Biweight Estimate: An Instrument For Harmonizing Fuel Prices As An Anti-poverty Measure In Cameroon.

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ABSTRACT

This paper presents the use of the Statistical Biweight Technique (SBT) as a tool for harmonising fuel prices in an attempt to spread the cost uniformly across the nation. The present disproportional incidence of high fuel prices generally tends to have a high negative impact on farmers and rural dwellers who are largely poor, hungry, barefoot and behind the hoe. Harmonised fuel prices in Cameroon will benefit both urban and rural areas alike, and could also serve as an anti-poverty strategy in countries over-ridden by debt and challenged by the daunting task of poverty alleviation in the face of dwindling or chronically scare resources. This will simultaneously stimulate industrialization, economic growth and employment as well as narrow the widening gap of poverty between the city and the rural areas, without negative political implications for the current fuel-pricing mechanism. The assumption of the model is that if fuel prices are lower for rural residents and agricultural producers, cheaper and more food can be produced thanks to reduced inputs and transport costs. The analysis based on this technique gives a reasonable decrease in the price of fuels (petrol, diesel and kerosene) in the rural areas whereas the corresponding increase in urban areas is relatively insignificant. This technique can be applied to determine the prices of other essential commodities such as rice, wheat, flour, sugar and other food items.

Key words: Bi-weight; Harmonized value; poverty reduction; fuel prices; economic growth.

RÉSUMÉ

Cet article présente l'utilisation de la technique statistique Biweight comme un outil pour l'harmonisation des prix du carburant dans le but de répartir les coûts de façon uniforme partout dans le pays. L'incidence actuelle disproportionnée de prix élevés du carburant a généralement tendance à avoir un impact très négatif sur les agriculteurs et les ruraux qui sont en grande partie pauvre, affamé, nu-pieds et derrière la houe. Une harmonisation des prix du carburant sera bénéfique aux résidents ruraux et urbains et pourra être utilisé comme une stratégie anti-pauvreté dans les pays supplantés par la dette et confrontés à la redoutable tâche de réduction de la pauvreté, face à une diminution chronique des ressources. Ce sera en même temps stimuler l'industrialisation, la croissance économique et l'emploi, tout en réduisant l'écart grandissant de la pauvreté entre la ville et les zones rurales, sans répercussions négatives sur la politique de l'actuel du mécanisme d'établissement des prix du carburant. L'hypothèse de cet model est que si les prix du carburant sont plus bas pour les résidents ruraux et les producteurs agricoles, des aliments moins chers peuvent être produites tout en réduisant les coûts énergétiques. L'analyse basée sur cette technique donne une diminution raisonnable du prix des carburants (essence, diesel et kérosène) dans les zones rurales et une augmentation relativement insignifiante dans les zones urbaines correspondantes. Cette technique peut être appliquée pour déterminer les prix des autres produits de première nécessité comme le riz, le blé, la farine, le sucre et autres denrées alimentaires.

Mots clés : Bi-weight; Valeur harmonisée; Réduction de la pauvreté; Rrix du carburant; Croissance économique.

1. INTRODUCTION

Societal development is a nebulous concept and an intricate process. No matter the strategies that have been adopted by world leaders to improve the quality of life of their citizens through the structural and ideational development of their populations, poverty reduction, the target of development, par excellence, is a complex phenomenon. In "Why Poor People Remain Poor" the author postulates that "poverty exists because of the structural biases, ideological prejudices and social stigma of the rich, the powerful and the privileged, (Nji, 2004:12).

Yet, these biases, prejudices and chronic stigma can be removed if political leaders and development scientists work together to find science-based solutions for societal problems particularly the chronic problem of poverty in the industrialized and developing societies. As a scientific tool, the bi-weight estimate has the potential of providing science-based sustainable anchor to decision-makers in the distribution of fuel for agriculture and other sectors of Cameroon for three main reasons:

1. The Biweight estimate is a pro-poor research tool. Therefore, encouraging pro-poor research for decision-making inevitably benefits the poor;

2. Experience with poverty reduction strategies has shown that success with substantially reducing poverty depends on building an effective State. This involves "…both the capacity and willingness to mobilize resources, exercise political power, manage the economy, implement policy, and promote human welfare in an inclusive manner, including delivery of vital services such as justice and security, health care, education, water and sanitation", (McKechnie, 2009:4)

3. Not enough of the world's knowledge, particularly research is relevant for the needs of the poor, unless "…research emphasizes the need to improve the access of poor people to knowledge and technology", (DFID, 2007:1).

In this context, the bi-weight estimate is a science-based pro-poor research tool that can be used to harmonize fuel prices in a developing country like Cameroon which is experiencing the prevailing impacts of climate change and other structural constraints on energy scarcity (Nji, 2009). Approximately 80% of the Cameroonian population depend on agriculture for their livelihoods. Yet, both the backward and forward linkages in agriculture do not favour agricultural producers. For example, inputs are often unavailable and costly, and transportation, marketing channels, food prices tend to remain high partly because of distorted agricultural policies and an un-enabling environment (Nji, 2004).

1.1 Role of Transport in Agro-industry

Recent research on constraints to agricultural production in Cameroon has shown that bad road infrastructure and the resulting high transportation costs, police harassment and climatic factors are strong determinants in the high price of food and agricultural products on the Cameroon market (Simeu, 2008; Moukend, 2009). Yet, a good all-season network invariably encourages farmers to produce more because they are sure to transport their produce to the cities where consumer demand is generally highest. Unfortunately, most farm-to-market roads in Cameroon are impassable in the rainy season (from June to August) which is ironically the peak of the agricultural season characterized by harvesting and transportation. Meanwhile, Austin (1981) has amply shown that in the agro-industrial sector, transport is a key factor for success, profitability and sustainability. Figure 1 demonstrates that transport is required in all levels of the agricultural/food chain from production to consumption.

In Cameroon, high transportation costs are largely attributed to bad roads and high prices paid for the fuel used in vehicles (petrol and diesel). Aware of the difficulties of transportation, farmers are discouraged to expand their farms, thus stifling agricultural productivity and production. The high cost of travel whether by public or private transport greatly reduces mobility as individuals and groups are increasingly incapable of paying for mobility.

In addition, the risks of accidents are high as transporters cramp up goods and passengers in the same space in order to maximize their profit. For example, the per head transport fare in the open back of a "bush pick up" from Bamenda to Oshie (60km) is 3,500 FCFA in the dry season and from 4,000 FCFA to 5,000 FCFA in the rainy season; the cost of transporting a 50kg bag of cement on the same road is 1000 FCFA per bag. That brings up the cost of a bag of cement by 25%, thus making it more expensive and difficult for rural residents to invest in shelter and agriculture and also improve their quality of life (Nji, 1981).

Such a price-troubled scenario seriously negates investment in agriculture and rural investment, cripples the supply of inputs, and stifles demand for agricultural products in an era increasingly characterized by globalization and the inherent competition and exigencies for quality control (Nji,

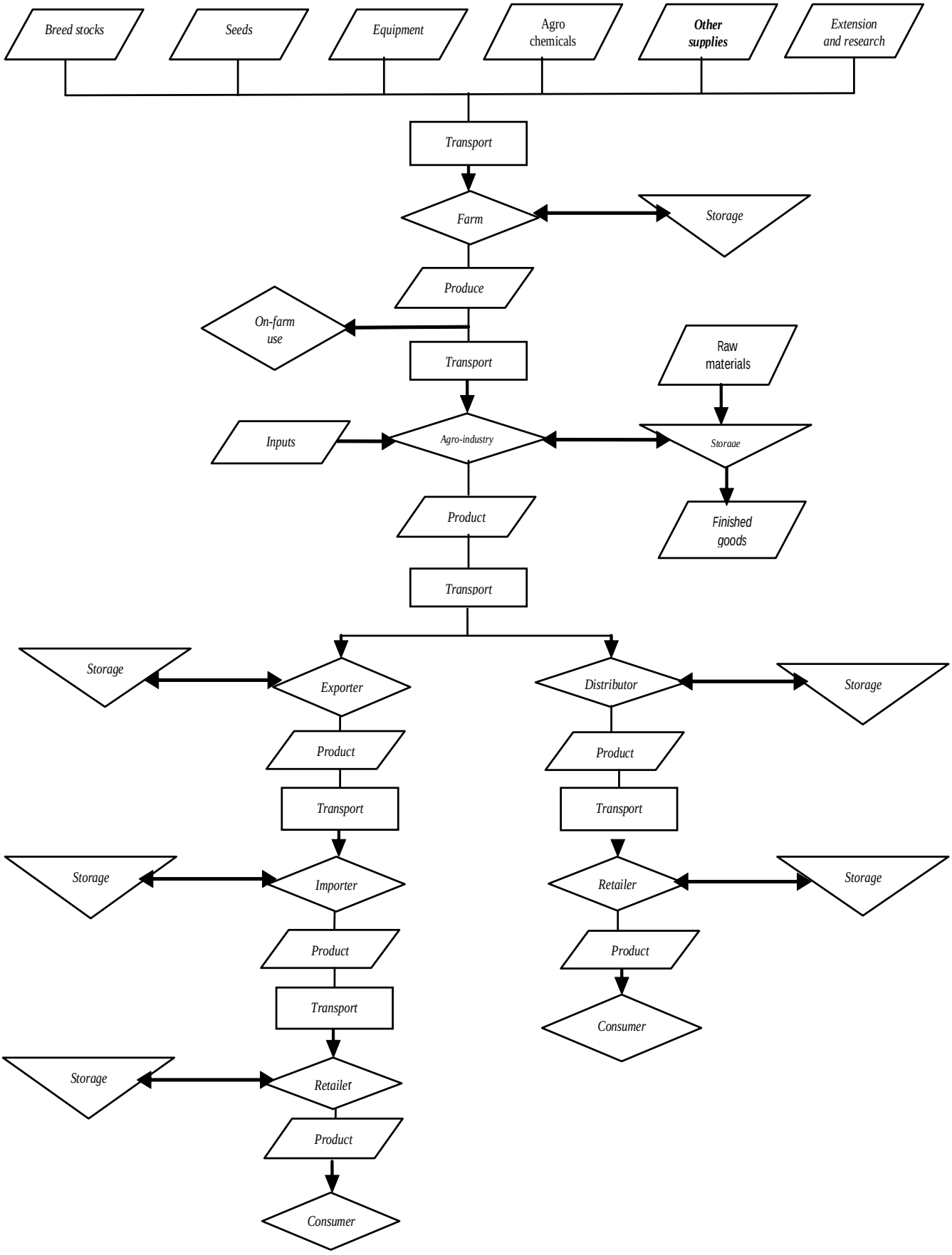

Figure 1: The role of transport in agro-industries. Adopted from Austin, 1981:16.

1995). Harmonizing fuel prices through the bi-weight estimate so that rural areas do not pay relatively higher transportation costs compared to their urban counterparts can greatly reduce the high financial burdens on the poor. Targeting the poor with the bi-weight estimate as an anti-poverty strategy will contribute to reverse low agricultural production which contributes to low farm incomes. Low incomes are considered to be at the root of poor nutrition in rural areas, poor health and lower capacity for agricultural productivity and effective participation in development (Dickson, 2009; Gamage, 2009; Dama, 2009). It is further argued that climate change and high energy costs account for the food crisis that swept across most developing countries in 2007 and 2008 (Nji, 2009).

1.2 Relationship Between Energy, Agricultural Production and Food Prices

An energy crisis tends to have differential impacts on the food production and consumption patterns in industrialized and developing countries. Clauson (2007) observed that "although food prices rose at an accelerated rate in 2007, Americans overall spent less than 10% of their disposable income on food…..because incomes rose at a faster rate than food prices". Meanwhile, lower income consumers spend a larger share (25%) of their available income on food than middle or higher income consumers who tend to spend less than 15%.

Austin (1981:30) has argued that "too often (agro-industrial) projects have failed because of a mismatch of production and marketing". And since the purpose of marketing is to define and meet consumer needs, socially responsible marketing must respond to needs existing within a cultural context such as taste, smell, colour, texture, product appearance and nutritional requirements. Transportation plays a great role in meeting these needs since smell, colour texture etc. depend on the packaging and rapidity with which the goods have been moved from the farm to the market and to the dining table.

In some industrialized countries, the design of agricultural machines and transportation equipment takes into account consumer preferences and the price factor. That is why fuel prices for agriculturists (for example in Canada and the USA) are lower than for other consumers. In fact large farms have their fuel pumps installed on the farm not only for convenience but also because it has been established that fuel constitutes 15% of farm operating expenses (Agriculture & Agri-Food Canada, 2008).

In the context of Cameroon, although it may not be acceptable from the point of view of farm economics that a consumer in Maroua should have to pay 5,000 FCFA (about $US10) for 20kg of a bunch of plantain which otherwise may cost 1,000 FCFA (US$2) in Nyasoso, it is understandable when retailers attribute the relatively high price of such a food item to the high transportation off-farm gate costs. Nyasoso is a village located in the South West Region with a favourable agro-ecological zone for plantain production where as Maroua is a semi-arid Sahelian region where millet and sorghum production tend to carry the day.

1.3 Coping Mechanism by Cameroon Farmers.

In the face of high transportation costs, some farmers in Cameroon, particularly peasant cultivators, have adopted a number of strategies to cope with the problem in order to continue feeding their families; and, where farmers are involved in commercial farming, to stay in business. Recent research on transportation and agricultural production shows that investment in the villages of the South Region of Cameroon is inversely affected by transport costs. While the propensity to save is reduced, farmers also tend to desist from further investment in agriculture, and businessmen and women in the Region fix "exorbitant prices for goods and services essentially as a result of the prevailing high transportation costs", (Piekap, 2010:63). In other instances, some farmers sell their crops in futures (i.e. when the crops particularly fruits are still on the tree), others sell their produce on the farm or market their crops in groups (Simeu, 2008: Moukend, 2009). Increasingly, the availability of cheap Chinese motorcycles on the Cameroon market has enabled some farmers to use motorcycles as a means of transport for goods and persons (Ngulebah, 2010).

1.4 Application of the Biweight Price Stabilization Tool.

This article proposes the use of Tukey's Biweight, a robust statistical procedure, which can be used to harmonize or stabilize fuel prices at fuel pumps across Cameroon. The inherent characteristic of this tool is its capacity to spread costs (in this case fuel prices at the pomp) as a means of reducing the relatively higher prices of fuel practiced in rural fuelling stations. Applying this strategy is an anti-poverty strategy that can effectively combat rural poverty through equitable redistribution of the national cake (petroleum fuel). Moreover, Tchakoa and Nji (1999:83) have argued that

"targeting rural poverty" through appropriate policies is critical for sustainable development if the African continent is to avoid the chronic "high opportunity cost: the happiness of a small minority ….achieved on the backs of the vast majority of the poor". Considering that Cameroon produces its own crude oil, such a strategy can contribute in no small way to create wealth through economic growth, income generation, employment creation and poverty alleviation in a sustainable way.

2.0 THE METHOD

Holding distance constant as a variable in fuel price determination, we find that fuel prices across Cameroon will vary very little if fixed in consonance with the Biweight formula. However, when distance is taken into consideration, the result is a vast disparity that prevails at gas or fuelling stations. The further away we move from the distribution centres, the higher the disparity. Cameroon's refinery is located in Limbe, South West region of Cameroon.

The main challenge here is to obtain unique prices for fuel products at gas stations across Cameroon despite differences in distances from the distribution centres of Limbe and Douala. The assumption is that, obtaining an estimated harmonized value for fuel prices is a statistical location problem which fortunately can easily be handled by the Tukey's Biweight procedure. Like all weighting procedures, the scheme is constructed in such a way that in the sample X1, X2, X3, . . ., Xn each data point Xi is assigned a weight, Wi.

The weights are calculated from the sample and depend on scaled deviations from an initial estimate, say $\hat{\theta}_{bw}$ with '*bw*' standing for Biweight. The general idea is that the scheme downweights the influence of extreme values. Thus, a sample point with a large deviation will have a relatively small weight and thus contribute very little influence in getting $\hat{\theta}_{bw}$ since each Wi furnishes a numerical measure of the influence that the corresponding Xi exerts in getting $\hat{\theta}_{bw}$.

2.1 The Biweight Estimate.

Constructed by Tukey as his contribution to the Princeton Robustness Study, (Andrews et al, 1972), the weighted estimator of the location parameter, say can be obtained as a solution to the equation

$$\hat{\theta}_{bw} = \frac{\sum_{i=1}^{n} Y_i W_i}{\sum_{i=1}^{n} W_i} \qquad (2.1.1)$$

$$W_i = \begin{cases} \left(1 - U_i^2\right)^2 & \text{if } |U_i| \leq 1 \\ 0 & otherwise \end{cases} \qquad (2.1.2)$$

$$U_i = \frac{Y_i - \hat{\theta}_{bw}}{cs} \qquad (2.1.3)$$

Where S is a robust estimate of variability and can be obtained as the median |yi - median(yi)|, that is the median of the absolute deviation (MAD), from the median, C is a tuning constant selected such that the efficiency of $\hat{\theta}_{bw}$ will be high if the underlying distribution is normal. Mosteller and Tukey (1977) have recommended that C values between 6 and 9 will be adequate for most practical situations. This is also shown in Onabid (1992). In this article the C value used is 6.

The product CS is called "measure of scale". The process is iterative since $\hat{\theta}_{bw}$ depends on the weights Wi which in turn is a function of $\hat{\theta}_{bw}$. A good candidate for the starting value of $\hat{\theta}_{bw}$ is the median of the sample set. This is chosen because the median has robust/resistant properties.

In a normally distributed population, the average value of S may roughly estimate 2/3 of the standard deviation, so that, with a C value of 6, we allow the residuals to count up to about 4x standard deviation (Okafor,1990), where S is the semi inter quartile range. That is:

S = ½(Q3 - Q1)

Where Q1 is the first quartile (lower quartile) and Q3 is the third quartile or upper quartile.

2.2 The Algorithm.

Consider the sample set X1, X2, X3, . . ., Xn for which we are to estimate the location parameter θ using the Biweight technique.

1) Suggest an initial value for θ, say $\hat{\theta}_{bw}^{(r=0)}$, most often the median of the sample is used. Here r is the iteration count and takes value of 0 at the initial estimate.

2) Calculate $U_i^{(r)}$ and then $W_i^{(r)}$ sing equations (2.1.3) and (2.1.2) respectively.

3) Increase r by 1 and then calculate a new estimate for θ as

$$\hat{\theta}_{bw}^{(r+1)} = \frac{\sum_1^n YiW_i^{(r)}}{\sum_1^n W_i^{(r)}}$$

4) Test for convergence using the convergence criterion

$$\left|\hat{\theta}_{bw}^{(r+1)} - \hat{\theta}_{bw}^{(r)}\right| < \varepsilon,$$

where $\varepsilon > 0$ is a suitably selected tolerance level. The process is repeated until step 4 is satisfied. The algorithm has been programmed in FORTRAN and R and can be obtained by request from the principal author of this paper.

3.0 EMPIRICAL APPLICATION OF THE ESTIMATOR

Cameroon produces crude oil which is transported by ship to its local refinery (SONARA) in Limbe, in the South West Region of Cameroon for refining into petrol, diesel and kerosene. From there the refined products are transported by land in trucks to other parts of the country for distribution and consumption. The assumption of our model is that the major determining factor of fuel price fixing in Cameroon is the distance between place of production and point of sale. The country is divided into ten administrative Regions and the Regions are further divided into Divisions and then Subdivisions. Therefore, the input of our model, which is the price of fuel (petrol, diesel and kerosene) at the point of sale, is the same for all legal dealers in fuel products.

To achieve the results presented in this paper, the sample data consists of official fuel prices at the pump as of 31st March 2011 from all ten Regional head quarters in Cameroon. Regional headquarters have been selected because of their similarities in economic, political and administrative status. The existence of other sources of fuel supply that are not regulated by government policies is acknowledged and this model does not take into consideration such sources. The data and the Biweight calculations are shown on Table-1.

4.0 RESULTS

The Biweight procedure is iterative; it was executed using a tuning constant C of 6 and the robust estimate of variability S calculated as the semi inter quartile range of the data set. The final Biweight estimates after 10 iterations are shown in the last row of Table-1. Although outliers (extreme values) are not found in

Table-1: Current fuel pumps prices in Cameroon and the adjusted Biweight prices.

Regional Head Quarters	Distance from the refinery (km)	*Fuel pump prices in FCFA as at 31st of March2011*			*Biweight weights (w) for the fuel prices*		
		Petrol	Diesel	Kerosene	Petrol	Diesel	Kerosene
Bafoussam	286	569	520	350	0.9549387	0.9549387	0.9549387
Bamenda	361	578	529	359	0.9345895	0.9345895	0.9345895
Bertoua	658	578	529	359	0.9345895	0.9345895	0.9345895
Buea	34	572	524	354	0.9968259	0.9968259	0.9968259
Douala	71	569	520	350	0.9549387	0.9549387	0.9549387
Ebolowa	410	588	539	369	0.4823020	0.4823020	0.4823020
Garoua	1256	569	520	350	0.9549387	0.9549387	0.9549387
Maroua	1489	593	544	374	0.2074511	0.2074511	0.2074511
Ngoundèré	960	569	520	350	0.9549387	0.9549387	0.9549387
Yaoundé	320	569	520	350	0.9549387	0.9549387	0.9549387
Adjusted per litre fuel prices for Cameroon based on Biweight estimate.					**573.076**	**524.2482**	**354.2482**

Source: Compiled and calculated from raw data collected by the authors (March, 2011)

the sample data set, the results show how the Biweight scheme down-weights extreme values. Values that are the same have the same weights and values which are far away from the estimate have smaller weights as their own contribution to the determination of the estimated value.

This analysis shows a substantial reduction in fuel prices in towns highly underprivileged by the current price structure while the increases noticed in the privileged towns is relatively very small. The underprivileged towns in this analysis are Bamenda, Buea, Bertoua, Ebolowa and Maroua while the privileged towns are Bafoussam, Douala, Garoua, Ngoundere and Yaounde. Garoua and Ngoundere particularly seem highly previledged in our view because inspite of their distance from the refinery, the fuel prices practised there are comparable to some of the nearest towns to the refinery.

An application of Biweight estimates shows that the price of petrol in Maroua will drop from 593 FCFA to 573 FCFA showing a reduction of 20FCFA per litre (3.5%) while the price for the same product in Douala, Yaounde, Bafoussam, Garoua and Ngoundere reveal only a slight increase from 569FCFA to 573 FCFA; that is an increase of only 4FCFA per litre (0.7%). This shows a net gain of 2.8% for consumers in lower fuel prices if the Biweight formula is used. The effect of this as one moves away from the headquarters into the hinterland areas can be overwhelming as these areas are those seriously affected by the current pricing scheme.

In real terms, our Biweight estimate will enable even a commercial motorcycle rider in rural as in urban Cameroon, as well as commercial "bush taxi" drivers to save enough money to buy a 200g loaf of bread after a six litre purchase of petrol. The positive impact on kerosene consumption will even be greater with several benefits to the economy as kerosene is the second major source of energy and light after firewood to the rural people in Cameroon.

We believe that, if the Biweight estimate is used, it will contribute significantly to reduce the feeling of relative deprivation (Sampson, 1971: 274) in Cameroon where some fuel consumers especially rural people, transporters and agricultural operators feel that they are relatively deprived from other Cameroonians in the distribution of the national cake -petrol. Homans (1950) informs us that distributive justice is one of the conditions necessary for maintaining group or society equilibrium. Further more it is not unlikely that lower prices of Cameroon fuels would in the long run dissuade consumers of smuggled fuels from neighbouring countries which is very rampant in several boarder regions of Cameroon.

The differences between the current prices of petrol for example and the proposed harmonized Biweight prices are shown on Table-2.

Table-2: Differences between current petrol prices and the proposed harmonized Biweight prices of petrol in Cameroon (per litre) as at 31st March 2011.

Regional Head Quarters	*Distance from the refinery (km)*	*Petrol price at pumps in FCFA*	*Estimated Biweight price (rounded) FCFA*	*Difference between the two prices in FCFA*
Bafoussam	286	569	573	-4
Bamenda	361	578	573	+5
Bertoua	658	578	573	+5
Buea	34	572	573	-1
Douala	71	569	573	-4
Ebolowa	410	588	573	+15
Garoua	1256	569	573	-4
Maroua	1489	593	573	+20
Ngoundèré	960	569	573	-4
Yaoundé	320	569	573	-4

A t-value of 0.862 obtained in comparing the means of both pricing schemes indicates no statistical significant difference at any level of significance. This means that by adopting the Biweight scheme, the resulting values will not be statistically different from the current pricing scheme. This is of course expected since the Biweight scheme is not an alternative pricing method but a means of harmonizing the current fuel prices. The advantage of this system is that, it will completely eliminate the idea of relative deprivation. A correlation of 0.39 was obtained between the distances of the Regional Headquarters from the oil refinery and the official fuel prices at the pump. This shows that other factors, than distance alone influence fuel price determination and fixing in Cameroon, if not then this should justify the need for harmonized prices across all ten Regional Headquarters.

5.0 DISCUSSIONS AND CONCLUSIONS

We have shown that the Biweight estimate can be used to harmonize fuel prices in Cameroon without negatively altering the "consumer economics" of current price fixing mechanisms such that prices at the pump in the rural areas and the agro-industrial sector can become more affordable to boost agriculture and rural development. This will encourage Cameroonians in towns further away from the refinery and those who live mainly on agriculture to consume more Cameroonian petrol in agriculture and job-creating initiatives as a poverty reduction strategy. This will also encourage employment and enhanced government policy on poverty reduction.

The idea of a uniform fuel price is not uncommon. This is what obtains in neighbouring Nigeria despite her vast territory. The advantage of such a policy is that nobody feels "cheated", "despised" or "ignored" in the distribution of the national cake. Moreover, the rampant and sometimes abusive increase of transport fares in the rural areas in Cameroon (Piekap, 2010) will be reduced or prevented as transporters may no longer attribute their behaviour to high fuel costs except in cases where the roads are extremely bad. Furthermore, this system of fuel price fixing will encourage consumption for internal tourism both in urban and rural areas. This can be achieved because the lower the price of fuel, the greater the willingness of tourists to drive long distances including spending nights in hotels. Moreover, since frequent hotel guests are invariably motorists, reduced fuel prices will leave more money in their pockets to spend on other activities. This obviously will increase turnover and profitability for the petroleum dealers and investors in the hospitality industry as well.

Lowering fuel prices and consequently transportation costs will benefits the poor more because of the high proportion of income that households spend on mobility. In Cameroon, rural areas tend to be inhabited by households that are poor in economic terms and depend mostly on agriculture. With rapid rural-urban migration (itself pushed by poverty), the proportion of poor people in urban slums is growing with its attendant problems of overcrowding and pressure on social amenities. The adoption of Biweight fuel prices in Cameroon should be seen as an effective, affordable and timely strategy that can encourage the growth of the primary sector especially agriculture which is the principal occupation of the inhabitants of rural areas. This will help in reducing poverty because "in China, growth in the output of the primary sector (mainly agriculture) was the chief driving force in poverty reduction," (Ravallion, 2010).

The evidence provided by the Biweight estimate suggests that if fuel prices remain high, all things being equal, Cameroon agriculture will remain caught in the snare of traditional low-input-low output farming. Therefore, the model presented is one way to release its predominantly traditional agricultural systems from chronic rudimentary, unprofitable and uncompetitive productive environments, into a mechanised and competitive based agricultural system.

Based on the scientific evidence the model provides, we hereby recommend the Biweight approach as a robust mechanism for stabilising prices for other commodities affected by price fluctuation due to distance and/or other factors that can be handled by the assumptions of the Biweight scheme. A correlation of 0.39 shows that other factors than distance bear on fuel prices. If that is the case, then the model rationally suggests that these other factors be removed or rationalized for the welfare of the population if poverty is to be reduced, the quality of life of the citizens improved, and sustainable development achieved.

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