Variety, Price and Quality in the South African Automotive Industy [2000-2009]

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Abstract

This paper will investigate whether the predictions of the Krugman [1979] monopolistic competition model, the Melitz [2003] model and models of vertical product differentiation hold true for the developments in the South African automotive industry for the period 2000 to 2009. A new and highly disaggregated dataset of car prices and car sales is used, listing 2252 car varieties. It is found that while car varieties have increased on aggregate, trends in the growth of car varieties differ at a more disaggregated level. While evidence indicates that there has been a slight convergence in the distribution of car prices over the period, the variation in car prices remains large, even when controlling for common car characteristics. Indeed, it is found that quality heterogeneity is important in explaining the dispersion of car prices. Ultimately, the South African automotive industry is highly complex and has substantial heterogeneity hidden at disaggregated level. Thus, while the predictions of Krugman [1979] and Melitz [2003] explain the growth in varieties, the 'new' trade theory of vertical product differentiation is a critical lens through which to view the South African automotive industry.

Introduction

As the world becomes increasingly globalised and integrated, economies are exposed to greater competition due to increased exposure to trade. This is certainly true of South Africa, which underwent substantial liberalisation of many key industries, including the automotive industry. Since the inception of the MIDP in 1995, the automotive industry has experienced declining tariff levels, from 47% in 2000 to 28% in 2009. Table 1 below presents the findings of the National Automotive Association of South Africa's [NAAMSA] 2011 Annual Report. This table shows that, overall, vehicle exports and imports increased between 2003 and 2008, indicating that the period can be characterised as one of increased openness. In other words, the declining tariff levels resulting from the MIDP saw the automotive sector becoming more integrated in the world economy.

Moreover, the period 2003-2009 was also one in which domestic production of vehicles expanded, reflecting an often cited success of the MIDP. Barnes, Kaplinsky and Morris [2004] discuss the rapid growth of the sector, including an increase in the automotive sector's share of gross output value from 9.7 to 13%, between 1994 and 2002. Thus, the MIDP certainly enabled the development of a more open, more productive automotive sector. Black [2001] and Black and Mitchell [2003] provide an overview of the history of the MIDP, as well as a discussion of the economic impacts of the programme, while Flatters [2005] discusses the economic rationale for its implementation.

The South African automotive sector is an interesting, nuanced case, and has been the subject of many macro- and micro-level studies. This paper, however, is primarily an exercise in data exploration, using a novel and comprehensive dataset listing 2252 varieties of cars at a high level of disaggregation. This exercise attempts to provide an overview of key features of the incredibly complex and heterogenous South African automotive sector, while examining to what extent 'new' trade theories can be empirically substantiated, for the period 2000 to 2009. While it is certainly difficult, and perhaps unwise, to discuss this sector removed from the 'real world' context, it is important to note at the outset that this paper is

	2003	2004	2005	2006	2007	2008	2009
Exports	126661	110507	139912	179859	171237	284211	174947
Imports	421965	455702	525227	587719	534490	562965	373923
Domestic Production	87296	136327	232091	306455	312855	254633	196246

Table 1: South African Vehicle Production and Sales Data 2003-2009 [Naamsa, 2011]

not explicitly testing the effect of reforms, liberalisation or the Motor Industry Development Programme [MIDP].

The reasons for this are two-fold. First, it has proved difficult to obtain data on the effective rate of protection [ERP] at the relevant level of disaggregation, taking into account all forms of protection under the MIDP. Second, this industry is subject to a myriad of influences, both local and international, and has experienced significant changes over the period being studied. However, it has sometimes been difficult to link specific influences to specific changes. For example, Black and Mitchell [2003] claim that since imports increased dramatically since the inception of the MIDP, this is a clear indication that ERP has fallen in the sector. However, it is difficult to quantify exactly how much ERP fell, since the period also saw a decrease in sales prices due to import competition and declining costs, from reduced tariffs on components, duty-free allowances for components imports, and the removal of local content requirements [Black and Mitchell, 2003]. Thus, attributing increased imports to unquantifiable declines in ERP becomes difficult. This paper, admittedly, abstracts from reality. However, this is a necessary step to accomplish the primary aim of this paper; namely, to document developments in the South African industry between 2000 and 2009, with respect to changes in variety, price and quality.

Krugman [1979] and Melitz [2003] predict that when an economy liberalises, this process will be accompanied by increases in the number of product varieties available to consumers and decreases in product prices facing consumers. In other words, increased exposure to trade amounts to net consumer welfare gains. Models of vertical product differentiation, for example in Hummels and Klenow [2009], claim that there is far too much heterogeneity in the real world of international trade for this result to hold. Products are not only differentiated

horizontally into varieties, but varieties are vertically differentiated on the basis of both observable and unobservable characteristics. While increased exposure to trade will still increase the number of varieties available to consumers, vertical differentiation will prevent prices from converging to an average price. Even where competitive pressures increase, firms produce such heterogenous varieties of products that these competitive pressures are ineffective in facilitating a convergence in the distribution of prices.

It is found that the automotive industry has experienced a growth in varieties. However, heterogeneity in this growth is hidden at a more disaggregated level, with the number of varieties of low-end cars decreasing over the period as car companies diversify into higher-priced car varieties. While evidence is found supporting the growth in varieties, as predicted by Krugman [1979] and Melitz [2003], the distribution of car prices converges only slightly, with the dispersion of car prices remaining large.

First, the unconditional distribution of car prices relative to the average car price is presented. This relative price distribution has wide dispersion, with observations of car prices almost 638.9% above and below the average car price. Again, this aggregate view hides considerable heterogeneity, since dispersion in car prices remains large even when conditioning on car types.

Second, variation in car prices is explained when conditioning on differences in car types, car companies or brands, and car characteristics, using hedonic price regressions. Variations in observable differences between cars explain, on average, approximately 95% of the variation in car prices. However, the residual from the hedonic price regression also has a wide dispersion, ranging about 171.83% above and below zero. This unexplained variation could arise from the omission of important observable car characteristics in the hedonic price regressions, or from vertical product differentiation on the basis of unobservable car characteristics, for example, quality differentiation.

Therefore, the final test in this paper is a test for quality heterogeneity between car varieties. This test was performed by checking whether there is a positive relationship between

car prices and the quantity of sales. The price-quantity regression fits a quadratic function between price and quantity of sales, and controls for all observable car characteristics. The results obtained from this regression prove that although price is negatively correlated with quantity of sales, at some point the relationship becomes positive and significant. Quality differentiation is, therefore, an important phenomenon preventing the convergence in prices. Models of vertical product differentiation are better able to explain the empirical distribution of car prices over the period 2000 to 2009.

This paper will begin with a more detailed discussion of the 'new' trade theories in Krugman [1979], Melitz [2003] and models of vertical product differentiation, particularly in Hummels and Klenow [2009]. Section 2 will present a descriptive analysis of trends in total car sales and the growth of car varieties, as well as analysing the distribution of car prices. Section 3 investigates whether vertical product differentiation is better able to explain the distribution of car prices, using a hedonic price regression as in Lutz [2004] and a price-quantity regression. Finally, the paper will be concluded by summarizing the main results arising from this analysis.

Theory

Conventional international trade models predict that, where economies have identical tastes, endowments and technology, there will be no trade and no gains from trade. These models, however, are based on constant returns to scale. If this assumption is relaxed to allow for increasing returns to scales, as it is in Krugman [1979], the prediction changes substantially. Now, increasing returns is both a cause of trade and a source of gains from trade.

Krugman [1979] presents a supply-side approach to describe the autarky equilibrium in an economy with one factor of production, labour. He assumes that all firms face the same demand elasticity for their goods and the same costs of production. In this sense, all firms

are identical. Equilibrium is determined through the profit-maximising behaviour of each individual firm, and through the entry of new firms which drives prices equal to average costs to maintain the zero-profit condition. Importantly, the firms modelled in Krugman [1979] are characteristic of Chamberlinian monopolistic competition. Firms have internal economies of scale and costlessly produce differentiated products. Moreover, products enter symmetrically into consumer demand such that no incentive exists for any two firms to produce the same product. Since consumers have a 'love of variety', when economies open, trade in differentiated products occurs. Not only does the Krugman model predict trade between identical economies, but the model also predicts welfare gains from trade in the form of increased consumer choice and a pro-competitive effect that drives down prices.

Broda and Weinstein [2006] estimated exactly how much this growth in varieties matters to consumers. Expanding on Feenstra [1994], Broda and Weinstein [2006] develop an aggregate import price index. This measurement requires the estimation of a number of variables, including consumers' elasticity of substitution for a large number of goods at a highly disaggregated level. In support of Krugman [1979], Broda and Weinstein [2006] find that, between 1972 and 2001, there has been a three-fold increase in the number of varieties available to consumers. Using their aggregate price index, they also find that the decline in import prices between 1972 and 2001 was 1.2 percentage points faster than would be concluded when considering a conventional price index. Finally, the authors calculate the compensating variation for consumers to be indifferent between the bundle of varieties available in 1972 and the larger bundle of varieties available in 2001. They find that consumers are willing to pay 2.6% of their income to access this expanded set of varieties. Globalisation, therefore, presents gains in terms of declining prices but also allows consumers to satisfy their 'love of variety'.

Despite the evidence in support of the Krugman model, empirics suggest that, contrary to the model's assumption, firms are not identical. Firm heterogeneity is substantiated by the "...large and persistent productivity differences among establishments in the same

narrowly defined industries" [Melitz, 2003]. Furthermore, Melitz [2003] states that differences in productivity between firms have a strong correlation between the ability of these firms to survive in export markets. Melitz [2003] introduces randomly allocated firm productivity heterogeneity, but still derives a result consistent with the Krugman model; consumers benefit from increased varieties.

Melitz [2003] also adds iceberg costs and fixed costs to better reflect the constraints a firm encounters when deciding whether or not to export. Now, a firm's export status is determined by its ability to 'afford' to cover export market entry costs based on its randomly drawn productivity level. Melitz [2003] discusses increased exposure to trade, including an increased number of trading partners and decreased fixed or variable costs. Firms now compete in the same labour pool, increasing the demand for labour which drives the real wage up. Costs go up and less efficient firms are forced to exit.

With increased exposure to trade, the Melitz model partitions firms according to productivity levels. The world consists of a continuum of firms. The bottom-most firms are those whose productivity is too low to exist in the domestic market, and so exit the market. Next are those firms who only produce for the domestic market. These firms have productivity levels that are too low to 'afford' costs incurred before entering export markets. Finally, with higher productivity levels, there are those firms who produce for both export and domestic markets. The Melitz model has firm profit levels and market share increasing in productivity. In the group of firms able to survive in both domestic and export markets, only a portion see an increase in both market share and profits, while the rest experience an increase in market share only. More inefficient firms that produce only for the domestic industry incur market share and profit losses. Finally, the most inefficient firms incur market and profit losses that are large enough to force them to exit. This process of self-selection based on randomly allocated productivity levels and the reallocation of market shares necessarily drives up average productivity, contributing to a welfare gain under trade. Even with the exit of a large number of domestic firms, consumers still typically enjoy an increase in

the number of varieties available since the number of firms exiting the market is dominated by the entry of new foreign firms.

Melitz and Ottaviano [2008] examines the line between bilateral trade liberalisation and declining mark-ups to investigate another channel of welfare gains. While the self-selection mechanism produces similar results, in that only the most efficient firms export and the least efficient firms are forced out of the market, this mechanism now works through a different channel. Since the CES demand specification of the original Melitz model has been relaxed, firms' residual demand price elasticities are no longer exogenously fixed. Import competition, therefore, plays a role in the domestic product market by shifting up the residual demand price elasticities for each firm at any demand level. Increased competition forces the most inefficient firms to exit. A combination of the selection effect and increased competition causes a downward shift in the distribution of mark-ups across firms. This extension of the original Melitz model predicts welfare gains from increased exposure to trade in three ways; lower mark-ups [due to a combination of the selection effect and import competition], increased average productivity of firms and increased product variety.

Schott [2003a] highlights a weakness of both the Krugman model and the Melitz model. He analyses US import unit values and finds that differences in unit values follow systematic patterns. First, relatively more capital- and skill-abundant countries produce higher priced varieties. Second, a positive correlation exists between varieties' unit values and the capital intensity of production techniques used to produce them. These results prove that heterogeneity in the productivity of firms is an important factor omitted from the Krugman model. The results also contradict Melitz and Ottaviano [2008] where firms with higher levels of productivity are predicted to produce lower priced varieties.

Emerging empirical evidence suggests that the vertical differentiation of products is an increasingly important phenomenon in international trade. This explains why price distributions have not narrowed as predicted by the monopolistic competition trade models. For example, Schott [2003b] cites the example of men's cotton shirts from Japan being thirty

times more expensive than the same product originating from the Philippines. Schott [2003b] claims the observed differences in prices arises because countries are producing products of such different quality levels, that they are virtually different products.

Hummels and Klenow [2005] investigate whether large countries export more because they are operating at the extensive margin, the intensive margin, or if they are engaged in quality differentiation of products. They find substantial price evidence supporting quality differentiation of goods. Consumers face the problem of maximising utility subject to a budget constraint. Here, consumers still have a 'love for variety' as in the Krugman model, but consumers also have a preference for higher quality goods. The consumer problem is given by:

$$\max U_m = \left[\sum_{j=1}^{J} \sum_{i=1}^{I} Q_{jmi} N_{jmi} x_{jmi}^{1-\frac{1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}}$$

subject to

$$\sum_{j=1}^{J} \sum_{i=1}^{I} N_{jmi} p_{jmi} x_{jmi} \leq Y_m$$

where, Q_{jmi} is the quality of varieties exported from country j to country m of category i, N_{jmi} is the number of symmetric varieties, x_{jmi} is the quantity of each variety exported, p_{jmi} is the price of each of the units of the variety and Y_m is country m's income.

Hummels and Klenow [2005] use consumer first-order conditions to express quality and varieties in terms of observed prices and quantities, such that:

$$\ln Q_j + \frac{1}{\sigma} \ln N_j = \ln p_j + \frac{1}{\sigma} \ln N_j x_j$$

Quality is, therefore, shown to be a demand shifter, allowing countries to export higher quantities of goods at given prices. This explains a phenomenon observed in empirical literature but unexplained by Krugman [1979]; namely, that "[b]y exporting higher-quality goods, richer economies can export higher quantities without lowering the price of their varieties on

world markets" [Hummels and Klenow, 2005]. Moreover, where firms have different levels of productivity, varieties with different quality levels exist. Instead of a negative correlation between price and firm productivity, models of vertical product differentiation indicate that a positive correlation is expected. More productive firms use their productivity advantage to differentiate their varieties on the basis of quality, and are able to maintain higher prices without experiencing a decrease in quantities demanded.

The South African automotive industry presents an interesting case in which to analyse the predictions of theories discussed above. The industry is certainly characteristic of the monopolistic competition structure, with a large number of differentiated varieties of a comparable product [the dataset contains 2252 distinct car models] and 37 heterogeneous firms. Under the Motor Industry Development Programme [MIDP], the automotive industry has experienced a process of ongoing liberalisation for the period 2000 to 2009. From a tariff of 47% in 2000, tariffs on CBU [completely built up] passenger vehicles have declined to 28% in 2009. While the MIDP incentive schemes have been designed to assist the industry in coping with international competitive pressures, it is nonetheless true that the South African automotive market has experienced increased exposure to trade. Moreover, the MIDP has a stated goal of improving the affordability, quality and choice-set of cars available to the South African consumer [DTI, 1995]. Since it is these criteria that are emphasised as welfare gains in the theories discussed above, an analysis of the automotive industry provides a useful lens to determine to what extent theory can be supported by empirics while simultaneously evaluating the success of the MIDP with respect to its stated goal.

Table 2 below presents a comparison of the theories of Krugman [1979], Melitz [2003] and models of vertical product differentiation, as well as the testable hypotheses that will be considered in the following sections. While the primary aim of this paper is to explore a new, rich dataset in order to gain a top-down description of trends emerging in the automotive sector, the paper will also consider to what extent the predictions of the monopolistic competition model, the Melitz model and models of vertical product differentiation are relevant

Theoretical Framework	Price	Varieties
Krugman [1979]	Convergence	Increase
Melitz [2003]	Convergence	Increase
Vertical product differentiation	Divergence	Increase

Table 2: Predictions of trade theories

for the South African automotive industry.

Description of the South African Automotive Industry

This section begins with an overview of the dataset. Stylised facts regarding quantities of sales and quantities of varieties will be presented next. Evidence of the growth in the number of car varieties supports claims of both the Krugman model and the Melitz model. Next, the distribution of car prices within car types will be considered. Here, little evidence of a convergence in the distribution of prices is found. This suggests that some phenomenon is preventing prices from responding to increased competition in the manner predicted by the Krugman model and Melitz model. Section 3 will consider whether or not models of vertical differentiation of varieties better explain the dispersion of car prices.

Data

The data was obtained from Response Group Trendline [RGT] who, in association with the National Automotive Association of South Africa [NAAMSA], is the sole source and supplier of new vehicle sales and price data for the South African automotive industry. Data use is subject to a confidentiality agreement between RGT, NAAMSA and the author. The data contains monthly price data and quarterly sales data, which was calibrated into a workable format for use in this paper. Additional information was added to existing data to create a highly disaggregated dataset. The steps taken in constructing this dataset are presented below.

The dataset consists of quarterly price and sales data for 2252 car varieties at a highly

Type	Frequency of Observations	Number of Observations
Convertible	7.41%	6512
Coupe	6.53%	5733
Hatchback	23.54%	20670
Sedan	30.77%	27027
Station Wagon	7.02%	6162
Family SUV	12.74%	11192
Offroad SUV	7.02%	10530
Total	100%	87826

Table 3: Description of car type variable

disaggregated level from the first quarter of 2000 to the third quarter of 2009. The dataset consists of 37 car companies, 7 types of cars, and 263 car models. These levels of disaggregation will be described below. Price data is at a monthly frequency and so the three-month average is found to align the price data with the quarterly sales data. Car models are omitted where either price or sales data is missing. Nonetheless, the data set encompasses a comprehensive listing of car models available in the South African market.

For the analyses that follow, cars are assumed to be different products based on their shape. Car body shapes are divided into convertibles, coupes, hatchbacks, sedans, station wagons, family-type SUVs and off-road SUVs. These dividing lines are used in an attempt to compare similar cars with each other. For example, convertibles and off-road SUVs appeal to dissimilar segments of the consumer market. Moreover, even though all cars fulfill the same basic function, convertibles and off-road SUVs offer very different characteristics and benefits to the consumer.

The differentiation between convertible and coupe was largely based on the name provided by RGT at each data point. Differentiation between hatchbacks, sedans and station wagons was based on Figure 1 below and the images provided of the cars on each company's website. In Figure 1, the first car is a sedan, the second a station wagon and the last a hatchback. It is important to bear in mind, from this figure, that hatchbacks are not defined exclusively as having 3 doors as depicted. Instead, the dataset includes both 3 door and 5

door hatchbacks. Finally, the differentiation between family SUVs and off-road SUVs was based on information available on each company's website. Here, cars were listed as family SUVs or off-road SUVs based on the company's marketing of the product. All cars were coded as one of these seven car types. Table 3 above contains the frequency of observations for each car type.

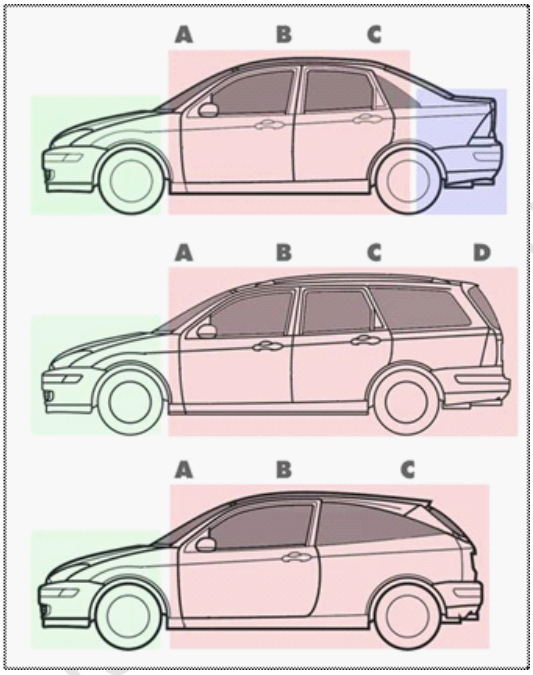

Figure 1: Sedan, station wagon and hatchback body shapes

Each car model is listed by RGT containing the car manufacturer's name or company's name, the car model name, its engine capacity, and certain characteristics. Car varieties are defined at a level below model name. The company name was isolated to create a variable containing car brands, and these were coded between 1 and 37. Table 4 below contains the frequency of observations, the number of observations, the number of car models and the number of varieties of car models for each company or brand.

Model characteristics were ascribed to each data point based on the name provided by RGT. Where no information was presented, characteristic information was listed as missing unless stated otherwise here. Table 5 below contains descriptions of the car characteristics

Company	Frequency of Observations	Number of Observations	Models	Varieties
Alfa	1.33%	1,170	8	30
Audi	10.57%	9,282	18	238
BMW	9.68%	8,501	8	218
Cadillac	0.40%	78	5	9
Chana	0.09%	273	1	2
Chery	0.53%	78	3	12
Chevrolet	1.95%	468	8	44
Chrysler	1.02%	1,716	6	23
Daewoo	1.15%	897	4	26
Dodge	0.58%	1,014	3	13
Fiat	1.42%	507	11	32
Ford	3.82%	1,248	8	86
Honda	0.36%	3,354	3	8
Hummer	0.18%	312	1	4
Jaguar	1.82%	156	12	41
Jeep	1.91%	1,599	6	43
Land Rover	1.91%	1,677	4	43
Lexus	0.84%	1,677	5	19
Mahindra	0.31%	741	2	7
Mazda	3.11%	273	11	70
Meiya	0.09%	2,730	1	2
Mercedes	7.90%	78	16	178
Mini	0.98%	6,942	2	22
Mitsubishi	1.51%	858	3	34
Nissan	5.15%	1,326	16	116
Peugeot	2.71%	4,524	10	61
Porsche	3.69%	2,378	6	83
Renault	5.24%	3,237	13	118
Saab	2.13%	4,602	2	48
Seat	0.67%	1,872	3	15
Smart	0.58%	585	3	13
Subaru	3.37%	507	5	76
Suzuki	0.44%	2,964	5	10
Tata	0.71%	390	4	16
Toyota	9.24%	624	19	208
Volvo	3.60%	8,112	11	81
Volkswagen	9.01%	3,159	17	203
Total	100%	87826	263	2252

Table 4: Description of company/brand name variable

Variable Name	Characteristic	Frequency of Observations
Number of doors	3 doors	6.53%
	5 doors	80.11%
	Missing	13.37%
Engine transmission	Manual	61.81%
	Automatic	27.53%
	Electronic	10.66%
Type of drive	4 wheel drive	12.78%
	All wheel drive	9.50%
	2 wheel drive	77.72%
Type of fuel	Diesel	17.85%
	Normal	82.15%
Engine capacity	0.8 to 1.9 litres	31.35%
	2.0 to 2.9 litres	39.30%
	3.0 to 3.9 litres	15.01%
	4.0 to 4.9 litres	6.17%
	5.0 litres and above	3.69%
	Missing	4.49%

Table 5: Description of car characteristics variables

variable and frequencies of observations. Model characteristics are:

1. Whether the car has 5 doors or 3 doors. For hatchbacks, sedans, station wagons, family SUVs and off-road SUVs [unless the model name contains contradictory information], cars are listed as 5 doors. However, coupes and convertibles are only listed as 3 doors where the information is contained in the model name.

2. Whether it is a manual, automatic or electronic transmission. Here electronic transmissions include all the variants found in the dataset; namely, Tiptronic, Volvo's Geartronic, Audi's S-tronic and R-tronic, Multitronic, Alfa's Selespeed and Q-tronic, Mercedes Touchshift and G-tronic and Subaru's Sportshift. Where a car is not explicitly listed as having either an automatic or electronic transmission, it is listed as having a manual transmission.

3. Whether it is a 4 wheel drive or an all wheel drive. These characteristics were ascribed to a car based on information listed in the name. No information was provided as to whether cars are front-wheel or rear-wheel drives, so all other cars are listed as 2 wheel

drives.

4. The car's engine capacity, measured in litres. Cars were place in broader categories; namely engine capacity between 0.8 litres and 1.9 litres, between 2.0 litres and 2.9 litres, between 3.0 litres and 3.9 litres, between 4.0 litres and 4.9 litres and 5 litres and above. Where engine capacity information is not provided, the observation is listed as missing.

5. Whether the car is listed as using diesel fuel or not. If the car model name does not contain information that the car uses diesel fuel, it is listed as using normal fuel.

To be clear, while both the BMW 1-Series and the VW Golf 5 are hatchbacks and are defined for the purposes of this paper to be the same product, they are produced by different companies. They are, therefore, defined as different brands of hatchbacks. The VW CitiGolf and the VW Golf 5 are different models of the same type of car [hatchback] with the same brand [VW]. The VW Golf 5 R32 3.2 5-dr and the Golf 5 2.0 Trendline 85kW 5-dr are different varieties of the same model [VW Golf 5] with the same brand [VW] and of the same type of car [hatchback]. Figure 2 below provides a schematic outline of the levels of disaggregation applied consistently to the data, and used in the analyses to follow.

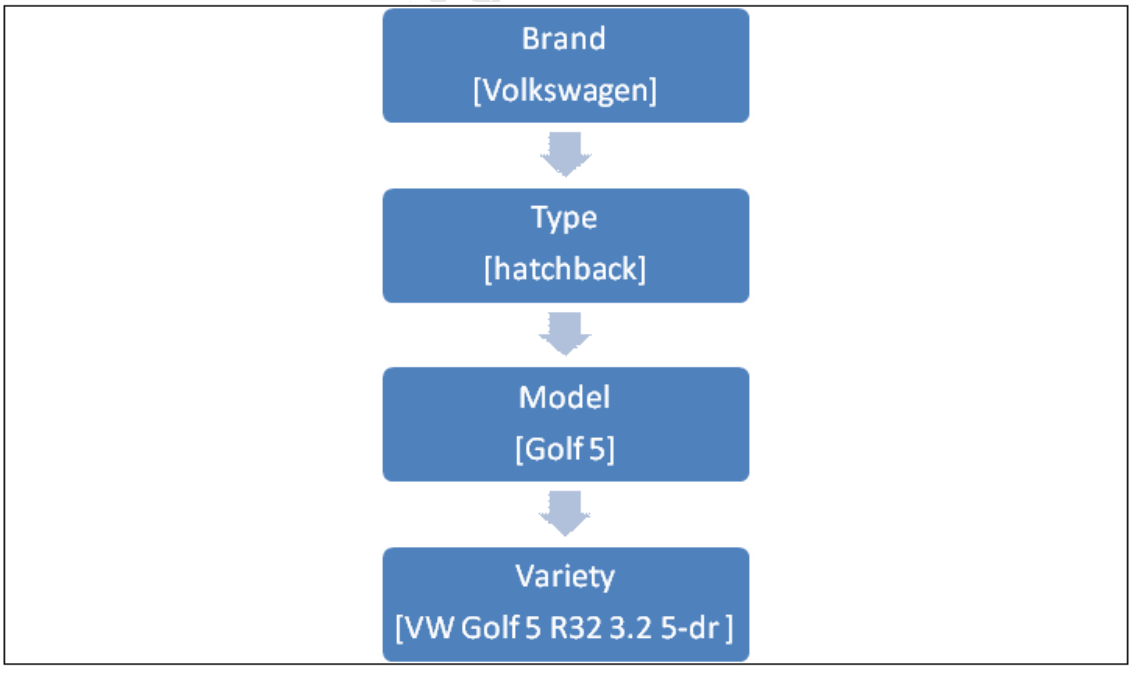

Figure 2: Schematic outline of levels of disaggregation

Sales and Variety Analysis

This subsection serves two purposes. First, a discussion of sales trends will be presented to obtain a broad overview of the South African automotive industry over time. Second, central to the aim of this paper, the discussion below will consider whether empirical evidence in the South African automotive industry supports the predictions of the trade theories discussed in the previous section. This section will, therefore, investigate whether the number of car model varieties has increased during the period 2000 to 2009 and how long car model varieties remain in the market.

Analysis of car sales and the number of car varieties was performed in order to address these two issues. In order to ensure that car sales and varieties were analysed according to consistent brackets over the entire period, cars were divided into price percentiles. The price percentiles were calculated using car prices deflated by the mean price within types of cars over the time period in order to obtain real prices. It was necessary to deflate prices to prevent an 'upward creep' in the price percentiles. Where the Bottom 20% included cars under R80 000 in 2000, this may have been inflated to a much larger Rand value by 2009. This would make a comparison of the car sales and the number of car varieties over the time period impossible. A robustness check was performed to ensure that the method of deflating prices does not affect the trends observed. This involved performing the same analysis based on actual prices, price deflated using the mean price, and price deflated using the median price. The trends present in all tables in this subsection are consistent regardless of which calculation of the price percentiles was used.

Table 6 below contains total car sales, in units, within price percentiles. Overall, the period 2000 to 2009 saw a decrease in total car sales when looking at the number of car units sold. From 2000 to 2006, the automotive industry experienced an increase in total sales of cars. However, there were slight decreases in total car sales in 2007 and 2008, with a substantial drop in 2009. The NAAMSA Annual Report [2011] shows a slight increase in total car sales [also in units of cars sold], from 354 632 units in 2000 to 395 222 units in

Percentile	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Bottom 20%	130.4	101.1	67.8	69.0	80.9	97.0	104.6	83.6	57.9	22.6
20%-40%	23.0	30.7	37.6	42.5	55.7	60.1	67.3	61.2	60.9	26.3
40%-60%	88.5	17.8	18.4	25.0	37.2	45.2	38.7	45.8	34.8	19.9
60%-80%	3.3	4.8	12.4	17.2	22.6	28.6	29.6	36.3	37.1	26.1
Top 20%	1.0	1.2	3.9	6.7	9.0	9.8	14.0	20.4	20.9	16.8
Total	246.2	155.7	140.1	160.5	205.3	240.7	254.1	247.3	211.5	111.6

Table 6: Total sales by price percentiles, in thousands of units

2009. The discrepancy in results obtained in this paper when compared to the NAAMSA report could be attributed to the car varieties within this dataset for which no sales data was available. It is possible that the dataset used by NAAMSA in calculating total car sales is more comprehensive, or that RGT have employed methodology for aggregating unit sales which is inconsistent with the methodology of this study. Next, mean car sales in units were calculated. Here, mean sales refers to the average number of units sold for each type of car, instead of aggregating across types of cars, as when calculating total car sales. Mean sales were declining until 2004, before increasing briefly until 2006 and decreasing considerably up to 2009. These trends are presented in Table 7 below. Overall, mean sales by car type more than halved between 2000 and 2009. This aggregate view of the automotive industry shows that, despite considerable support under the MIDP, the industry has experienced declining consumer demand in the latter half of the period investigated.

The aggregate analysis of total sales above disguises the key feature of the South African automotive industry; namely, considerable heterogeneity at more disaggregated levels. The decline in total car sales was largest in low-end cars, where total car sales in 2009 was less than a fifth of total car sales in 2000. However, while this trend is consistent with the aggregate, all other car price categories experienced increased sales between 2000 and 2009. This point will be revisited when analysing the trends in the number of varieties over the period.

As per the predictions of Krugman [1979] and Melitz [2003], the process of liberalisation of the automotive industry was accompanied by a three-fold increase in varieties. This is

Percentile	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Bottom 20%	183.0	140.6	129.7	194.3	242.1	290.3	268.1	175.2	109.1	63.7
20%-40%	54.8	65.9	88.0	97.4	117.8	140.8	120	108.4	105.5	68.6
40%-60%	41.5	57.8	59.7	56.9	74.8	81.3	71.3	69.3	50.6	43.7
60%-80%	46.5	36.6	44.1	42.0	44.3	50.8	49.9	40.4	45.2	41.4
Top 20%	12.6	9.4	16.9	22.9	23.8	21.4	27.8	29.1	21.2	17.8
Total	111.0	88.8	76.4	83.0	92.7	102.2	98.2	78.5	58.8	40.3

Table 7: Mean sales by price percentiles, units

shown in Table 8 below. However, this aggregate view hides interesting developments within the spectrum of car models. In 2000, there were 172 varieties of low-end cars. It is clear that there has been a movement away from producing in this price bracket. By 2009, car manufacturers were producing substantially more high-end cars, with the top 40 percentiles consisting of 530 varieties. Moreover, while the bottom percentile experienced a decline in the number of varieties between 2001 and 2005 and only picked up slightly from 2005 to 2009, there was an increase in varieties of higher priced cars across all other percentiles.

To some extent, these trends provide evidence that car manufacturers concentrated on intensive growth in the number of varieties as opposed to extensive growth in volumes of fewer varieties. While the number of varieties of low-end cars has fallen, total sales of low-end cars and mean sales of low-end cars remained the highest values in each year over the entire period. This indicates that, although there is evidence that car manufacturers have attempted to diversify out of this price bracket, the South African consumer has consistently demanded lower priced cars. The South African automotive industry is characteristically low-end. This is notwithstanding a substantial shift in consumer demand out of the lower end of the market. In 2000, 80% of consumer demand was concentrated in the bottom 40% price percentile. By 2009, however, approximately 43% of consumer demand for cars was remained within the bottom 40% price percentile.

Next, the duration for which a car is available in the market is considered. Table 9 and Table 10 below present information as to how many price observations are found by car type and car company, respectively. It is assumed that price observations are indicative

Percentiles	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Bottom 20%	172	185	127	88	82	82	98	113	135	114
20%-40%	103	115	104	110	115	111	139	139	143	126
40%-60%	53	74	97	109	128	140	132	169	171	149
60%-80%	14	32	70	104	127	137	147	174	196	210
Top 20%	21	32	63	74	94	116	130	185	240	320
Total	363	438	461	485	546	586	646	780	886	919

Table 8: Number of varieties by price percentiles

Type	Duration in market	Proportion of time in market	Years in market
Convertible	1694	26.01%	2.54
Coupe	1573	27.44%	2.68
Hatchback	5531	26.76%	2.57
Sedan	7398	27.37%	2.67
Station Wagon	1763	28.61%	2.79
Family SUV	2954	26.39%	2.57
Offroad SUV	2745	26.07%	2.54
Total	23658	26.94%	2.63

Table 9: Duration in market, by car type

of presence in the car market, listed as duration in market in Table 9 and 10. The price observations divided by all potential observations gives an indication of the proportion of the total period for which a car is available. The proportion of time in the market multiplied by 39 quarters is used to obtain the average duration of car variety 'lives'. This analysis is important when considering the aggregate growth in the number of varieties between 2000 and 2009. If car varieties remain in the market for short periods, the growth in varieties may only represent churning within the industry, where old varieties are replaced by newer varieties. However, if car varieties remain in the market for longer periods, this provides evidence in support of Krugman [1979] and Melitz [2003] since increased exposure to trade has enabled the consumer to access a wider set of car varieties.

At the aggregated level, there are 23 658 price observations out of all possible observations. This translates into cars being available in the market 26.94% of the time. Since the period analysed consists of 39 quarters, this amounts to 2.62 years. Individual car types

Company	Duration in market	Proportion of time in market	Years in market
Alfa	364	31.11%	3.03
Audi	2386	25.71%	2.51
BMW	2109	24.81%	2.42
Cadillac	77	21.94%	2.14
Chana	14	17.95%	1.75
Chery	59	12.61%	1.23
Chevrolet	584	34.03%	3.32
Chrysler	215	23.97%	2.34
Daewoo	209	20.61%	2.01
Dodge	116	22.88%	2.23
Fiat	279	22.36%	2.18
Ford	791	23.58%	2.30
Honda	67	21.47%	2.09
Hummer	42	26.92%	2.63
Jaguar	377	23.58%	2.30
Jeep	428	25.52%	2.49
Land Rover	568	33.87%	3.30
Lexus	180	24.29%	2.37
Mahindra	74	27.11%	2.64
Mazda	787	28.83%	2.81
Meiya	14	17.95%	1.75
Mercedes	1976	28.46%	2.78
Mini	214	24.94%	2.43
Mitsubishi	299	22.55%	2.20
Nissan	1098	24.27%	2.37
Peugeot	791	33.26%	3.24
Porsce	802	24.78%	2.42
Renault	1295	28.14%	2.74
Saab	552	29.49%	2.88
Seat	194	33.16%	3.23
Smart	141	27.81%	2.71
Subaru	826	27.87%	2.72
Suzuki	57	14.62%	1.43
Tata	244	39.10%	3.81
Toyota	1891	23.31%	2.27
Volvo	1087	34.41%	3.35
Volkswagen	2451	30.96%	3.02
Total	23658	26.94%	2.63

Table 10: Duration in market, by car company

do not differ much from this aggregate view, with station wagons remaining in the market longest [for 28.61% of the total time period or 2.79 years] and convertibles remaining in the market shortest [for 26.01% of the total time period or 2.54 years]. However, there is considerable heterogeneity present at a more disaggregated level, when the duration of a car's availability in the market is considered at the company or brand level. As is clear from Table 10, companies keep car models in the market from 1.23 years [Chery] to 3.81 years [Tata].

Figure 3 below is a histogram of the duration each car variety is present in the market. The mode here, of close to 200 cars, is just less than 10 quarters or 2.5 years. This is not much different from the mean duration for the entire dataset at 2.62 years. It should be noted, however, that observations of car varieties introduced in 2009 have been retained. The lower end of the histogram in Figure 3 may be exaggerated due to the introduction of new varieties. However, 296 car varieties are in the market for less than a year and 581 car varieties last in the market between one and two years. This is contrasted with 144 car varieties existing for 5 years and more, and 401 car varieties existing for 4 years and more. This leaves approximately 37% of car varieties in the middle of the distribution. Ultimately, car varieties remain in the market for a period long enough to conclude that the growth in the number of car varieties between 2000 and 2009 represents an increase in the choice set of car varieties available to consumers.

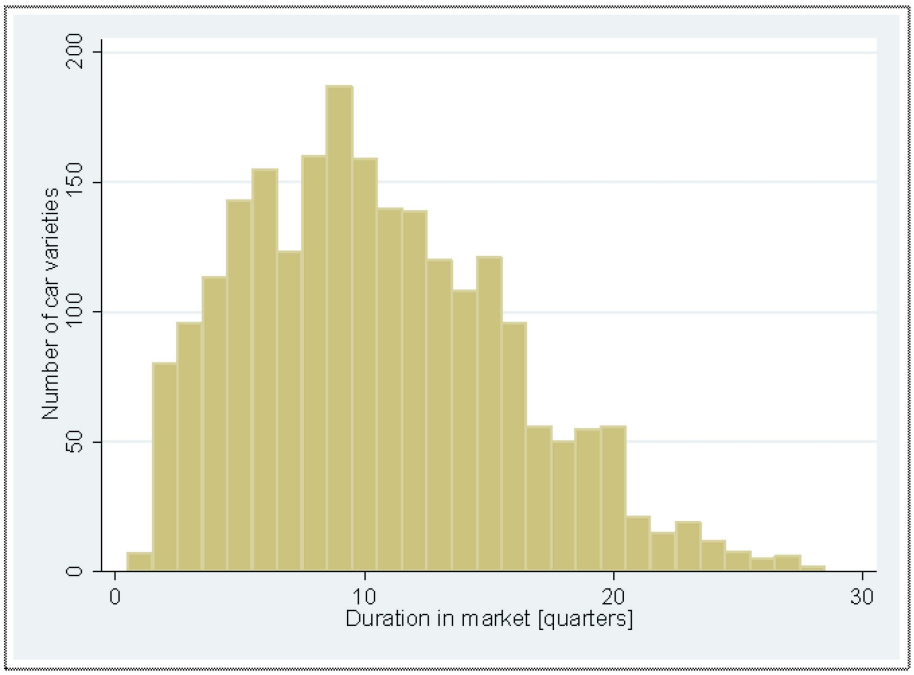

Figure 3: Histogram of duration in market, by car variety

Price Analysis

Evidence presented in the previous section lends credibility to the claims of Krugman [1979] and Melitz [2003] that increased exposure to trade will facilitate an expansion in the number of varieties available to consumers. The South African automotive industry has, indeed, experienced substantial growth in the set of car varieties present in the market. Analysis of the number of car varieties shows that overall, car varieties have increased, albeit with a reallocation of varieties within the price distribution. The analysis in the previous section also hints at the intricacy of the South African automotive industry. The aggregate view hides substantial heterogeneity. This section will consider whether increased exposure to trade and increased market integration has prompted car prices to converge, as predicted by Krugman [1979] and Melitz [2003].

Firms' pricing decision is informed by a number of factors. To begin, this section will consider how often firms change their prices. The frequency of price changes within the

South African automotive industry may be informed by the macroeconomic environment, liberalisation and the policy landscape, or microeconomic factors like market structure. Since the South African automotive industry consists of a large number of firms, simultaneous price changes may not be indicative of price collusion. Instead, firms may be responding individually to an external factor that affects all firms similarly.

The discussion below will investigate trends in the number of price changes at various levels of disaggregation. Even where a relationship exists between the sequencing of price changes and changes in the macroeconomic environment, it is still likely that liberalisation has partly informed price changes. As tariff barriers fell and the automotive industry was increasingly exposed to competitive pressures, Krugman [1979] and Melitz [2003] predict that prices should converge to a mean price. In other words, as the South African automotive industry becomes increasingly integrated into the global economy, it would be expected that the distribution of car prices will narrow over time.

Crucini et al [2005] study good-by-good deviations from the LOP between all European Union countries for the years 1975, 1980, 1985, and 1990. Lutz [2004] performs a similar analysis to test whether car prices have converged within the European Union. As stated by Lutz [2004] regarding the European automotive industry, the South African automotive industry presents a useful and relevant case for which to analyse LOP deviations. The product under consideration is tradable, the market considered is increasingly integrated into the global economy, and deviations from average price present substantial arbitrage opportunities. This section will use the method of Crucini et al [2005] and Lutz [2004] to consider whether prices have converged to the average price of a car within the South African market. This should be the case if competitive pressures from increased exposure to trade have resulted in firms decreasing mark-ups in order to maintain market share.

However, as previously discussed, the South African automotive industry is characterised by considerable diversity at disaggregated levels. At first glance, this could suggest that cars are vertically differentiated from each other. As in Schott [2003a], if this is the case, the

Type	Number of price changes	Frequency	Frequency in quarters
Convertible	516	30.46%	2.82
Coupe	467	29.69%	3.06
Hatchback	2408	43.54%	4.44
Sedan	2899	39.19%	4.08
Station Wagon	645	36.59%	4.09
Family SUV	1271	43.03%	4.65
Offroad SUV	1183	43.10%	4.49
Total	9389	39.69%	4.15

Table 11: Number and frequency of price changes, by type of car

difference between a Mazda sedan with five doors and a Lexus sedan with five doors may be so large as to make price comparisons between these two cars impossible. With this level of heterogeneity, it seems unlikely that cars with such different characteristics will converge to a common mean price. Nonetheless, this section will consider the distribution of prices relative to the average price, in order to investigate whether prices have converged or if models of vertical integration are a better lens with which to analyse this industry.

First, the number of price changes was recorded. The frequency of price changes, based on the previously calculated duration for which a car is available in the market, was estimated. These price changes are recorded in Table 11 above. At the highest aggregation, price changes occur every 4.15 quarters. Again, there is substantial differences in these statistics at a more disaggregated level, with prices of convertibles changing every 2.82 quarters and prices of family SUVs changing every 4.65 quarters. Price changes at the company level are presented in Table 12 below, which shows that car price changes range from every 0.49 quarters [Porsche] and 1 quarter [Chana], to every 7.488 quarters [Tata] and never [Meiya].

Company	Number of price changes	Frequency	Frequency in quarters
Alfa	127	34.89%	4.26
Audi	959	40.19%	4.07
BMW	964	45.71%	4.34
Cadillac	28	36.36%	2.80
Chana	2	14.29%	1.00
Chery	36	61.02%	2.94
Chevrolet	136	23.29%	3.81
Chrysler	82	38.14%	3.10
Daewoo	97	46.41%	3.29
Dodge	59	50.86%	4.65
Fiat	165	59.14%	4.80
Ford	318	40.20%	4.02
Honda	28	41.79%	2.97
Hummer	16	38.10%	4.02
Jaguar	99	26.26%	2.09
Jeep	197	46.03%	4.64
Land Rover	253	44.54%	5.05
Lexus	69	38.33%	4.29
Mahindra	18	24.32%	3.59
Mazda	346	43.96%	5.25
Meiya	0	0.00%	0.00
Mercedes	705	35.68%	3.97
Mini	98	45.79%	3.89
Mitsubishi	129	43.14%	4.54
Nissan	522	47.54%	4.46
Peugeot	252	31.86%	4.49
Porsche	51	6.36%	0.49
Renault	503	38.84%	4.54
Saab	228	41.30%	3.95
Seat	37	19.07%	2.36
Smart	17	12.06%	1.62
Subaru	247	29.90%	3.29
Suzuki	42	73.68%	4.23
Tata	119	48.77%	7.48
Toyota	809	42.78%	3.85
Volvo	414	38.09%	4.56
Volkwagen	1217	49.65%	5.57
Total	9389	39.69%	4.15

Table 12: Number and frequency of price by changes, by company

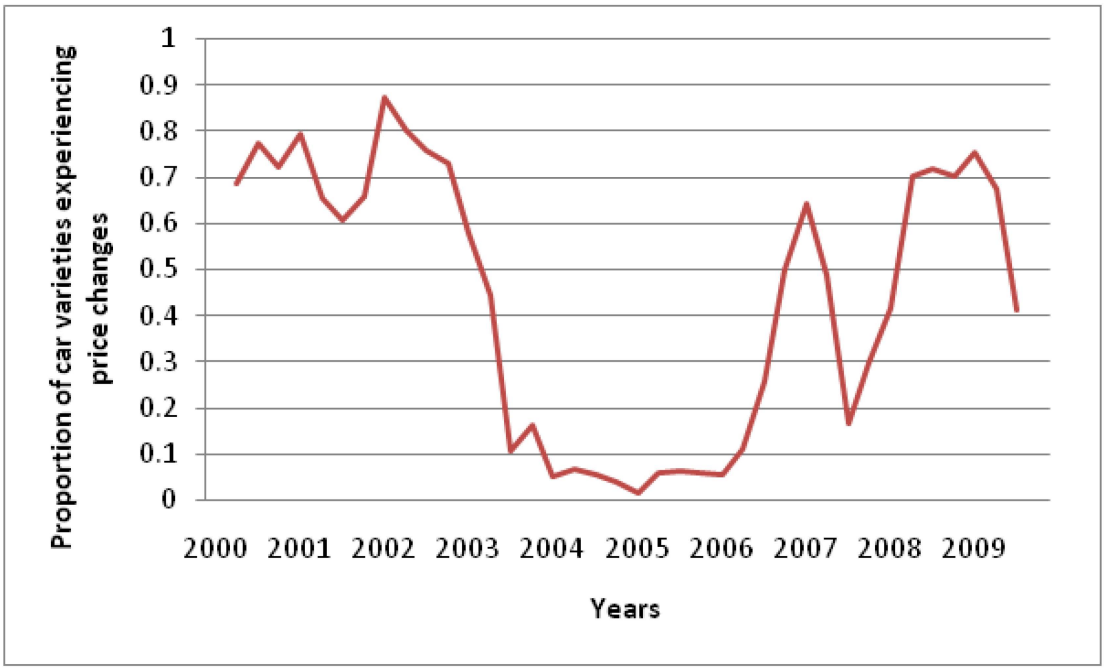

Figure 4: Proportion of car varieties experiencing price changes, by year

Figure 4 above is a line plot of the proportion of car varieties that experience price changes per year. It is clear from this diagram that the hypothesized synchronicity of price changes discussed above is true of the automotive industry. Figure 4 shows that between 2000 and 2002, a large proportion of car varieties experienced price changes. From 2003 to 2006, fewer cars experienced price changes. Then, the proportion of car varieties experiencing price changes increased to the end of the period, with a slight dip in the third quarter of 2007. In summary, while price changes are, at the aggregate level, infrequent, there is evidence of synchronisity in South African automotive firms' pricing decision. This synchronisity could be explained in numerous ways, for example as evidence of import parity pricing behaviour or, at the micro-level, of monopolistic competition pricing games. While this evidence is extremely interesting, it remains outside the scope of this paper; namely, a top-down exploration of trends in South African automotive sector data. However, this is certainly an avenue for future research.

Relative Price Distribution

It is clear from the discussion so far that the South African automotive industry is complex. Car varieties stay in the market for around two and a half years, but there is substantial heterogeneity at more disaggregated levels. Car prices change infrequently, around once every year. Again, however, at car type and car brand level the number of price changes varies considerably. There appears to be evidence of car pricing decisions being synchronised between car manufacturers. The increase in varieties is consistent with the predictions of the effect of increased exposure to trade in Krugman [1979] and Melitz [2003]. However, it remains to be seen whether the predictions of Krugman [1979] and Melitz [2003] concerning the effect of increased exposure to trade on prices of products holds for the South African automotive industry.

In a world of homogenous products, the Law of One Price [LOP] states that the same products should have a common price across competitive markets, free of all barriers to trade. This is not the case, however, where products are heterogenous, even within broad product classifications. The intent of the next subsection is primarily to study the dispersion of car prices, benchmarking against the average price of all cars and then, benchmarking against the average price within types of cars. Most empirical studies based on the LOP theory attempt to answer whether products have common prices across borders, relating domestic prices to foreign prices. This study, however, uses a modified approach intended to analyse the distribution of car prices to answer whether or not there has been convergence in car prices. While this intention may seem unrelated to the question of whether common prices prevail across borders, the study remains pertinent. In so far as there is a large variation in domestic prices it is difficult, if not impossible, to prove the LOP empirically, since the dispersion in prices results directly from the fact that the products in question are too heterogenous to be compared under the same criteria.

Following the method used by Crucini et al [2005], the price data is transformed into log deviations from the geometric average price. Price deviations relative to the geometric

average are given by:

$$q_{ij} = \log P_{ij} - \sum_{j=1}^{M} \frac{\log P_{ij}}{M}$$

These price deviations can be expressed as prices relative to the average price of a car within the South African market. The plot in Figure 5 is the distribution of relative prices for all car models for the years 2000, 2005, and 2009. It should be noted that, where the dataset shows evidence that only a few car varieties have been sold, these observations have been omitted from the analysis to ensure that these thinly traded varieties do not distort the price distribution.

This first feature of interest is that deviations from the average car price within South Africa can be large, with prices varying up to approximately 638.9% above and below the mean. If the LOP held for the automotive industry, the relative price distribution would be a spike at zero. However, for all years the relative price distribution is located roughly at zero, indicating that there are roughly as many overpriced cars as underpriced cars. Second, the relative price distribution has long, flat tails. This suggests that there are a small number of very cheap cars and of very expensive cars relative to the average price in the automotive industry. Finally, while the dispersion of relative prices stays fairly constant between 2000 and 2005, it widens slightly by 2009. This indicates that, at the aggregated level, the distribution of price is widening over time.

The dispersion of prices and widening of the price distribution over time suggests that one of two factors [or, indeed, both factors] may be at play. As the set of car varieties available to the South African consumer increased between 2000 and 2009, cars within this market have become more dissimilar. Where differences in car types, car brands and car characteristics are correlated with differences in car prices, this would mean that the dispersion of prices increases alongside the growth in varieties. On the other hand, as discussed in the models of vertical product differentiation, differences in the quality of cars could result in car prices failing to converge. Even where all observable car characteristics are accounted

for, an unobservable factor like quality differences could still prevent price decreases or price convergence as predicted in Krugman [1979] and Melitz [2003].

To give an indication of whether this line of reasoning is realistic, car type classifications were used in an attempt to compare more similar cars with each other. Figure 6 and Figure 7 present plots of the relative price distribution by type of car, for the years 2000 and 2009 respectively. These plots suggest substantial heterogeneity in the distribution of prices, even at a more disaggregated level. It is clear from Figure 6 and Figure 7 that the magnitude of deviations from average price may be considerably different to the average suggested by Figure 5. Likewise, the outliers present in Figure 5 may not be present when comparing similar cars with each other.

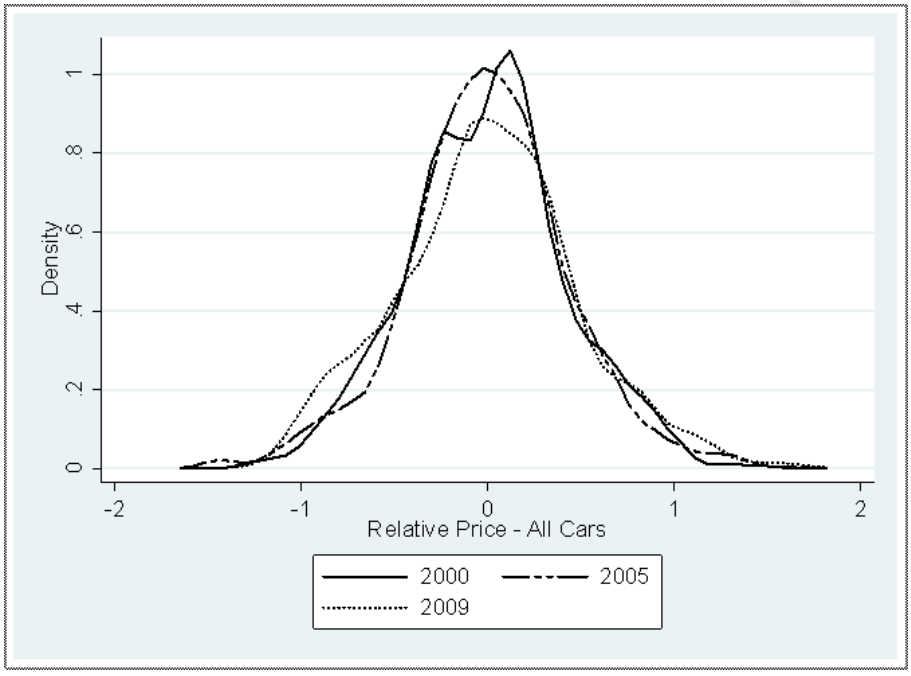

Figure 5: Relative price distribution – all cars [2000, 2005, and 2009]

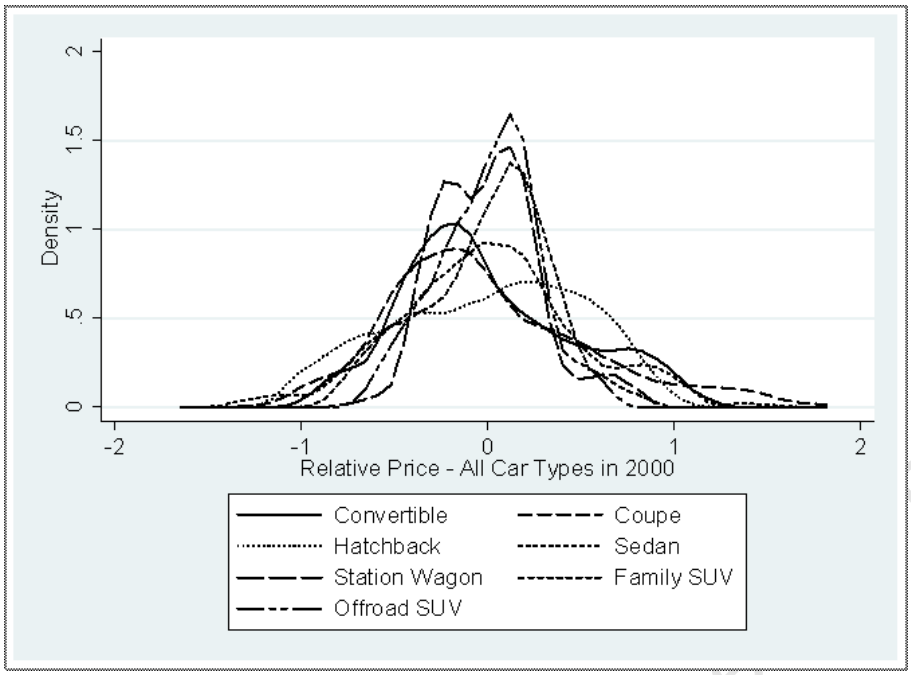

Figure 6: Relative price distribution – by type of car [2000]

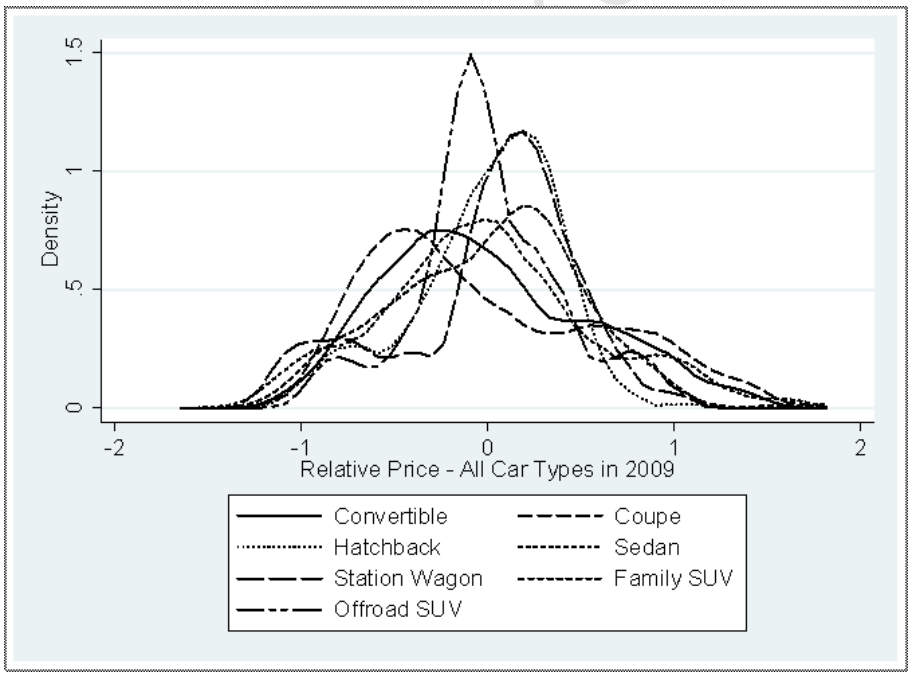

Figure 7: Relative price distribution – by type of car [2009]

Finally, although the distribution of price has widened over time on average, evidence on

Type	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
Convertible	0.518	0.480	0.496	0.565	0.550	0.592	0.566	0.605	0.579	0.544
Coupe	0.521	0.702	0.761	0.785	0.767	0.714	0.600	0.653	0.635	0.601
Hatchback	0.401	0.385	0.369	0.345	0.304	0.331	0.364	0.362	0.378	0.383
Sedan	0.477	0.466	0.480	0.443	0.476	0.485	0.499	0.524	0.536	0.580
Station Wagon	0.287	0.291	0.269	0.255	0.302	0.324	0.370	0.390	0.430	0.473
Family SUV	0.340	0.343	0.364	0.364	0.348	0.357	0.394	0.449	0.469	0.488
Offroad SUV	0.266	0.270	0.280	0.296	0.295	0.355	0.385	0.378	0.385	0.386
Total	0.420	0.425	0.445	0.439	0.437	0.439	0.445	0.464	0.477	0.487

Table 13: Standard deviation of relative price - all cars [2000-2009]

the standard deviation of relative price dispersions indicate that this is not true for all types of cars. Evidence from Table 13 and Figure 8 proves this point. The standard deviation of the relative price of coupes is higher than that of all car types and widens substantially at the beginning of the period before decreasing by 2009. On the other hand, the standard deviation of the relative price of hatchbacks fluctuates only slightly and decreases overall by the end of the period. It is true, however, that all other car types experienced an overall increase in the dispersion of relative price distribution, but trends within each series differs and decreases in the standard deviation are not of the same magnitude across car types.

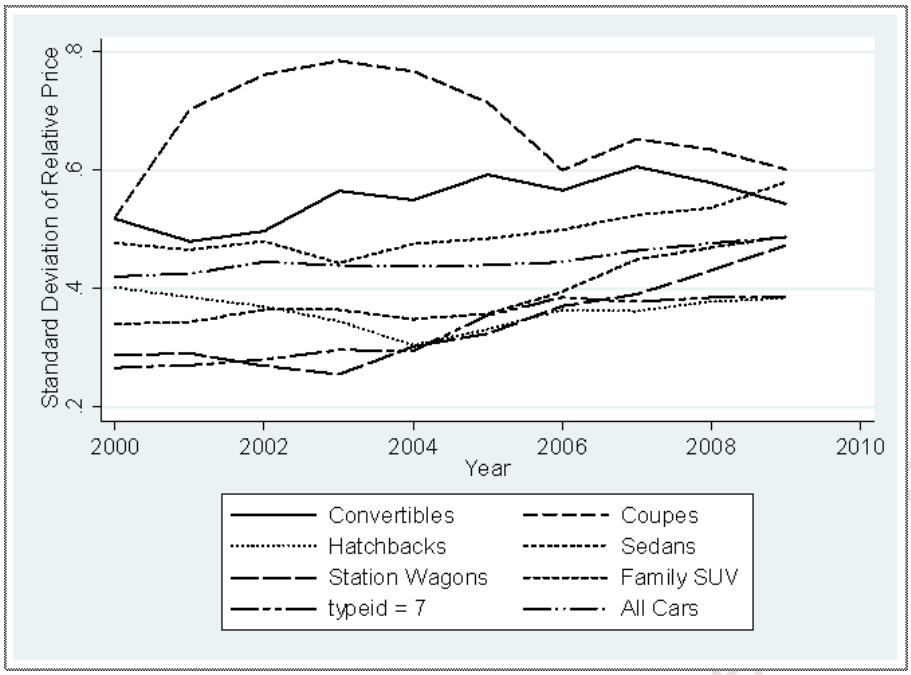

Figure 8: Standard deviation of relative price - all cars [2000-2009]

Figures 1 to 7 of Appendix A contain plots of the distribution of prices relative to the average price by type of car for the years 2000, 2005 and 2009. Even when prices are compared within very similar types of cars, the dispersion of prices in all cases is generally in the range of between 171.83% above and below the mean car price. This suggests that even within broadly defined car body characteristics, cars have inherent differences that translate into large price differences. The widest distribution of prices is that of the coupes, while the narrowest distribution of prices is that of off-road-type SUVs.

Surprisingly, the relative price distributions in the figures below are only centred at zero for a few cases. For example, the relative price distribution for hatchbacks is left-skewed in 2000, but the mode moves closer to zero in 2005 before becoming left-skewed again in 2009. This indicates that within hatchbacks there are more overpriced cars than underpriced cars, relative to the average price of a hatchback. This particular case is unexpected, since hatchbacks are commonly entry-level cars within the automotive industry. However, it should

be noted that the hatchbacks in this dataset vary widely in terms of all the car characteristics defined in Section 2. Similarly, the mode of the relative price distribution for convertibles is left of zero, indicating more underpriced convertibles than overpriced convertibles. Again, this is surprising, given that convertibles are generally top-end cars. The relative price distribution of coupes has modes left of zero for 2000 and 2005, but a bimodal distribution emerges in 2009. This indicates that two very different types of coupes get sold in the South African market. The relative price distribution of sedan remains quite close to zero between 2000 and 2009; however the relative price distributions of the station wagons, family SUVs and off-road SUVs shift around zero.

While this paper will not attempt to explain why the relative price distributions are not consistently located at zero, it is reasonable to consider that the entry of new firms and new varieties in the South African automotive industry has resulted in 'non-traditional' types of car models to be sold. For example, as Volkswagen and BMW develop new, high-end varieties of hatchbacks the relative price distribution can be expected to have a mode to the right of zero. Likewise, Peugeot and Renault may sell relatively cheaper versions of the convertible when compared with Porsche convertibles. Ultimately, the relative price distributions disaggregated by type of car still mask heterogeneity that exists at the company-level of disaggregation.

This section has shown that car varieties have increased as the South African automotive industry liberalises and becomes increasingly integrated into the global economy. Analysis of the price distribution shows that during this period of liberalisation, while there was some convergence in prices, the dispersion of car prices remains large. A possible explanation is that products have become increasingly vertically differentiated as the number of car varieties available in the market grows, for example with the entry of marginal brands at both the top- and bottom-end of the price distribution. This vertical differentiation could be on the basis of observable or unobservable characteristics. The following section will investigate whether the vertical differentiation of car varieties is important in explaining observed car

prices.

Vertical Differentiation in the Automotive Industry

The previous section presented stylised facts about the South African automotive industry. The discussion began with an analysis of trends in the growth of car varieties and the growth of car sales. It was found that there has been an aggregate increase in the growth of varieties, although this aggregate view masks the decrease in the number of bottom-end car varieties. Total car sales had decreased by the end of the period, although this had been increasing up to 2007. Analysis of mean car sales shows a substantial decrease, indicating that the growth in varieties offset increases in total car sales. Again, the aggregate view hides the fact that consumer demand of bottom-end cars shifted into higher price brackets. However, the South African automotive industry largely serves consumer demand for low-end cars despite car manufacturers diversifying into car varieties in higher price brackets.

This analysis supports claims made by Krugman [1979] and Melitz [2003] that increased exposure to trade will result in an increase in the number of varieties of products available. However, evidence found when examining the distribution of car prices does not support a convergence in prices to the average car price. On aggregate, car prices can differ by 638.7% in either direction. Even where similar types of cars are compared, deviations from average price are still large. There is no evidence that the distribution of car prices has narrowed over time. In fact, for all car types except hatchbacks, the standard deviation relative prices has increased between 2000 and 2009.

Plots of the distribution of car prices indicate that cars are too dissimilar to make price comparisons at an aggregated level meaningful. Cars within the South African automotive industry are vertically differentiated. This section will condition price on the basis of observable car characteristics in an attempt to explain the dispersion in the distribution of prices. A possible deduction from this analysis is where differences in car type, car brands and

car characteristics are correlated to car price differences, price convergence as predicted by Krugman [1979] and Melitz [2003] will not occur. Finally, this section will consider whether quality differentiation is an important determinant of the price of cars, as predicted in Hummels and Klenow [2005]. If this is the case, it can be concluded that quality differentiation is important in explaining the dispersion of prices despite the increased integration of the South African automotive industry into the global economy, and contrary to Krugman [1979] and Melitz [2003].

Hedonic Price Regression

The analysis in Section 2 indicates that even where similar types of cars are grouped together, substantial price differences remain. These price differences arise as a result of observable characteristics between dissimilar cars within the same type, as well as unobservable characteristics between similar cars within the same type. In order to control for price differences arising from observable characteristics, a hedonic price function was estimated. Hedonic price functions model differences in the prices of differentiated products as a function of their characteristics [Lutz, 2004]. Coefficients obtained through the estimation of a hedonic price function can be thought of as 'implicit prices' of each characteristic. Following the method in Lutz [2004], the following model was estimated:

$$\ln P_{imjk,t} = X_{imjk,t}z + \sum_{m=1}^{7} a_m + \sum_{j=1}^{37} b_j + \sum_{k=1}^{263} c_k + \sum_{t=2000}^{2009} x_t$$

where $lnP_{imjk,t}$ is the natural log of the retail car price, $X_{imjk,t}$ is a row vector consisting of observable characteristics of car i model k of the type j of company m, z is a column vector of implicit prices of these characteristics and $\varepsilon_{imjk,t}$ is the residual. Table 1 in Section 2 contains a description of these observable characteristics.

The independent variables a_m, b_j, c_k and x_t are included to capture company, car type, model type and year specific effects respectively. These specific effects were added to test

the conjecture that some observable characteristics that are constant across car varieties are important in explaining car prices. It is expected that some companies will have a higher price premium attached to their car varieties due to consumer preferences relating to brands, reputation, perceived service standards, and so forth. The car type specific effect controls for similarities between cars associated with their body shape, for example the size of car and the consumer market at which the car type is targeted. The year specific effect is useful to control for the price escalation associated with inflation and macroeconomic conditions that have an effect common to all car varieties.

Table 14 presents coefficients obtained when estimating the hedonic price function above, using ordinary least squares and controlling for car type and company specific effects. Robust standard errors are reported in parenthesis below each coefficient. Estimation of the hedonic price function was constrained to the years 2000, 2005 and 2009 in order to determine whether the model fit was changing over time. The majority of the coefficients are significant and positive as expected. This suggests that car varieties, for which any of the characteristics included in the regression is true, are associated with a higher car price on average relative to the base car company and car type, Volkswagen convertible. The base car company was chosen to allow for the analysis later on, in which the 'implicit prices' associated with car brands is compared. The base car type was chosen since convertibles are, on average, the most expensive of car types. This allows for a simple check of the coefficients on the indicator variables associated with all other car types, since these should be negative. Indeed, this proved to be true, although the coefficients on indicator variables are not reported here.

In 2000 and 2005, car prices are expected to be higher for electronic transmission cars than manual or automatic transmission cars. In 2009, however, one would find that automatic transmission cars have higher prices, on average. Similarly, on average, cars with all wheel drives have higher prices than cars with 4 wheel or 2 wheel drives. Cars that use diesel fuel also have a price premium. Higher car prices are associated with those cars that have larger engine capacities. Cars with an engine capacity of less than 2 litres are the base

Independent variables	Coefficients [2000]	Coefficients [2005]	Coefficients [2009]
Automatic transmission	0.102***	0.085***	0.073***
	[0.013]	[0.012]	[0.014]
Electronic transmission	0.132***	0.112***	0.056**
	[0.027]	[0.013]	[0.024]
4 wheel drive	0.045	-0.095***	0.032
	[0.030]	[0.026]	[0.031]
All wheel drive	0.246***	0.169***	0.176***
	[0.028]	[0.019]	[0.033]
Uses diesel fuel	0.150***	0.098***	0.125***
	[0.030]	[0.012]	[0.012]
2.0 to 2.9 litre engine	0.304***	0.224***	0.275***
	[0.018]	[0.011]	[0.014]
3.0 to 3.9 litre engine	0.533***	0.436***	0.499***
	[0.027]	[0.016]	[0.021]
4.0 to 4.9 litre engine	0.768***	0.754***	0.804***
	[0.030]	[0.022]	[0.038]
5.0 litre engine and above	1.346***	0.988***	1.134***
	[0.045]	[0.032]	[0.033]
R-squared	0.8811	0.8711	0.8706
Std. error of regression	0.20549	0.19196	0.21874
Number of observations	1408	2236	1802

Table 14: Hedonic price regression with car type specific effects [base car type is convertible] and company specific effects [base company is Volkswagen]

case, and cars with 5 litre engine capacity and above command the highest price premium. The coefficients on engine capacity variables consistently have the largest coefficients. These coefficients may be indicative of the escalated prices of performance and luxury cars in the South African automotive industry.

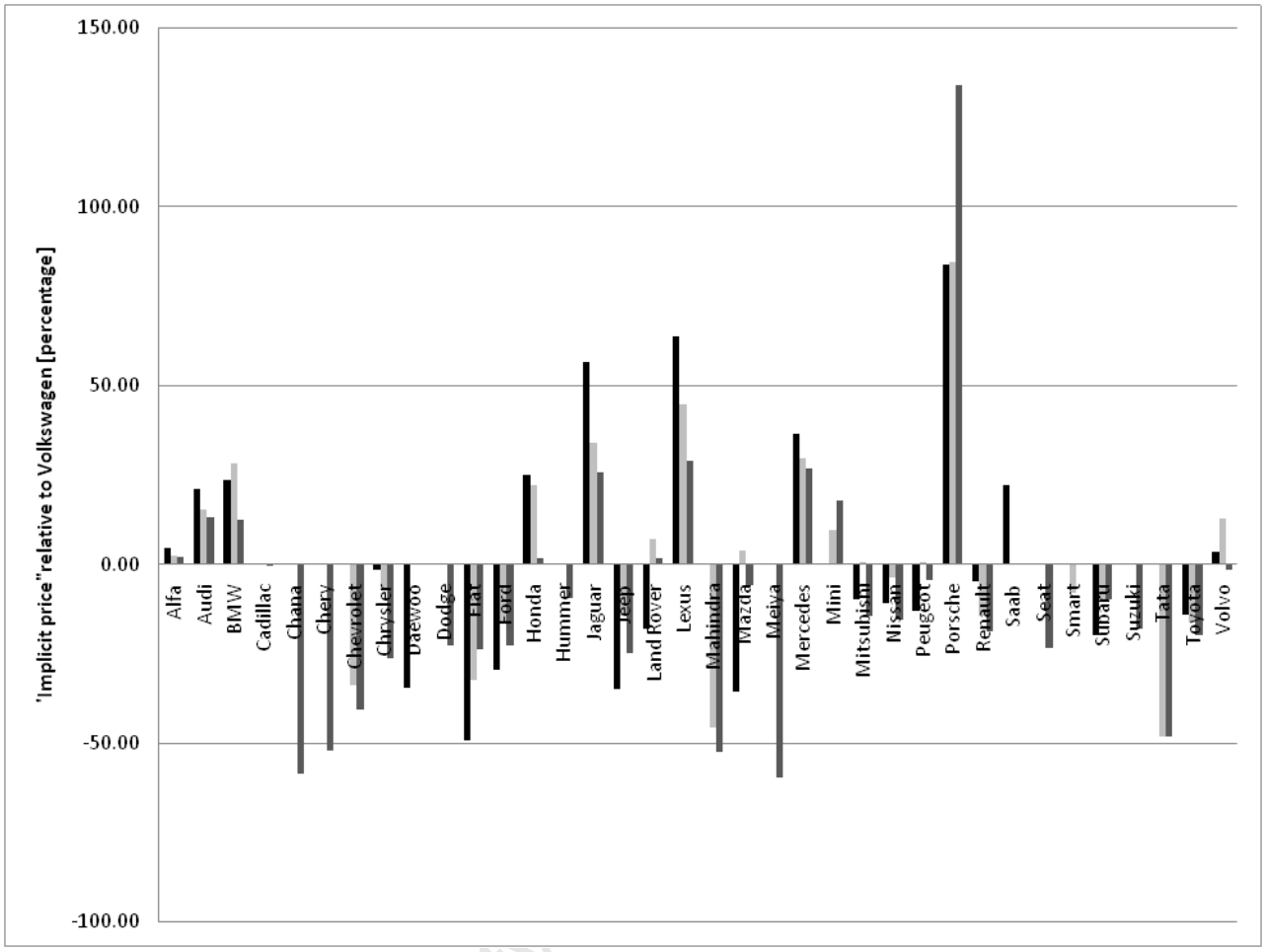

Figure 9: 'Implicit prices' by car company [2000-2009] relative to Volkswagen

Since the hedonic price regression enables the measurement of 'implicit prices' associated with car characteristics, the coefficients on the car company indicator variables provides an estimate of the price premium commanded by each car company. These 'price premiums' are plotted in Figure 9, for the years 2000, 2005 and 2009. It should be noted that the base company is Volkswagen. The Y axis measures percentage differences between the average price of each car company's products and the average price of Volkswagen's products, once differences in car types and car characteristics have been controlled for.

Figure 9 above shows that 9 car companies [Alfa, Audi, BMW, Honda, Jaguar, Lexus, Mercedes, Mini, Porsche and Saab] are consistently priced higher than Volkswagen cars, on average. It is interesting to note that, for the majority of car companies, their associated

'implicit price' difference relative to Volkswagen decreases between 2000 and 2009. This could be indicative of the effect the entry of new firms and new varieties has had in increasing competition, and decreasing the price mark-up companies are able to charge on the basis of their brand. Ultimately, the most important observation from this diagram is that differences in car brands are important observable characteristics in determining car price differences. This indicates that contrary to the assumptions of the Krugman model [1979], the South African automotive industry is populated by diverse firms, and that this diversity is correlated to car price differences.

Plots of the relative prices and the residual from the regression Table 14 for 2000, 2005 and 2009 are presented in Figure 10. These plots indicate that even when one controls for car type, company and observable characteristics, there is still considerable and unexplained price heterogeneity at the car variety level. The dispersion of the residual suggests that prices differ greatly between cars with the same characteristics. From the residual plots, on average, the unexplained variation in prices is in the range of 171.83% above and below zero. It is true that observed prices within car types and car companies show great dispersion. For example, the mean price of BMW sedans is R413 055. However, the minimum price of a BMW sedan is R127 300 for a BMW 316i and the maximum price of a BMW sedan is R1 200 000 for a BMW 750i. The standard deviation of BMW sedan prices is 194290.3. A cursory glance shows that the heterogeneity within car companies and car types holds true for many observations, as companies try to serve as broad a spectrum of the car market as possible.

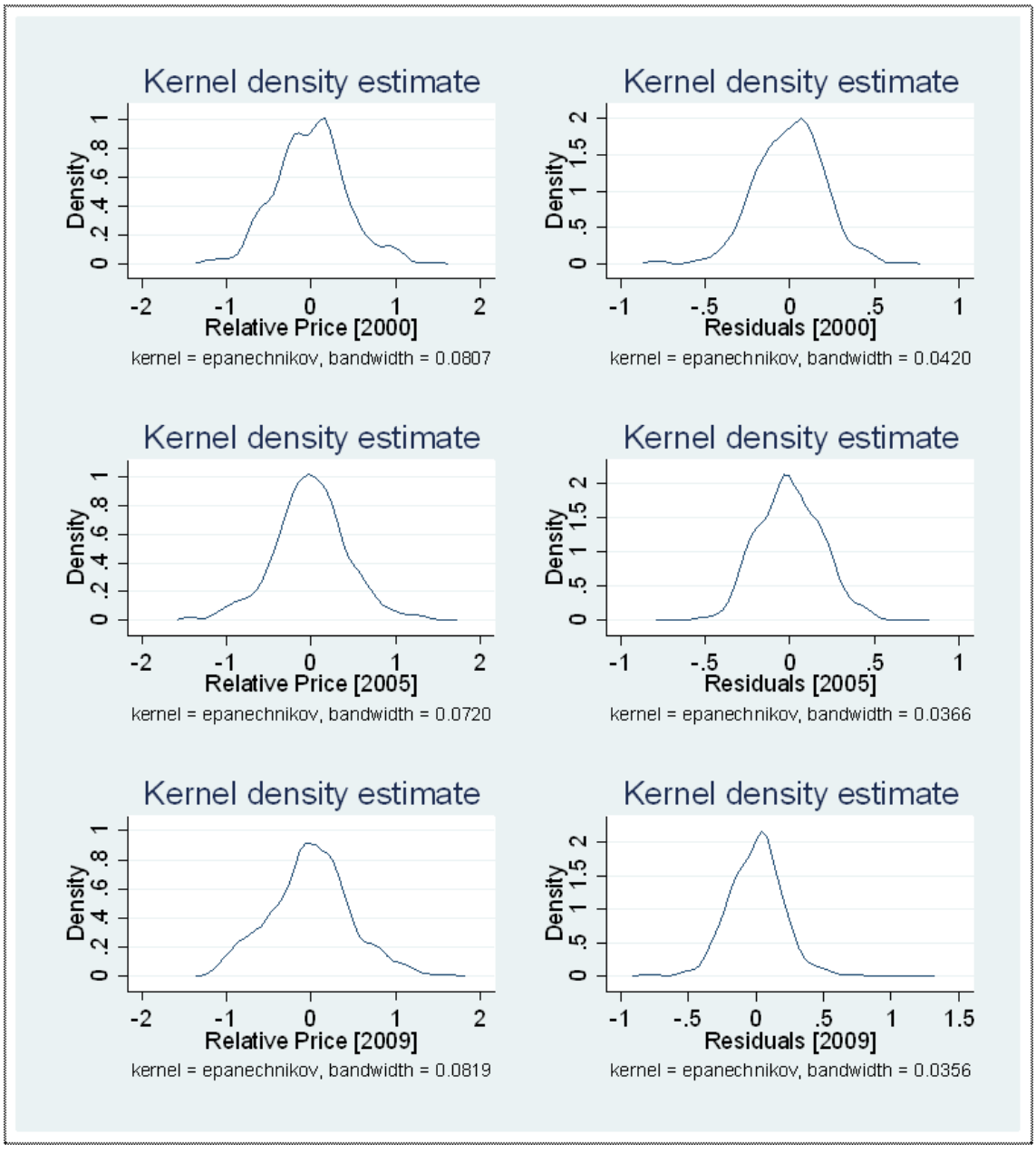

Figure 10: Distribution of relative price and the residual, for each regression in Table 13

Based on this observation, car model specific effects were included to control for price variation at the car model level. Here, based on the label provided in the dataset, car varieties were grouped according to car models, creating indicator variables to control for car model specific effects. For a description of the car models observed for each car company see Table

Independent variables	Coefficients [2000]	Coefficients [2005]	Coefficients [2009]
Automatic transmission	0.046***	0.054***	0.046***
	[0.010]	[0.009]	[0.009]
Electronic transmission	0.070***	0.041***	0.031**
	[0.013]	[0.008]	[0.013]
4 wheel drive	0.137***	0.049**	-0.008
	[0.029]	[0.022]	[0.028]
All wheel drive	0.199***	0.156	0.047*
	[0.014]	[0.014]	[0.026]
Uses diesel fuel	0.028	0.053***	0.081***
	[0.022]	[0.006]	[0.007]
2.0 to 2.9 litre engine	0.207***	0.153***	0.134***
	[0.021]	[0.011]	[0.012]
3.0 to 3.9 litre engine	0.322***	0.294***	0.323***
	[0.028]	[0.013]	[0.014]
4.0 to 4.9 litre engine	0.357***	0.434***	0.575***
	[0.032]	[0.024]	[0.043]
5.0 litre engine and above	0.676***	0.623***	0.693***
	[0.046]	[0.022]	[0.024]
R-squared	0.956	0.956	0.969
Std. error of regression	0.12841	0.11502	0.11294
Number of observations	1408	2236	1802

Table 15: Hedonic price regression with car model specific effects [base car model is Toyota Ascent]

1 of Appendix B. Now, the chosen base car model is the Toyota Ascent. This was the default choice of base made by the statistical software. The regression results are presented in Table 15 above. Again, most coefficients are positive and significant as expected. Overall, with a few exceptions, the trends observed in Table 14 seem to hold for these regressions too. The R-squared statistic for these regressions declines marginally from 2000 to 2009, showing that the explanatory power of observable car characteristics decreases insignificantly over time.

Plots of relative price and the residual from the regressions in Table 15 are provided in Figure 11. Once car model fixed effects are added to the regression, the dispersion in the residual decreases. In 2000, the residual ranges between 49.18% below zero and 82.21% above zero. In 2005 and 2009, the residual is between 64.87% above and below zero, with a few outliers. While the unexplained variation in car prices has been substantially reduced

with the inclusion of car model fixed effects, this unexplained variation is by no means insignificant.

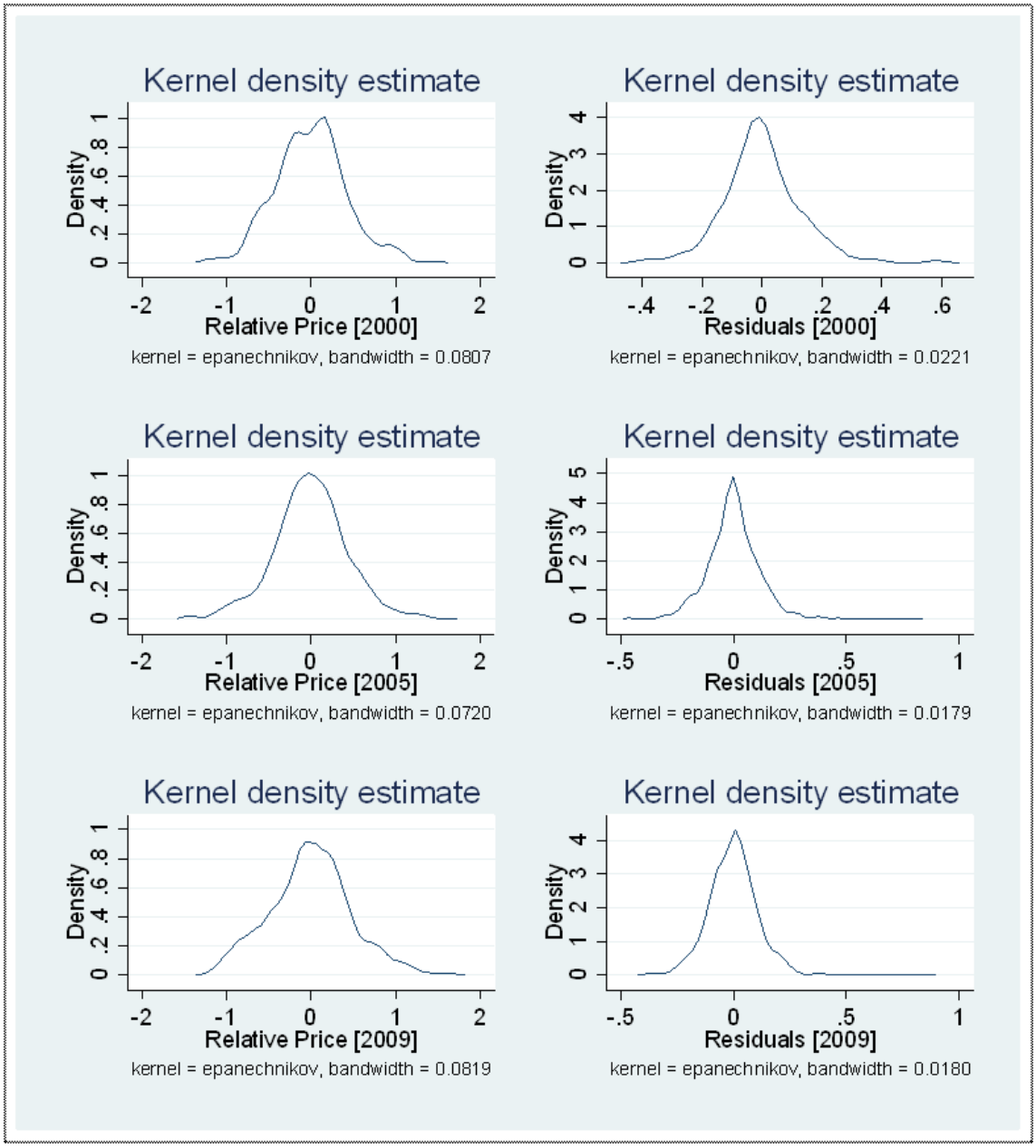

Figure 11: Distribution of the relative price and the residual, for each regression in Table 14

Finally, a regression was run on the entire panel, including car model specific effects and year specific effects. Again, all trends discussed above are true for the coefficients presented

Independent variables	Coefficients
Automatic transmission	0.053*** [0.003]
Electronic transmission	0.048*** [0.003]
4 wheel drive	0.058*** [0.008]
All wheel drive	0.159*** [0.005]
Uses diesel fuel	0.073*** [0.002]
2.0 to 2.9 litre engine	0.151*** [0.004]
3.0 to 3.9 litre engine	0.296*** [0.005]
4.0 to 4.9 litre engine	0.422*** [0.009]
5.0 litre engine and above	0.619*** [0.008]
R-squared	0.9538
Std. error of regression	0.12596
Number of observations	22435

Table 16: Hedonic price regression, with car model specific effects [base car model is Toyota Ascent] and year specific effects [base year is 2000]

in Table 16 above. Even though only the main model characteristics have been captured, for example service plans and interior extras information is not available, the hedonic price function fits the data extremely well, explaining 95.38% of the variation in car prices.

Figure 12 below presents plots of relative price and the residual for the entire period. As discussed in Section 2, the dispersion of relative price is large. However, even when conditioning on car model specific effects, year specific effects and car characteristics, the unexplained variation in prices ranges from approximately 122.55% below zero and 171.83% above zero. This unexplained variation in car prices is considerable and deserves closer inspection. One of two cases [or, indeed, both cases] may apply. First, the hedonic price function may be misspecified, with omitted characteristics that would better explain variations in car prices. Second, unobservable characteristics of cars, like quality heterogeneity, may play an impor-

tant role in explaining why these car prices are higher than predicted by the model. The next section will consider the importance of quality heterogeneity in explaining the distribution of car prices.

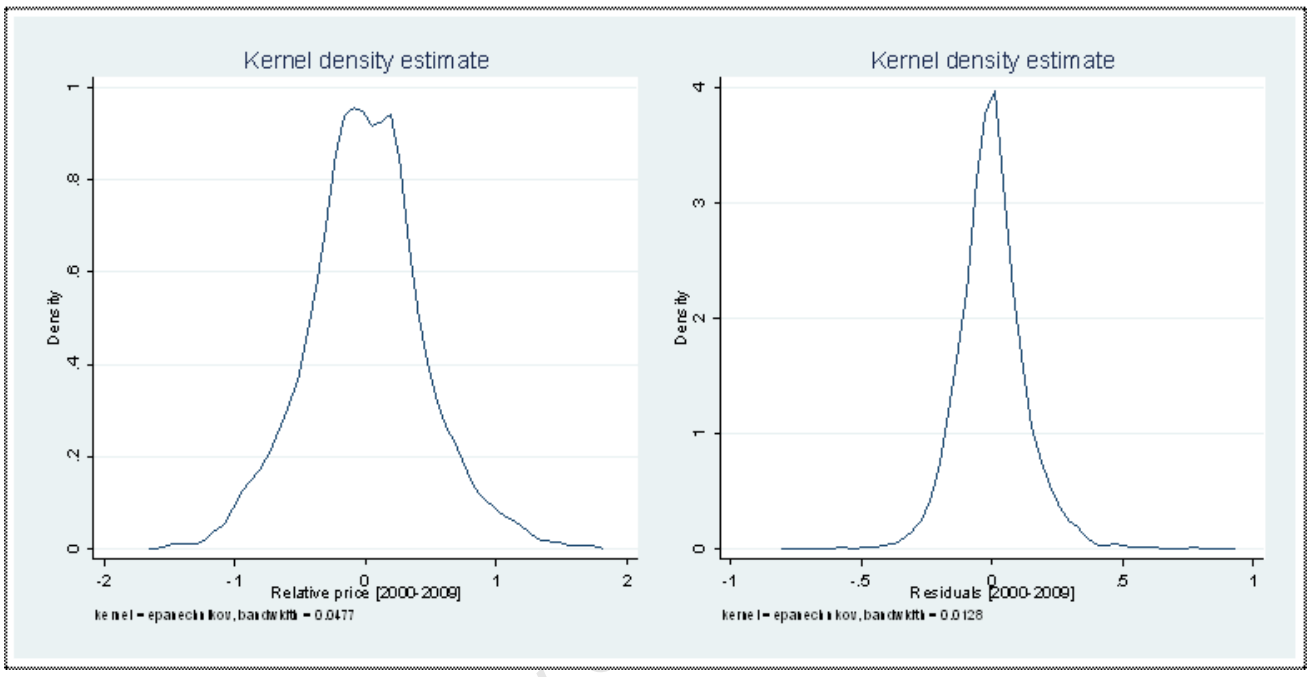

Figure 12: Distribution of the relative price and the residual, for the regression in Table 15

Quality Heterogeneity

Hedonic price functions which explain car prices in terms of observable car characteristics fit the data extremely well. However, the residual is large and there are a number of outliers. As discussed in the previous section, this indicates either significant characteristics have been omitted from the model, or that unobservable characteristics are important determinants of car prices. These unobservable characteristics could be an indication of quality heterogeneity between similar types and models of cars, within car brands.

Hummels and Klenow [2005] develop a theory in which quality is a demand shifter, allowing greater quantities to be demanded even where prices are higher. In other words, if Tata and Volkswagen produce hatchbacks of different qualities, the higher price of the

Volkswagen hatchback will not deter consumers from purchasing this higher quality car instead of the Tata hatchback. This theory is presented graphically in Figure 13 below. Figure 13 depicts the demand for cars. If cars are not differentiated on the basis of quality, high priced cars will have low sales as at point B and low priced cars will have high sales as at point C. However, where quality differentiation of cars occurs, quality shifts demand outwards. Now, consumers are willing to consume at point A and demand high quantities of cars at high prices.

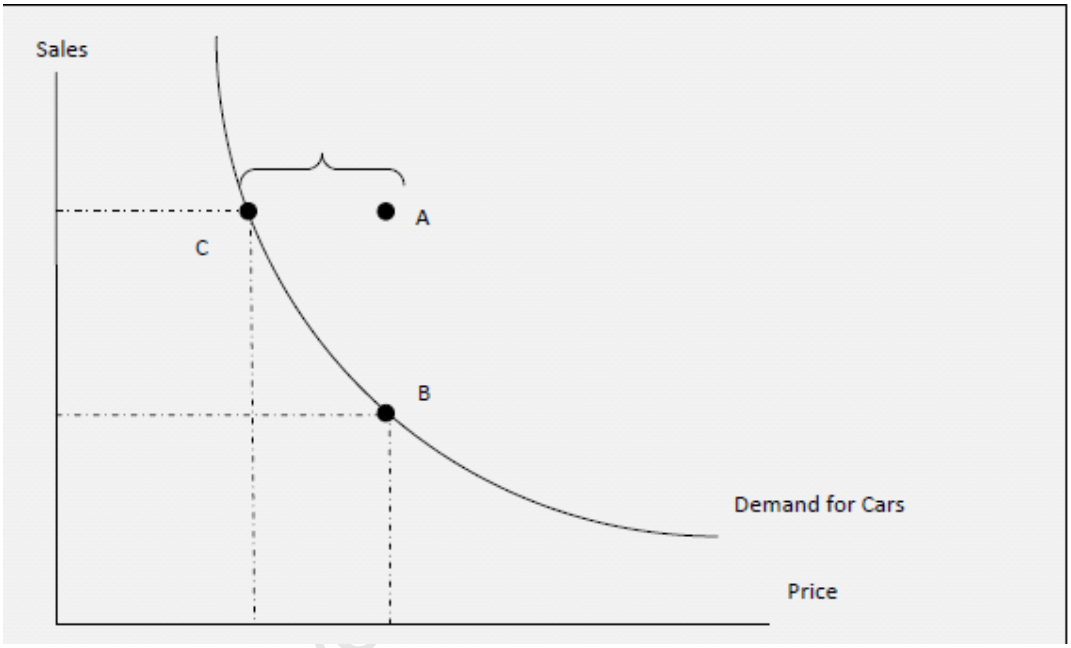

Figure 13: Quality as a demand shifter

The following model was fitted to the data:

$$\ln SALES_{it} = \beta_1 + \beta_2 \ln (PRICE_{it})^2 + \beta_3 \ln (PRICE_{it}) + \varepsilon_{it}$$

To this base model, car model specific effects, year specific effects and car characteristics dummy variables were added. These controls partition out price variation correlated with observable car characteristics. In so doing, it is possible to assess whether car prices higher than predicted by the hedonic price function are observed. If these higher than predicted car

Independent Variable	Coefficient
Natural log of price	-13.430***
	[1.133]
Natural log of price-squared	0.479***
	[0.045]
Automatic transmission	0.099**
	[0.031]
Electronic transmission	0.013
	[0.044]
4 wheel drive	-0.196**
	[0.085]
All wheel drive	-0.822***
	[0.071]
Uses diesel fuel	0.177***
	[0.032]
2.0 to 2.9 litre engine	-0.111**
	[0.039]
3.0 to 3.9 litre engine	-0.259***
	[0.055]
4.0 to 4.9 litre engine	-0.347***
	[0.079]
5 litre engine and above	-0.284**
	[0.093]
R-squared	0.4176
Std error of regression	1.3384
Number of observations	19988

Table 17: Price-quantity regression, with car model [base car model is Toyota Ascent] and year [base year is 2000] specific effects

prices are correlated with an unobservable characteristic that induces consumers to demand high quantities even at high prices, then one expects that beyond a certain point sales and price will be positively related. In other words, this regression allows explicit testing of whether higher than predicted car prices exist because these car varieties are differentiated on the basis of quality. Table 17 above presents the results from this regression.

As expected, the coefficient on price is negative and significant and the coefficient on price-squared is positive and significant. The coefficients on price and price-squared should be interpreted simultaneously. Finding the turning point of this quadratic function indicates

that for car varieties where the natural log of price is greater than approximately 14.02, a positive relationship exists between car sales and car prices. Up to this value of the natural log of price, a negative relationship exists between car sales and car prices. This means that for 389 price observations in this dataset, car prices are higher than would be predicted without accounting for an outward shift in the demand for cars. Therefore, while evidence of quality heterogeneity is found, quality variation is important in explaining the variation in prices for only a small proportion of the price observations in this dataset.

When company specific effects are added to the regression model of Table 17, it is possible once again to gauge the 'implicit prices' associated with car company brands. While it is not possible to compare these 'implicit prices' with Figure 9 directly, since the regressions have different dependent variables, it is possible to rank the coefficients on the company indicator variables in order of magnitude. This was done for the regressions in Table 14 and the regression in Table 17, with rankings presented in Table 18. It should be noted that the number of car companies for which varieties are present in the market changes between 2000, 2005 and 2009. Cadillac, Chery, Dodge, Hummer, Meiya and Suzuki are new brands available in 2009, while varieties of Daewoo and Saab are only observed in 2000. Since the final regression in Table 17 is pooled across all years, 'implicit prices' are observed for all car companies.

It should be noted that the overall quality rank in Table 18 conditions car price differences on all observable characteristics, as well as consumers' perceptions of quality heterogeneity between car companies. Even if a car is highly priced and this is motivated by its characteristics, if consumers do not demand high quantities of that car, its quality ranking may be lower than suggested by its price. This reasoning also holds for lower priced cars that are of a sufficiently high quality as to attract high consumer demand. For example, Ford is ranked 5 out of 11 in 2000, 6 out of 27 in 2005 and 11 out of 24 in 2009 on the basis of the coefficients obtained in the hedonic price regressions. However, when Ford branded car prices are conditioned on sales, Ford is ranked 21 out of 37 companies. This indicates that

Company	2000 Rank out of 24	2005 Rank out of 27	2009 Rank out of 34	Overall quality Rank out of 37
Alfa	16	16	27	9
Audi	17	21	29	30
BMW	19	23	28	35
Cadillac			23	16
Chana			2	4
Chery			4	13
Chevrolet		3	6	14
Chrysler	13	11	7	19
Daewoo	4			2
Dodge			12	26
Fiat	1	4	9	5
Ford	5	6	11	21
Honda	20	22	25	36
Hummer			19	22
Jaguar	22	25	31	23
Jeep	3	7	8	25
Land Rover	7	18	26	24
Lexus	23	26	33	31
Mahindra		2	3	8
Mazda	2	17	20	27
Meiya			1	1
Mercedes	21	24	32	37
Mini		19	30	18
Mitsubishi	11	15	17	32
Nissan	10	12	16	20
Peugeot	9	14	21	12
Porsche	24	27	34	28
Renault	12	8	14	11
Saab	18			3
Seat			10	6
Smart		10		10
Subaru	6	9	18	15
Suzuki			15	34
Tata		1	5	7
Toyota	8	5	13	33
Volvo	15	20	22	17
Volkswagen	14	13	24	29

Table 18: Company rankings based on 'implicit prices', in ascending order

consumers have a positive perception of the quality of Ford branded cars and are willing to pay a price higher than predicted on the basis of observable characteristics.

On the other hand, Alfa is ranked 16 out of 24 in 2000, 16 out of 27 in 2005 and 27 out of 35 in 2009, as seen in columns 1 to 3. However, Alfa's overall quality ranking is 9 out of 37, when price is conditioned on sales. Despite Alfa branded cars having higher prices associated with their observable characteristics, these cars have lower consumer demand when compared to similarly ranked Audi branded cars. Since consumer's perception of the quality of cars is directly linked to the number of cars sold, this indicates that consumers believe that Audi produces cars are of a higher quality than Alfa.

To conclude, quality differentiation is found to be an important determining factor in the variation of car prices. Moreover, this result explains why, with substantial quality heterogeniety even at highly disaggregated levels, strong convergence in car prices is not found. Not only are the substantial differences between cars of similar types and cars produced by the same company, but there is also significant vertical heterogeneity at the car variety level. While car prices have definitely converged slightly between 2000 and 2009, the distribution of car prices remains large. This result challenges the theories of Krugman [1979] and Melitz [2003]. Ultimately, the South African automotive sector consists of car varieties that are simply too diverse, in terms of both observable and unobservable characteristics, to allow for the predictions of 'new' trade theory to be a catchall explanation for all trends in the sector.

Conclusion

This paper investigates developments in the South African automotive industry over the period 2000 to 2009. During this period, the industry experienced a process of liberalisation under the MIDP, accompanied by increased exposure to trade. Krugman [1979] and Melitz [2003] predict that, according to the monopolistic competition model, this increased exposure to trade should be accompanied by gains from trade. Specifically, the monopolis-

tic competition model predicts consumer welfare gains in the form of increased varieties of products available to consumer and decreases in product prices faced by consumers. The analysis above finds evidence supporting the former prediction but does not test explicitly for the latter. Models of vertical product differentiation, as discussed in Hummels and Klenow [2005], suggest that, where product quality differs greatly, product prices may not converge as predicted in monopolistic competition models. This paper finds evidence indicating that quality heterogeneity is an important determinant in the variation of prices, and acts to prevent a strong convergence in car prices as predicted in Krugman [1979] and Melitz [2003].

Moreover, the stated goal of the MIDP is to generate consumer gains in the form of improving access to a wide range of affordable, high quality cars. This paper finds that the South African consumer's choice set of cars has expanded in the period 2000 to 2009 of the MIDP. While this paper has not explicitly tested for changes in the affordability of cars, evidence has been found suggesting that the distribution of car prices has only marginally converged on the average. The dispersion of car prices remains large. Finally, while this paper finds that cars are differentiated on the basis of quality, further investigation is needed to establish whether the quality of cars in this market is increasing over time.

References

Barnes, J., Kaplinsky, R. and Morris, M. (2003) "Industrial Policy in Developing Economies: Developing Dynamic Comparative Advantage in the South African Automobile Sector" TIPS Forum Papers

Bernard, A.B., Jensen, J.B., Redding, S.J. and Schott, P.K. (2007) "Firms in International Trade" *The Journal of Economic Perspectives* Vol. 21 No. 3 pp. 105-130

Black, A. (2001) "Globalisation and Restructuring in the South African Automotive Industry" *Journal of International Development* 13

Black, A. and Mitchell, S. (2002) "Policy in the South African Motor Industry: Goals, Incentives and Outcomes" *South African Journal of Economics* Vol. 70 No. 8

Broda, C. and Weinstein, D.E. (2006) "Globalisation and the Gains from Variety" Quarterly Journal of Economics Vol. 121 No. 2 pp. 541-585

Crucini, M.J., Telmer, C.I. and Zachariadis, M. (2005) "Understanding European Real Exchange Rates" *American Economic Review* Vol. 95 No. 5 pp. 724-738

DTI (2003) *Current Developments in the Automotive Industry* [available online] http://www.dti.gov.za/publications/automotiveindustry.pdf [date accessed: November 2010]

Feenstra, R. (1994) "New Product Varieties and the Measurement of International Prices" American Economic Review Vol. 84 No. 1 pp. 151-177

Flatters, F. (2005) "The Economics of MIDP" [available online] http://qed.econ.queensu.ca/faculty/flatters/main/writings.html

Hummels, B.A. and Klenow, P.J. (2009) "The Variety and Quality of a Nation's Exports" *American Economic Review* Vol. 95 No. 3 pp. 704-723

International Monetary Fund (2011) *International Financial Series* [available online] http://www.imf.org/data

Krugman, P.R. (1979) "Increasing Returns, Monopolistic Competition and International Trade" *Journal of International Economics* Vol. 19 pp. 469-479

Krugman, P.R. (1980) "Scale Economies, Product Differentiation and the Pattern of Trade" *American Economic Review* Vol. 70 No. 5 pp. 950-959

Krugman, P.R. (1981) "Intraindustry Specialisation and the Gains from Trade" *Journal of Political Economy* Vol. 89 No. 5 pp 959-973

Lutz, M. (2004) "Pricing in Segmented Markets, Arbitrage Barriers and the Law of One Price: Evidence from the European Car Market" *Review of International Economics* Vol. 12 No. 3 pp. 456-475

Malin, B.A. and Klenow, P.J. (2009) "Microeconomic Evidence on Price-Setting" *The Handbook of Monetary Economics*

Melitz, M.J. (2003) "The Impact of Trade on Intraindustry Reallocations and Aggregate Industry Productivity" *Econometrica* Vol. 71 No. 6 pp. 1695-1725

Melitz, M.J. and Ottaviano, G.I.P. (2008) "Market Size, Trade and Productivity" *Review of Economic Studies* Vol 75 pp. 295-316

NAAMSA (2010) "Annual Report: 2009-2010" [available by request from NAAMSA]

Schott, P.K. (2003) "Across-Product versus Within-Product Specialisation in International Trade" *Quarterly Journal of Economics* Vol. 119 No. 2 pp. 647-678

Schott, P.K. (2003) "One Size Fits All? Hechscher-Ohlin Specialisation in Global Production" *American Economic Review* Vol. 93 No. 3 pp. 686-708

Appendix A

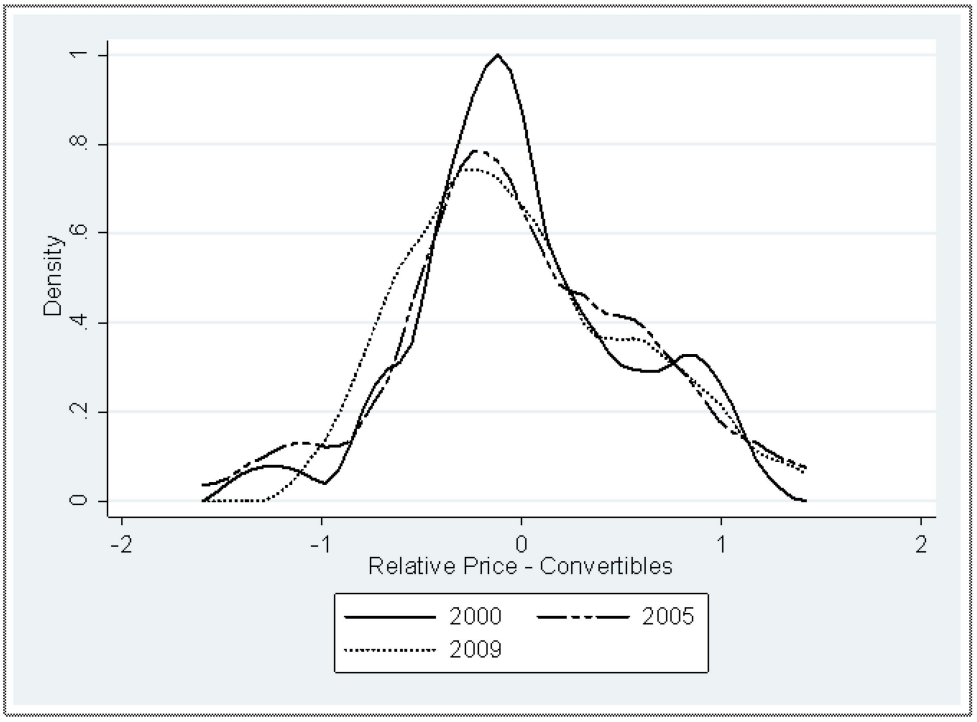

Figure 1: Relative price distribution – convertible [2000, 2005, and 2009]

Figure 2: Relative price distribution – coupe [2000, 2005, and 2009]

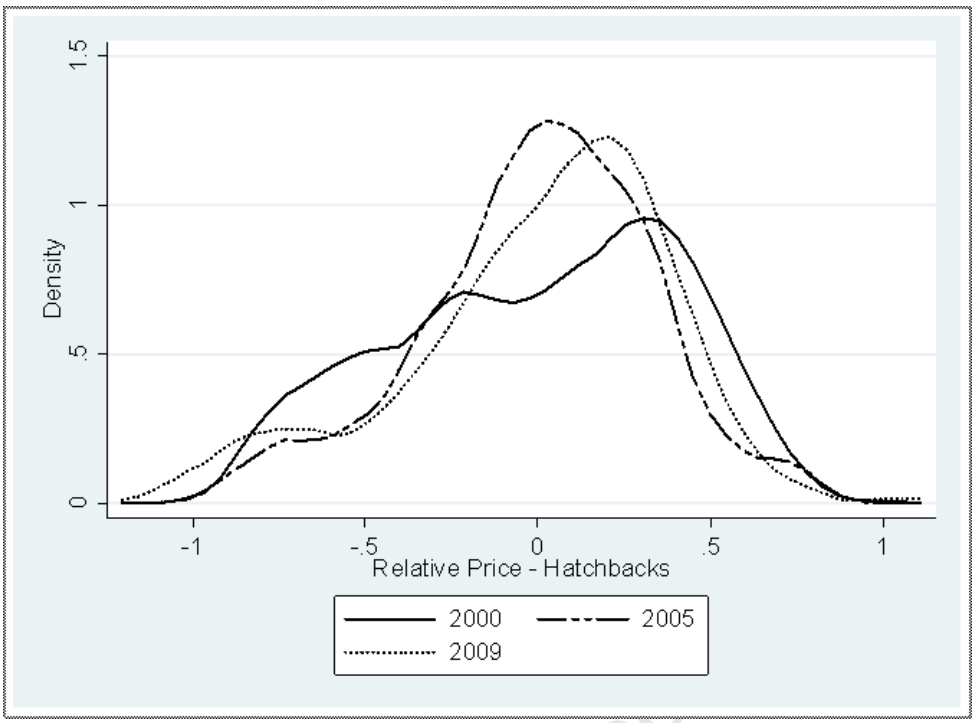

Figure 3: Relative price distribution – hatchback [2000, 2005, and 2009]

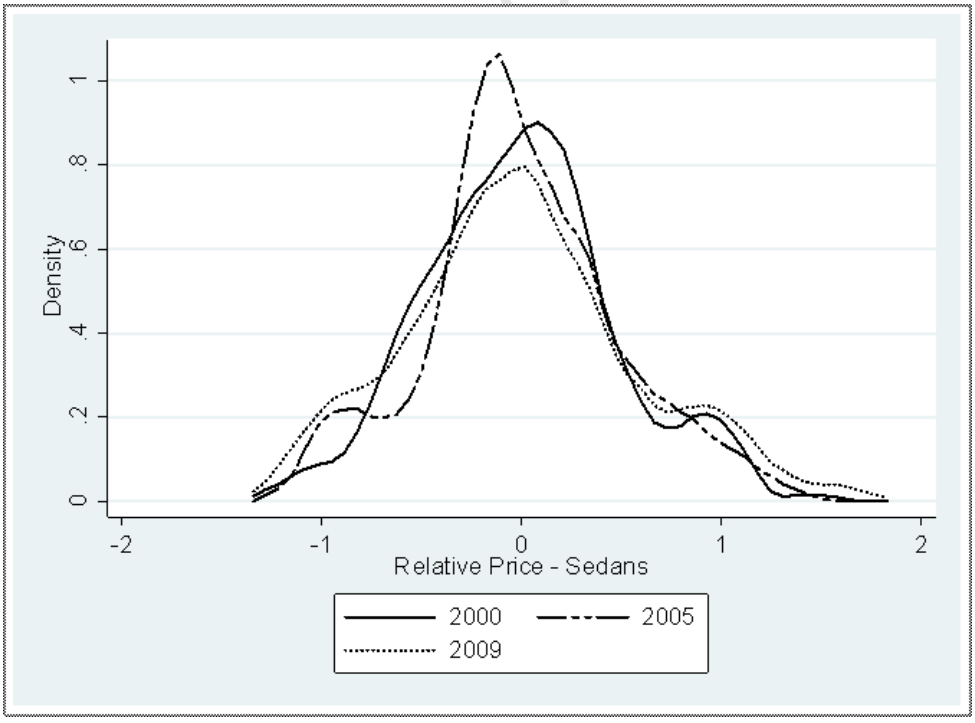

Figure 4: Relative price distribution – sedan [2000, 2005, and 2009]

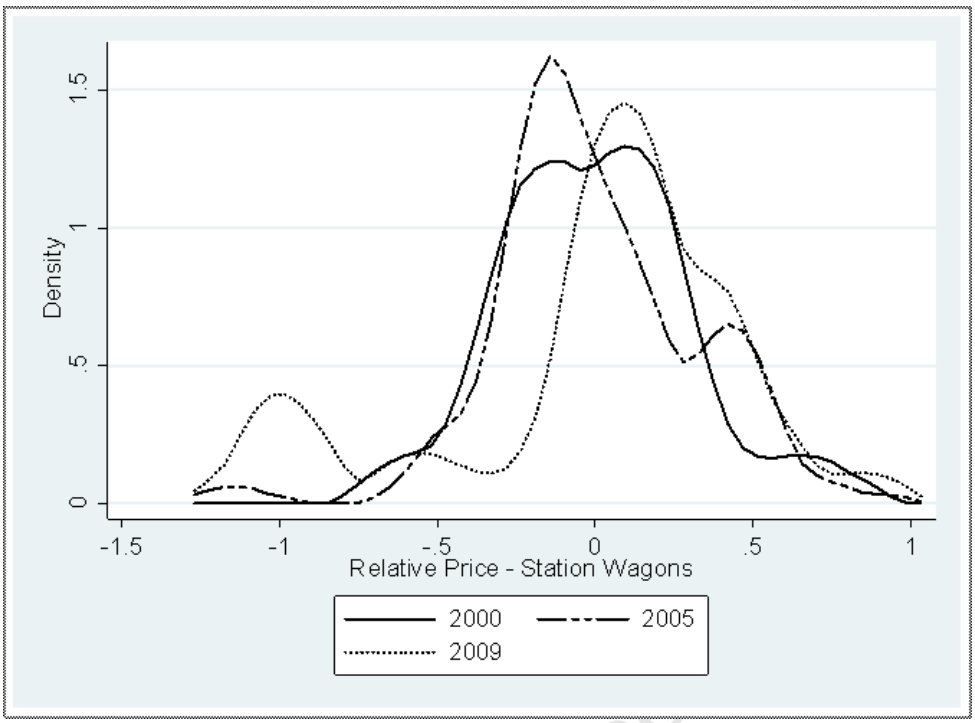

Figure 5: Relative price distribution – station wagon [2000, 2005, and 2009]

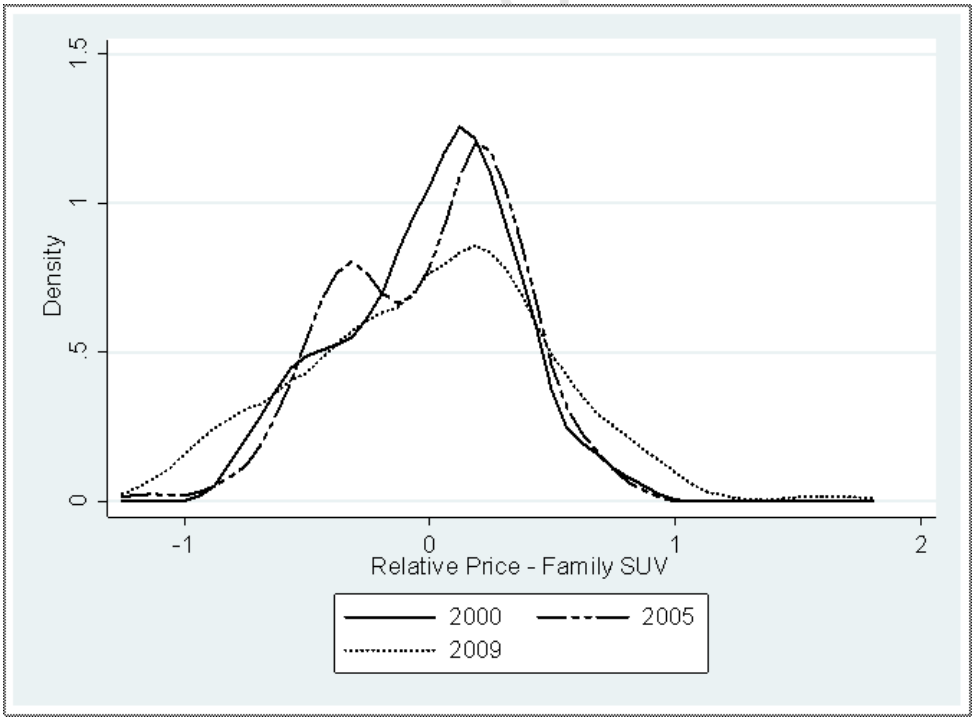

Figure 6: Relative price distribution – family SUV [2000, 2005, and 2009]

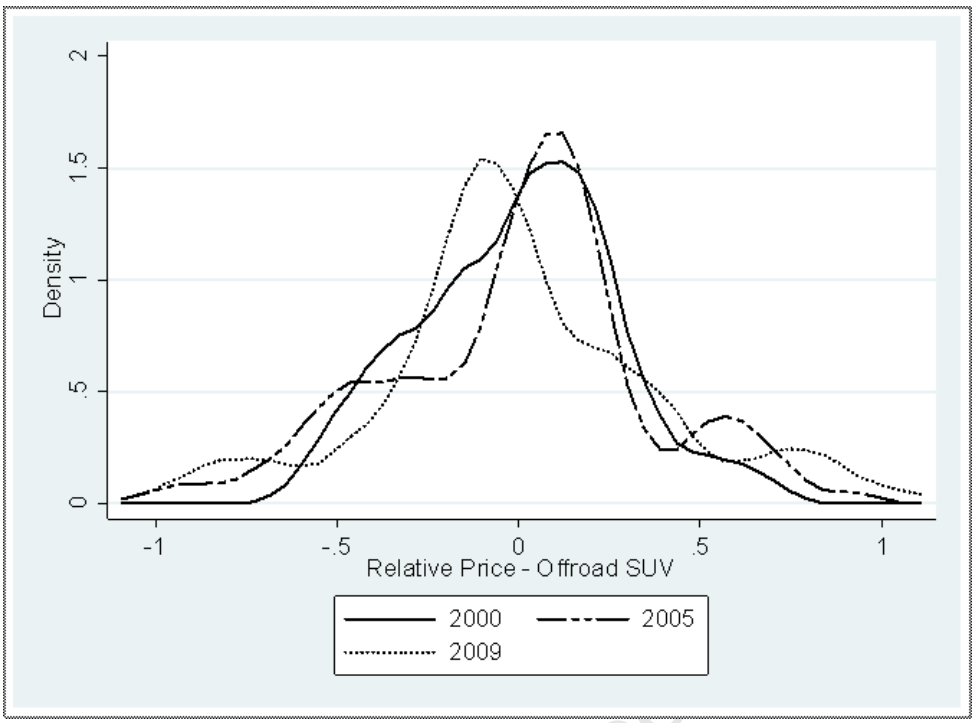

Figure 7: Relative price distribution – off-road SUV [2000, 2005, and 2009]

Appendix B

Car Company and Model Name	Number of Varieties
ALFA	1170
145	39
147	429
156	351
159	156
166	39
Brera	39
GT	78
Spider	39
AUDI	9282
8	156
A3	1599
A4	3706
A5	156
A6	1404
A8	156
Q5	156
Q7	195
RS	39
RS4	77
RS6	117
S3	234
S4	390
S5	78
S6	78
S8	78
TT	507
TTS	156
BMW	8501
1series	1482
3series	3120
5series	1209
6series	273
7series	468
Mseries	351
Xseries	1014
Zseries	584
CAD	78
Seville	78
CADILLAC	273
BLS	156
CTS	39
SRX	39
STS	39
CHANA	78
Benni	78

Car Company and Model Name	Number of Varieties
CHERY	468
J5	117
QQ3	195
Tiggo	156
CHEVROLET	1716
Aveo	624
Blazer	117
Captiva	156
Lumina	351
Optra	117
Spark	195
Vivant	156
CHRYSLER	897
300C	156
Grand Voyager	234
Neon	78
PT Cruiser	234
Sebring	156
Voyager	39
DAEWOO	1014
Lanos	507
Matiz	78
Nubira	273
Tacuma	156
DODGE	507
Caliber	234
Journey	117
Nitro	156
FIAT	1248
500	117
Bravo	117
Croma	39
Grande Punto	273
Linea	39
Palio	234
Panda	117
Punto	39
Seicento	78
Siena	39
Uno	156
FORD	3354
Falcon	117
Fiesta	1326
Focus	1014

Car Company and Model Name	Number of Varieties
Ikon	234
Ka	117
Mondeo	273
Territory	234
Tracer	39
HONDA	312
Jazz	156
Prelude	39
S2000	117
HUMMER	156
H3	156
JAGUAR	1599
Daimler	39
Sovereign	39
S-Type	234
XF	312
XFR	39
XJ6	39
XJ8	78
XJR	39
XK	117
XK8	78
XKR	195
X-Type	390
JEEP	1677
Cherokee	546
Commander	117
Compass	117
Grand Cherokee	429
Patriot	117
Wrangler	351
LEXUS	741
GS	117
IS	234
LS	156
RX	195
SC	39
LAND ROVER	1677
Defender	312
Discovery	546
Freelander	546
Range Rover	273
MAHINDRA	273
Scorpio	195
Xylo	78

Figure 1: Number of Varieties by Car Company and Car Model

Car Company and Model Name	Number of Varieties
MAZDA	2730
6	546
323	156
626	78
CX-7	39
Etude	390
Mazda2	156
Mazda3	897
Mazda5	195
MX-5	117
RX-8	78
Soho	78
MEIYA	78
Wagon	78
MERCEDES	6942
A series	195
B series	234
CL	273
CLC	117
CLK	702
CLS	78
C series	2223
E	1209
GL	78
ML	273
R series	78
SL	273
SLK	429
S series	546
Viano	117
Vito	117
MINI	858
Cooper	741
John Cooper	117
MITSUBISHI	1326
Lancer	234
Outlander	117
Pajero	975
NISSAN	4524
350Z	156
370Z	78
Almera	624
Grand Livina	78
Livina	195
Maxima	117
Micra	351

Car Company and Model Name	Number of Varieties
Murano	78
Pathfinder	390
Patrol	507
Primera	234
Qashqai	195
Sentra	390
Terrano	156
Tiida	312
X-Trail	663
PEUGEOT	2378
107	39
206	195
207	312
306	312
307	351
308	312
406	312
407	429
806	39
807	77
PORSCHE	3237
911	1560
987	195
911/997	585
Bokster	312
Cayenne	273
Cayman	312
RENAULT	4602
Clio	1287
Espace	312
Grand Scenic	234
Kangoo	39
Koleos	156
Laguna	351
Logan	39
Megane	897
Modus	78
Safrane	39
Sandero	312
Scenic	780
Twingo	78
SAAB	1872
9-3	1443
9-5	429
SEAT	585
Altea	156

Car Company and Model Name	Number of Varieties
Ibiza	234
Leon	195
SMART	507
forfour	156
fortwo	273
Roadster	78
SUBARU	2964
Forester	585
Impreza	1248
Legacy	936
Outback	156
Tribeca	39
SUZUKI	390
Alto	39
Grand Vitara	117
Jimny	39
Swift	117
SX4	78
TATA	624
B-Line	39
Indica	234
Indigo	273
Safari	78
TOYOTA	8112
Ascent	78
Auris	312
Avanza	312
Avensis	156
Camry	741
Condor	858
Conquest	78
Corolla	2340
Corolla Verso	195
Fortuner	429
Landcruiser	468
Landcruiser Prado	351
MR2	39
Prius	39
RAV4	741
RunX	624
Tazz	234
Yaris	117
VOLVO	3159
C70	117
S40	897

Figure 2: Table 1 - Number of Varieties by Car Company and Car Model

Car Company and Model Name	Number of Varieties
S60	390
S70	78
S80	156
V40	429
V50	117
V70	351
XC60	78
XC70	234
XC90	312
VOLKSWAGEN	7917
Beetle	78
Caddy	195
Caravelle	507
CitiGolf	312
CrossPolo	78
Eos	117
Golf	1404
Jette	975
Kombi	313
Passat	780
Polo	1365
Scirocco	117
Sharan	234
T5	194
Tiguan	429
Touareg	429
Touran	390

Figure 3: Table 1 - Number of Varieties by Car Company and Car Model