Estimating Demand for Passenger Cars : A Model for the Indian Market

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Abstract

Purpose : This study analyzed trends in Indian passenger car sales for the decade 2010–2011 to 2019–2020. These trends were decoded via demand functions estimated using multiple linear regression. This has crucial theoretical and managerial implications.

Methodology : Multiple linear regressions were carried out using SPSS for different segments of the passenger car industry, namely, mini, compact, super compact, mid-size, executive, and premium. While sales of passenger vehicles were the dependent variable, personal disposable income, product price, fuel price, and interest rates were explanatory variables. Secondary data from the Society of Indian Automobile Manufacturers (SIAM), State Bank of India (SBI), Indian Oil Corporation Limited (IOCL), and the Ministry of Statistics and Programme Implementation (MoSPI) were sourced.

Findings : Demand for most types of passenger cars in India has slowed down, except for compact cars. The regressions show that the mini segment is affected by vehicle price and interest rates, and a lower Goods and Services Tax (GST) for small cars could boost sales. In the compact segment, the price remains a significant factor. Interest rates matter most for the super compact segment, while the preference for better category cars or utility vehicles increases with rising income for mid-size and executive segments.

Practical Implications : A demand-side analysis can benefit companies and inform policy decisions to overcome the recent slowdown. The regression model can advance theory and academic research and aid in supply chain management, demand forecasting, and inventory management studies.

Originality : Unlike prior research on the Indian automobile sector, this study bifurcates the heterogeneous market into segments and conducts econometric analyses.

Keywords : **passenger cars, demand estimation, multiple linear regression, Indian automobile sector**

JEL Classification Codes : C01, C13, L62, M21

Paper Submission Date : July 5, 2022 ; Paper sent back for Revision : April 2, 2023 ; Paper Acceptance Date : April 15, 2023 ; Paper Published Online : May 15, 2023

Given its tremendous multiplier effects, a country's automobile sector is widely considered a key driver of growth. It contributes to varied dimensions of economic growth, in particular, and economic development, in general. It contributes to making a nation a global player (Shoeb, 2017). The impact of the auto sector can be strongly felt on employment (both organized and unorganized through backward and forward linkages), exports, foreign direct investment (FDI) inflows, total factor productivity, and research and

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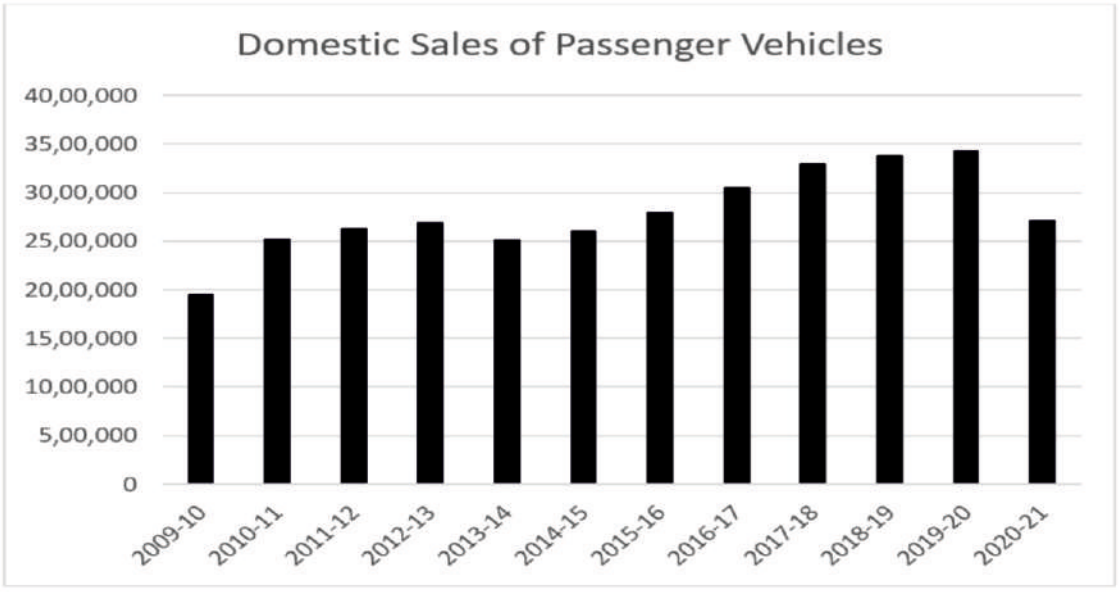
DOI : https://doi.org/10.17010/pijom/2023/v16i5/170124

Figure 1. ***Domestic Sales of Passenger Vehicles in India***



Source : Society of Indian Automobile Manufacturers Yearly Reports.

development (R&D) frontiers in a country. The total worth of the automobile industry in India is ₹ 4.8 trillion. It generates employment for 37 million people and contributes an impressive 7.5% to India's GDP. Between April 2000 and December 2018, FDI inflows to the auto sector stood at US $ 20.85 billion (Abbas, 2018). This makes the automobile sector a core industry and an important pillar of the Indian economy (Chowdhury, 2020). Figure 1 tracks the domestic wholesale sales of passenger vehicles in India over the years 2009–2010 to 2020–2021. In these years, the sales rose by an impressive 39%.

Given the immense importance of the automobile sector, particularly the passenger vehicle segment (its share in the total was 13% in 2017–2018), in economic growth and development, it is useful to examine the sector from a demand–side perspective. In addition, a growing customer focus shall guide most of the companies' decisions because India is fortunate to have a demographic dividend, which is a large share of the working population in the total vis-à-vis that of dependants. Half of India's current population of over 1.2 billion is under the age of 26, making it the youngest country in the world. This demographic dividend is expected to translate into a growing demand for vehicles by the youth.

An analysis of the market pulse in the auto sector has tremendous managerial implications, particularly in the post-COVID current scenario, as it helps automobile companies to make informed decisions regarding production and inventory management. With the uncertainty around the pandemic's impact on consumer behavior, accurate demand estimation can help companies adjust their strategies and prevent potential losses. Companies would be in a better position to spot gaps between customer expectations and their market offerings, and this, in turn, would enable better resource allocation within automobile companies. Companies would, thus, be able to chart out the path for future technical progress and R&D, which is essential in today's competitive and dynamic environment. The analysis can also serve as a pointer for government policy in the sector.

Additionally, low car penetration in India presents a golden opportunity for passenger vehicle manufacturers. To capitalize on the opportunity, they must gear production strategies according to changing demand conditions and consumer perceptions. India has 22 cars per 1,000 people as opposed to China, which has 164, and the US, which has 980 (Abbas, 2018).

This study analyzes the trends in sales of passenger cars for the decade 2010–2011 to 2019–2020 for the Indian market. These trends have been decoded via demand functions estimated using multiple linear regression for all categories of passenger cars as per the Society of Indian Automobile Manufacturers (SIAM) classification. Such an exercise overcomes the research gap of the non-availability of a rigorous econometric exercise in the Indian context that takes into account the inherent heterogeneity in the Indian automobile market. While sales of passenger cars are the dependent variable, personal disposable income (PDI), product price, price of fuel, and interest rates are the independent or explanatory variables. These variables have been drawn with help from a literature review and results from dual moderator focus group interviews. The study is organized as follows. The following section of the study is a literature review of the field. This is followed by the identification of gaps in existing literature, objectives, research methodology, data collection procedures, and the results and analysis. The subsequent sections give the conclusions and managerial and theoretical implications.

Literature Review

In the literature, several attempts have been made to analyze the automobile sector and its associated demand in various countries. The study analyzes the work accomplished over the last six decades and traces the evolution of the sector and demand estimation techniques for the automobile sector. Over the years, researchers have learned to include new determinants of demand as well as factors in the transformation of the sociocultural fabric of society, which brought about a change in consumer reasons for the purchase of products. So important are consumer preferences, and it has been shown by Yoo et al. (2021), that consumer preferences are as important as technological advancement when estimating demand for automobiles in Japan.

A model for the United States (Suits, 1958) estimated the demand for new passenger automobiles. The independent variables were real disposable income, stock of passenger cars, average retail price of new passenger automobiles, and a dummy variable to account for the special conditions of the automobile market. However, the study estimated aggregate demand and ignored the inherent heterogeneity in several subsectors of automobiles. To take account of this heterogeneity, Carlson (1978) developed a multi-equation model (five equations) that could explain demand. The results indicated that disposable income as a variable had the greatest impact on the model. The importance of disposable income was also unearthed in the Indian context (Shende, 2014). The researcher did not use an econometric approach like previous studies mentioned here but concluded, like Carlson's study, that disposable income is the main driver for a car purchase.

The importance of price and income effects has been further emphasized in a study on the automobile sector in Brazil (Vartanian & de Oliveira, 2020), wherein the determinants of demand have been analyzed using an econometric model. Along similar lines as Vartanian and de Oliveira's (2020) study, a study in the Canadian context was reviewed in the literature (Davies, 1976). In this study, the stock of automobiles is described as a function of real per capita disposable income, the purchase price of automobiles, the price of gasoline, the cost of an alternate mode of transportation, the maintenance costs of the vehicle, and the real rate of interest. All the variables had the correct hypothesized signs, and it turned out that the stock of automobiles in Canada reacted quite strongly to changes in the price of gasoline energy. A study related to the analysis of determinants of demand for the German automobile industry was also reviewed (Soellner & Guerzoni, 2009). It explored the impact of the uniqueness-seeking behavior of individuals on the demand schedule. The study showed that consumers have an intrinsic need for uniqueness seeking, and the degree to which a product satisfies this need is to be considered as an additional product characteristic.

Many researchers have studied the American market, the largest in the world, especially in the 1980s and 1990s when native companies like General Motors (GM) and Ford faced stiff competition from Japanese manufacturers (Nissan, Honda, and Toyota). Researchers showed how US automobile majors like GM and Ford failed to keep

pace with changing consumer preferences, which had tilted toward Japanese small cars (Mannering et al., 1991). The latter proved to be much superior in terms of product offerings, price, and quality, and that led to the loss of brand loyalty for American automobile companies. This stresses the fact that researchers should seriously consider brand loyalty. Over time, the Japanese automakers had built trust and loyalty, and the same for American automakers had taken a beating. Years later, in a 2021 study, it was shown that over the period 1980–2018, market concentration in the US market decreased (Grieco et al., 2021).

Another important variable for estimating demand is quality. Trandel (1991) considered the bias attributed to omitting quality when estimating automobile demand. He claimed that because quality as a variable influences the demand for a heterogeneous good and has a positive correlation with price, one cannot possibly omit such a variable in a demand regression. When quality considerations were taken into account, it was observed that there was an increase of 83% in price elasticity. Trandel's analysis did not lay much emphasis on the physical characteristics of automobiles per se. According to him, they were not significant determinants of demand. The latter finding contrasts with many previous disaggregate demand models that find the price and physical characteristics to be significant determinants of demand. However, a study by McCarthy (1996) mentions that Trandel's result of the physical characteristics not having any significant influence on demand could be attributed to the problem of the existence of multicollinearity in his model. According to McCarthy, this also raises the issue of faulty estimation of Trandel's price elasticity because the separate effects of the collinear variables cannot be disentangled. In McCarthy's study, it was found that excluding vehicle quality from a well-specified model (his was a multinomial logit model) is found to have little effect on the estimated income and price elasticities. Direct and cross-price elasticities of demand for gasoline, diesel, hybrid, and battery electric cars have also been calculated for Norway (Fridstrøm & Østli, 2021). The analysis that used a discrete choice model highlighted vehicle and fuel prices as prime factors affecting automobile demand. However, in a very recent study of China, the effects of changes in petroleum prices have not been found to be significant (Lo et al., 2022). In this study, researchers found the effect of tax policy on automobile demand to be more significant. This clearly shows that fiscal policy can also have a telling impact on automobile demand.

Demand forecasting for automobiles can be quite tricky, especially when it varies tremendously at different times of the year. Challenges of demand estimation have been brought to the forefront by Berry et al. (2021). Demand for automobiles is dependent on seasons, festivals, changes in input prices, economic booms and troughs, and intra-country social and economic differences and may depend on the country of origin as well. This view was captured in a study, where it was shown how the demand for automobiles varied depending on the country of origin (Özçam & Sağhk Özçam, 2012). The study revealed that consumers could be biased for or against a product depending on the country in which it is manufactured. This gave a different perspective to demand-side analyses.

Intra-country variability in demand, especially in a heterogeneous country like India, warrants special analyses for specific areas within India. To identify the determinants of preference for passenger cars in Madurai City in Tamil Nadu, a study that used both primary and secondary data was conducted in 2015 (Rajasekar & Rameshkumar, 2015). The study attempted to identify and analyze the factors influencing the selection of a certain brand of car by consumers in Madurai City. The results showed that price and fuel efficiency are the prime factors, and pick-up, comfort, and the latest technology are the least important factors influencing the sample consumers in the study area while purchasing selected brands of cars.

Recent studies have focused on relevant issues like green marketing and sustainability. A study by Diwan and Bodla (2011) emphasized the importance of adopting a sustainable and environmentally conscious approach in the automobile industry and suggested that green marketing can be an effective tool for companies to meet this demand while also gaining a competitive edge in the market. Another study examined consumers' awareness level in Indore, Madhya Pradesh, regarding green marketing in the automobile industry (Thakar et al., 2009). The study

discussed the results of a survey conducted among a sample of consumers in Indore, which revealed that consumers are becoming increasingly aware of the environmental impact of their purchase decisions and are willing to pay a premium for eco-friendly vehicles. The study also identified factors, such as price, quality, and brand reputation, that significantly shaped consumer attitudes toward green marketing in the automobile industry.

An interesting approach emphasizes the importance of using digital channels for understanding the behavior and preferences of car buyers in India and suggests that segmenting car buyers based on their digital behavior can be an effective tool for car manufacturers and marketers to improve their marketing efforts (Rekha & Mishra, 2017). In another study, the authors conducted a survey and used confirmatory factor analysis to identify five key factors that impact purchase behavior, which include brand loyalty, innovation and technology, social influence, price and quality, and convenience (Menon & Jagathy Raj, 2013). The study found that brand loyalty and innovation and technology were the two most important factors that affected consumer behavior. Additionally, the study found that consumers were willing to pay a premium for brands they perceived as innovative and technologically advanced. Specifically, consumer perception on selecting mid-segment cars has been studied (Goyal & Shiva, 2016). The authors conducted a survey using a conjoint analysis approach to examine the relative importance of various car attributes, such as price, brand, fuel efficiency, safety features, and aesthetics. The study found that price was the most important attribute, followed by fuel efficiency and brand reputation, in influencing the selection of mid-segment cars by students.

Another car segment targeted for the study was the premium segment (Ravi & Rangarajan, 2016). The authors conducted a survey and used exploratory factor analysis and confirmatory factor analysis to identify the key dimensions of premium car purchases. The study found that the dimensions of premium car purchases included brand image, perceived quality, prestige value, product features, and price. Specifically, the intention to purchase hybrid cars in India was examined by Khandelwal et al. (2016), who concluded that Indians would take some time to adapt to the idea of hybrid cars. Indians are also gradually warming up to the idea of cab services using apps that indirectly affect the purchase of cars. One such primary study by Chakraborty (2021) concluded that availability and convenience are the most important factors for app-based cab services.

As mentioned above, like some studies on countries other than India, an econometric analysis has not been attempted for India to study the demand estimation of passenger cars, particularly considering the market's heterogeneity. This study attempts to overcome these crucial research gaps.

Research Methodology

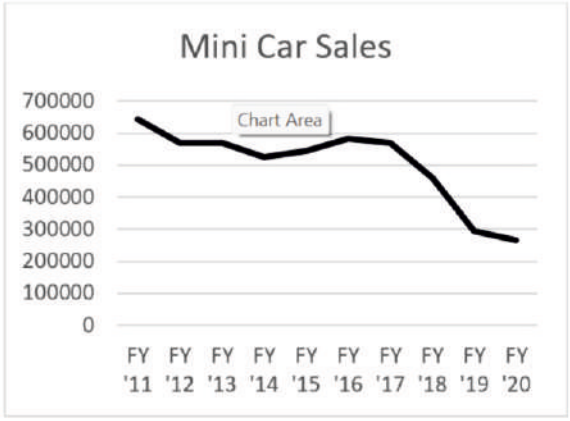
Using data from SIAM, trends have been unearthed for different categories of passenger cars for the Indian market. These have been explained using a demand estimation model, which is a multiple linear regression model. While sales of passenger vehicles are the dependent variable, PDI, product price, price of fuel, and interest rates are the independent or explanatory variables. A detailed literature review and results from dual moderator focus group interviews have helped select these variables. This conforms to panel data analysis using ordinary least squares (OLS).

Trends in Passenger Car Sales

During the reference period, that is, 2010–2011 to 2019–2020, car sales for almost all car segments, barring compact cars, show a decline in sales. The automobile industry in India seemed to face a deep structural slowdown. SIAM data show that the industry faced a steep rise in commodity prices. This, along with higher fuel prices dampened consumer sentiments. The OEMs also increased vehicle prices during the year to offset the higher raw material prices (commodity costs) that increased the purchase price for end-users, further restricting

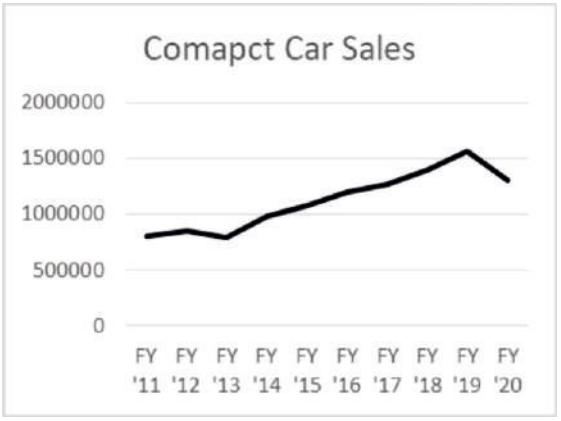
growth. This weakening of demand sentiments, reflected in the graphs in Figures 2 – 7, prompts us to explore the possible causes behind the overall deceleration via demand estimation.

Figure 2. ***Mini Car Sales***



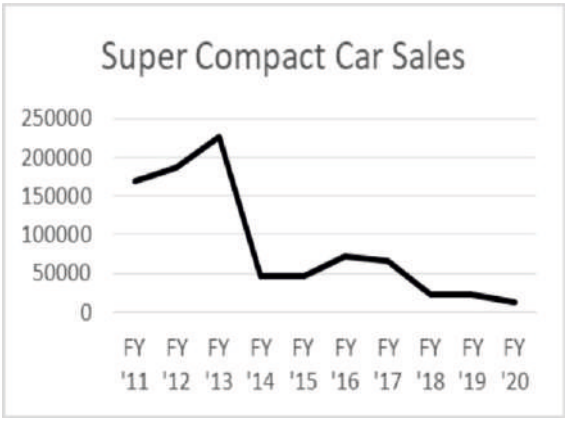
Source : SIAM.

Figure 3. ***Compact Car Sales***



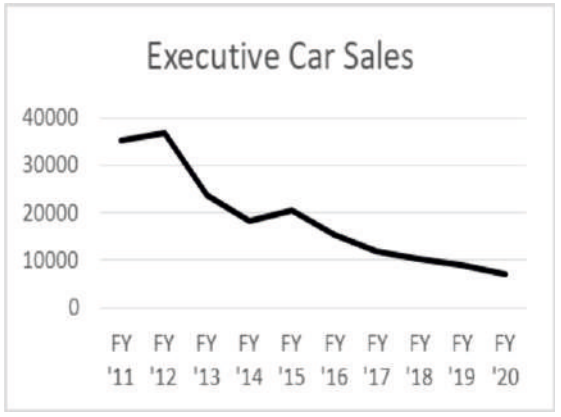
Source : SIAM.

Figure 4. ***Super Compact Car Sales***



Source : SIAM.

Figure 5. ***Executive Car Sales***



Source : SIAM.

Figure 6. ***Mid-Size Car Sales***

Source : SIAM.

Figure 7. ***Premium Car Sales***

Source : SIAM.

Multiple Linear Regression Model

The variables for the model were chosen with help from a literature review and dual moderator focus group interviews. A group of the following four experts from SIAM and Maruti Suzuki India Ltd. (the company with almost 50% market share in passenger vehicles) was constituted to identify the determinants of demand for passenger vehicles:

(1) Mr. Tarun Khurana, Deputy General Manager, Supply Chain Management, Maruti Suzuki India Ltd.

(2) Mr. Pinaki Mukherjee, Senior Manager, Maruti Suzuki India Ltd.

(3) Mr. Kartike Karwal, Associate Director, SIAM.

(4) Ms. Jasleen Kaur, Assistant Director, SIAM.

The researchers, Anjali Khurana and Dr. Vandana Ahuja, served as moderators.

Some of the key questions posed to the group of experts were as follows:

(1) How is the market for passenger vehicles categorized?

(2) What are the determinants of demand for passenger vehicles?

(3) Which variables can be quantified and, therefore, practically used in the mathematical analysis?

(4) How can the price of the vehicle be incorporated in the mathematical and econometric analysis as it keeps varying even within the financial year?

Results were analyzed, and determinants of demand for passenger vehicles were incorporated into an econometric model (Equation 1). We also concluded that given the heterogeneity of the passenger cars market in India, multiple linear regressions need to be conducted for different homogeneous market segments.

According to SIAM, the market for passenger cars can be classified as given in Table 1.

Table 1. ***Classification of Passenger Cars***

Category	Identifying Features
(i) Mini	Seats upto five; Length normally <3,600 mm; Body style-Hatchback ; Engine displacement normally upto 1.0 litre.
(ii) Compact	Seats upto five; Length normally between 3,600 – 4,000 mm; Body style-Sedan/Estate/Hatch/Notchback; Engine displacement normally upto 1.4 litre.
(iii) Super Compact	Seats upto five; Length normally between 4,000 – 4,250 mm; Body style-Sedan/Estate/Hatch/Notchback; Engine displacement normally upto 1.6 litre.
(iv) Mid-Size	Seats upto five; Length normally between 4,250 – 4,500 mm; Body style-Sedan/ Estate/Hatch/Notchback; Engine displacement normally upto 1.6 litre.
(v) Executive	Seats upto five; Length normally between 4,500 – 4,700 mm; Body style-Sedan/Estate/Notchback; Engine displacement normally upto 2 litre.
(vi) Premium	Seats upto five; Length normally between 4,700 – 5,000 mm; Body style-Sedan/Estates; Engine displacement normally upto 3 litre.

Source : SIAM.

Table 2. ***Dependent and Independent Variables***

Dependent Variable	Independent Variables
Wholesale Sales of Passenger Vehicles	(i) Personal Disposable Income
	(ii) Product Price
	(iii) Price of Fuel
	(iv) Interest Rates

Source : The authors using literature review and dual moderator focus group interviews.

In the proposed model, quantity demanded (wholesale sales of passenger vehicles) is the dependent variable; independent variables are given in Table 2.

The independent variables have been tracked over the 10 years (2010–2011 to 2019–2020). They are explained in detail as follows:

↳ ***Product Price.*** This is the price of a particular vehicle in the category (representative vehicle model for the category) that is traced over the period 2010–2011 to 2019–2020. Following the discussion with experts, it was concluded that this should be treated as an indicative price for the category as a whole, as the price of cars varies even within the financial year at least three to four times. This could be due to seasonality, at the time of festivals, or with the change in input prices. Additionally, the price changes from city to city and even from one color to another of the same car model. Therefore, the price of one model (in a certain category) for the same month in a certain city should be tracked over all the financial years. One must also bear in mind that the prices available with SIAM are ex-showroom prices. The car models mentioned in Table 3 are taken into account in each category by SIAM, out of which the relevant model (for which prices can be tracked over the 10 years) has been chosen to represent the entire category of passenger cars.

Table 3. ***Car Models as per SIAM Data***

Category	Car Models	Model Chosen to Track Price
(i) Mini	Hyundai Eon, Maruti Suzuki Alto, Old Wagon R, and Renault Kwid	Maruti Suzuki Alto
(ii) Compact	Ford Figo, General Motors Beat, Honda Jazz, Honda Brio, Honda Amaze, Hyundai Grand i10, Hyundai Xcent, Maruti Suzuki New Wagon R, Nissan Micra, Nissan Datsun, Tata Indica, Tata Indigo, Tata Zest, Toyota Liva, Volkswagen Polo, and Volkswagen Ameo	Maruti Suzuki Wagon R
(iii) Super Compact	Mahindra Verito, Toyota Etios, and Volkswagen Beetle	Mahindra Verito
(iv) Mid-Size	Honda City, Hyundai Verna, Maruti Suzuki Ciaz, Nissan Sunny, Skoda Rapid, Toyota Yaris, Volkswagen Ameo, and Volkswagen Ameo	Honda City
(v) Executive	Honda Civic, Hyundai Elantra, Skoda Laura, Skoda Octavia, Toyota Corolla	Hyundai Elantra
(vi) Premium	Skoda Superb, Volkswagen Passat, Ford Mustang, Toyota Prius, and Toyota Camry	Skoda Superb

Source : SIAM.

↳ ***Interest Rates.*** The interest rate of auto loans from the State Bank of India (SBI), one of the largest Indian banks, has been traced over the said period.

↳ ***Price of Fuel.*** The price of petrol has been used. They have been sourced from Indian Oil Corporation Limited (IOCL).

↳ ***PDI.*** This is the income that remains with a consumer after the deduction of taxes for spending or saving as desired. Net national disposable income was taken to represent PDI. The data were sourced from the National Statistical Office (NSO), Ministry of Statistics and Programme Implementation (MoSPI).

Incorporating factors, such as PDI, interest rates, and fuel prices, will help in deciphering the role of macroeconomic factors on demand for passenger vehicles.

The econometric model (estimated using SPSS) is given below in Equation (1):

Equation (1)

$$S_t = \alpha - \beta_1 P_t - \beta_2 i_t - \beta_3 P_{ft} + \beta_4 I_t + \varepsilon_t \quad (1)$$

where,

S_t = Sales of passenger vehicles in time period t,

P_t = Price of a car,

i_t = Interest rate prevailing in time period t,

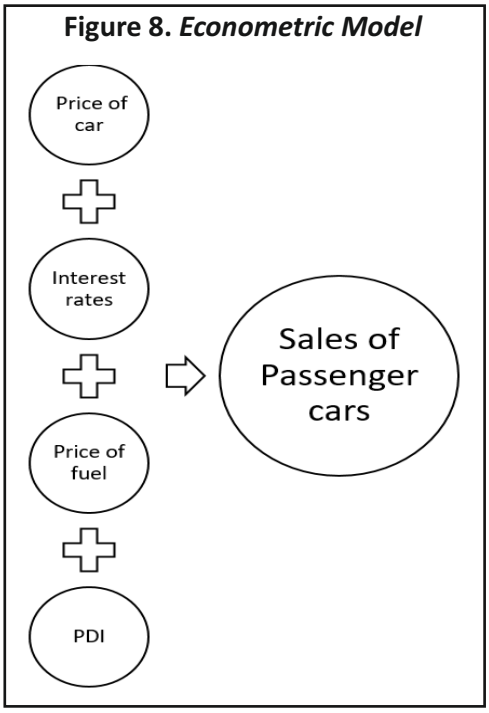
P_{ft} = Price of fuel in time period t,

I_t = Personal disposable income in time period t,

ε_t = Error.

This model is illustrated in Figure 8.

Figure 8. ***Econometric Model***



Analysis and Results

The multiple linear regression has thrown up interesting results that the researchers present in this section. The regression tables are presented in the Appendix.

Mini Segment

For the mini segment, the results have been depicted in Appendix Tables A1, A2, A3, and A4. The regression is robust, with an *R*-square of 0.887. This means that 88.7% of the variation in the dependent variable is explained by all independent variables. This shows that the model is robust. The standardized beta coefficients can also be interpreted here. For the mini segment of cars, all four coefficients are negative. This means that when vehicle price increases by one unit, the sales fall by 0.536. When the fuel price increases by one unit, the sales fall by 0.124 units. When interest rates rise by a unit, car sales drop by 0.722. One can see here that interest rates have the maximum impact on sales of mini cars. This means that for very small cars, the cheapest segment, sales become very sensitive to changes in interest rates. From the macroeconomic policy point of view, the government and RBI should work toward reducing interest rates on very small cars to boost sales. Given that India has a growing middle class, the government can boost car sales and give a fillip to the national income, given that the automobile sector contributes 7.5% to the total GDP. Now coming to PDI, this is the only variable that has a negative relationship with sales, which means that as PDI rises, sales of mini-cars fall. This means that as income rises, people prefer to move to better car models.

Compact Segment

In this case, the *R*-square is quite high, 0.915, indicating that the model is quite robust. In comparison with the mini car category, income is the dominant variable here, affecting car sales in the compact segment. It can be seen from the results that as income rises by one unit, car sales rise by 2.6 units. In addition, as the price of compact cars rises by one unit, the sales decline by 1.159 units. Petrol price has a negligible impact on car sales in the compact category. Interest rates have a positive relationship here with compact car sales, but not a very significant one. These results have been depicted in Appendix Tables B1, B2, B3, and B4.

Super Compact Segment

The results have been shown in Appendix Tables C1, C2, C3, and C4. The model for the super compact category turns out to be robust, with an *R*-square of 0.684. The price of cars and fuel are not very important factors in determining the sales of super compact cars. However, interest rates matter more. As they rise by one unit, the sales drop by 0.484. PDI has a strong inverse relationship with sales of super compact cars as, when it increases by one unit, sales drop by 1.496 units, indicating that when income goes beyond a certain level, people would like to shift toward the mid-size, executive, and premium segments of cars or even the utility vehicles.

Mid-Size Segment

The model is again robust with an *R*-square of 0.609. For the mid-size segment, when vehicle price rises by one unit, sales rise by nearly one unit, indicating that to some extent cars in the mid-size segment are considered brands and cars people can flaunt. These are treated as luxury goods. Fuel price is highly insignificant as a factor affecting sales in this category of cars. A counterintuitive result, in this case, is that as income increases by one unit, sales fall by 1.58 units, indicating that people prefer to move to executive and premium segments or utility vehicles (as

explained above) as income increases. The mathematical results are shown in Appendix Tables D1, D2, D3, and D4.

Executive Segment

Once again, as shown in the Appendix Tables E1, E2, E3, and E4, the *R*-square of 0.897 indicates that the model is quite robust. In this category, price is not a very significant variable affecting car sales. However, as fuel price rises by a unit, sales of this segment of cars fall by nearly one unit. Once again, as income rises, people move to the next premium segment of cars or utility vehicles, as there is a negative relationship of PDI with car sales in the executive segment.

Premium Segment

The model is robust, with an *R*-square of 0.676. The results as depicted in Appendix Tables F1, F2, F3, and F4, have been analyzed. Car sales in the premium segment are highly sensitive to changes in price. As the price increases by one unit, sales fall by slightly more than two units, that is, almost double. Fuel price change has a lesser but still significant impact. Disposable income also has a significant impact. As PDI increases by one unit, car sales also increase by almost a unit. In this segment of cars, interest rates have quite an insignificant impact.

Managerial and Theoretical Implications

Rapid urbanization has increased the demand for passenger vehicles in India. Although demographic and macroeconomic trends fluctuate in contemporary times, it is clear that the sector will soon bounce back, with the long-term government focus on the same. As India prepares for the National Electric Mobility Mission plan, the government and industry will see a manifold rise. India is expected to rise hugely as a manufacturing hub, as the government brings in plans to bring emission standards in line with global standards and improve the fuel efficiency of its automobiles. As the Indian automobile sector prepares to venture into the future with goals for electrification, internet connectivity, and shared mobility, backed by better transport infrastructure, the demand for passenger vehicles is set to escalate. A more informed set of decision-makers in this sector will benefit as research studies, like this venture, head to reduce the perception gap between consumer expectations and organizational decision-making.

Given the recent slowdown in the automobile sector in India (Goyal, 2019), a demand-side analysis can strengthen our understanding of the sector and suggest ways to get out of this trough. It can be of immense benefit to companies to know how much demand side factors influence automobile sales, particularly in a scenario when the government's sustained push for electric mobility has created doubts for buyers who are now comparing the ownership cost of a petrol/diesel car to that of a battery-powered car. This can be crucial for companies already invested in India as well as potential entrants. The model constructed and estimated in this study can help advance theory and academic research by testing existing theories, developing new theories, refining measurement techniques, improving forecasting accuracy, and informing policy decisions. Supply chain management studies, demand forecasting studies, and inventory management studies can use this model effectively to further build the academic body of research.

Conclusion

The above analysis has attempted to outline the trends in all segments of passenger cars in India. These trends clearly show that the demand for almost all types of passenger cars, barring compact cars, has decelerated over the

period in question. Examination of the results from demand estimation using multiple linear regression for each of these segments elucidates different factors that affect demand and thus aid in policy recommendations.

For the mini segment, vehicle price and interest rates are significant variables affecting demand. For very small cars (length <3600 mm and engine displacement up to 1 liter), this is to be expected as companies pitch for these cars based on their attractive price. This is the entry-level passenger car category and, therefore, very sensitive to price. This has implications for the government's taxation policy. A lower Goods and Services Tax (GST) for small cars is likely to give a good boost to sales and aid in India's transformation in terms of giving a fillip to manufacturing and industry, which is deemed necessary for India's growth and development (Suresh Babu & Jithin, 2020). For the compact segment, once again, for the reasons explained above, price is a significant factor affecting demand. As for the super compact segment, interest rates matter most. In this segment, PDI has an inverse relationship with demand, indicating a strong preference of consumers for better category cars or utility vehicles as income rises. This is also true for the mid-size and executive segments.

Limitations of the Study and Suggestions for Future Research

The researchers strongly feel that demand for utility vehicles and vans (the other two categories of passenger vehicles, besides passenger cars) can be taken up for further research. This might give a detailed insight into the demand for passenger vehicles as a whole. In this sense, the present study leaves room for future research and analysis.

Authors' Contribution

Anjali Khurana conceived the idea and developed the quantitative regression model to analyze the passenger car segment over the aforesaid time. Prof. Vandana Ahuja and Anjali Khurana served as moderators for the dual focus group interviews. Prof. Phani Tej Adidam helped extract research papers with high repute, and Prof. Vandana Ahuja and Anjali Khurana filtered these based on keywords and chose the relevant variables that would serve as dependent and independent variables. The analysis of the data was done by Anjali Khurana and Vandana Ahuja. Anjali Khurana wrote the manuscript in consultation with both authors.

Conflict of Interest

The authors certify that they have no affiliations with or involvement in any organization or entity with any financial interest or non-financial interest in the subject matter or materials discussed in this manuscript.

Funding Acknowledgement

The authors received no financial assistance for the research, authorship, and/or publication of this article.

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Appendix

Appendix A. *Mini Segment*

Table A1. *Variables Entered/Removed*[a]

Model	Variables Entered	Variables Removed	Method
1	Interest Rates, Fuel Price, Vehicle Price, and Disposable Income[b]	.	Enter

Note. [a.] Dependent Variable: Sales of Vehicles.

[b.] All requested variables entered.

Table A2. *Model Summary*

Model	*R*	*R*-Square	Adjusted *R*-Square	Std. Error of the Estimate
1	.942[a]	.887	.797	56595.019

Note. [a.] Predictors: (Constant), Interest Rates, Fuel Price, Vehicle Price, and Disposable Income.

Table A3. *ANOVA*[a]

Model		Sum of Squares	*df*	Mean Square	*F*	Sig.
1	Regression	126056008327.620	4	31514002081.905	9.839	.014[b]
	Residual	16014980751.980	5	3202996150.396		
	Total	142070989079.600	9			

Note. [a.] Dependent Variable: Sales of Vehicles.

[b.] Predictors: (Constant), Interest Rates, Fuel Price, Vehicle Price, and Disposable Income.

Table A4. *Coefficients*

		Unstandardized Coefficients		Standardized Coefficients		
Model		*B*	Std. Error	Beta	*T*	Sig.
1	(Constant)	3028698.580	1173401.841		2.581	.049
	Vehicle Price	–2.565	4.289	–.536	–.598	.576
	Fuel Price	–2468.824	5126.659	–.124	–.482	.650
	Disposable Income	–.003	.003	–.906	–.840	.439
	Interest Rates	–113349.186	71469.490	–.722	–1.586	.174

Appendix B. Compact Segment

Table B1. *Variables Entered/Removed*[a]

Model	Variables Entered	Variables Removed	Method
1	Interest Rates, Fuel Price, Disposable Income, and Vehicle Price[b]	.	Enter

Note. [a.] Dependent Variable: Sales of Vehicles.

[b.] All requested variables entered.

Table B2. ***Model Summary***

Model	*R*	*R*-Square	Adjusted *R*-Square	Std. Error of the Estimate
1	.956[a]	.915	.846	103714.443

Note. [a.] Predictors: (Constant), Interest Rates, Fuel Price, Disposable Income, and Vehicle Price.

Table B3. ***ANOVA***[a]

Model		Sum of Squares	*df*	Mean Square	*F*	Sig.
1	Regression	576244953170.037	4	144061238292.509	13.393	.007[b]
	Residual	53783428218.063	5	10756685643.613		
	Total	630028381388.100	9			

Note. [a.] Dependent Variable: Sales of Vehicles.

[b.] Predictors: (Constant), Interest Rates, Fuel Price, Disposable Income, and Vehicle Price.

Table B4. ***Coefficients***

		Unstandardized Coefficients		Standardized Coefficients		
Model		*B*	Std. Error	Beta	*t*	Sig.
1	(Constant)	1090283.537	3027500.676		.360	.733
	Vehicle Price	–6.415	6.673	–1.159	–.961	.381
	Fuel Price	–8863.012	9636.000	–.211	–.920	.400
	Disposable Income	.018	.007	2.607	2.381	.063
	Interest Rates	137843.509	142726.835	.417	.966	.379

Appendix C. *Super Compact Segment*

Table C1. ***Variables Entered/Removed***[a]

Model	Variables Entered	Variables Removed	Method
1	Interest Rates, Fuel Price, Vehicle Price, and Disposable Income[b]	.	Enter

Note. [a.] Dependent Variable: Sales of Vehicles.

[b.] All requested variables entered.

Table C2. ***Model Summary***

Model	*R*	*R*-Square	Adjusted *R*-Square	Std. Error of the Estimate
1	.827[a]	.684	.432	58320.283

Note. [a.] Predictors: (Constant), Interest Rates, Fuel Price, Vehicle Price, and Disposable Income.

Table C3. *ANOVA*[a]

Model		Sum of Squares	*df*	Mean Square	*F*	Sig.
1	Regression	36841079506.507	4	9210269876.627	2.708	.152[b]
	Residual	17006276859.093	5	3401255371.819		
	Total	53847356365.600	9			

Note. [a.] Dependent Variable: Sales of Vehicles.

[b.] Predictors: (Constant), Interest Rates, Fuel Price, Vehicle Price, and Disposable Income.

Table C4. *Coefficients*

		Unstandardized Coefficients		Standardized Coefficients		
Model		***B***	**Std. Error**	**Beta**	***T***	**Sig.**
1	(Constant)	624095.025	805908.647		.774	.474
	Vehicle Price	.183	.808	.128	.227	.829
	Fuel Price	2257.326	5222.501	.184	.432	.684
	Disposable Income	–.003	.002	–1.496	–1.258	.264
	Interest Rates	–46804.427	77995.803	–.484	–.600	.575

Appendix D. *Mid-Size Segment*

Table D1. *Variables Entered/Removed*[a]

Model	Variables Entered	Variables Removed	Method
1	Interest Rates, Fuel Price, Disposable Income, and Vehicle Price[b]	.	Enter

Note. [a.] Dependent Variable: Sales of Vehicles.

[b.] All requested variables entered.

Table D2. *Model Summary*

Model	*R*	*R*-Square	Adjusted *R*-Square	Std. Error of the Estimate
1	.780[a]	.609	.296	28890.646

Note. [a.] Predictors: (Constant), Interest Rates, Fuel Price, Disposable Income, and Vehicle Price.

Table D3. *ANOVA*[a]

Model		Sum of Squares	*df*	Mean Square	*F*	Sig.
1	Regression	6498792181.608	4	1624698045.402	1.947	.241[b]
	Residual	4173347261.292	5	834669452.258		
	Total	10672139442.900	9			

Note. [a.] Dependent Variable: Sales of Vehicles.

[b.] Predictors: (Constant), Interest Rates, Fuel Price, Disposable Income, and Vehicle Price.

Table D4. *Coefficients*

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	**Std. Error**	**Beta**	***t***	**Sig.**
1	(Constant)	–154128.005	1229306.450		–.125	.905
	Vehicle Price	.349	1.340	1.184	.260	.805
	Fuel Price	–508.409	2703.546	–.093	–.188	.858
	Disposable Income	–.001	.004	–1.578	–.379	.720
	Interest Rates	14562.559	40469.276	.338	.360	.734

Appendix E. *Executive Segment*

Table E1. *Variables Entered/Removed*[a]

Model	Variables Entered	Variables Removed	Method
1	Interest Rates, Fuel Price, Vehicle Price, and Disposable Income[b]	.	Enter

Note. [a.] Dependent Variable: Sales of Vehicles.

[b.] All requested variables entered.

Table E2. *Model Summary*

Model	*R*	*R*-Square	Adjusted *R*-Square	Std. Error of the Estimate
1	.947[a]	.897	.814	4503.866

Note. [a.] Predictors: (Constant), Interest Rates, Fuel Price, Vehicle Price, and Disposable Income.

Table E3. *ANOVA*[a]

Model		Sum of Squares	*df*	Mean Square	*F*	Sig.
1	Regression	880525432.781	4	220131358.195	10.852	.011[b]
	Residual	101424056.119	5	20284811.224		
	Total	981949488.900	9			

Note. [a.] Dependent Variable: Sales of Vehicles.

[b.] Predictors: (Constant), Interest Rates, Fuel Price, Vehicle Price, and Disposable Income.

Table E4. *Coefficients*

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	**Std. Error**	**Beta**	***T***	**Sig.**
1	(Constant)	–26234.387	76375.170		–.343	.745
	Vehicle Price	.010	.041	.166	.245	.816
	Fuel Price	–454.672	409.349	–.274	–1.111	.317
	Disposable Income	.000	.000	–.391	–.492	.643
	Interest Rates	7175.303	5625.418	.550	1.276	.258

Appendix F. *Premium Segment*

Table F1. *Variables Entered/Removed*[a]

Model	Variables Entered	Variables Removed	Method
1	Interest Rates, Fuel Price, Disposable Income, and Vehicle Price[b]	.	Enter

Note. [a.] Dependent Variable: Sales of Vehicles.

[b.] All requested variables entered.

Table F2. *Model Summary*

Model	*R*	*R*-Square	Adjusted *R*-Square	Std. Error of the Estimate
1	.822[a]	.676	.416	1315.054

Note. [a.] Predictors: (Constant), Interest Rates, Fuel Price, Disposable Income, and Vehicle Price.

Table F3. *ANOVA*[a]

Model		Sum of Squares	*df*	Mean Square	*F*	Sig.
1	Regression	18021271.527	4	4505317.882	2.605	.161[b]
	Residual	8646828.873	5	1729365.775		
	Total	26668100.400	9			

Note. [a.] Dependent Variable: Sales of Vehicles.

[b.] Predictors: (Constant), Interest Rates, Fuel Price, Disposable Income, and Vehicle Price.

Table F4. *Coefficients*

		Unstandardized Coefficients		Standardized Coefficients		
Model		*B*	Std. Error	Beta	*t*	Sig.
1	(Constant)	34322.163	36839.558		.932	.394
	Vehicle Price	–.013	.011	–2.038	–1.171	.294
	Fuel Price	–98.879	120.484	–.361	–.821	.449
	Disposable Income	7.064E–5	.000	1.604	1.071	.333
	Interest Rates	122.473	1978.536	.057	.062	.953

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