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Equilibrium in Used Car Market with Rental Capital: Evidence from the Nigerian Market

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Abstract: *At the point of equilibrium in a used car market, buyers and sellers maximize their utility when the rate of depreciation on the car equalizes the prevailing rental cost of capital. In the main, buyers and sellers rarely agree on the valuation of the two factors. While buyers attached greater weight to depreciation, sellers were more interested in recouping the value of the residual cost of the car. The study solved a bilateral contracting model to explain the motivation behind seller-buyer equilibrium in a used car market. A sale is said to be in equilibrium when the buyer's price is at least equal to the monetary value of the utility the seller derives from the car. The finding is believed will aid a good understanding of the used car market and provide important insights for making competitive automobile policy.*

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I. Introduction

A study on the Nigerian used car market is of particular importance for two reasons. First, the interactions in the market involve the optimization decision of buyers and sellers from two different sides of the market. The seller is willing to sell because the utility derived from the continued ownership of the car is less than the rents realizable if the car were to be sold and the capital invested. On the other side, the buyer is buying because the value of the expected utility from buying the car is higher than the value of the rental profit he will earn if he chooses to invest his capital. The fact that trade continuously occurs in the market shows that the subsisting equilibrium in the markets may not have been adversely selected as suggested by the majority of the thinking in the literature (see Akerlof (1970), Wison (1977, 1979), **Berry, Levinsohn and Pakes (1995), Eisfeldt and Adriano (2007), and** Guerrieri, Shimer and Wright (2010)). If sellers of used cars do not find good prices for their offers, it is likely that sales will not be made and the used car market will not be thriving.

The existence of goods with differential satisfaction in many markets poses interesting and important problems for markets theory and equilibrium determination. A consumer may choose to expend a given monetary outlay on a consumption good or investment. For either of these choices, there are payoffs. The consumer could enjoy some satisfaction by purchasing an automobile or invest the money and earn returns. In each case, there may be indifference between the value of the utility derived from the possession of the automobile and the amount of yield realizable by renting the capital. This foregoing analysis may explain the reasons why there are always owners of used car who will want to sell and buyers who will want to buy at any point in time. The extent to which buyers are willing to pay the equivalent value of the vehicles determines the extent of the equilibrium refinement. Market statistics has been known to be useful in judging the quality of prospective purchases in many markets.

This paper relates a seller's reserved price for a used car against the market acceptance price. It attempts to evaluate the extent to which prices for used cars in the market approximate the market value by supposition that the funds used for the purchases were rented from the money market. The focus on the automobile market is because of its concreteness to the explanation of the problem that has been set out to be addressed by this note. The rest of the paper is organized as follows. Section II summarizes a model of equilibrium price determination. Section III contains some examples and applications of the model while section IV concludes the paper.

II. A Seller's Model of Equilibrium Refinement

Consider an individual, who wishes to sell a car, used for n number of years at price p_s. For the sake of comparability, the car is considered to be purchased with a rental capital at the price of r_k. The seller is indifferent selling the car as long as the selling price is equal to the residual value of the car. Each seller in the

market supplies 1 unit of car at every point in time and rents whatever capital it uses from the financial market. The seller's price takes the form

$$S(p) = K(1+ r)^n - \delta(K_n) \quad (1)$$

The consumption of the vehicle is the depreciation. The utility the seller derives depends on how much he eventually realize from the sale of the vehicle. If the seller had not used the car heavily (δ is low), he will want to be compensated by higher sale price. The seller's utility function takes the form of

$$U = \int_r^p e^{-r(t)} U(p(t)) \quad (2)$$

Here, depreciation (δ) is assumed to be a fixed yearly value and positive such that the seller is only willing to sell when the value of the utility derived from the car is at least equal to the rental cost of the capital expended on the purchase of the car. Following Rose (1993), at any point in time, the supply of cars may be thought of as the proportion of cars for which this is true:

$$S(p) = prob\ (q \geq \tfrac{\delta}{r}) = \int_r^p f(q)dq \quad \text{for} \quad p > r = \delta$$
$$0 \quad \text{otherwise} \quad (3)$$

where p represent the value of the utility derivable from the consumption of the car $(V(u(.))$. S(p) is the selling price of the car, K is the stock of capital the seller rented to buy the car and r is the rental price. The equality of the rental cost of capital and the rate of depreciation (r= δ) implies the indifference of the seller between the value of the utility derived from the possession of the automobile and the amount of yield realizable from renting the capital. $S($p) is assumed to account for all costs that has been expended on the vehicle by the seller except for some subjective factors. It denotes the value of the car to the seller at the point of sale. The seller arrives at the price by netting out the value of the utility derived over time on the car from the present value cost. The seller takes the path of δ and r as given such that the budget constraint specifies that the reserved price for the car cannot exceed the residual value. The residual value is the difference between the present value of the historical cost and depreciations on the vehicle.

$$\int_r^p e^{-r(t)}[K(1+ r)^n - \delta(K_n)] \leq \int_r^p f(q)dq \quad (4)$$

It is because of this constraint that sellers will only be willing to sell a car at the point when they maximize this difference. The seller's problem is to choose the price path, p(t) to maximize utility (2) subject to the budget constraint (4). Since the marginal utility of consumption is always positive, the seller satisfies its budget constraint with equality. We can therefore use the objective function, (2) and the budget constraint (4) to set up the Lagrangian:

$$L = B\int_r^p e^{-r(t)} U(p(t))dp + \lambda[\int_r^p f(q)dq + \delta(K)]dr - \int_r^p e^{-r(t)}[K(1+ r)^n dr] \quad (5)$$

The seller chooses the price level to sell the car at each point in time that maximizes δ and r over the years of usage. The first-order condition is

$$r\, e^{-r(t)}\, p'(t) = \lambda\, \delta'(K) \quad (6)$$

$$r\, e^{-r(t)}\, p'(t) = r\, e^{-r(t)} K'(1+r) \quad (7)$$

A seller is interested in the equilibrium between δ and r

$$\lambda\, \delta'(K) = r\, e^{-r(t)} K'(1+r)\, dr$$

$$\lambda = \frac{r\, e^{-r(t)} K'(1+r)\, dr}{\delta'(K)} \quad (8)$$

Given that δ is a fixed value of K. δ'(K) will therefore zero. The implication of this is that sellers will continuously want to sell their used cars provided that the market price compensates for the rental cost of capital. Since λ measures the marginal rate of substitution, the rate of depreciation does not from part of what constitute the determinant of the seller's choice to sell but the rental price of capital, r. For most car market, increases in prices are not usually as high as the incremental compound interest on the rental cost of capital used in the purchase of the car.

III. The Buyer's Model of Equilibrium Refinement

Buyers and sellers of used car always operate from two different sides of the market in the course of their transactional lock-in. From the perspective of the buyer, the first consideration is to think of a used car as half of the price for a new one[1] plus the net deviations in its value based on physical evaluation. In view of this, the buyer's price can be stated as

$$S(b) = ½(N_p) + \varepsilon_k, \qquad \varepsilon_k \gtreqless 0 \tag{9}$$

where N_p represent the price of a new car. ε represent the buyer's evaluation pertaining to the quality of the car. When the buyer's assessments imply the car to be of high value, ε_k will be positive. Otherwise, it is nil. In some instance, it is possible that as a result of heavy usage, the value of the car may have deviated far beyond the average quality such that ε_k will be negative. Because buyers are offered the opportunity to directly assess the vehicle, the likelihood of adverse selection is precluded. We can always think of the capital used for the purchase of the car as being rented such that equation (9) can be rewritten as

$$S(b) = ½ [K(1+ r_k)^n] + \varepsilon_k \tag{10}$$

For a car that is heavily used, one will expect that the depreciation will be high and εk will be negative. This will imply that the price that a used car will be bought depend on the degree of its usage (δ_i) and the effective market price of the new one, $K(1+ r)^n$.

$$\varepsilon_k = F(\delta_i) \tag{11}$$

By substituting (11) into (10), we derive (12)

$$S(b) = ½ [K(1+ r_k)^n + F(\delta_i)] \tag{12}$$

A buyer's price implies that he must have considered the net of the streams of depreciation and possible utility on the residual value of the car.

$$S(b) = \int_r^{\delta} e^{-r(t)} [½(K(1+ r_k)^n + F(\delta_i)] \tag{13}$$

From the perspective of the buyer, the key objective is to maximize the difference between his potential utility on the car (U_k) and the rental cost of capital. In effect, we can differentiate equation (13) with respect to r given the utility function

$$U = \int_{\delta}^{r} e^{-r(t)} U(p(t)) \tag{14}$$

The optimization implies that we solve the Lagrangian with respect to r and δ

$$Z = B\int_{\delta}^{r} e^{-r(t)} U(p(t))dp + \lambda[\int_r^{\delta} e^{-r(t)} [½(K(1+ r_k)^n + F(\delta_i)dr] \tag{15}$$

The first-order condition with respect to r and δ will be

$$r\, e^{-r(t)}\, p'(t) = ½\lambda\, [e^{-r(t)} K'(1+r) \tag{16}$$

$$r\, e^{-r(t)}\, f'(\delta) = 0 \tag{17}$$

$$\lambda = 2\frac{r\, e^{-r(t)}\, p'(t)}{K'(1+r)} \tag{18}$$

An intuitive explanation can be made for equation (17). Since we have assumed the rate of depreciation to be fixed, it is likely that buyers will be more interested with the number of years for which the vehicle has been used than the rate at which the vehicle depreciates. Since λ measures the marginal rate of substitution, the rate of depreciation here also does not form part of what constitute the determinant of the buyer's purchase choice but only the rental cost of capital, r. Looking at equation (13), one will observed that both the sellers and buyers price formations are determined by similar variables.

[1] As a brand new or a 'tokunbo'

IV. Examples and Applications

An intuitive application explanation from the model implies that depreciation will always be positive and increases with the years of usage of the vehicle. The central assumption of the model concerned the behavior of the depreciation factor, δ and the rental cost of capital for the purchase of any asset in the market, r. The two variables are of important interest in their own right when the vehicle being considered is used through many years. The easiest way to analyze this model is to consider a vehicle that is used for one year before reselling rather than considering the behavior of the two augments of the model, δ_i and r_i over many years. By this assumption, equation (7) becomes

$$\delta_i = ½[K(1+r)] \qquad (19)$$

By depreciating equation (8) with respect to the rental cost of capital, we obtain

$$\frac{\partial \delta i}{\partial r} = \frac{1}{2} < 1$$

since $0 < r < 1$, one will observe that the weight of depreciation is lesser than the rental cost of the capital used in the purchase of the vehicle. Depending on the severity of usage, the seller concern is to maximize the value of the utility derivable from the car . The utility that the seller derives from the sale of the vehicle is represented by the amount he chooses to rent the capital. When the seller believes he still obtain high satisfaction from a vehicle, he will hold on to selling it. But if he believes the satisfaction derivable has fallen such that the alternative returns he will receive from the capital realized from the sale of the vehicle is now greater than foregone utility. Usually, in the first years of the purchase of a vehicle, the owner will be enjoying high satisfaction such that he will be willing to part with it the interest receivable were the capital used in the purchase of the vehicle be invested. It is important to mention that at these years, the depreciation costs will be low. However, as the years passes by, the utility declines and approaches the rental cost of capital. Equilibrium is established at the point of this equalization. Second hand vehicle sellers always tend to sell off their vehicle depending on the individual valuation of how the personal utility derived from the use of the vehicle and weight of usage. For a bad and heavy user, he may be willing to part with a purchased new vehicle for half of the purchase price after 2 or 3 years and still remain in equilibrium. For a light user, the personal valuation may still be higher than the acceptable market price even after long years of usage. From the perspective of the seller, the residual price of how much to offer a car for sale depends essentially on the how much satisfaction that has been derived from the ownership of the vehicle and the amount the market is willing to accept the vehicle. This fact underlines the reason why private holders of vehicles that are useful for commercial purposes are always quick to sell their vehicle because they tend to get higher price offers than for vehicles which are not used for transport. When a vehicle owner knows that he can get good bidding at the used vehicle market, he is quicker to sell than when otherwise. Also, because fashion and models plays important role in used vehicle market, new vehicle owner will find it easier to sell his vehicle after a few years of usage to evade the eventual fall in the prices of vehicles which happens with the passage of time and model. The seminal paper by Akerlof (1970) attempted to illustrate a typical problem of economic disequilibrium arising from information asymmetry in market for used cars. In response, several works corroborated with the findings. A major implication from the studies suggests that buyers will only be willing to pay the price of lemons for all used cars. The intuition from this will be that in the absence of legislation or warranties, many used car markets would break down. Contrary to this expectation, the Nigeria used car market has continued to be growing despite the uncertainty problems. The reason for this is that the buyers and sellers in the market tend to find their equilibrium prices around a number of factors.

V. Conclusion

The attempt in this study is to provide a basis to explain seller and buyers equilibrium refinement in a used car market. Price formations were examined from the perspective of the buyers and sellers. While buyers attached greater weight to depreciation, sellers are more interested in the value of rental cost of capital invested on the car. This study solved a bilateral contracting model to explain the motivation behind seller-buyer equilibrium in a used car market. Sales is said to be in equilibrium when the buyer's price is at least equal to the monetary value of the utility the seller still derives from the car. The finding is believed will aid a good understanding of the used car market and provide important insights for making competitive automobile policy.

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