A Microeconomic Analysis of the Full-Size Automobile Market

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Introduction

The automobile production industry in the United States is in a clear state of turmoil, particularly in the case of domestically owned firms. Sharon Silke Carty attributed problems in the industry, one example being the bankruptcy of parts supplier and former General Motors holding Delphi, to "escalating raw material prices, reduced automaker production and soaring benefits and labor costs." According to Carty, this bankruptcy did not bode well for GM, itself in beleaguered condition.[1] The other remaining domestically owned automobile production firm at the time of the collection of the data presented herein,[2] the Ford Motor Company, is also in poor condition; Dorinda Elliott attributed the companies' weak positions to successful foreign competition.[3]

Ford and GM have responded to their often-unprofitable conditions by employee and output cuts. Ford, as an example, reduced output by 21% in the fourth quarter of 2006.[4] At

[1] Sharon Silke Carty, "Analyst: Delphi's Chapter 11 filing pushes GM closer to brink," *USA Today*, October 11, 2005.

[2] On May 14, 2007, the US-based private equity firm Cerberus purchased an 80% holding in Chrysler Group from the German DaimlerChrysler conglomerate, the product of a 1998 acquisition of Chrysler Corp. by Daimler-Benz, returning the company to American ownership and control (*The Economist,* "Putting the shine back on," May 14, 2007). Since data collection took place during Daimler's control of Chrysler, Chrysler Group products will be considered to have been produced by a foreign firm except in forward-looking views of domestic market share.

[3] Dorinda Elliott, "Can this man save the American auto industry?" *Time*, January 30, 2006.

[4] *The Economist,* "Engaging reverse gear," August 26, 2006.

first glance, this might appear to be the result of macroeconomic or industry conditions, but Toyota Motor's February 2007 announcement that the company will open an eighth North American factory with a 150,000-unit production capacity in 2010 suggests that the automobile market as a whole is not depressed.[5] An August 2006 article in *The Economist* suggests that "[w]ith the high cost of petrol, customers are moving down to smaller SUVs or even to cars" from pickup trucks and large sport utility vehicles, to the detriment of firms that have enjoyed much of their success in sectors of the automotive market associated with high gasoline consumption.[6] These firms, then, could likely ameliorate the woes facing them with well-planned product decisions, and this study aims to render a demand-side assessment of the product dimension.

More specifically, this study will focus on the full-size car segment, which offers a compromise in size and efficiency between trucks and smaller cars. A reasonable starting point for a definition of a full-size car is what the United States government defines as a "large sedan," having 120 cubic feet or more of combined passenger and cargo volume for model year (MY) 2007.[7] Limousines and hearses will be excluded, because they are not intended for personal transport, as will station wagons and "crossover" vehicles regardless of platform, due to their greater similarity in form and use to minivans, a distinct segment. Due to their irrelevance to current decisions, discontinued products such as the 2007 Ford Taurus will also be excluded, as well as specialty ultra-luxury vehicles such as the Bentley Arnage, Maserati Quattroporte, and Maybach 57, for which insufficient sales and retained value data are available for analysis. This study will examine the effects of costs[8] to the consumer, both initial and continuing, and perceived quality on consumer behavior in this market segment, with special attention to how a financially beleaguered firm such as General Motors or Ford could better exploit it to improve revenues.

Data Collection and Preprocessing Methodology

Data collected for this study are summarized in tabular form in Worksheets A and B. Worksheet A (Adjusted Costs of Full-Size Automobiles) compares the costs of products in the full-size automobile market. The model presented takes into consideration both purchase and gasoline costs, as well as retained value. One may readily estimate initial costs with the manufacturer's suggested retail price (MSRP) for MY2007. Due to the unpredictability of options and geographic variations in taxation, these will be disregarded for the sake of simplicity. There are many continuing costs associated with automobile ownership – taxes, maintenance, insurance, et cetera – but among them, this study will specifically examine the cost of energy from gasoline. Approximations of annual fuel costs provided by the United States Environmental Protection Agency and a reasonable five-year assumed duration of

[5] *Detroit Free Press,* "Briefing: auto headlines," March 13, 2007.
[6] *The Economist,* loc. cit.
[7] United States Department of Energy and Environmental Protection Agency, "Frequently asked questions," http://www.fueleconomy.gov/feg/info.shtml (accessed March 14, 2007).
[8] The concept of cost has a variety of meanings. In the context of this study, it generally refers to a generalized price, broader than initial purchase price, paid by a consumer.

ownership, consistent with the assumptions made by industry insiders,[9] have been used to produce a fuel-adjusted cost, calculated as MSRP plus the present value of lifetime gasoline costs under a simplified model of static gas prices. A 6% discount rate was selected due to the availability of savings accounts that yield interest at that rate.[10] Finally, the predicted five-year retained value of the vehicle, calculated in Worksheet B, was discounted to present value using the same discount rate and subtracted from the fuel-adjusted cost to determine the final adjusted cost. This variable differs from a true total cost of ownership due to the simplifying assumptions listed above, but will provide a reasonable approximation for the purposes herein.

For the purposes of this study, quantity demanded has been assessed through sales delivery reports by the automakers for the period between May 2006 and April 2007, roughly representing model year 2007. Sales data, though, are not the only information needed for a well-reasoned analysis. A convenient way to measure such qualitative factors as the market's perception of the quality of manufacture of an automobile is by predicting its value retention following a reasonable duration of ownership. Ray Windecker describes a method[11] for calculating retained value that will be utilized herein, with the exception that rebates and transaction costs, of which Windecker makes use, will continue to be disregarded as a simplifying assumption. Worksheet B (Retained Value of Full-Size Automobiles) calculates the percentage of value of a MY2002 vehicle retained in May 2007 using the Kelley Blue Book estimate of the selling price of an excellent example with basic-level equipment driven 68,000 miles. This differs from the better known "trade-in" Kelley figure in that it estimates the fair-market value of the automobile[12] rather than what one might expect to receive from a dealer in the trade-in process.[13] This factor is then used to estimate the future retained value and 5-year depreciation of the MY2007 vehicle.

The non-existence of certain key products, such as the Dodge Charger and Ford Five Hundred, in MY2002 posed a challenge to the development of this model of retained value. When a firm had previously sold a product under a different name, but it was otherwise substantially similar to that sold at the end of the period (e.g. the Cadillac DTS, formerly DeVille), the model presumes that changes to nomenclature did not affect value retention. When there was no direct continuity with a prior model, however, the retained value rates of the closest equivalent MY2002 products within a brand were averaged on Worksheet B to predict what a typical retained value rate for the brand and size class might be. For example,

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[9] Ray Windecker, "Pay attention to the depreciation," *Automotive Industries* 184 (2004): 16

[10] First National Bank of Omaha, "FNBO Direct home page," FNBO Direct, https://www.fnbodirect.com/ (accessed May 1, 2007).

[11] Windecker, loc. cit.

[12] Kelley Blue Book Co, "Kelley Blue Book," http://www.kbb.com/KBB/PopUps/Definition.aspx?ContentUniqueName=KBBWebContent%3a60&ParentView=UsedCarsPricingReport&PriceType=Private+Party&VehicleClass=UsedCar (accessed May 6, 2007).

[13] Kelley Blue Book Co., "Kelley Blue Book," http://www.kbb.com/KBB/PopUps/Definition.aspx?ContentUniqueName=KBBWebContent%3a59&ParentView=UsedCarsPricingReport&PriceType=Trade-In&VehicleClass=UsedCar (accessed May 6, 2007).

the retained value rate for a Mercury Montego is presumed to be the mean rate for full-size Mercury products as were available for MY2002, namely Grand Marquis and Sable. In the case of Kia, no full-size car was available for MY2002; therefore, the retained value rate for the company's largest midsize offering, the Optima, was substituted. This particular substitution is less than ideal, but superior to omitting the product from the study, since the omission of a data point – indeed, an entire brand -- would jeopardize significance of results in a segment with a reasonably small number of data points. In all other cases, the brands' MY2002 product lines included either one or two full-size products.

Statistical Analysis

Given the availability of cost and sales data, it is reasonable to explain the demand relationship and consumer behavior in this market segment as well as possible through statistical analysis.

The correlation model is quite convenient for determining what factors among the data collected might ultimately have an influence on sales. In addition to sales volume and the data displayed in Worksheets A and B, the statistical analysis included a binary variable to determine any effect that domestic ownership of the manufacturer (i.e., Ford or General Motors) might have on the other variables. This line of inquiry did in fact bear fruit. Though causation is not clear in the correlation model, the correlation coefficient between domestic ownership and the percentage of value retained over five years is -.757, indicative of a markedly significant[14] inverse relationship between the two. This shows the problem that Ford and GM face in manufacturing products that hold their value well over time. As stated above, we may presume that value-retention problems in the secondary market may be indicative of perceived goods quality and durability issues that would also affect sales performance in the primary market. This is further reinforced by the -.501 correlation coefficient between sales and depreciation; those vehicles that are likely to lose value most rapidly are less popular.

Price elasticity of demand, discussed in further depth below, shows the efficacy of the adjustments made to the cost model. Using power-curve regression to determine the demand function, one may assess the price elasticity of demand using each price measurement:

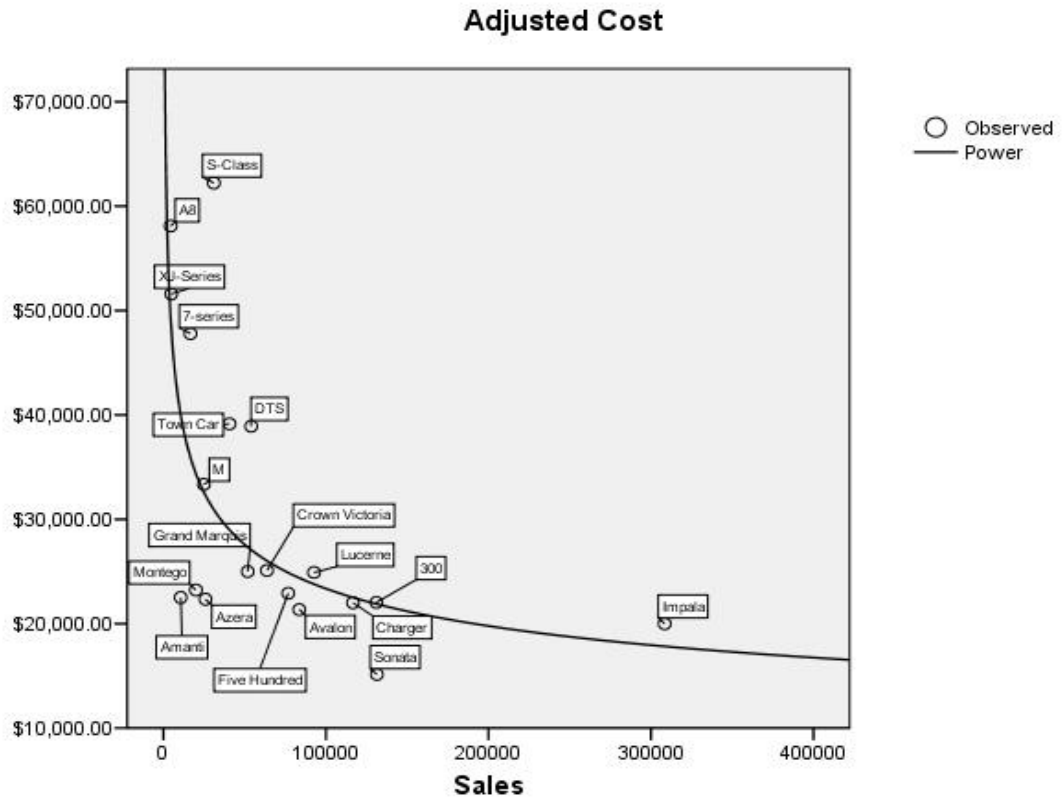
Price Measure	Elasticity of demand	r^2	Adjusted r^2
MY2007 MSRP	-1.548	.445	.413
Fuel-Adjusted Cost	-1.769	.442	.409
Adjusted Cost	-1.869	.448	.416

Quantity demanded, then, is more sensitive to changes in both adjusted costs than to the manufacturer's suggested retail price in its unadjusted form. In addition, the greater sensitivity of quantity demanded to the final adjusted cost that accounts for value retention than for the fuel-adjusted cost, which accounts only for fuel costs, underscores the validity of the value retention measurements.

Regression analysis is a useful tool for exploring the nature of the demand relationship in a nonlinear market. Without access to confidential data, it is infeasible to determine demand

[14] Koenker, Robert. *Simplified Statistics* (Bloomington, IL: McKnight and McKnight, 1961), 52.

curves for individual products or a worthwhile supply model, but one may readily plot all products within the market together to determine the effects of cost on the full-size car segment as a whole. Applying the adjusted cost measure and a year's worth of sales to a power-curve regression model, the following demand curve becomes apparent:



This approximation of the demand curve, $Q=(9*10^{12})*P^{-1.869}$, was statistically significant ($p=.002$; $r^2=.448$, adjusted $r^2=.416$, $F=13.810$). Upon visual analysis, it clearly fits the data points within the sample with reasonable accuracy. In fact, several observed data points lie directly upon the derived line. It therefore appears to be a strong candidate for economic analysis.

Market Dynamics

An overview of market shares and concentration is beneficial to understanding of a market segment. Market shares have been calculated based on the sales volumes for the period studied. Since the intent here is to use market share for future-oriented analysis, Daimler and Chrysler are treated as two companies due to the divestiture that was ongoing at the time of analysis. The Herfindahl-Hirschman Index, calculated as the sum of the squares of all market shares,[15] for the segment is approximately 2,238; according to the United States Department of Justice, which uses the index in the prosecution of antitrust cases, this is

[15] Lynne Pepall, Daniel J. Richards and George Norman, *Industrial Organization: Contemporary Theory and Practice* (Cincinnati, OH: South-Western, 2001), 56.

indicative of a concentrated market.[16] This clearly suggests an oligopolic market structure, likely due to the high expenses associated with the factors of automobile production. American manufacturers (including Chrysler) produce 74.52% of full-size automobiles sold in the United States, even with strong foreign firms having entered the market; this stands in marked contrast to Ford, GM, and Chrysler's 48.2% overall market share as of July 2007.[17] These large market shares suggest that American companies are capable of performing well in this segment, and should strive to capitalize on this strength. The absence of Honda, a major participant in other automotive market segments, also works to the significant advantage of those firms that are presently participating in the full-size segment, though that company has redesigned the Accord, previously a midsize vehicle, as a full-size model for MY2008.[18] This, coupled with Kia's relatively recent entry into the segment, suggests that companies are increasingly recognizing the profit potential of this type of product.

Price elasticity of demand also bears consideration in analyzing the behavior of the market. Given the nature of the automobile market, in which products, and perhaps more significantly their substitutes, often change significantly as often as their prices do, elasticity must be calculated among similar products within a time period, rather than between the same product in different time periods. Ideally, one could consult marketing data and derive demand curves for individual products, but such data are apparently unavailable to the public. One may presume that automobile manufacturers collect such data, but hold them confidentially. It is the belief of this researcher that this type of elasticity measurement is superior to a total lack of data with regard to price elasticity of demand.

Based on the power-regression demand curve above, it is clear that the overall price elasticity of demand for the full-size automobile market is approximately -1.869. According to Edwin Mansfield, the determinants of elasticity include the number and closeness of substitutes and relative degree of significance in the consumer's budget.[19] Consequently, we may presume that the broad availability of substitutes both within and outside the segment contributes to the generally price-elastic nature of the products. Breaking the segment into smaller segments and using the same power regression model to determine price elasticity of demand (the *b* value of the power equation) can show the price elasticity effects of variations within the segment. As an example, the domestic products in the segment exhibit a price elasticity of demand of -2.579 (r^2=.525, adjusted r^2=.457), as compared to -1.585 (r^2=.442, adjusted r^2=.372) for foreign automobiles in the full-size segment. Interestingly, this is despite the mean price of foreign vehicles ($32,682) being over $3,400 higher than that of domestic' manufacturers products ($29,277.44), and therefore likely to be more significant in the

[16] United States Department of Justice, "DOJ/Antitrust: Herfindahl-Hirschman Index," http://www.usdoj.gov/atr/public/testimony/hhi.htm (accessed May 17, 2007).

[17] Alan Ohnsman and Bill Koenig, "Toyota Leads Asian Carmakers to Record U.S. Share," *Bloomberg,* http://www.bloomberg.com/apps/news?pid=20601087&sid=aAUo_CCW2b0g&refer=home (accessed August 11, 2007).

[18] G. Chambers Williams III, "Accord morphs to full-size," *San Antonio Express-News,* September 1, 2007.

[19] *Ibid.*, 95

consumer's budget. This, like the very strong relationship between manufacture by a domestically owned firm and reduced value retention, discussed above, alludes to problems with quality of manufacture.

In addition, the foreign category includes the German premium vehicle giants BMW and Mercedes-Benz.[20] These firms' high-end reputations, also visible through the lens of value retention as in Worksheet B, reflects heightened status-symbol value of the BMW and Mercedes-Benz offerings relative even to other vehicles in the luxury price range, and possibly a superior reputation for quality as well. These factors of image and reputation for quality provide enhanced utility, which reduces the extent to which other products in the full-size segment can serve as substitutes for the S-Class and 7-series.

Domestic Producers: A Case Study

For the domestic-owned firms, though, mere price increases may not be sufficient to ensure stabile profits. Other actions, particularly within the lucrative full-size segment in which these firms already have a strong presence, would likely be highly beneficial on the bottom line. We will now take a close look at the offerings of Ford Motor Company and General Motors in the full-size segment with the intent of determining possible courses of action that would enhance the companies' financial situations.

Ford controls 20% of the full-size automobile market, and General Motors holds a larger market share of about 35%. Given Daimler's sale of its Chrysler Group brands to Cerberus Capital Management, approximately 75% of full-size cars sold are produced by domestic firms, presuming that the sale of Chrysler has not significantly shifted demand. Notably, the sales volume for GM's Chevrolet Impala during the period examined exceeds that of all six Ford products within the segment, making it the principal contributor to GM's dominance of the segment. It should not be surprising, then, that General Motors has recently been exhibiting some financial improvement.[21] We may presume that the success of the Impala is contributory to this, even if it is likely not the only contributor to these gains. Multiplying the base MSRP by sales, the best approximation available given the lack of information about sales of specific trim levels, indicates an approximate minimum gross revenue from the Impala of about $6.46 billion. In contrast, the higher-priced Ford Five Hundred, the gasoline expenses for which are the same, has a minimum gross revenue of about $1.77 billion. Combined with the Crown Victoria's $1.57 billion, Ford is generating only $3.34 billion minimum revenue for itself and its dealers through its full-size products marketed comparably to the Impala. Ford executives would do well to study the case of this Chevrolet and ascertain the determinants of its success. Lower pricing probably is highly beneficial to Impala sales, due to the substitution effect; it features one of the lowest costs in the full-size segment and would also offer higher marginal utility per dollar over midsize products.

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[20] Richard Feast, "Why BMW wears the crown," *Automotive News Europe*, December 12, 2005, in *Business Source Premier*, EBSCO*host* (accessed April 16, 2006).

[21] General Motors, "GM reports preliminary first quarter financial results," http://www.gm.com/company/investor_information/earnings/hist_earnings/07_q1/index.html (accessed June 4, 2007).

Ford makes extensive use of joint processing in the full-size market. For example, the Ford Five Hundred and Mercury Montego are built on the set of technologies and components known as the D3 platform, a derivative of the P2 platform developed by Volvo Cars, a Ford subsidiary. For the Ford Crown Victoria, Lincoln Town Car, and Mercury Grand Marquis, the company continues to use the Panther platform. [22] From this extensive use of joint production, we may presume that economies of scope, as the cost-saving benefits of joint production,[23] are significant in the automotive industry. In contrast to the D3-based products and other vehicles of more modern design, the basic engineering of the Panther automobiles is quite old, being that of the MY1979 Ford LTD.[24] This usage of old engineering may result in inflexibility in adapting to current market needs. Nevertheless, this older engineering is not without its merits; National Highway Traffic Safety Administration tests suggest that the 2007 Crown Victoria is at least as safe as the 2007 Five Hundred when equipped with side air bags.[25] Due to the relative novelty of the D3 platform, which necessitated value retention rate estimations in the quantitative model above, it is not feasible to render a meaningful direct comparison of retained value between the two platforms.

General Motors is pursuing similar platform sharing in the full-size segment, and will be using the Zeta platform, engineered by GM Australian subsidiary Holden and likely to be manufactured in Canada, for the MY2011 Impala as well as new Pontiac and Buick products. Specifics of Zeta implementation under the Cadillac brand are as yet unknown,[26] but bears consideration as a means of controlling development and production costs. Insomuch as the platform and its capabilities constitute the product, this process of designing and manufacturing vehicles thereupon for a variety of price points is a system of price discrimination with great potential. For price discrimination to succeed, a market must be stratified in a manner conducive to segregation and unfavorable to arbitrage.[27] The brand-based nature of the discrimination scheme eliminates concerns of arbitrage, as it would be a significant challenge to resell one model of automobile as another to a reasonable buyer, regardless of the platform upon which it were built. Separate branding and differences in optional feature availability demonstrate the use of marketing to create stratification as a prerequisite for price discrimination. Separation of point of sale through multiple dealer networks also strengthens the attempt to segregate those customers likely to buy higher-priced versions of a product. A company, then, can reduce its costs by using the same basic engineering for a wide range of similar products and maximize profits by differentiating them sufficiently through the processes of design and marketing for effective price discrimination.

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[22] Amy Wilson, "Ford's future partly based on foreign platforms," *The San Diego Union-Tribune,* October 30, 2004.

[23] Mansfield, *op. cit.*, 328

[24] Jamie Kitman, "Enteprise: all hail the Crown Victoria," *Metropolis*, May 2000.

[25] United States National Highway Traffic Safety Administration, "SaferCar.gov," http://www.safercar.gov/ (accessed June 12, 2007).

[26] Edmunds Inside Line, "Future watch: big plans for GM's big RWD platform," http://www.edmunds.com/insideline/do/News/articleId=120968 (accessed June 14, 2007).

[27] Mansfield, *op. cit.,* 494

Ford, too, is looking to take further advantage of this method of optimizing profits through intra-platform price discrimination. Following the example of its own success with the Town Car, the company plans to produce its next luxury-tier full-size sedan, the Lincoln MKS, using the D3 platform.[28] Manufacture at the same Ford plant in Chicago as the current D3 vehicles, which has been operating below capacity due to marketing issues with the Five Hundred,[29] will minimize the fixed costs associated with the new product. Due consideration will also be given to the relationship, statistically demonstrated above, between gasoline costs and sales. To improve fuel efficiency, an engine with six cylinders will power the MKS, rather than eight as originally planned, though it will still differentiate it with higher performance than comparable Ford- and Mercury-branded products.[30] In addition, Ford chief executive officer Alan Mulally has indicated that higher-efficiency hybrid powertrains may be forthcoming on the D3 platform, along with other possibilities for increasing fuel economy.[31] A flagship product featuring newer engineering than that of the Panther-based Town Car may also improve upon the dismal value retention of that product, whose retained value percentage ranks among the lowest in the class according to the calculations performed in Worksheet B. If handled well, the introduction of the Lincoln MKS could be an incredibly profitable opportunity for the Ford Motor Company.

Conclusion

In conclusion, despite the troubles faced by domestically owned automobile producers in the United States of America, these firms have opportunities for growth. One such opportunity, discussed herein, is the full-size segment of the car market, in which they continue to hold significant market share and for which the substitution effect dictates growth as energy costs increasingly heighten the expense of inefficient sport utility vehicles.

In addition to the purchase price, other costs and factors have notable effects on automobile sales. Statistical analysis demonstrated that consumers seem to be influenced significantly by fuel economy. Depreciation, too, is a cost to which the market pays attention; variation in value retention rates likely reflect qualitative aspects of products, such as their reliability, comfort, and quality of manufacture. In this arena of retained value, however, American-owned manufacturers Ford Motor Company and General Motors have been faltering; the correlation between domestic ownership of the manufacturer of a product in this market and its five-year value retention rate is strongly negative.

These very firms, though, are making excellent progress in the exploitation of economies of scope through joint production, which they are combining with price discrimination in hopes of maximizing the profits of their enterprise. The automotive industry's characteristics, such as easy stratification and the irrelevance of arbitrage to the new-vehicle market, make it an obvious market in which to engage in these strategies, and the domestic

[28] Jim Mateja, "Camaro on way back; MKS on way," *Chicago Tribune,* August 10, 2006.
[29] Jim Mateja, "MKS only major change coming at Chicago plant," *Chicago Tribune,* September 28, 2006.
[30] Rick Kranz, "Lincoln will get a new 3.7-liter V-6," *Automotive News,* October 30, 2006.
[31] Sarah A. Webster, "Ford celebrates the revival of Taurus," *Detroit Free Press,* June 22, 2007.

automakers have been making moves to increase their exploitation thereof. Ford, in particular, has made progress in this arena, though it seems that some products such as the Mercury Montego – to be renamed Sable for MY2008, to coincide with the repositioning of a revamped Ford Five Hundred as the heir to the only recently discontinued Taurus name[32] – could be more profitable if positioned more distinctly from the products with which it shares its engineering. General Motors, too, is moving in this direction with the development of the Zeta platform, though it remains unclear if this will extend throughout the product range, including the Cadillac luxury brand. What is clear is that while the road ahead for American automobile manufacturers may have a few potholes, it is not necessarily a dead end, particularly if they maximize the potential of the full-size segment.

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[32] Webster, *loc. cit.*

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