A Business Dynamics Exploratory Model for Reviewing Industry Evolution in Developing Countries: The Case of the Egyptian Automobile Industry

Mohamed Askar, Ph.D[1]
Karim Assabghy, MBA[2]
Syed Imam, Ph.D[3]
The American University in Cairo

Abstract

The automotive industry is considered as one of the main drivers of today's global economy. The industry spans across the globe, with nearly each country trying to develop the industry and its supply chain within its boundaries. This paper presents a Business Dynamics model that maps the Egyptian Automotive industry, which started as a public industry and then transformed to a market driven private industry. The Egyptian automotive industry focuses on the local Egyptian market, with no current plan for exporting to the global market. Such focus provides the Egyptian automotive industries with challenges that impede its growth.

The Business Dynamics model presented in the paper presents an explanation of the current status of the Egyptian Automotive industry. The model is then used to provide insights for the current status of the industry, as well as testing several policy options for stimulating the industry's growth.

Introduction

The automotive industry is considered one of the largest global industries in today's economy, employing a direct workforce of about four million workers, with a further ten million workers involved in automotive material and component production. The industry is dominated by triad groups of trans-national giants from the USA, Japan, and Europe who operate throughout the globe and account for 90 per cent of the total output. According to Donnelly (2002), the industry is considered as one of the main drivers of global economic growth, where attempts are still being made to develop the industry farther in all parts of the world, namely; Argentina, Brazil, Uruguay, Paraguay, Thailand, Korea, Malaysia, India, Vietnam, as well as China. This paper presents a model that investigates the future prospects of the Egyptian Automotive industry. The model is formulated using systems dynamics, which provides a framework for capturing and analyzing the dynamics of the industry.

[1] Assistant Professor of Operations Management, Department of Management, The American University in Cairo, 11 Youssef El Gindi Street, Cairo, Egypt; email: maskar@aucegypt.edu

[2] MBA Graduate, The American University in Cairo

[3] Associate Professor of Operations Management, Department of Management, The American University in Cairo, 11 Youssef El Gindi Street, Cairo, Egypt; email: simam@aucegypt.edu

This paper presents a business dynamics model that examines the factors affecting the growth of the Egyptian Automotive Industry. Following this introduction, some of literature related to the Automotive Industry is presented, outlining the automotive industry's growth opportunities and the major forces that shape its future. The state of the Egyptian Automotive Industry, its historical development, current structure and the main obstacles facing its growth are then presented. Next, the business dynamics model that maps the structure of the Egyptian Automotive Industry is presented. The various policy scenarios for stimulating Egyptian Automotive Industry growth are then presented and analyzed. Finally, some concluding remarks and recommendations for further research are presented.

The Global Automotive Industry

The automotive industry is a dynamic global industry that spans over ever all continents of the globe, with each country trying to establish foot hold on the global market place. The industry dynamics is attributed to many factors such as; over-capacity, increasing customer requirements, tougher environmental regulations, and rapid technology developments, Corswant (2002). When considering the trends that shape the industry, there is strong evidence towards global industry operations, where car manufacturers and their suppliers are reaching out to open new global markets and establish global production facilities, Sturgeon (1999), and Ghemawat (2000).

There are several forces that shape the competitive environment of the automotive industry. First, the automotive industry has been experiencing several mergers and acquisitions, where companies merge together to expand their global product offering. Examples of such actions are; the merger between Daimler and Chrysler, Ford's acquisition of Volvo and Jaguar, and General Motors acquisition of Saab. This trend further extends to the automotive supplier's companies where few actors are becoming the main player by the acquisition of smaller suppliers, McIvor (1998) and Lewis (1999).

Second, there has been an increased emphasis on outsourcing throughout the automotive industry, Mercer (1995). This has resulted in companies outsourcing certain specialized activities to specialized suppliers, so they can free and focus their productive capacities on activities they are distinctively good at, Venkatesan (1992). Such outsourcing has led to the placing of important activities outside the boundaries of the firm, Richardson (1972), which in turn has called for the development of strategic alliances between the automotive companies and their suppliers, Financial Times (1994), and Donnelly (2002).

Third, dynamic technology developments coupled with increased global competition and changing customer needs have resulted in shorter product life cycles. This in-turn has put pressure on the industry to reduce cost, reduce product development, and implement technologies and practices that lead towards faster production ramp-ups, Lamming (1993) and Almgren (1999).

Moreover, best practices that govern the automotive industry call for the reduction of inventories. This move is due to the adoption Just-In-Time based production strategies, where companies focus on reducing all forms of inventories, Womack (1996).
At the same time, customers are demanding product customization, that require companies to develop modular designs, reduce finished product inventories, as well as decrease product delivery times, Baldwin (1997), Mercer (1995), Monden (1983), and Elias (2000), all of this has an effect of moving the industry towards a build to order environment rather than the classical build to stock environment, Holweg (2002).

Based on this brief presentation of the literature related to the automotive industry, Corswant(2002) have identified the following trends that govern the future of the automotive industry. These trends are presented in table 1.

Table 1. Trends Affecting the Automotive Industry

Increasing importance of key performance criteria (delivery precision, quality, cost)
Shorter product life cycles
Production and product development activities become more global
Outsourcing is increasing
Companies reduce their supply base
Product development time is decreasing
Supplier account for an increasing share of product development resources
Use of JIT deliveries is increasing

The Development of the Egyptian Automotive Industry

The Egyptian Automotive Industry started as part of the National Industrialization policies of late President Nasser during the early 1960's era. The industry started by the establishment of the public owned assembly companies for the production of passenger cars, trucks and buses. These companies assembled cars under license agreements with the Italian manufacturer Fiat, the former East German manufacturer NSU, and the German truck and bus producer Magirus Deutz. The industry was established to produce cars for the domestic market, with no plans being established for expanding the industry's focus towards exports.

Following the 1960's era, Egypt engaged in an open door policy under President Sadat's regime, where imports were allowed, and Egyptian consumers had the choice of foreign cars besides the locally assembled cars. The local public companies served the lower end of the market, producing mainly economy cars that are based on simple technology that is cheap to maintain and repair given the unskilled after market auto repair industry. Further, locally assembled cars were protected by the government who imposed high import tariffs and customs that made the foreign imported cars extremely expensive compared to the locally assembled cars.

During the 1980's the Egyptian economy was hit with several set backs due to the falling oil prices as well as the increased trade and budget deficits. This has resulted in the

government engaging in several economic reform programs focused on controlling the budget deficits, and limiting the exploding foreign trade deficit. Polices under such reform programs included several currency devaluations, and imposing severe restrictions on imports that included ban on any product that is locally produced. Such import ban extended to cover the automobile market, leaving Egyptian customer with no choice but buying the locally assembled cars.

The economic reform policies that started during the late 1980's were focused on reducing foreign imports at the same time providing an environment that supports the creation of Egyptian industries that produce products to replace the foreign imports. The industrialization policy that started during the late 1980's was focused on providing the private sector the leadership in starting up industries that were formerly controlled by public sector companies. This included the opening of the automotive industry for the private sector, which started developing assembly plants during the 1990's.

The 1990's decade have witnessed the growth of the Egyptian automotive industry, where private investors entered the automotive industry forming partnerships with the various global giants, to assemble cars in Egypt. The competitiveness of the automotive assembly industry was based on the lower tax and customs bracket imposed on importing car components, as well as the extent of use of local components and labor in the assembly process. This is compared to the much higher customs tariffs imposed on foreign manufactured cars that range from 100% to 200% of the car value, while components enjoy a 40% customs tariffs.

To encourage the growth of the automotive industry, the government provided the newly formed private automotive industry with investment incentives such as tax breaks to help start the industry. Added to that, the Egyptian government required these assemblers to use certain percentage of locally assembled components. Such percentages are periodically reviewed and increased to stimulate local component production.

Moving to the size of the Egyptian automotive market, the Egyptian market consumes an average of about 50,000 per year. This is relatively small compared to other world markets. Table 2 presents a summary of the total market size for 2003 broken down by locally assembled and imported cars.

Table 2. Egyptian 2003 Automotive Sales based on Origin

Car Origin	2003 Sales [units]
Locally Assembled Cars	31,569
Imported Cars	20,368
Total	**51,937**

The volume of the locally assembled cars is the result of assembling cars for 13 different manufacturers. The total number of units produced by each of these assemblers in 2003 is presented in table 3.

Table 3. Breakdown of Locally Assembled Cars by Manufacturer [2003]

Car Make	2003 Sales [units]
BMW	35
Citroen	101
Daewoo	10,851
Fiat	2,257
Hyundai	1,622
Jeep	806
KIA	1,203
Lada	870
Mercedes	1,682
Opel	4,071
Peugoet	1,752
Suzuki	152
Tofas	6,167
Total	**31,569**

Formulation of Business Dynamics Model

After presenting a summary of the trends affecting the global automotive industry, and a short history about the development of the Egyptian automotive industry, this section presents a business dynamics model for the mapping of the Egyptian Automotive Industry. The model is developed using IThink software, and is mapped as follows.

The mapping of the Egyptian Automotive Industry is developed in two parts; Car market, and Spare Parts market. There are two sources for new cars in the Egyptian market; Locally assembled and Imported cars. The causal structure of the Egyptian automotive market is presented in figure 1.

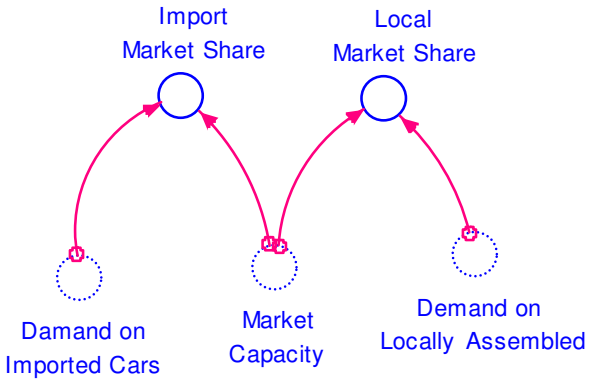

Figure 1 Structure of the Egyptian Car Market

The market capacity is determined by the size of the current market multiplied by the annual market growth rate, which is modeled as an exogenous variable determined by the economic conditions of the country. The demand figures for the locally assembled and

imported cars are determined by the price gap; defined as the difference between the price of the imported cars in the Egyptian market, and the price of the locally assembled cars. The price on the imported cars is determined by the price of the car in the international market measured in US dollars, multiplied by the Dollar-Pound exchange rate times the customs rate imposed by the Egyptian government of imported cars. The customs rate and the Dollar-Pound exchange rate are modeled as exogenous variables that are changed during the simulation to reflect the various policy scenarios set by the Egyptian government. The mapping of this structure is presented in figure 2.

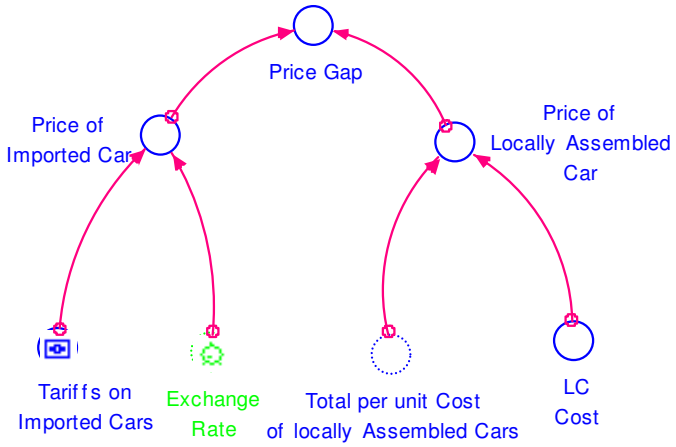

Figure 2 Mapping of the Price Gap between Locally assembled cars and Imported Cars

The price of the locally assembled car is the sum of the price of components used; local and imported, and per unit cost of local assembly. The per unit cost of the local assembly is calculated as the sum of the cost of components; local assembly cost per unit which is subjected to economies of scale forces.

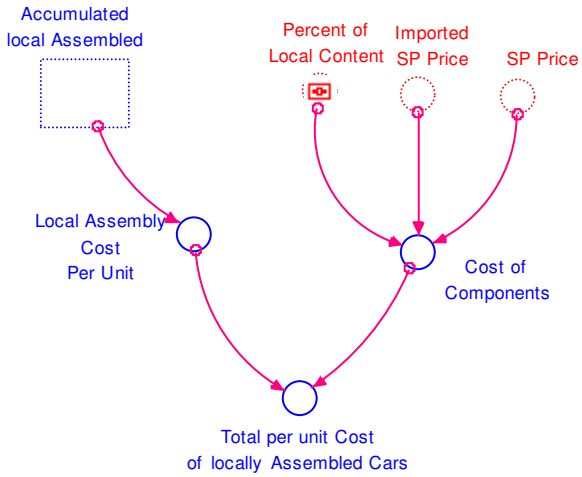

Figure 3 Mapping of the Per Unit Cost of Local Assembly

The price gap then determines the buying decision of the Egyptian customer, whether to buy imported or locally assembled cars. The total annual sale of new cars is then calculated as the sum of the local assembled and imported cars. The aging of the cars is then mapped in an aging chain presented in figure 4. The chain contains three stocks that represent the various types of cars on the Egyptian roads. The first stock represents the late cars on the road. These cars usually are in good shape and have minor demand of spare parts. The second stock represents the older cars on the road, which require lots of repair, hence demanding more spare parts for their running. Finally, the third stock represents the amount of cars discarded and scraped, and no longer are economical to fix or drive.

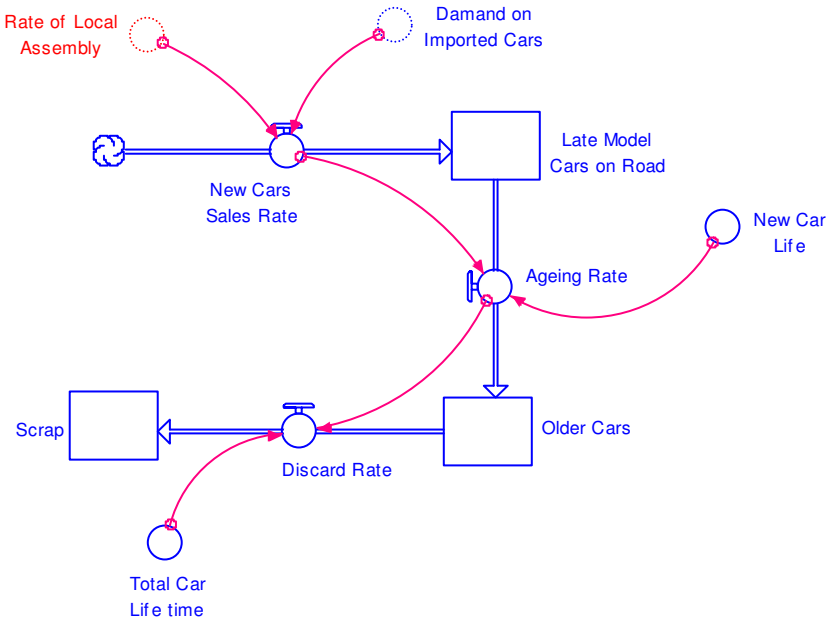

Figure 4 Car Aging Chain

The local assembly process is then modeled as presented in figure 5. The rate of local assembly is determined by the demand of locally assembled cars. The total of units assembled is then calculated, as it provides the total experience acquired by Egyptian assemblers that determine the extent of dynamic economies of scale and learning curve effect.

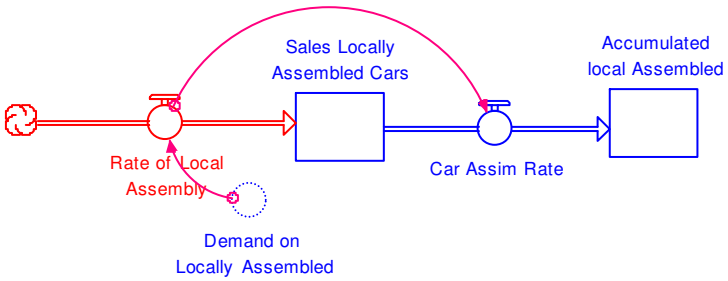

Figure 5 Local Car Assembly Flow

Moving to the structure of the spare parts market, it is modeled in a similar fashion as the car assembly. The production flow is presented in figure 6, which demonstrates a modeling pattern similar to the local assembly flow presented in figure 5.

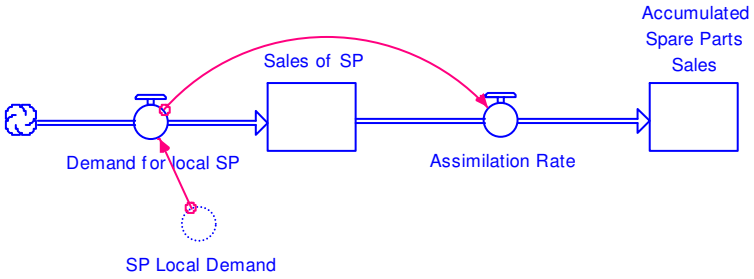

Figure 6 Spare Parts Production Flow

The demand for spare parts is calculated as the sum of the spare parts consumed by the local assembly process, and the spare parts consumed by cars on the road. The spare parts demand generated by the local assembly process is calculated as the product of the rate of local assembly multiplied by the percent of the local content consumed in their production. The extent of local content is modeled as an exogenous policy variable to test the effect of increasing the percentage of local content on the Egyptian Automotive Industry.

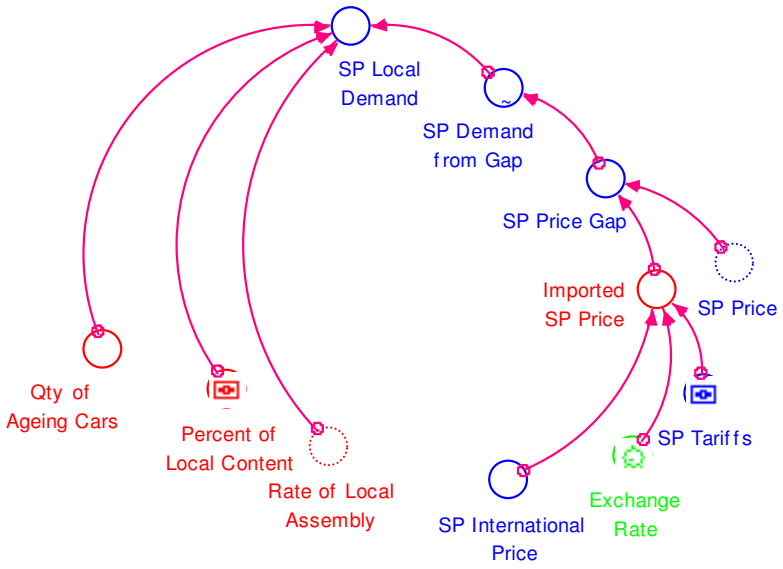

Figure 7 Demand for Locally Produced Spare Parts

Added to the demand generated by the local assembly operations in Egypt, another form of locally produced spare parts demand is generated due to the price advantage of the locally produced spare parts compared to the imported spare parts. The price differential between the locally produced spare parts and the imported spare parts form a price gap, similar to that of the finished cars. The price gap then determines the demand on locally

produced spare parts generated due to the cost advantage of local production versus imported spare parts.

The final leg of the model deals with investment in final car assembly and spare parts production. This is mapped using two similar flows presented in figures 8 and 9 respectively. The rate of entry of new investors to the assembly market is determined by the return on investment on local car assembly. This is determined by the local assemblers profit, as it increases it creates an environment that attracts more investors to the local assembly market. On the other side, the decrease in return on investment for local assembly process due to increased competition forms a negative feedback loop that drives investors out of the market, hence decreasing the number of assembly operations operating in the Egyptian market.

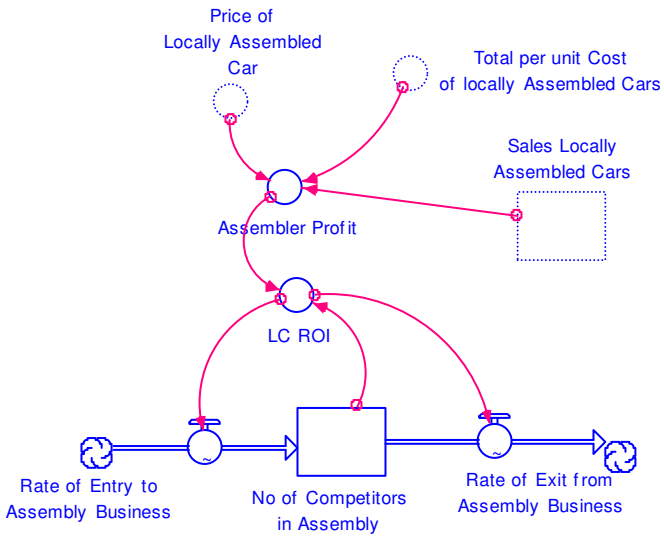

Figure 8 Investment in Final Car Assembly model

The same logic is used to model investment in the spare parts market. The increase in spare parts profits increases the return on investment in the spare part manufacturing. This in turn increases investments in the Egyptian spare parts manufacturing, hence increasing the number of Egyptian spare parts producers. However, the decrease in return on investment in spare parts triggers a negative feedback loop that decreases the number of Egyptian spare parts producers, decreasing the total number of Egyptian spare parts producers.

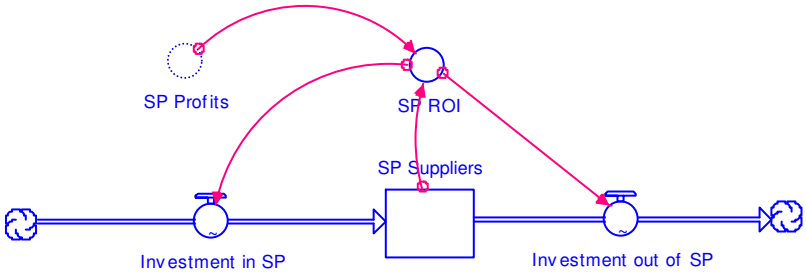

Figure 9 Investment on Spare Parts Production Model

Policy Analysis and Simulation Results

This section presents three scenarios for testing the business dynamics model presented in the previous section. These scenarios describe the following cases:

1. The state of the Egyptian Automotive Industry prior to 2004 Economic reform policies.
2. Effect of 2004 Economic reform policies.
3. Stimulating future growth of the Egyptian Automotive Industry.

Each of these scenarios is simulated for a period of 10 years that start from the year 2003 which represents year 1. The details of each scenario are presented in the following subsections.

Scenario 1: State of the Egyptian Automotive Industry before 2004 Economic Reform Policies

The Egyptian government has imposed several economic reform policies during the summer of 2004. These reforms were focused on reducing customs on imports of components as well as on certain class of cars. Prior to 2004 reform policies, the government used to impose customs on imported cars based on their engine capacity that range from 100% to 200% of the car price. In formulating this scenario, we considered cars with engine capacity less than or equal to 1.6 liters, which was subjected to decrease in customs tariffs from 100% to 40%.

Table 4. Scenario 1 Assumptions

Variable	Value
Price of Imported Car [US Dollars]	$16,000
Egyptian Pound-US Dollar Exchange Rate [Pounds per Dollar]	6.25
Customs Rate on Imported Cars [%age of Car Price]	100%
Customs Rate on Imported Spare Parts [%age of price]	50%
Minimum percentage of Local Content [%age of Car Value]	40%
Initial Market Size [Units sold per Year]	50,000
Annual Market Growth rate [%age growth per year]	10%
Average life of cars on the Egyptian Roads [Years]	25

This scenario represents the basis for evaluating the growth of the Egyptian Automotive Industry. In developing this scenario, the assumptions presented in table 4 were considered.

The simulation of scenario 1, with the input values presented in table 4 identifies several challenges facing the lifelong competitiveness of the Egyptian Automotive Industry. The growth of the Egyptian car market is presented in figure 10.

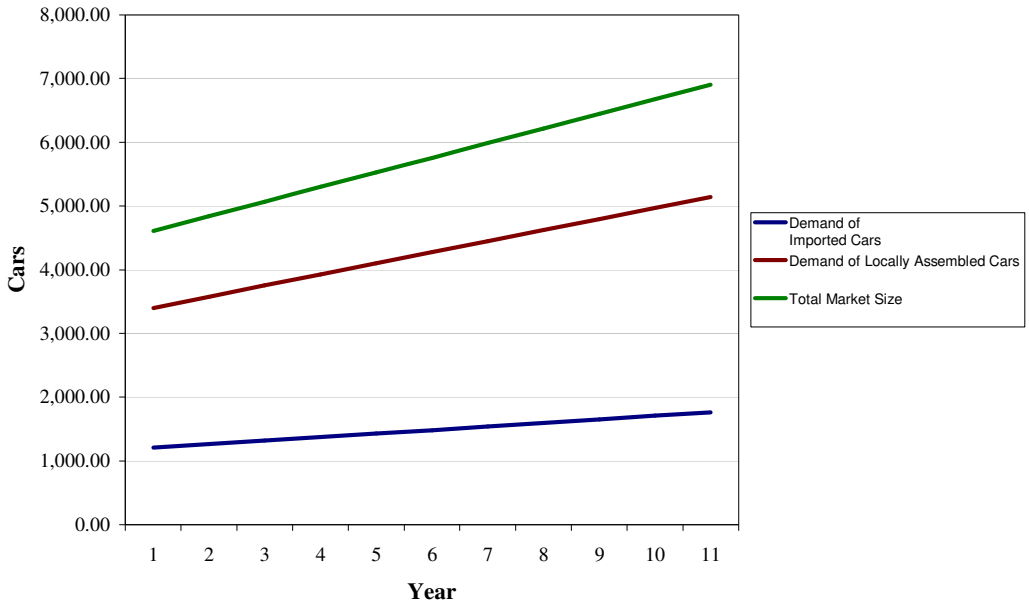

Figure 10 Growth of the Egyptian Automotive Market; Scenario 1

The upper curve presents the growth of the Egyptian market; Locally produced and Imported cars. The majority of the units sold are for the locally assembled cars, which continue to enjoy prices in the Egyptian market that are lower than the imported cars. Figure 11 presents the pricing of cars in the Egyptian market in Egyptian Pounds for locally produced and imported cars.

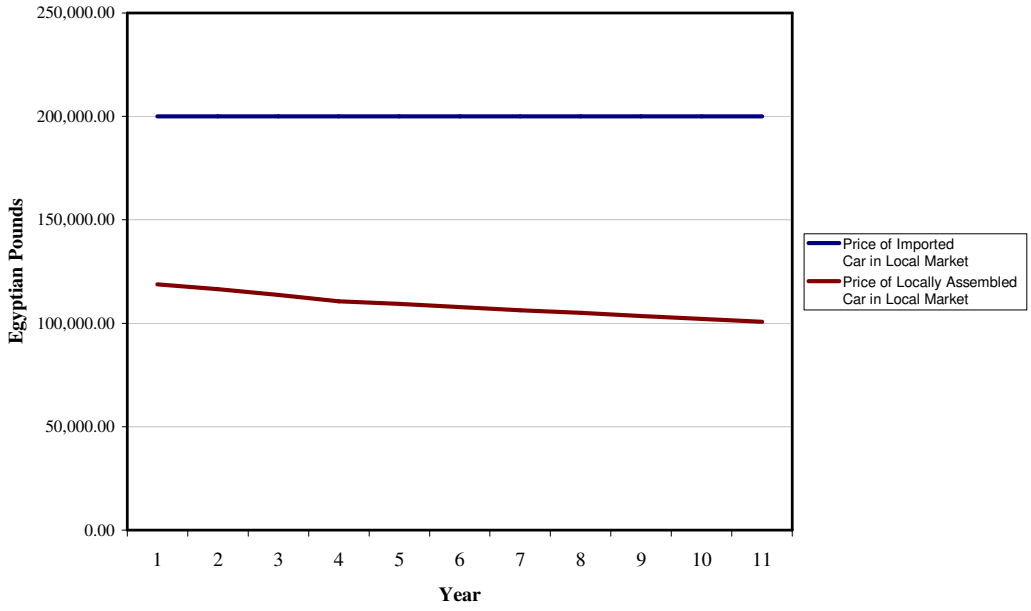

Figure 11 Price Comparisons between Locally Assembled and Imported Cars in Egyptian Pound; Scenario 1

However, when comparing the prices of the locally produced cars in the international market, they are still higher than the international prices of cars produced outside Egypt. This gap impedes the growth of exports of the locally Assembled cars to the international markets, figure 12.

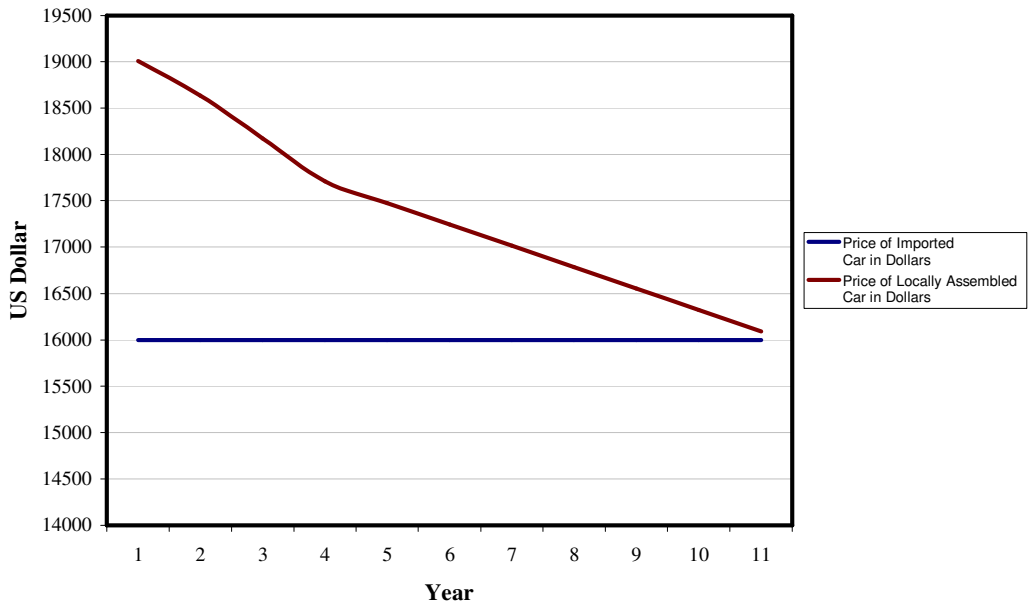

Figure 12 Comparison of Car Prices in International Market**; Scenario 1**

Scenario 2: Impact of 2004 Economic Reform Policies

During the summer of 2004, a new Egyptian government was sworn in with a charge to stimulate the economic growth of Egypt through economic reform policies. The government engaged in several policies that focused on reducing customs, trade barriers, and streamlining governmental processes to attract new investments and stimulate economic growth. The implementation of these policies has resulted in increase in foreign direct investments in Egypt, increase in trade, and Egyptian Pound appreciation compared to the US dollar and other world currencies. The assumptions governing the economic reform policies of 2004 are presented in table 5.

Table 5. Scenario 2 Assumptions

Variable	Value
Price of Imported Car [US Dollars]	$16,000
Egyptian Pound-US Dollar Exchange Rate [Pounds per Dollar]	5.80
Customs Rate on Imported Cars [%age of Car Price]	40%
Customs Rate on Imported Spare Parts [%age of price]	25%
Minimum percentage of Local Content [%age of Car Value]	40%
Initial Market Size [Units sold per Year]	50,000
Annual Market Growth rate [%age growth per year]	10%
Average life of cars on the Egyptian Roads [Years]	25

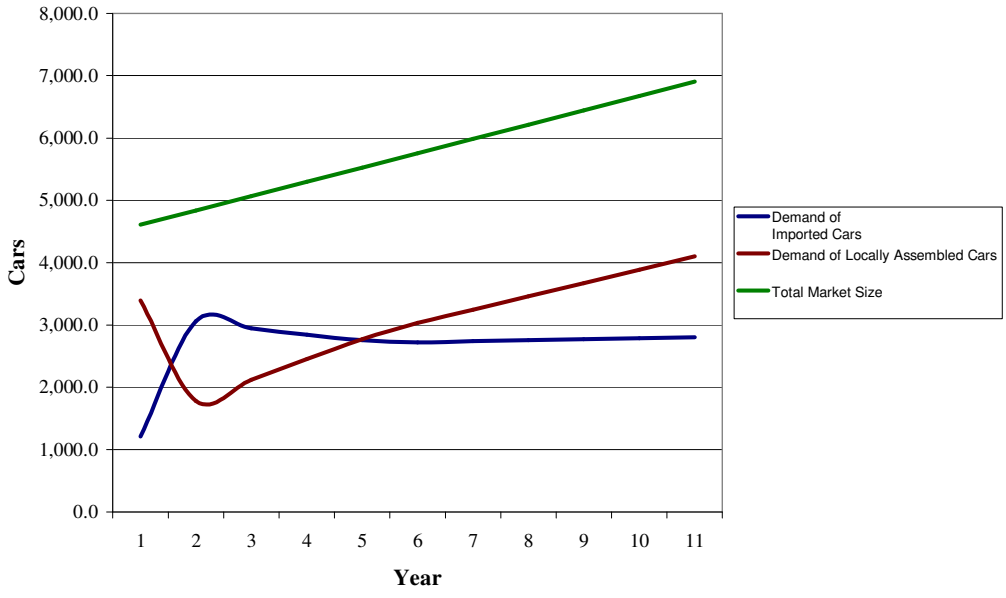

Figure 13 Growth of the Egyptian Automotive Market; **Scenario 2**

To examine the effects of the Economic reform policies of 2004, the model was run for one year, and then the economic reform policies were introduced in year 2. Figure 13 presents the impact of these policies on the market size. Due to the reform policies, imported cars became more affordable leading to increase in import market share. Locally assembled cars suffered as a result in loss of market share; however they will be able to regain some of the lost ground as time goes due to increased production volume and economies of scale.

The price comparison presented in figure 14 show the drop in imported cars prices in the local Egyptian market triggered by the economic reform and trade liberalization policies of 2004. However, locally assembled cars still enjoy lower prices, but the gap has shrunk. Such shrinking in the gap resulted in increased sales of imported cars in Egypt. This is due their affordability and their perceived image of higher quality and better features. This scenario reflects the current state of the Egyptian market, where imports have gained ground over locally assembled cars.

As time goes on, the effects of economies of scale coupled with learning curve will have an impact on the cost of the locally assembled cars resulting in the decrease of locally assembled car prices as presented in figure 14. While locally assembled cars go down in price with time, they still remain higher than the imported cars in the international market. This results in the industry being focused towards local market with no potential for exports.

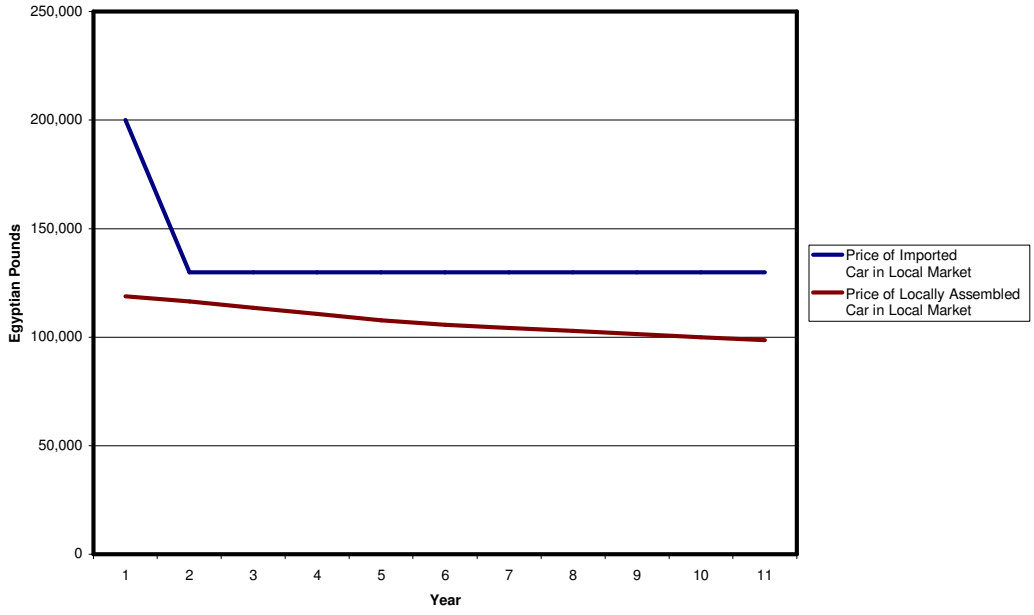

Figure 14 Price Comparisons between Locally Assembled and Imported Cars in Egyptian Pound; Scenario 2

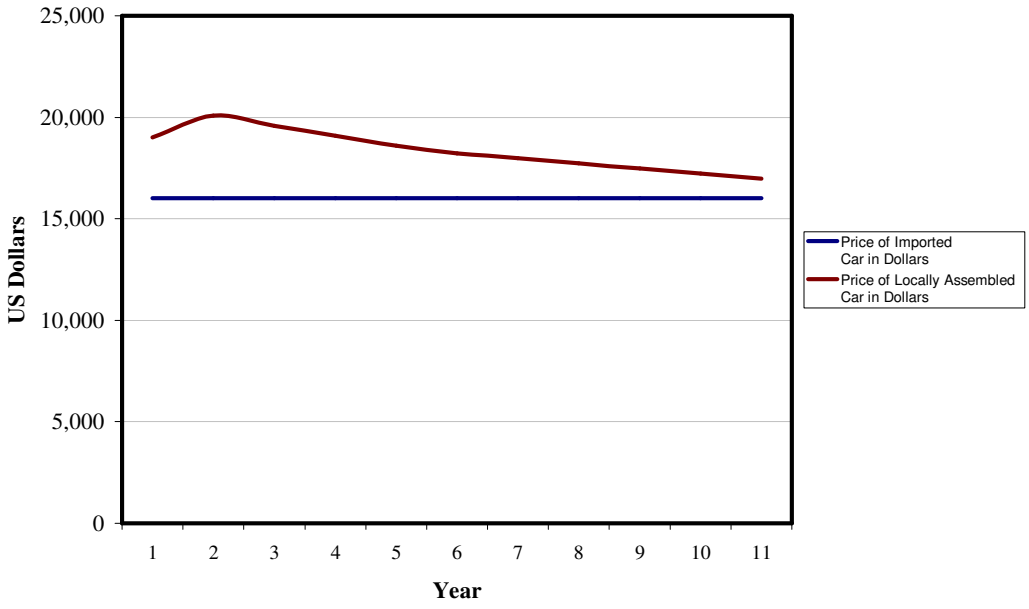

Figure 15 Comparison of Car Prices in International Market**; Scenario 2**

Scenario 3: Stimulating Future Industry Growth

After presenting the first two scenarios, the challenge that rises is what kind of policies needs to be implemented in order to enhance the Egyptian Automotive Industry's competitiveness.

In dealing with this challenge, the following policy options are identified.

1. Liberalizing the Egyptian Automotive market.
2. Removing Trade Barriers imposed on the imported automotive components.
3. Supporting growth of the automotive industry's feeding industries and increasing the local content.

The first policy option will have a negative impact on the Egyptian automotive industry. This is due to the fact that imported cars are priced more competitive in the global market, figure15. Therefore, by removing the customs imposed on imported cars, they will become more affordable than the locally assembled cars; hence the Egyptian consumer will buy them instead of the local assembled cars. This will lead to total loss of market share enjoyed by the local assemblers leading to totally closing the industry.

The second option will lead to decrease of some extent in the cost of the locally assembled cars, due to the lifting of the taxes imposed on the imported content used in the local assembly process. However, the decrease in imported component prices will not have a significant effect on reducing the cost of the locally assembled cars in the global

market place, figure 16. This still makes the industry a local industry, focusing only on the Egyptian market.

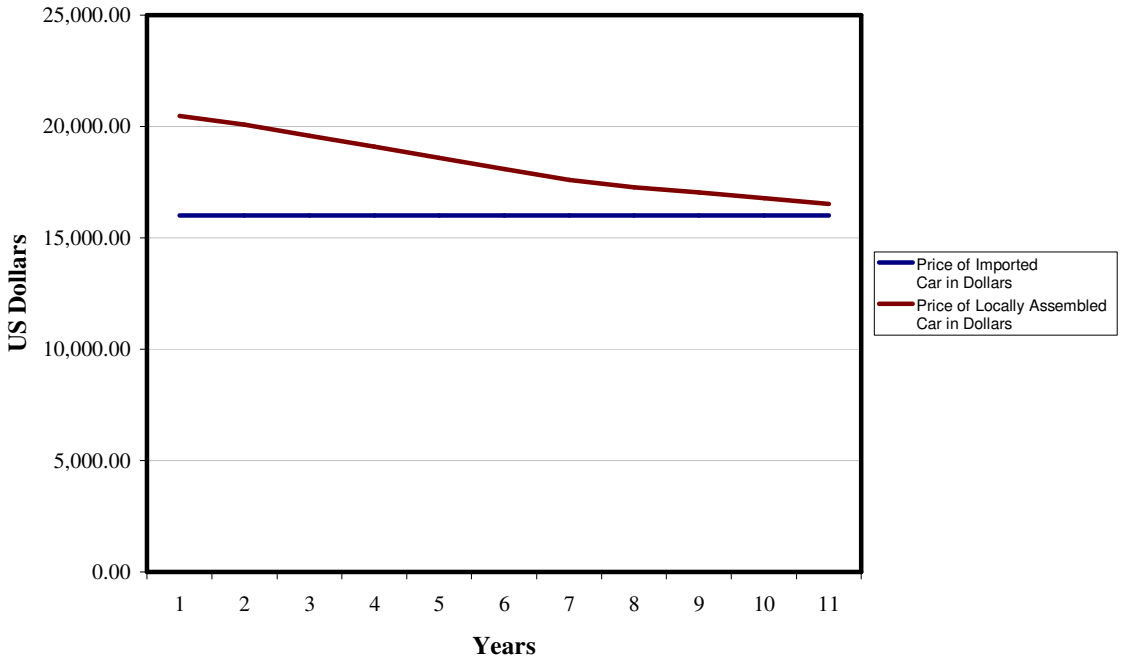

Figure 16 Comparison of Prices in the International Market; No Customs on Spare Parts

Moving to the third policy option, through increasing the local component to 75%, and lifting the customs imposed on the imported content, the Egyptian automotive industry will be able to develop global competitive advantage. Under this policy, the locally assembled cars have the chance of creating a cost advantage in the global market through the support of the local feeding industry, where economies of scale effects will take place to reduce the total cost of the local spare parts. Once these benefits are materialized, the Egyptian automotive industry will have the opportunity to become a global player, opening new export market that will lead to more production volumes. This in turn will trigger more economies of scale effects that will further reduce the cost of the Egyptian produced cars, enhancing their competitive advantage in the global market place.

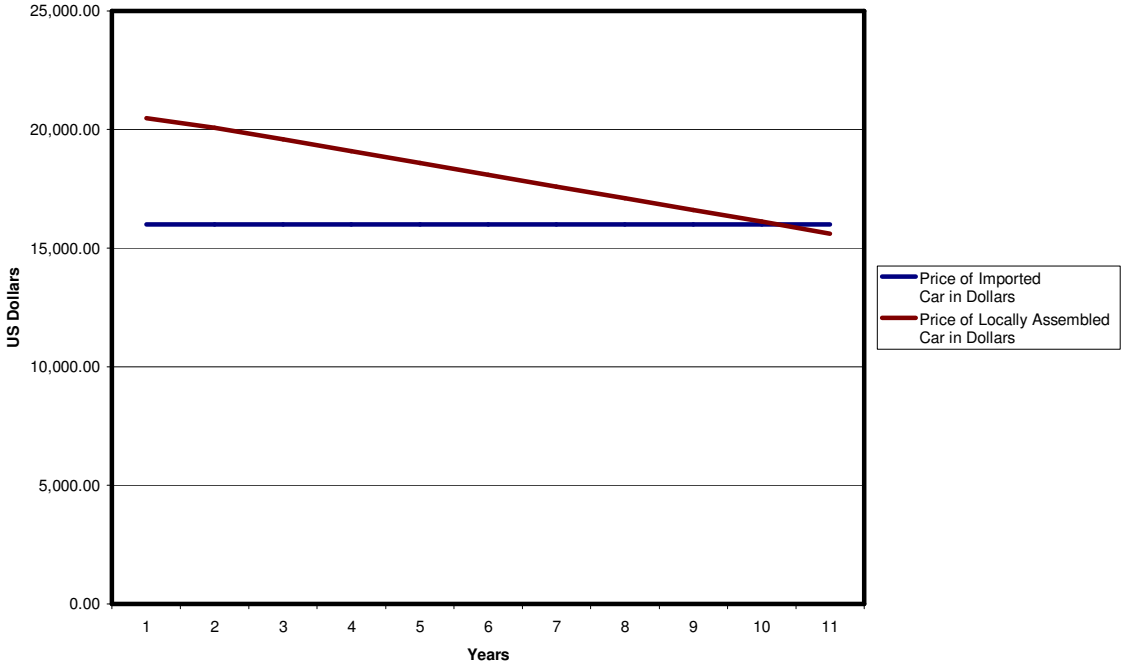

Figure 17 International Price Comparison; Scenario 3

Conclusions and Recommendations for Further Research

This paper presents an overview of the state of the global automotive industry and how the industry is developed in Egypt. The Egyptian automotive industry is considered relatively small compared to the global industry. This is due to the fact that the Egyptian industry focuses only on satisfying the local Egyptian market, with no plans made since its development for exports.

The protection of the industry by the government provided the industry an advantage in the Egyptian market either through imposing import bans on foreign cars, or imposing customs on imported cars. This created an environment where companies focused on the local market on the expense of focusing on operational efficiency such as cost, quality and innovation.

The model presented provided insights about the policies that could be implemented for gaining competitive advantage in the global market place. The model provided an adequate understanding of the effects on 2004 reform policies, and how the reduction in customs impacted the market share of the Egyptian Automotive industry. Further, the model provides a warning signal against the total liberalization of the Egyptian trade policies by totally removing the customs and tariffs imposed on cars imported in Egypt. Such action will kill the Egyptian Automotive industry, as it does not have the foundations for competing in the global market place. This is due to the fact that Egyptian assembled cars are priced higher than the imported cars in the international markets.

The process of improving the Egyptian automotive competitiveness could be achieved through attracting investments for the development of automotive supply chain and feeding industries. This will enable the increase of the local content, hence providing a cost advantage to the locally assembled cars that will enable competition o the global market place.

When considering directions for further research, the expletory model presented in this paper needs to be expanded further to incorporate the effects of the operational efficiencies on the growth of the Egyptian Automotive industry. This provides recommendation for further research to incorporate the effect of Just in Time techniques on the cost structure, as well as delivery and flexibility of the Egyptian Automotive industry.

Moreover, further research needs to focus the positive feedback loops generated by improving the quality of the Egyptian automotive industry, and how this quality improvements will enable the industry to secure local competition from imported cars which are perceived of higher quality, as well as opening new global markets,

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