INPUT USE EFFICIENCY IN THE AUTOMOTIVE INDUSTRY IN IRAN, 1984-2013

by

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KECEKAPAN PENGGUNAAN INPUT DALAM INDUSTRI AUTOMOTIF DI IRAN, 1984-2013

ABSTRAK

Kajian ini adalah mengenai produktiviti dan kecekapan input di dalam industri automotif di Iran, di antara tahun 1984-2013. Meskipun sektor automotif begitu penting di dalam sektor bukan sumber, ia telah menghadapi produktiviti dan output yang turun naik. Hal ini biasanya dikaitkan dengan sekatan ekonomi yang dikenakan terhadap Iran yang menghadkan input import yang penting kepada industri tersebut. Kajian ini mengkaji sama ada ketidakcekapan penggunaan input mungkin menjadi faktor penyumbang juga. Ekoran daripada itu, kajian ini, mempunyai lima objektif yang khusus: (i) untuk menyiasat antara tiga fungsi pengeluaran utama, iaitu Cobb-Douglas, Constant Elasticity of Substitution (CES) dan Translog, yang mana sesuai untuk menjelaskan sektor automotif di Iran; (ii) untuk menganggarkan keanjalan output input modal, buruh dan bahan; (iii) untuk menentukan jenis skala pulangan yang dialami oleh industri automotif; (iv) untuk menilai sama ada penggunaan buruh, modal dan bahan adalah cekap atau tidak; dan (v) untuk menganggarkan keanjalan penggantian antara ketiga-tiga input tersebut. Cobb-Douglas, CES dan Translog telah dianggarkan bagi sektor automotif; didapati bahawa fungsi pengeluaran Cobb-Douglas adalah yang paling sesuai. Input modal merupakan input yang paling produktif, dan industri mengalami skala pulangan konstan sepanjang tempoh kajian. Didapati juga penggunaan ketiga-tiga input tidak cekap di industri automotif kerana nilai output marginal setiap input adalah lebih rendah daripada harga input masing-masing. Akhirnya, didapati bahawa keanjalan penggantian di antara input adalah rendah. Adalah disyorkan lebih elok dengan pengurangkan input-input tersebut untuk

memastikan penggunaan cekap, ialah inisiatif untuk meningkatkan produktiviti input. Ini boleh dilakukan dengan melabur dalam teknologi dan inovasi baru serta menaikkan kualiti buruh dengan melabur dalam pendidikan dan latihan yang berkaitan. Peningkatan produktivi input-input akan menjadikan harga tinggi yang dibayar kepada input tersebut lebih munasabah.

INPUT USE EFFICIENCY IN THE AUTOMOTIVE INDUSTRY IN IRAN, 1984-2013

ABSTRACT

This research is about the productivity and efficiency of input in the automotive industry in Iran between1984-2013. Despite the importance of the automotive sector in the non-resource sector, it has faced fluctuating productivity and output. This has been commonly attributed to restrictions in imported inputs because of economic sanctions. This study investigates if input use inefficiency might also be a contributory factor. Towards this end, the study had five specific objectives: (i) To investigate which of the three main production functions, that is, Cobb-Douglas, Constant Elasticity of Substitution or the Translog, appropriately describes the automotive industry in Iran; (ii) To estimate the output elasticity with respect to capital, labour and materials; (iii) To determine the nature of the returns to scale being experienced by the industry; (iv) To evaluate whether or not capital, labour and materials are being used efficiently, and (v) To estimate the elasticity of substitution between the three inputs. The Cobb-Douglas, CES and Translog production functions were estimated for the automotive sector, and the Cobb-Douglas production function was found to be the most appropriate. Based on the output elasticity of inputs, capital was the most productive input, and the industry was experiencing constant returns to scale during this period. More significantly, input use was inefficient in the Iran automotive industry since the values of the marginal products of each input was less than their respective input prices. Finally, the elasticity of substitution between inputs was found to be positive but low.

It is recommended that rather than reducing inputs to ensure their efficient use, initiatives to increase their productivity must be undertaken. This can be done by investing in new technology and innovation, and by raising the quality of labour by investing in education and relevant training. The resulting increase in the productivity of inputs will justify the high prices they are being paid.

CHAPTER ONE

INTRODUCTION

1.1 Introduction

Production, economically, is defined as the process of transforming factors of inputs into outputs, goods and services, in order to increase consumption and investment (Nicholson & Snyder, 2014). Efficient production is the maximum output which can be achieved from any possible combination of inputs by a firm. The production function is therefore a mathematical tool which is most often applied by economists to describe the relationship between inputs and the goods or services which are produced. The inputs are usually categorized into human resource, natural resource (such as land) and capital (such as tools and machinery), while the outputs are classified into tangible and intangible products which are called goods and services, respectively.

Due to increasing global competition, every firm no matter what it produces, needs to find ways in order to decrease the production costs or alternatively, to increase output using given inputs (Agheli, 2006; Zaranajad & larki, 2004). In fact, all firms focus on finding the techniques to attain the maximum output using minimal resources. This is called the desire to achieve more efficiency and productivity (Kavousi, PourAzbari, & Khayati, 2010; Kim & Sooil, 2008). Indeed, the effective use of each input is illustrated by its productivity and its improvement increases the

performance of the firm. Productivity is therefore an indicator of performance (Ebrahimipour, Azadeh, Rezaie, & Suzuki, 2007; Sepehrdoust, 2011; Song, 2005).

All firms need to look for opportunities to reduce the costs of production and improve their productivity and efficiency. However, they also need to innovate and increase their outputs (Sarwar, Ishaque, Ehsan, & Pirzada, 2012; Shahabi, Kakaie, Ramazani, & Agheli, 2009).

The general objective of this thesis is to study the structure of the Iranian automotive sector to determine if it can continue to contribute positively to the Iranian economy. The automotive sector is one of the major non-resource industries in the country and may well replace oil as a dominant source of economic activity since oil is a diminishing resource and has seen fluctuations in output and prices. The more specific objectives are stated in section 1.6.

1.2 The Iranian Economy: Overview

Since the scope of this study is the automotive industry of Iran, it is necessary to discuss the background of the Iranian economy and to establish the importance of the automotive industry.

Iran has an area about 1.64 million square kilometers. It stretches from the Caspian Sea or Khazar Sea in the north to the Gulf of Oman and Persian Gulf in the south. Iran is bordered by the Caspian Sea, Azerbaijan, Armenia and Nakhchivan in the north, the Gulf of Persian and the Gulf of Oman in the south, Pakistan and

Afghanistan in the east and Iraq and Turkey in the west (Razaghi, 2014b; Rezvani & Dabiri, 2014).

The Iranian economy faces many difficulties. One is stagflation. It has also confronted unprecedented internal and external shocks such as multiple increases in the exchange rate and the intensification of international trade and financial sanctions against Iran. The growth rate of the Gross Domestic Product (GDP) of Iran has fluctuated frequently and registered a decline since 2010. It fell from 6.5% in 2010 to 4.3% in 2011, before registering negative 6.8% in 2012 and to negative 1.9% in 2013. The growth rate of GDP in Iran between 1984 and 2013 is shown in Figure 1.1 below.

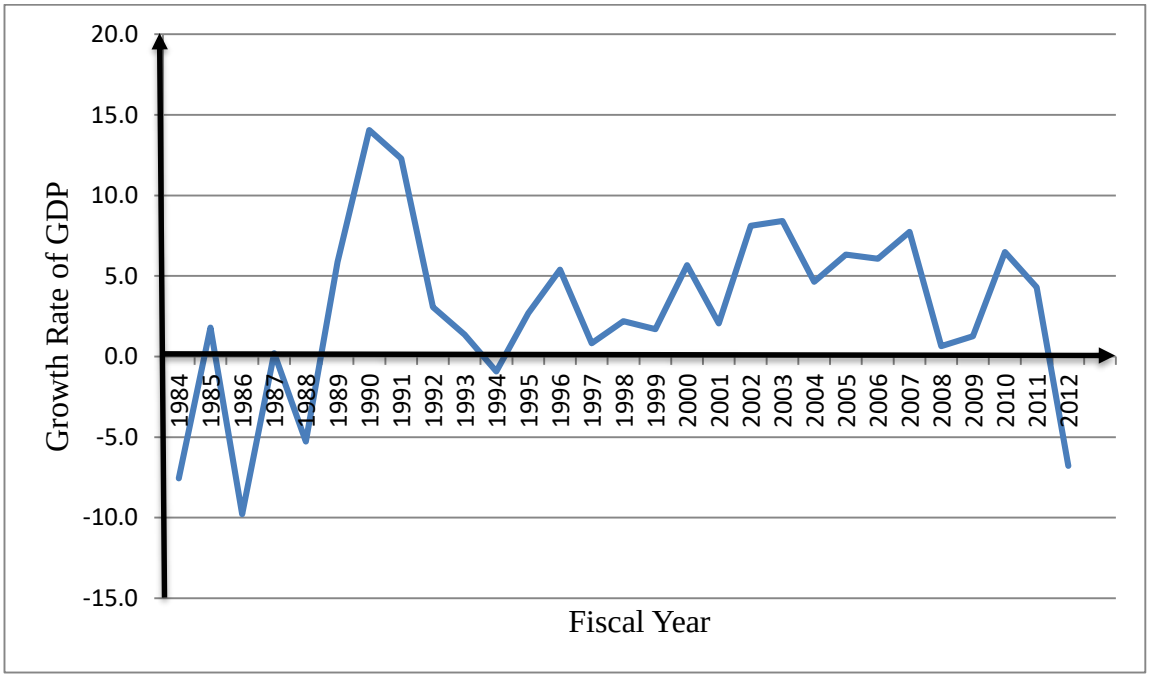

Figure 1.1 GDP annual growth rate in Iran

Source: Iran Central Bank (www.cbi.ir), compiled by researcher

The expanding monetary base and economic sanctions against Iran has contributed to a rising rate of inflation. The inflation rate increased from 12.4% in 2010 to 21.5% in 2011, to 30.5% in 2012 and finally to 34.7 in 2013 (Razaghi, 2014a, 2014b; Rezvani & Dabiri, 2014; Severi, Asgari, Heshmati, & Goli, 2014; Zamanzadeh, 2013). Attempts to control inflation have not been very successful.

The contribution of different economic sectors to the GDP in 1984 and 2013 (the latest year for which data are available) are shown in Table 1.1.

Table 1.1 Contribution of different economic sectors to the GDP, 1984 and 2013

Economic sectors	Share of GDP 1984	Share of GDP 2013
Agriculture	6.02%	6.91%
Oil	14.96%	10.02%
Mining	0.33%	1.09%
Manufacturing	6.74%	15.53%
Construction	9.17%	6.93%
Services	62.33%	59.36%

Source: Statistical Center of Iran (www.amar.org.ir), compiled by researcher

The service sector in Iran contributes the most to GDP, though its share has declined in 2013. In comparison, the share of the oil sector was much lower and has declined even more by 2013 due to falling oil prices and economic sanctions against Iran. The

manufacturing sector, on the other hand, has increased its share in the GDP substantially during this period, from 6.7% to 15.5%.

The share of manufacturing value added in GNP for the period, 1984 – 2013 is shown in Figure 1.2, P. 6. Despite the overall rising trend, it has experienced many fluctuations. One of the most important causes of these fluctuations is the severe dependence of the Iranian economy on oil revenues (Razaghi, 2014a, 2014b; Rezvani & Dabiri, 2014; Severi et al., 2014; Zamanzadeh, 2013). The economic fluctuations in Iran always occur in the wake of changing oil price. In addition, many political issues in international relations, international shocks and price changes of export goods, raw materials, intermediate goods and capital imports goods also impact on the production process. In fact, the reaction of economic growth to the oil shocks is asymmetric in Iran. This means that the economic growth goes up slightly when the oil revenues of Iran move up but the decline in the oil revenues due to a negative shock strongly reduces economic growth and economic capacity (Maroufkhani, 2009; Razaghi, 2014a, 2014b; Rezvani & Dabiri, 2014; Severi et al., 2014; Zamanzadeh, 2013).

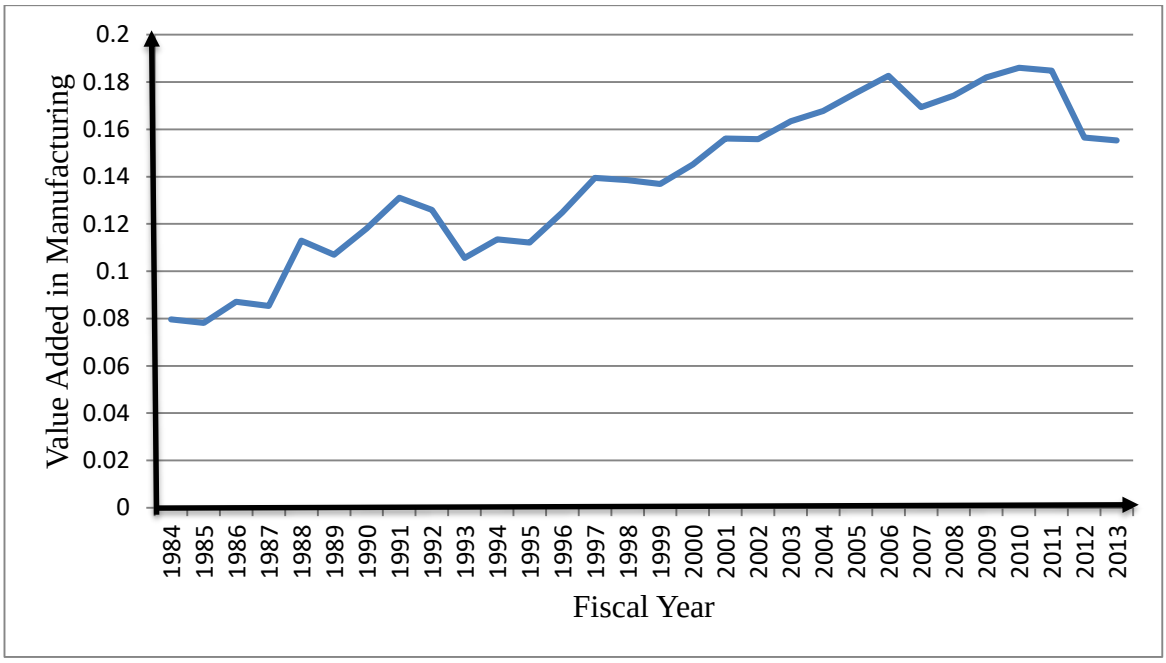

Figure 1.2 Value added in manufacturing as a proportion of GNP in Iran, 1984-2013

Source: Iran Central Bank (www.cbi.ir), compiled by researcher

Table 1.2 shows the percentage shares of different manufacturing activities within the manufacturing sector in Iran.

Table 1.2 Shares of manufacturing activities in the non-resource manufacturing sector, 2004 and 2013

Activity	Share in manufacturing 2004 (%)	Share in manufacturing 2013 (%)
Food products	17.67	15.09
Textile	7.52	3.65
Wood	3.03	1.72
Chemicals	16.07	28.91
Automotive	13.17	9.26

Source: Statistical Center of Iran (www.amar.org.ir), compiled by researcher

It is clear from the table, that the automotive sector's share in non-resource manufacturing fell from 13.2 % to 9.3% over the 10-year period. The oil industry is considered separately in the GNP due to its importance in the Iranian economy and is therefore not included in the activities shown above.

1.3 The Automotive Industry in Iran

The automotive industry in Iran is one of the key non-resource sectors of the economy (Afsharipour, Afshari, & Sahaf, 2006; Maroufkhani, 2009). It contributes substantially in terms of value added, number of employees, total investment, and financial turnover (Afsharipour et al., 2006; Ahmadi & Sarhangi, 2009; Askari, 2004; Mehri & Khodadad, 2005; Mohammadrezaie & Eskafi, 2007; Molaee, Gharahbaghian, & Sabbagh, 2002; Molaei, 2005a).

The automotive sector in Iran is the second most important industry with respect to its value added, after the oil and gas industry (see Table 1.3, P. 15), and accounted for 3.9% of the GDP in 2010. However, this decreased to 2.5% in 2013 (see Table 1.4, P. 16). It employed 14% of the total workforce of the country in 2013 (see Figure 1.6, P. 17). In 2013, Iran was the 20th largest automobile maker in the world and one of the largest in Asia with an annual production more than 700,000 units (see Table 1.6, P. 21).

1.3.1 Growth and development in the automotive sector in Iran

The first car in Iran was purchased by Muzafarddin Shah, the fifth king of Iran, in 1902. The car was made by Ford and was purchased in Belgium. Due to the heavy smoke being emitted by the vehicle, it was nicknamed the ‘smoke carriage’. With increasing urbanization, the imports of automobiles increased by 1920. Most of the cars were imported from America and Britain.

The automotive industry in Iran started with the arrival of foreign vehicle manufacturers in the early 1960s (Ahmadi & Sarhangi, 2009; Mahmoudzadeh, Mansour, & Karimi, 2013; Moghbel & Qoudarzi, 2004). The first auto company in Iran, Iran National Company, was established by three brothers— Ahmad, Mahmood and Hassan Khayami. The primary objective was to produce bodies for the Benz' buses in Iran that were being sold in the Iranian market in 1963. In 1996, a private company called the Iran National Company signed a contract with a British company, Talbot, to assemble the first car, the *Hillman Hunter*. A year later, it assembled and sold the car under the new and indigenous name of *Paykan* in the Iranian market. The *Paykan* was sold until 2005 (Ahmadi & Sarhangi, 2008; Manteghi, 2005) and it was eventually replaced with a new model.

The Iran National Company was nationalised in 1979, after Islamic Revolution, and the government changed its name to Iran Khodro. The Iranian branch of Talbot Company was closed after the Islamic Revolution. With the Iranian government controlling the production line, the *Paykan* became known as Iran's first national car.

The second national car that Iran Khodro produces is called the *Samand* that came into production in 2005 to replace the *Paykan.* In 2007, Iran Khodro got the EFQM Award[1] and it supplied new models of *Samand*, and *Samand Soren* that year. After one year, it also received the Export National Award based on its design of a new model, *Runna.* In 2009, it increased its export by 40% as compared to the previous year (Mahmoudzadeh et al., 2013). By 2010, Iran Khodro was producing more than 700,000 cars and controlled about 50% share of the auto market. In 2011, another

[1] An Iranian quality award based on the European Foundation for Quality Management

high-quality car called *Dena* was produced by Iran Khodro. Subsequently, it has focused on improving models rather than producing new ones.

Currently, the Iran Khodro Company has 6 foreign sites located in Senegal, Azerbaijan, Syria, Belarus, Egypt and Venezuela and has emerged as the biggest car manufacturer in Iran, accounting for nearly 50.2% of automotive output in 2013.

The second largest car producer in Iran is Saipa. It was established in 1966 as a private company in partnership with the Citroen French Company with the capital of 160,000,000 *rials.* The first two cars of this company were *Vanet Aka* and *Jeean* and over the past decade it has produced more than 30 kinds of vehicles. In 2013, its share in the total automotive production was 39.3%. Saipa, like Iran Khodro, was also nationalized after the Islamic Revolution, in 1979, but it now jointly owned by the government and the private sector with the former holding the majority shares.

There are 24 other companies but they together only account for 11.5% of the total automotive output. These companies are privately owned but receive government support; each of them produces or assembles a special model.

Iran vehicle manufacturers have been involved in joint investments with several famous international car manufacturers such as Proton (Malaysia), Peugeot and Citroën (France), Nissan and Toyota (Japan), Volkswagen (Germany), Chery (China), Kia Motors (South Korea) and many others. These agreements have resulted in the automotive industry of Iran improving not only the quantity and quality of output but also gaining entry into global markets by producing well-known brands such as Peugeot 206, Peugeot GLX, Peugeot Pars, Nissan (medium-sized trucks),

Benz (cars and trucks) and so on (Ahmadi & Sarhangi, 2009; Rezvani & Dabiri, 2014).

The exports of the automotive sector amounted to US$ 264 million in 2013; of this 99% was exported to Iraq, with the rest going to Egypt, Afghanistan, Armenia, Tajikistan, Venezuela and Azerbaijan (Government of Iran, 2015).

The growth of the automotive Industry in Iran went through five broad phases as follows (Ahmadi & Sarhangi, 2008; Manteghi, Eskandari, & Jafari, 2011; Solimanian & Zarifi, 2005):

The first phase (1962 to 1979) was devoted to the assembly of vehicles; the private companies such as Iran Khodro and Saipa were involved in the assembly of vehicles in cooperation with famous foreign companies, with the primary goal of earning profits. The output of assembled models increased year by year during this period, with about 15,000 units in the beginning of the period and 180,000 units at the end of the phase. On the other hand, the size of the automobile imports was also increasing as the imports stood at 5,000 units in 1969 and about 90,000 units by 1978. In the later part of this period, progress was made in auto designing which continues till today.

The second phase (1979- 1988) coincided with the Islamic Revolution (in 1979) that saw the removal of the Pahlavi Dynasty and witnessed the Iran-Iraq war (1980-1988). In the start of this period, the auto industry became completely government owned through nationalization and private sector participation in the industry was disallowed. This phase was one of economic instability and disruptions that resulted in the output of the automobile sector suffering a drastic fall. Total production fell

from 165,000 units in 1979 to 27,000 units by 1988. In general, the government did not have any strategy or policy for the overall development of automotive industry during this phase. It was still engaged in assembly type operations. Much of its output and related imports were geared to support the needs of the war, as it became the national priority.

The third phase was between 1988 and 2003; this period saw more active government support for the automotive industry. Its objective was spelt out clearly: the aim was to achieve self-sufficiency in production. In pursuit of this objective, the government launched an import-substitution strategy aimed at decreasing imported cars. Car imports fell to an annual average of just 500 units during this period. The mass production of cars was going ahead at full speed. The first efforts at producing spare parts were also begun during this phase and has gained root in the sector.

There were two consequences from the protection of domestic car market from foreign competition. First, the price of domestically produced cars shot up, and, second, the quality of these domestically produced cars deteriorated. The annual growth rate of value added in the automotive sector was negative 0.11% in 1988, the beginning of this phase, and it managed to creep up slowly to just 0.55% in 2003, at the end of this phase (see Figure 1.3, P. 12).

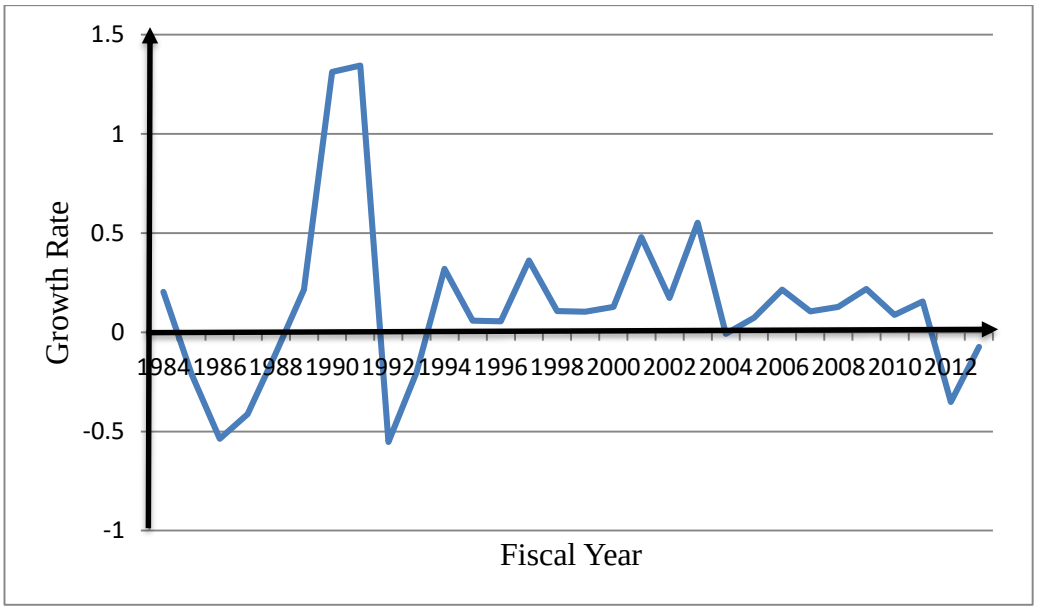

Figure 1.3 The annual growth rate of value added in the automotive sector of Iran, 1984-2013.
Source: Statistical Center of Iran (www.amar.org.ir), compiled by researcher

In the fourth phase (2003 to 2005), the automotive sector attempted to move beyond import substitution to export expansion. This meant that it had to become more competitive in order to gain more export opportunities. Attempts were therefore made to improve on the quality of cars produced to international standards. This saw Iran Khodro replacing the old *Paykan* with the better quality *Samand* in 2005. It is known as second national car in Iran and was found to be suitable for export.

The fifth period is from 2005 onwards. This period started with the intention of the auto motive sector to become a global market leader. Toward this end, the two major car makers hope to become major automakers in the world with a well-recognised national brand. By 2004, Iran began mass automobile exports.

Figure 1.4, P. 13, displays the auto exports by Iran from 2004 to 2013. As is evident, exports showed a generally rising trend from 2004 to 2010, but dropped sharply after

that. Largely because the US led sanctions in 2013 restricted the imports of vehicle parts from major companies like Peugeot and Renault that were necessary to support the Iranian automotive sector. The output of cars fell drastically in 2012 before recovering in 2014 when sanctions were relaxed after Iran agreed on a short-term freeze of its nuclear programme. Second, inflation further increased the cost of production with the rate soaring from 12.4% in 2010, to 34.7% in 2013. Consequently, exports declined drastically between 2010 and 2013 even as total production decreased from 1,599,454 in 2010 to 743,680 in 2013. Hence, Iran lost its place as a major auto maker in the region and its exports too were limited to a few countries like Iraq, Egypt and Azerbaijan.

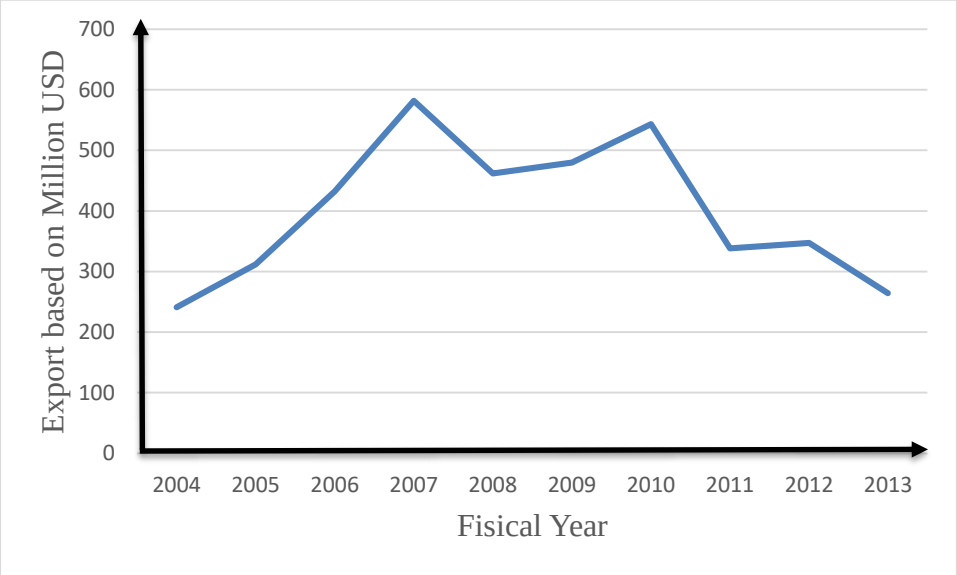

Figure 1.4 Exports of Iranian Cars, 2004-2013
Source: Statistical Center of Iran (www.amar.org.ir), compiled by researcher

1.3.2 Key indicators of the automotive sector in Iran

The importance of the automotive industry as a key non-resource industry in Iran is evident from the following.

1.3.2.1 Growth in value added

The increase in value added of automotive sector remained positive in most years between 1984 and 2013. The average rate of growth in value added for this period was 12.6%. However, the rate of annual growth has fluctuated as Figure 1.3, P. 12, shows.

The value added in the sector decreased severely between 1985 and 1988 because of the war between Iran and Iraq and the subsequent reduction of foreign exchange quota for the automotive industry. Growth recovered to positive levels from 1994 before another serious drop in 2004. This year marked the end of the Third Economic Plan. There was some doubt about how the auto industry will be treated in the subsequent plan and this period of uncertainty was a key factor in the fall in output. The automotive sector again experienced the negative growth values since 2011 to 2013, because of inconsistency in the rules and regulations, the unclear and unpredictable monetary and foreign exchange policies by government, the continuous changes in macro-economic decisions and policies, and the US- led economic sanctions against Iran that affected imported inputs such as clutches, gear boxes, electric parts and so on. The foreign exchange constraint further disrupted the purchase of imported inputs.

The average real value added in the automotive sector between 2006 and 2013 was 18853.5 billion *Rial*[2], far exceeding the value added in other key sectors. Food and chemical products take the second and third places, respectively (Table 1.3, and Figure 1.5).

Table 1.3 Comparing of the real value added some key industries of Iran, 2006-2013

(Billion *Rial*)

Year	Automotive	Food Product	Chemicals Product
2006	14,674	16,275	9,874
2007	16,227	17,308	11,248
2008	18,306	17,653	12,113
2009	22,304	19,013	12,853
2010	24,255	18,948	15,931
2011	23,984	19,003	15,577
2012	15,559	17,186	14,726
2013	15,519	16,154	13,032
Average	18,853.5	17,692.5	13,169.25

Source: Statistical Center of Iran (www.amar.org.ir), compiled by researcher

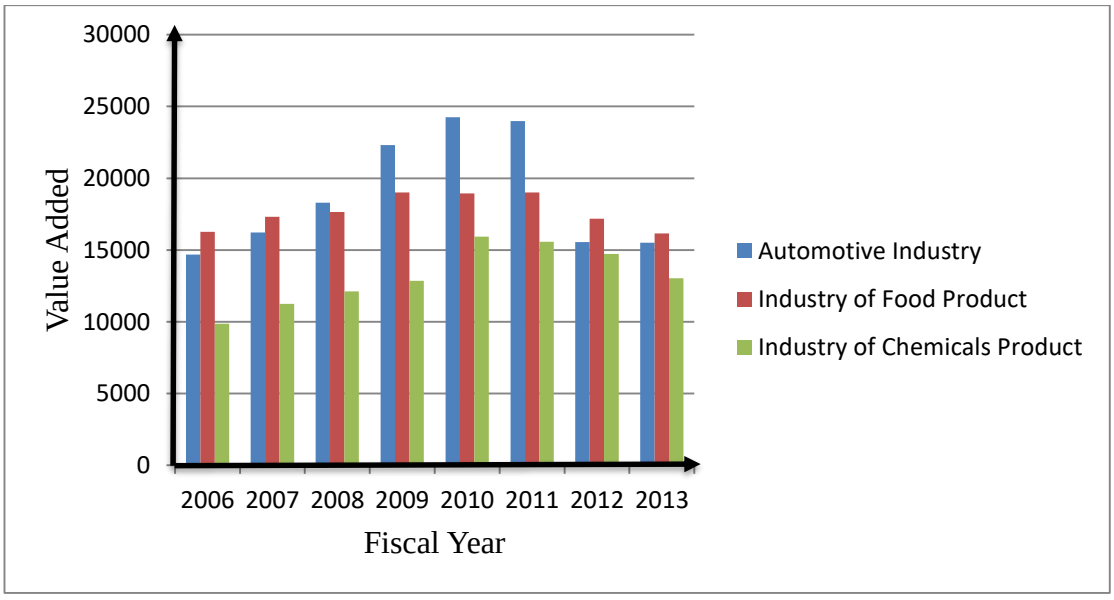

Figure 1.5 Comparing the value added of some key industries of Iran

Source: Statistical Center of Iran (www.amar.org.ir), compiled by researcher

[2] One US dollar is approximately 28,950 *Rial*

1.3.2.2 Contribution to GDP and non-resource activities

The automotive industry is the most important non-resource industry in Iran and its value added as a proportion of GDP and the output of other industries have been rising between 2004 and 2010 (Table 1.4). In 2010, value added in the automotive sector, as a proportion of real GDP, and value added in the automotive sector, as a proportion of the output of all non-resource industries, were 3.9% and 19.1%, respectively. But after that they have declined year by year until 2013 due to reasons discussed earlier.

Table 1.4 Contribution of the automotive sector to GDP and non-resource industries, 2004-2013

Year	$\frac{\text{VA Automotive sector}}{\text{GDP}}\%$	$\frac{\text{VA Automotive sector}}{\text{Output of non-resource industries}}\%$
2004	2.4	13.2
2005	2.5	13.1
2006	2.8	14.6
2007	2.9	15.0
2008	3.2	16.1
2009	3.8	18.4
2010	3.9	19.1
2011	3.4	16.6
2012	2.8	12.9
2013	2.5	11.3

Source: Statistical Center of Iran (www.amar.org.ir), compiled by researcher

The real value added by the non-resource sectors indicates more clearly the dominant position of the automotive sector.

1.3.2.3 Contribution to employment:

One of the advantages of the automotive industry in Iran is the high level of employment generated by it directly, and indirectly through activities related to it. This would include jobs in sales, service and repairs, carwash, spare parts shops, car dealerships and so on. Figure 1.6 shows the rising share of direct employment in the automotive sector, as a proportion of all employment in the non-resource industries. Despite some fluctuations, it has shown a rising trend since 1994. In 2009, it accounted for slightly over 16% of all industrial employment but it has decreased between 2010 and 2013, due to the fall in output of the sector. The factors disrupting output was discussed earlier.

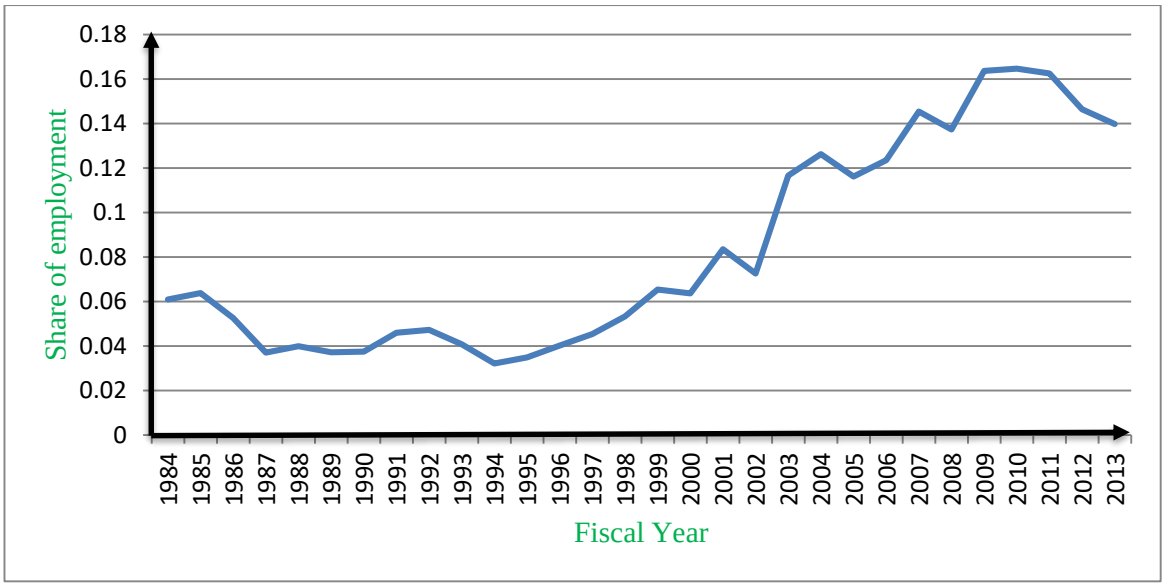

Figure 1.6 Employment in the automotive sector as a proportion of employment in the non-resource industries, 1984-2013

Source: Statistical Center of Iran and Industrial Development and Renovation www.amar.org.ir and Government of Iran (Various years), compiled by researcher

1.3.2.4 Production statistics

Table 1.5 shows the production statistics in the automotive sector between 2004 and 2013.

Table 1.5 Production statistics in the automotive sector, 2004-2014

Year	Cars	Commercial Vehicles	Total	% year on year change
2004	707,773	80,885	788,658	35.5
2005	923,800	153,390	1,077,190	36.6
2006	800,000	104,500	904,500	10.7
2007	882,000	115,240	997,240	10.3
2008	1,048,307	225,474	1,273,781	27.7
2009	1,170,503	223,572	1,394,075	9.4
2010	1,367,014	232,440	1,599,454	14.7
2011	1,412,803	236,508	1,649,311	3.1
2012	856,927	143,162	1,000,089	-39.3
2013	630,639	113,041	743,680	-25.6
2014	925, 975	164871	1,090,846	46.68

Source: OICA annual reports (www.oica.net)

Production has increased year by year from 2007 until 2011. In the two subsequent years (see Figure 1.7, P. 19), production has fallen, largely on account of the economic sanctions against Iran initiated by the US because of its displeasure over Iran's nuclear development programme.

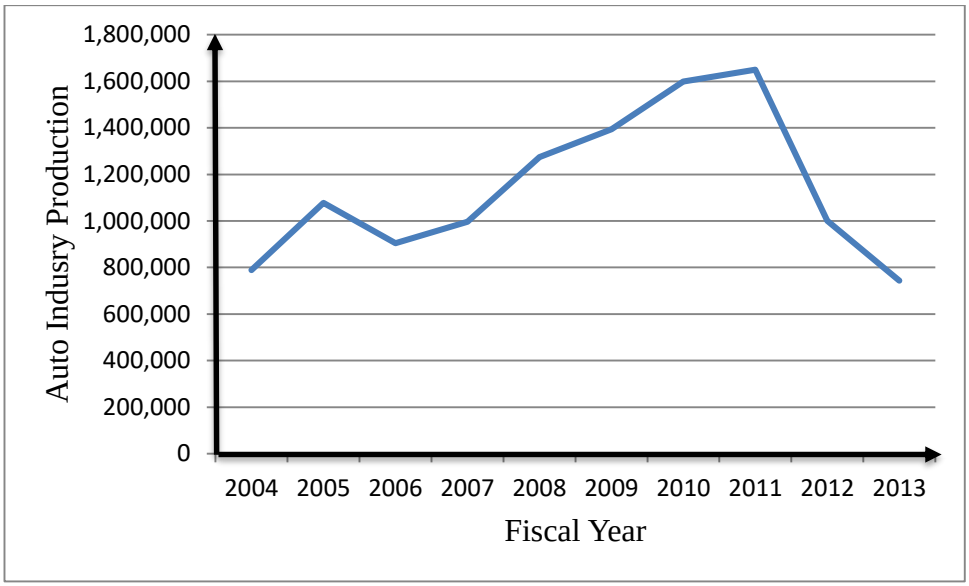

Figure 1.7 The trend of production statistics in the automotive industry in Iran
Source: OICA annual reports (www.oica.net), compiled by researcher

Figure 1.7 displays the trend of production statistic from year to year. It is evident that production started falling in 2011, the immediate effect of the sanctions, and recorded negative percentage changes in subsequent periods. Output recovered only in 2014, after the sanctions were relaxed when Iran agreed to a short-term freeze of its nuclear programme.

1.3.2.5 Value added per worker

Figure 1.8 shows the value added per worker for automotive industry in Iran. It has clearly fluctuated between 1984 and 2013. Productivity per worker indicated an upward trend till about 2010, but has been falling since. Since labour productivity is determined by available capital, once again, the restricted inputs to the industry in the post-2010 period might be cited as a major cause. The world economic crises also affected Iran as did foreign exchange shortages.

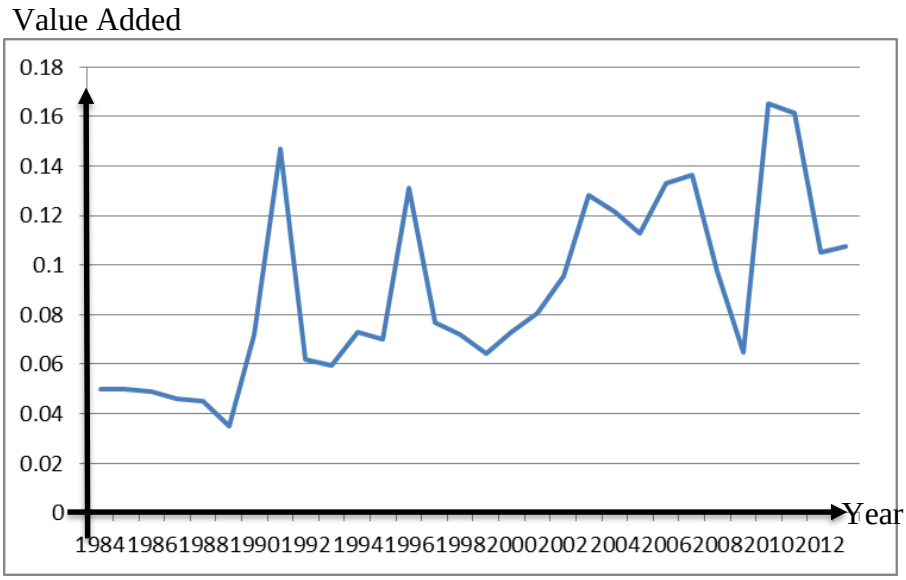

Figure 1.8 The value added per worker for automotive industry in Iran

Source: Statistical Center of Iran and Industrial Development and Renovation Organization of Iran[3], compiled by researcher

Despite these developments, in 2013, Iran was the 20th largest vehicle producer in terms of total output in the world, ahead of Malaysia and Sweden (Table 1.6, P. 21).

[3] Statistical Center of Iran, www.amar.org.ir and Government of Iran (Various years)

Table 1.6 Automobile production in the world in 2013 (in units)

No	Country	Cars	Commercial Vehicles	Total
1	China	18,084,169	4,032,656	22,116,825
2	USA	4,368,835	6,697,597	11,066,432
3	Japan	8,189,323	1,440,858	9,630,181
4	Germany	5,439,904	278,318	5,718,222
5	South Korea	4,122,604	398,825	4,521,429
6	India	3,155,694	742,731	3,898,425
7	Brazil	2,722,979	989,401	3,712,380
8	Mexico	1,771,987	1,282,862	3,054,849
9	Thailand	1,071,076	1,385,981	2,457,057
10	Canada	965,191	1,414,615	2,379,834
11	Russia	1,927,578	264,667	2,192,245
12	Spain	1,754,668	408,670	2,163,338
13	France	1,458,220	282,000	1,740,220
14	UK	1,509,762	88,110	1,597,872
15	Indonesia	924,753	281,615	1,206,368
16	Czech Rep.	1,128,473	4,458	1,132,931
17	Turkey	633,604	491,930	1,125,534
18	Slovakia	975,000	0	975,000
19	Argentina	506,539	284,468	791,007
20	Iran	630,639	113,041	743,680
21	Italy	388,465	269,741	658,206
22	Malaysia	543,892	57,515	601,407
23	Poland	475,000	115,159	590,159
24	South Africa	265,257	280,656	545,913
25	Belgium	465,504	38,000	503,504
26	Romania	410,959	38	410,997
27	Taiwan	291,037	47,683	338,720
28	Hungary	317,857	3,430	321,287
29	Uzbekistan	246,641	0	246,641
30	Australia	170,808	45,118	215,926
31	Austria	146,566	19,862	166,428
32	Sweden	161,080	·	161,080
33	Portugal	109,698	44,318	154,016
34	Serbia	113,487	805	113,878
35	Slovenia	89,395	4,339	93,734
36	Ukraine	45,758	4,691	50,449
37	Egypt	13,777	17,027	30,804
38	Netherlands	0	29,183	29,183
39	Finland	7,600	103	7,703
40	Others	523,679	119,936	643,615

Source: OICA annual reports (www.oica.net)

1.4 Problem Statement

Despite the importance of the automotive sector in the non-resource sector of the Iranian economy, the preceding review reveals several troubling trends over the 1984-2013 period. It was noted that total output that registered an increasing trend since 2004, peaked in 2011, and has fallen since then (Figure. 1.7, P. 19). At the same time, the growth of real value added in the industry has also fluctuated widely over the entire period, with growth settling at relatively low level, between 2006 and 2010, before plunging to negative levels in subsequent periods (Figure. 1.3, P. 12). Consequently, the percentage contributions of the automotive sector to GDP and the non-resource sector have been declining since 2010 (Table 1.4, P. 16). Meanwhile, employment in the sector has registered a steady increase since 1994, but began to decline slightly between 2010 and 2013. Over this same period, however, the value added per worker did not display a corresponding rising trend. It has fluctuated widely, suggesting that employment increases have not always coincided with increased productivity per worker (Figure. 1.8, P. 20).

Two main reasons have been advanced to explain the erratic growth of the automotive industry in Iran. The most widely held view is that the automotive sector in Iran, being highly dependent on imported inputs, has been severely affected from time to time by events that disrupted the economy such as the Islamic revolution, the Iran-Iraq war and the US-led sanctions designed to stop Iran's nuclear development programme. There is no doubt that these disruptive events along with high rates of domestic inflation had serious, adverse effects on the automotive sector in Iran. Another factor that is often cited is the fluctuations in oil price. Iran is highly dependent on oil revenue and serious dips in world price for oil affects the economy

in many ways, including depleting foreign exchange. This, in turn, affects its capacity to obtain imported inputs, including parts needed for the automotive sector.

While the role of these factors in affecting the growth and development of the automotive sector cannot be denied or downplayed, the primary focus on them divert attention from factors within the automotive sector that might be constraining its smooth growth. In other words, while the above factors may play a role in explaining the problems of the automotive sector, there is also the possibility that the disturbing trends noted above are also symptomatic of problems within the structure of the automotive industry and the efficiency of input use therein. This is an aspect that has been neglected for a long time. Only two studies have looked at the automotive sector from this perspective. Shadi (2016) applied the Cobb-Douglas production function to study the largest producer in the auto sector, Iran Khodro. He relied on time series data over the 1988 to 2012 period to derive various results but failed to comment on the efficiency of input use in this company. A much older study by Amini (1999) looked at three companies in the automotive sector using the cost function approach. He too did not report anything on input use efficiency.

The present study therefore attempts to fill this gap. Its primary focus is on the structure of the automotive sector as viewed through a production function approach, with particular emphasis on the efficiency of the use of three major inputs (labour, capital and materials), although other related aspects will also be examined. In order to do so, the underlying production function that best describes the sector has to be identified first. While there are several types of production function that can be used (Cobb-Douglas, Constant Elasticity of Substitution and Translog, for example), most

studies of this nature adopt the Cobb-Douglas production function (C-D Production Function) simply because it is both easy to estimate and interpret in its log form. Shadi (2016), for example, adopted the C-D production function to study the Iran Khodro company. However, very few studies precede their choice with an examination of whether the C-D production function is the appropriate one to use, especially since the Constant Elasticity of Substitution (CES) production function and the Translog Production function (TLPF) are gaining currency in the literature. The proper approach to choosing a production function is therefore to compare all three, in order to determine which one fits the data the best. Once the appropriate production function is determined, it is possible to examine not only the efficiency of input use but also other factors related to it such as the output elasticity with respect to key inputs, the substitution possibilities between inputs and the type of returns to scale the industry is experiencing during a given period.

1.5 Research Questions

Based on the discussion above, the research questions in this study are as follows:

1. What is the production function that best describes the automotive industry in Iran during the period being studied?
2. What are the contributions of the main inputs—labour, capital and materials—to output?
3. What type of returns to scale characterizes the automotive industry?
4. Are the main inputs being used efficiently?
5. What are the substitution possibilities between the three inputs?