
Public PI As Double, PI0 As Double
Public B As Double, B0 As Double, BZ As Double, DELB As Double, DELBZ As Double, DB As Double
Public XX As Double
Public PDIF As Double, CDIF As Double
Public DBA As Double, DP1 As Double, DP2 As Double, P1R As Double, P2R As Double, PP1 As Double, PP2 As Double
Public IZA As Integer, IZB As Integer
```

```
Public Sub Ben(B, PI, P1, P2)
    Q1 = AL0 + AL1 * P1 + AL2 * P2
    Q2 = BE0 + BE1 * P1 + BE2 * P2
    C = F + (C1 * Q1 + C2 * Q2)
    PI = ((P1 * Q1) + (P2 * Q2)) - C
'   Benefits measured from demand curves with prices in and quantities per annum.
    B = ((TH0 + Q1 * TH1/2) * Q1+(PS0 * Q2 + PS1 * Q1 * Q2 + PS2 * Q2 * Q2/2)) - C
End Sub

Option Explicit

Public i As Integer, j As Integer

Private Sub Command1_Click()
    Screen.MousePointer = vbHourglass
    txtDebug.Text = ""
'   Marginal Cost first class and second class
    C1 = Int(txtC1.Text) / 100
    C2 = Int(txtC2.Text) / 100
    txtDebug.Text = txtDebug.Text & "Marginal Costs C1= " & Int(txtC1.Text) & "; C2=
" & Int(txtC2.Text) & vbNewLine
'   Profit Target
    Target = CDbl(txtTarget)
    txtDebug.Text = txtDebug.Text & "Profit Target= " & Target & vbNewLine
'   Initial Prices
    P10 = Int(txtIP1.Text) / 100
    P20 = Int(txtIP2.Text) / 100
    txtDebug.Text = txtDebug.Text & "Base Prices IP1= " & Int(txtIP1.Text) & "; IP2= "
& Int(txtIP2.Text) & vbNewLine
'   Q1 & Q2 are the estimated quantities at the initial prices
    Q1 = AL0 + AL1 * P10 + AL2 * P20
    Q2 = BE0 + BE1 * P10 + BE2 * P20
    txtDebug.Text = txtDebug.Text & vbNewLine
    txtDebug.Text = txtDebug.Text & "Estimated Quantities at initial prices Q1= 0" &
Format(Q1, ".000000E+00") & "; Q2= 0" & Format(Q2, ".000000E+00") & vbNewLine
```

```
'   F = Profit + Fixes Costs implied.
    F = P10 * Q1 + P20 * Q2 - C1 * Q1 - C2 * Q2
    'txtDebug.Text = txtDebug.Text & "Profit + Fixed Costs= " & F & vbNewLine
'   F is now updated to include the profit increase/decrease
    F = F + Target
'   Compute inverse demand equations
    G1 = C2 * AL2 * AL2 - C2 * BE2 * AL1 + AL2 * AL0 - AL1 * BE0
    G2 = C1 * (AL2 * AL0 - AL1 * BE0)
    G3 = C2 * (BE2 * AL0 - AL2 * BE0)
    G4 = C1 * (AL2 * AL2 - AL1 * BE2) + AL2 * BE0 - BE2 * AL0
    G6 = AL2 * AL2
    G7 = -G6 + BE2 * AL1
    PS0 = (-AL1 * BE0 + AL2 * AL0) / G7
    PS1 = -AL2 / G7
    PS2 = AL1 / G7
    TH0 = (-BE2 * AL0 + AL2 * BE0) / G7
    TH1 = BE2 / G7
    TH2 = -AL2 / G7
    'txtDebug.Text = txtDebug.Text & "Marginal Costs and Base Prices>> C1= " & C1 &
"; C2= " & C2 & "; IP1= " & P10 & "; IP2= " & P20 & vbNewLine
'   Subroutine Ben calculates welfare benefits and the profit change from the status quo
position
    Call Ben(B, PI, P10, P20)
'   B0 is the initial level of welfare
    B0 = B
'   PI is F+Profit - (F+Profit at initial prices)
'   Thus at initial prices this is zero - PI0 = 0, But F = F + Target, That is PI = -Target
    PI0 = PI
    txtDebug.Text = txtDebug.Text & vbNewLine
    txtDebug.Text = txtDebug.Text & "Initial Profit+Fixed Costs>> F = 0" & Format(PI,
".00000E+00") & vbNewLine
    txtDebug.Text = txtDebug.Text & vbNewLine
    txtDebug.Text = txtDebug.Text & "Initial Welfare>> B0= 0" & Format(B0,
".00000E+00") & vbNewLine
'   P1 & P2 are prices, P2 calculated via Ramsey rule and given values for P1, C1, C2
```

```
   P1 = 0.05
Jump25:
   P2 = (G1 * P1 - G2 - G3) / G4
   Call Ben(B, PI, P1, P2)
'  Q : number of letters per annum
'  PI is the change in profit relative to initial prices
   DELB = B - B0
'  Since fixed costs are unknown, Welfare cannot be measured in absolute terms;
'  however, it is possible to measure the change in welfare from that at the initial prices;
'  DELB is this.
   If PI >= 0 Then GoTo Jump26
   PA = P1
   P1 = P1 + 0.01
   PIA = PI
   GoTo Jump25
Jump26:
   PB = P1
   'txtDebug.Text = txtDebug.Text & "Debug PI= " & PI & vbNewLine
   PIB = PI
Jump27:
   P1 = PA + ((PA - PB) * PIA) / (PIB - PIA)
   P2 = (G1 * P1 - G2 - G3) / G4
   Call Ben(B, PI, P1, P2)
   DB = B - B0
   XX = Abs(PI)
   'txtDebug.Text = txtDebug.Text & "Debug PI= " & PI & "; XX= " & XX &
vbNewLine
   If XX <= 1000 Then GoTo Jump29
   If PI <= 0 Then GoTo Jump28
   PIB = PI
   PB = P1
   GoTo Jump27
Jump28:
   PIA = PI
   PA = P1
```

```
    GoTo Jump27
Jump29:
    PDIF = P1 - P2
    CDIF = C1 - C2
    txtDebug.Text = txtDebug.Text & vbNewLine
    txtDebug.Text = txtDebug.Text & "Exact Solution: DB= 0" & Format(DB, ".00000E+00") & vbNewLine
    txtDebug.Text = txtDebug.Text & "                PI= 0" & Format(PI, ".00000E+00") & vbNewLine
    txtDebug.Text = txtDebug.Text & "                P1= 0" & Format(P1, ".00000E+00") & vbNewLine
    txtDebug.Text = txtDebug.Text & "                P2= 0" & Format(P2, ".00000E+00") & vbNewLine
    txtDebug.Text = txtDebug.Text & "                Q1= 0" & Format(Q1, ".00000E+00") & vbNewLine
    txtDebug.Text = txtDebug.Text & "                Q2= 0" & Format(Q2, ".00000E+00") & vbNewLine
    txtDebug.Text = txtDebug.Text & "                Price Diff= 0" & Format(PDIF, ".00000E+00") & vbNewLine
    txtDebug.Text = txtDebug.Text & "                Cost Diff= 0" & Format(CDIF, ".00000E+00") & vbNewLine
    txtDebug.Text = txtDebug.Text & vbNewLine
    DBA = -1E+15
    DP1 = P1 * 100
    DP2 = P2 * 100
    P1R = Int(DP1)
    P2R = Int(DP2)
    For i = 1 To 5
        PP1 = P1R - 3 + i
        For j = 1 To 5
            PP2 = P2R - 3 + j
            If Not (PP2 >= PP1) Then
                P1 = PP1 / 100
                P2 = PP2 / 100
                Call Ben(B, PI, P1, P2)
```

```
DB = B - B0
txtDebug.Text = txtDebug.Text & "P1R= " & Format(P1R, "0.000") & "; DP1= " & Format(DP1, "0.000") & "; P1= " & Format(P1, "0.000") & "; PP1= " & Format(PP1, "0.000") & "; I= " & i & "; J= " & j
If DB < 0 Then
  txtDebug.Text = txtDebug.Text & "; DB= -0" & Format(Abs(DB), ".00000E+00")
  If PI < 0 Then
    txtDebug.Text = txtDebug.Text & "; PI= -0" & Format(Abs(PI), ".00000E+00") & vbNewLine
  Else
    txtDebug.Text = txtDebug.Text & "; PI=  0" & Format(PI, ".00000E+00") & vbNewLine
  End If
Else
  txtDebug.Text = txtDebug.Text & "; DB=  0" & Format(DB, ".00000E+00")
  If PI < 0 Then
    txtDebug.Text = txtDebug.Text & "; PI= -0" & Format(Abs(PI), ".00000E+00") & vbNewLine
  Else
    txtDebug.Text = txtDebug.Text & "; PI=  0" & Format(PI, ".00000E+00") & vbNewLine
  End If
End If
txtDebug.Text = txtDebug.Text & "P2R= " & Format(P2R, "0.000") & "; DP2= " & Format(DP2, "0.000") & "; P2= " & Format(P2, "0.000") & "; PP2= " & Format(PP2, "0.000") & "; I= " & i & "; J= " & j
If DB < 0 Then
  txtDebug.Text = txtDebug.Text & "; DB= -0" & Format(Abs(DB), ".00000E+00")
  If PI < 0 Then
    txtDebug.Text = txtDebug.Text & "; PI= -0" & Format(Abs(PI), ".00000E+00") & vbNewLine
  Else
```

```
                txtDebug.Text = txtDebug.Text & "; PI=  0" & Format(PI, ".00000E+00") & vbNewLine
            End If
        Else
            txtDebug.Text = txtDebug.Text & "; DB=  0" & Format(DB, ".00000E+00")
            If PI < 0 Then
                txtDebug.Text = txtDebug.Text & "; PI= -0" & Format(Abs(PI), ".00000E+00") & vbNewLine
            Else
                txtDebug.Text = txtDebug.Text & "; PI=  0" & Format(PI, ".00000E+00") & vbNewLine
            End If
        End If
        If PI >= -1000 Then
                If Not (DB < DBA) Then
                        P1A = P1
                        P2A = P2
                        DBA = DB
                        Q1A = Q1
                        Q2A = Q2
                        PIA = PI
                End If
        End If
      End If
    Next j
  Next i
  PDIF = P1A - P2A
  CDIF = C1 - C2
  txtDebug.Text = txtDebug.Text & vbNewLine
  txtDebug.Text = txtDebug.Text & "Discrete Optimal DB= 0" & Format(DBA, ".00000E+00") & vbNewLine
  txtDebug.Text = txtDebug.Text & "               PI= 0" & Format(PIA, ".00000E+00") & vbNewLine
  txtDebug.Text = txtDebug.Text & "                 P1= 0" & Format(P1A, ".00000E+00") & vbNewLine
```

```
   txtDebug.Text = txtDebug.Text & "                P2= 0" & Format(P2A, ".00000E+00") & vbNewLine
   txtDebug.Text = txtDebug.Text & "                Q1= 0" & Format(Q1A, ".00000E+00") & vbNewLine
   txtDebug.Text = txtDebug.Text & "                Q2= 0" & Format(Q2A, ".00000E+00") & vbNewLine
   txtDebug.Text = txtDebug.Text & "                Price Diff= 0" & Format(PDIF, ".00000E+00") & vbNewLine
   txtDebug.Text = txtDebug.Text & "                Cost Diff= 0" & Format(CDIF, ".00000E+00") & vbNewLine
   txtDebug.Text = txtDebug.Text & vbNewLine
'   Next is test to see if require grid printout
   If Not (ICHECK >= 1) Then
      txtDebug.Text = txtDebug.Text & "GRID VALUES AROUND OPTIMUM" & vbNewLine
      For IZA = 1 To 3
         For IZB = 1 To 3
            P1Z = P1A + (-2 + IZA) / 100
            P2Z = P2A + (-2 + IZB) / 100
            Call Ben(BZ, PIZ, P1Z, P2Z)
            DELBZ = BZ - B0
            txtDebug.Text = txtDebug.Text & "P1= 0" & Format(P1Z, ".0000E+00") & "; P2= 0" & Format(P2Z, ".0000E+00") & "; DelBenefit= "
            If DELBZ < 0 Then
               txtDebug.Text = txtDebug.Text & "-0" & Format(Abs(DELBZ), ".000000E+00")
            Else
               txtDebug.Text = txtDebug.Text & " 0" & Format(DELBZ, ".000000E+00")
            End If
            If PIZ < 0 Then
               txtDebug.Text = txtDebug.Text & "; DelProfit= -0" & Format(Abs(PIZ), ".000000E+00") & vbNewLine
            Else
               txtDebug.Text = txtDebug.Text & "; DelProfit=  0" & Format(PIZ, ".000000E+00") & vbNewLine
```

```
            End If
        Next IZB
    Next IZA
End If
Screen.MousePointer = vbDefault
End Sub

Private Sub Form_Load()
'   Demand parameter values
    AL0 = 5582151900#
    AL1 = -15856346000#
    AL2 = 19136127000#
    BE0 = 4744597900#
    BE1 = 19136127000#
    BE2 = -29889429000#
End Sub
```