The Resellers' Regulated Demand Price of 93 Octane Petrol in Namibia Relative to OPEC Crude Oil Price, 1991

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This paper examines the efficiency implications of the regulated demand price of 93 octane petrol relative to OPEC crude oil price across 183 Namibian localities in 1991. It describes briefly pricing problems associated with managing petroleum and petro-products. Assuming that demand price depends on expected profits (incomes) and the quantities demanded and supplied, econometric estimations show the actual average petrol prices higher than the estimated (optimal) prices. Moreover, prices are generally higher in Namibia than in either OPEC countries or the rest of the world, with the exception of the OECD countries. Two measures of efficiency conclude that managed prices in Namibia are non-optimal, and therefore recommend liberalization of the petrol market in order to increase actual competition and efficiency, lower prices, and increase consumer surplus.

JEL code: Q4, Q41,

1. INTRODUCTION

[+]This paper was prepared for a background discussion to a research proposal while the author was with Ore Body Engineering, Ltd (OBE), PO Box 3573, Tucson, AZ 85722, USA. The ideas in this paper do not reflect the opinions of OBE and its staff. The editorial assistance of Tamara A.Bishop-Amavilah is appreciated, but the usual disclaimer holds.

This paper examines the efficiency implications for retailers (resellers) of the regulated 93 octane petrol demand price across 183 Namibian localities in 1991 given the fixed average OPEC crude oil price for the same year. As **Figure 1** shows petrol consumption represents the second largest block of energy demand in Namibia

(**Fig. 1a**). The level of end-user petrol consumption in industry, government, mining, and agriculture is also significant (**Fig. 1b**). Yet no quantitative study has been devoted to the efficiency with which petrol is dispensed.

Section 2 below describes the problems associated with managed petroleum and petro-product pricing in Namibia. Section 3 outlines the framework. The data used are sketched, and estimations and empirical findings presented, in Section, while Section 5 highlights the implications and conclusions of the analysis.

2. PROBLEMS: REGULATED PETROLEUM AND PETRO-PRODUCT PRICING

Although Namibia is a relatively free market economy, in the energy sector only a few private companies supply petroleum and petro-products. These companies utilize a non-market pricing scheme instituted in the early 1980's (van der Linden, 1993)[i].

In 1990 the Petroleum Products and Energy Act created the National Energy Fund (NEF)[ii] to monitor the energy sector. NEF authorizes the opening up of new, and the closing down of old, petrol outlets. The Namibian Government has retained the role of administering local energy prices in order to lessen the impacts of exogenous energy price and income shocks on the country's economy. Under this role the government has stipulated "regulations regarding prices for the reselling (retailing) of petrol", and has administered petrol prices according to that stipulation (Ministry of Mines and Energy, 1991).

It is not clear how regulated petrol prices are determined.

However, Van der Linden (1993) reports that for planning purposes

Figure 2

the future (t+i) price (P_{t+i}) of 93 octane petrol is projected on the basis of world refined oil product prices (P_w), and then adjusted for transport costs (C), exchange rate (ξ), variations in the cost of local inputs (w_i), and local inflation costs (ρ), i.e.,

$$P_{t+i} = f(P_w, \xi, C, w_i, \rho).$$

One problem is that the scheme has not succeeded in stemming the upward trend in energy prices since 1991, nor has it made price hikes predictable. Petrol and diesel prices rose by 5% in 1992, and by 10% in 1993. While they remained unchanged in 1994, petrol and diesel prices increased by 7% and 8% respectively in 1995. Two additional price hikes which took place in 1996 increased petrol and diesel prices by a combined total of 21.5% (Africa Research Bulletin, 1996).

One of the aims of the scheme is to reduce uncertainty and ensure price and income stability, security, and predictability of petroleum and petro-products. However, by requiring each petrol distributor (reseller) "to open one new outlet every five years and for each additional outlet opened ... to close down three unprofitable ones", the scheme complicates business decisions on the part of resellers (van der Linden, 1993, p. 3). While the rationale for the "open 1: close 3" rule is apparently "to prevent capital investments [from] being wasted" (op. cit), it is inconsistent with economic theory. Theory suggests that even though a firm's accounting profit may be zero or negative at a

point in time, its economic profit may still justify continued operation for other important considerations. This implies that price and income security, stability, and predictability may not even be objectives for a given firm. In that sense the "open 1: close 3" policy induces inefficiency.

The Petroleum Products and Energy Act provides for the reimbursing local oil companies for losses exceeding N$5 million incurred in any accounting period. The money for reimbursement is raised from a consumption tax on petrol, diesel, and paraffins. To-date NEF has spent N$65 million in compensation to local oil companies, N$15 million in 1996 alone. One can clearly argue that these subsidies have helped petroleum and petro-product firms offset their losses. Just as clearly they have given an incentive for resource redistribution which has brought into question the gains envisioned from managed petrol pricing. Managed pricing schemes are tolerated in crisis situations when price and income stability, security, and predictability are preferred to efficiency. In the long-run supply and demand responses tend to reduce the usefulness and desirability of artificial price administration. Thus, the problem is that the scheme essentially subsidizes distributive unfairness.

In response to the problems stated above, the government and domestic oil companies agreed in 1992 to permit new entrants into the local petrol and petro-product market, thereby promoting some measure of market contestability and competition. Nonetheless, incumbent firms already controlled local petrol and petro-product

distribution networks, which served a technical barrier to entry. If anything the agreement advanced potential competition.

3. THE FRAMEWORK

Figure 2 shows conceptual system of crude oil and petrol distribution, which links Namibia to OPEC and non-OPEC crude oil producers through the world oil marketplace. The figure makes clear that there are no oil refiners in Namibia. Therefore, Namibian petrol wholesale suppliers either buy petrol and other refined petro-products, or buy crude oil and contract refining services in South Africa, then sell it to local resellers. Thus, the relationships between South African and Namibian oil companies influence the price of 93 octane petrol in Namibia. Such relationships also conceal the link between petrol prices in Namibia and the OPEC crude oil price, even though such a link is essential to the understanding of the efficiency with which 93 octane petrol is dispensed.

To establish the link one can argue that OPEC and non-OPEC producers charge differential prices for their crude oil, but crude oil prices are recalculated by world oil market demand and supply forces. Market forces tend to lower non-OPEC prices and raise OPEC prices. Hence, given OPEC's market dominance one can assume that the world (market) and non-OPEC average crude oil prices both
depend on the OPEC crude oil price. In that sense the OPEC crude oil price influences the Namibian petrol price.

Economic theory suggests that the demand for gasoline is a

function of the price of petrol as a measure of interfuel (diesel for petrol) or intra-fuel (unleaded for leaded, regular for premium) substitutability, consumer budget, and other variables,

Figure

such as the stock of vehicles using petrol. Other things being constant, theory also predicts an inverse relationship between the own price and quantity of petrol demanded (Dahl and Sterner, 1991; Siddayao, 1986; Newberry, 1985; Drollas, 1984). Accordingly assume that resellers' demand price of 93 octane petrol in the j^{th} Namibian locality (P_j) is a function of the world price of refined petro-products (P_w), expected profit or income (Π_j), and quantity of petrol demanded and supplied (q_j), i.e.,

$$P_j = f(P_w, \Pi_j, q_j), \qquad 2$$

where, for j = 1, 2, ..., 183 localities, P_j is the regulated retail price of 93 octane petrol, P_w is the world price of refined oil products, Π_j is expected profit from the (re)sale of petrol used to purchase (import) petrol for further (re)sale, q_j is the quantity demanded and supplied.

Since P_w, and non-OPEC (P_{NO}) average crude oil prices both depend on the OPEC crude oil price (P_O), *ceteris paribus*, then P_O enters (1) instead of P_w such that the demand price for 93 octane petrol in the j^{th} Namibian locality is determined as[iii]

$$P_j = f(P_O, \Pi_j, q_j), \qquad 3$$

where $P_w = f(P_{NO}(P_O))$.

Let (3) be Cobb-Douglas (multiplicative) in form, such that

$$P_j = A_j P_O^{\alpha} \Pi_j^{\beta} q_j^{\gamma} e^{\mu_j} \qquad \textbf{4}$$

where $A > 0$, $\alpha > 0$, $\beta > 0$, and $\gamma < 0$ are parameters to be estimated, **e** is the natural logarithmic base, and for $i \neq j$ $\mu_j \sim N[E(\mu_j \mu_i) = 0, E(\mu_j^2) = \sigma^2]$ are random disturbance terms. Adjusting P_O for the exchange rate (ξ), and (3) for the domestic inflation rate (ρ), yields,

$$[P_j/\rho \equiv p_j] = A[p_O \equiv \xi_j P_O/\rho]^{\alpha} [\pi_j \equiv \Pi_j/\rho]^{\beta} q_j^{\gamma} e^{\mu_j}, \qquad \textbf{5}$$

where p_j is the real regulated retail price of 93 octane petrol in Namibia, p_O is the real OPEC crude oil price, and π_j is real expected profit.

Since p_O is a single datum one can treat it as a numeraire, i.e., dividing both sides of (5) by p_0, results in

$$p_j^* = A\pi_j^{\beta} q_j^{\gamma} e^{\mu_j}. \qquad \textbf{(6.1)}$$

Taking the logs of (6) above gives,

$$lnp_j^* = lnA + \beta \ln \pi_j + \gamma lnq_j + \mu_j, \qquad \textbf{(6.2)}$$

where $p^*_j = p_j/p_O$ is the relative demand price of petrol in

Namibia, and reflects the efficiency of crude oil utilization in the jth Namibian locality. The closer to unity (one) p^*_j is, the cheaper and more efficient the Namibian regulated price of 93 octane petrol. The further away from unity, the higher the cost differential between petrol prices in Namibia and the OPEC crude oil price. Assuming that petrol costs are lowered as p_j approaches p_O such that p^*_j goes to unity, two measures of efficiency follow. The first is the "within sample" efficiency (E_1),

$$E_1 = \frac{1}{J}\sum_j^J (\hat{p}^*_j - p^*_j)/\, p^*_j, \qquad \textbf{(7.1)}$$

where p-hat is estimated and pj is actual. Alternatively,

$$E_{11} = \sqrt{(E_1)^2}, \qquad \textbf{(7.2)}$$

A measure of "outside sample" efficiency (E_2) is,

$$E_2 = \frac{1}{J}\sum_j^2 (\hat{p}^{**}_j - p^{**}_j)/\, p^{**}_j,$$

$$\hat{p}^{**}_j = \hat{p}^*_j / p_i, p^{**}_j = p^*_j / p_j, \qquad \textbf{(8.1)}$$

for which the root mean square is,

$$E_{21} = \sqrt{(E_2)^2}. \qquad \textbf{(8.2)}$$

In (8.2) p_i is the observed real gasoline price in the i^{th} country or region, e.g. world, South Africa, OECD, and OPEC.[iv] The lower (in magnitude) are (7) and (8), the smaller the difference between actual and estimated prices.[v] A zero magnitude implies that the market clears; below or above zero inefficiency can be inferred.

These simple measures of efficiency are easier to implement than the complex cointegration measures suggested by Moosa and Al-Loughani (1994) and Eltony and Al-Mutairi (1995).

4. DATA, AND ESTIMATIONS AND FINDINGS

Data

Price (p_j). The 1991 price data for regulated 93 octane petrol were drawn from the Government Gazette No. 299 of the Ministry of Mines and Energy. As **Table 1** indicates the OPEC crude oil price in was fixed at N$0.2717/liter f.o.b., and export-weighted in Namibia

Table

dollars (N$) at the annual US$-N$ exchange rate (see **Table 1**).

Expected profit (π_j). The expected profit data for all 183 localities were generated on the assumption that real net profit is highly correlated with gross surplus, defined as real overhead plus net real profits, such that expected profit is simply the difference between real 93 octane retail price (p_j) and the 93 octane wholesale price (p^h_j) , i.e., $\pi_j = [((p_j - p^h_j)/p_o)/\rho]$, where $\rho = 10.6\%$ was the inflation rate in 1991 (Bank of Namibia, 1993). The wholesale price of petrol (p^h_j) was derived as the crude oil price in South Africa plus refinery costs in South Africa plus transport costs from South Africa to Namibia. It turned out p^h_j = N$1.027/liter. Cost calculations follow Hubbard's (1966) and Marquez's (1984) methods.

Since the retail price is regulated, the retailer can only vary overhead costs, such that as π_j gets smaller the quantity demanded and supplied also gets smaller. Given p_o, this means that the quantity desired increases as profits rise. Thus, π_j is a good proxy for the disposable income a retailer in the j^{th} locality wishes to spend on petrol.

Quantity demanded (q_j). For lack of data let $q_j = 1$ if $p_j > p_o$, implying $p^*_j > 0$, otherwise $q_j = 0$. But because the log of one is zero, and the log of zero is a negative, Eq. (6.2) must be modified to

$$p^*_j = A\pi_j^{\beta} e^{\gamma q_j} e^{\mu_j}, \qquad \textbf{12}$$

which in log-form, making the conventional econometric adjustments

for statistical problems, can be estimated by the ordinary least squares method as

$$lnp_j^* = lnA + \beta \ln \pi_j + \gamma q_j + \mu_j .$$

Estimations and Findings

The results from (9) are given in **Table 2**. The findings in **Table 2.1** are uncorrected, while those in **Table 2.2** are adjusted, for heteroskedastic variance, assuming dependent variable heteroscedasticity. From this

table, parameter estimates are consistent with demand theory. The significant Durbin-Watson (DW) statistics, which range from 1.6678 to 2.0937 for individual localities, imply that the assumption of zero autocorrelation is to be accepted. Also adjusted R^2's indicate that over 99% of variations in the relative price of 93 octane petrol in Namibia are explained by locality profits (incomes) and quantities demanded.

The average relative price of petrol in Namibia turned out to be N$[antilog 1.5907]/liter or N$0.466/liter. A low **s**tandard **e**rror of the **e**stimate (SEE = √variance = $\sqrt{\sigma^2}$) in both cases implies high model predictive power. Specifically the estimated spread of data around the estimated mean of the dependent variable (SEE/[mean of p^*_j]) is about one tenth of one percent. This means that over 99% of the data points fall direction from the estimated mean of p^*_j. The high log-likelihood functions (LLF) for both models also confirm that no better set in the linear form of these models other than OLS estimators can be produced.[vi]

Individual parameters have expected signs. In both cases the

Table

coefficients of locality income are positively significant at the usual five percent significance level. The quantity demanded is inversely related to its price. However, in the uncorrected case the hypothesis of constant variances for the low and high price localities, as one would have expected from cross-sectional data, was not accepted (see Greene, 1990).[vii] This motivated correction using[viii],

$$\sigma_i^2 = \sigma_i^2 \hat{\delta}_i^2, \qquad (9)$$

where δ_i^2-hat = $[\mu_j/f(p^*j)]^2$ transformed the original data (see White, et. al., 1990). This correction produced only slight improvement in the "technical efficiency" of the estimated parameters (as can be expected). In both uncorrected and corrected estimations the constant term accounted for more than one third of changes in the dependent variable, suggesting missing variables such as the stock of vehicles and such in each locality which use petrol. Despite these weaknesses, the results are informative as the next section illustrates.

5. IMPLICATIONS AND CONCLUSIONS

Ceteris paribus, a significantly positive correlation between the relative price of 93 octane and expected profit (income) for the average locality in Namibia means that an increase of N$1.00 in expected profit (income) tends to raise the petrol price by N$0.23/liter. More is demanded (at a higher price) if locality income is increased - an outward shift of the demand curve. The analysis also finds that a rise in the quantity of liters demanded

induced an effect of -0.004 in the price of 93 petrol in Namibia - a change in the price along a fixed demand curve. Both results are consistent with theory (Plourde and Ryan, 1985; Chern, 1987, Dahl, 1994). Note that from (6)

$$q_j = \sqrt[\gamma]{(P_j^*/A\pi^\beta e^{\mu_j})}. \qquad \textbf{(10.1)}$$

But from (9),

$$q_j = \frac{\ln p_j^* - lnA - \beta \ln \pi_j - \mu_j}{\gamma}. \qquad \textbf{(10.2)}$$

Parameter signs above derive from the first law of demand for any normal good. Experimentation with (10.2) gave the quantities of 93 octane petrol demanded. Assuming the estimated national average price of N$[ln1.5907]/liter and the actual average price of N$[ln1.6400]/liter, it was clear beyond a doubt that less than a liter is demanded at a higher actual (regulated) price than would have been demanded optimally (at a lower estimated price).

These findings conclude that if profit and price are both exogenous to a locality, any adjustment toward the desired output-price coordinate takes place only through quantity (reduction). This explains why petrol prices have increased substantially since 1992 in spite of the regulatory effort to keep them down. A separate extension that will include the missing independent variables will surely help improve understanding and further clarify these results. For now it can be concluded that the stability and surplus gains from price regulation in Namibia have been limited.

The estimated (optimal) average cross-sectional relative price

Table

Table

of 93 octane petrol in Namibia (N$0.466/liter) underestimates the actual average price (N$0.49094/liter). As measured by E1 and E11 Namibia's actual price is non-optimal by 0.051%. The implication is lower quantities demanded at the actual prices than would have been demanded optimally. Consequently sellers' expected incomes were lowered by a dead-weight loss of N$0.2494/liter.

To illustrate the measures of "outside sample" technical efficiency, consider **Table 3** which lists 1991 gasoline prices in selected countries and regions. From this table if the world price of petrol is taken to represent the equilibrium price, then the relative price of 93 petrol in Namibia would be N$0.0164/liter (1.64 cents) above the world price. Inefficiency ranged from 0.01% to 0.05%.

Table 4 shows how the Namibian price compares to gasoline prices elsewhere on the basis of the E_2 and E_{21}. Excluding the heavily subsidized cases of Nigeria, Iran, Kuwait, Venezuela, and Libya, at the weighted average price gasoline was more expensive than in Namibia only in the OECD countries.[ix] This confirms the price non-optimality portrayed in Table 4. Namibia would probably gain consumer surplus from reducing, but certainly lose predictability from continuously raising, the petrol price. Even considering the fact Namibia offers a small market and an industry with natural monopoly characteristics, which theoretically speaks for monopoly deadweight loss and possible rent-seeking activities, one might still want to consider liberalization of the petrol industry in order to increase actual competition. Competition

would encourage efficiency, and lower prices.

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NOTES

i. These include BP, Engen, Caltex, Shell, Total, Trek, and Noble. The structure of the petrol industry in Namibia is a photocopy of that of South Africa. South Africa ruled Namibia until independence in 1990. Before independence crude oil acquisition in

both Namibia and South Africa was coordinated by the Strategic Fuel Fund Association (SSF) of South Africa which imported crude oil and sold it to local refiners at a price set by the Department of Mineral and Energy Affairs, and the SSF itself (See Eberhard and Van Horen, 1995).

ii. NEF is the Namibian copycat of South African SSF (see fn 1 above).

iii. OPEC crude oil price is chosen for obvious reasons. Most importantly prior to the Kuwaiti-Iraqi war in 1991 Iraq was reportedly South Africa and Namibia's major oil suppliers. Presently Namibia's crude oil sources are South Africa (55%), and the Netherlands Antilles, Middle East, Ivory Coast, Angola, and Venezuela (45% combined).

iv. E_1 and E_{11} are "within sample" measures because the refer only efficiency within and across localities in Namibia, unlike E2 and E21 which compares efficiency in Namibian localities to other countries or regions.

v.Note that $\frac{1}{J}\sum_{j}^{J}(p_i^* - p_j^*)^2 = (\hat{p}_j^* - \overline{p}_j^*)^2 + Bias^2 + 2 * Cov$ **Error! Main Document Only.**

vi. This statement refers to the linear form only. It does not rule out the fact that other (non-linear) functional forms may yield better model fits.

vii. A generalized Wald t ~ $\chi 2$ suggest that the normality assumption of classical regression, $\mu jt \sim N(0, \sigma 2)$, is to be questioned. This observation is confirmed by a significant Jarques-Bera lagrange test (J-B-LM ~ $\chi 2$ (d.f.)) indicating the presence of outliers which must be purged from the data or corrected with dummy variables. A variety of other test, e.g., the Harvey, the Breusch-Pagan-Godfrey, the Glejser, point to $\mu 2jt \neq \sigma 2$. Diagnostic tests rule out severe specification bias (wrong functional form) and misspecification (irrelevant variables).

viii. This is a strong assumption since other functional forms of nonhomoscedasticity such as multiplicative, ARCH, linear standard deviation, and linear variance, are possible as well. For a

discussion of various heteroscedasticity tests and remedies see e.g. Greene (1990).

ix. Ayodelo (1992) reports a government subsidy of up to 70% of international gasoline price in Nigeria.