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STRUCTURAL ANALYSIS AND PERFORMANCE OF PETRO- CHEMICAL INDUSTRIES IN KUWAIT

Key Words

*Productivity;
Performance;
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Abstract

The growth of petrochemical production capacity world-wide has been spectacular in the last 15 years and it appears that this trend will continue for years to come. With the internationally increasing concern with free trade policies, the petrochemical manufacturing industry has become increasingly more significant, especially in Kuwait. This study analyses the structure of Kuwait petrochemical industry. This covers mainly aspects of value of gross output and labor. Major differentiation is made between large- and small-sized firms. A model developed by Denny and Fuss and Gollop is used to measure productivity. The empirical results indicated that the small-sized firms were relatively more labor intensive and consume a higher level of energy. They were also found to constitute 95 per cent of the total number of manufacturing firms in Kuwait. The results also showed that the growth rates of the labor productivity at the small-sized firms were disappointing. In the meantime, the performance indicators showed that the large-sized firms were the more productive and gave a significantly higher growth rate of output.

Introduction

The growth of petrochemical production capacity world-wide has been spectacular in the last 15 years and it appears that this trend will continue for years to come. Basic

petrochemicals include methanol, ammonia, olefins ethylene, propylene, butadiene and butylenes, aromatics benzene, toluene and xylene and methyl tertiary butylether. The petro-

chemical industry is virtually a symbiosis between petroleum refining/natural gas processing and metro-chemistry, which has been superimposed on an existing chemical industry. Today, petrochemicals represent more than half of the total output of chemicals in the world (Goldman, N.& Preiss, P, 1999)

In the 1960s and early 1970s, the United States, Western Europe and Japan dominated the international production and trade in petrochemical products, a situation dictated by technological and market conditions (United Nations Industrial Development, 1998). However, after the sharp increase in energy costs, a dramatic shift in the structure of production economies of petrochemical products occurred, whereby variable costs, mainly raw materials and energy, assumed the largest share. This provided an opportunity for developing countries with abundant and low cost energy resources to invest in large-scale petrochemical capacity geared towards high domestic populations and consumption levels. During the 1970s, major developing countries like Korea, Taiwan, Brazil and Mexico dominated the industry and assumed competitive position in production and subsequently, international trade.

Since the early 1980s, a so-called "third Phase" in the development and trade of the global petrochemicals industry emerged, as Middle Eastern

producers, primarily in Saudi Arabia and Kuwait began to export. In fact, the emergence of petrochemicals as an export commodity is one of the most striking external trade developments in the GCC region. From an estimated \$863 million in 1983, total GCC petrochemical exports surged to more than \$3.2 billion in 1995 ("GATT Deal to Boost Gulf Petrochemical Exports", Arab News, 1996) at an annual growth rate of 20.8%. Given the limited domestic demand for these products, petrochemicals currently feature prominently in the non-oil component of GCC exports and the percentage share is expected to continue increasing for the coming few years as new plants and capacity expansions come on-stream. (Middle East Economic Digest, 1997)

With the world increasing concern with free trade policies, petrochemical manufacturing industry becomes one of the most significant industrial issues, especially, with a country such as Kuwait. Undoubtedly, Kuwait has to have an efficient and productive petrochemical manufacturing industry as it is vital to the economic diversification process. (Middle East Economic Digest, 1998).

Following the Iraqi invasion of Kuwait, a variety of structural changes have taken place in the Kuwaiti economy. This paper is confined to study the structure and performance of Kuwaiti petrochemical industry before and after the Gulf war. It aims to determine the most productive elements of the indus-

try and identify structure strengths and weaknesses. Such investigation will provide valuable information to the decision makers especially in the investment process of the Kuwaiti petrochemical manufacturing industry that is currently taking place.

The rest of the paper is organized as follows: In the next section, the structure of Kuwait petrochemical industry is described. Section III, presents the model that will be used to measure and analyze the performance (Labour Productivity (LP), Pure Productivity (PP), output and inputs growth rates) of Kuwait petrochemical manufacturing industry. The data and the empirical results are discussed in section IV. Section V gives the energy requirements for the petrochemical industry. Section VI presents the conclusions and some policy implications.

The Structure of Kuwait Petrochemical Industry:

The study utilized the industrial organization paradigm. Generally, it uses the International System of Industrial Classification (ISIC). More specifically, it has been defined that the industry include manufacture of chemicals, chemical products, petroleum, rubber and Plastic products. (Al - Subiah, 2003)

Petrochemical manufacturing industries are the largest industries in the Kuwaiti economy. The industry contributed about 70% of the non-oil gross domestic product (GDP) in 2001, while the contribution of petrochemical manufacturing industries to the total manufacturing industries was 76%. (Ministry of Planning, 2001)

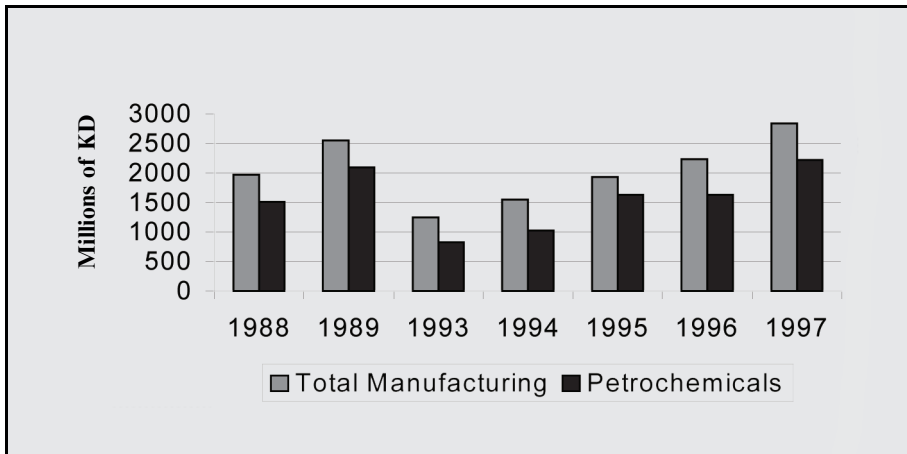
Table 1, (Graphs 1 & 2) illustrate the annual and the percentage shares of petrochemical industry (ISIC-35) in the gross output of total manufacturing industries sector.

Table 1
Kuwait Manufacturing Industries Employment
and Value of Gross Output Trends: 1988-1997

Item /	Year	1988	1989	1993	1994	1995	1996	1997
Value of Gross Output		1964.9	2547.3	1242.9	1547.2	1927.7	2235.1	2841.1
Total Manufacturing		1509.1	2094.9	826.9	1026.2	1631.1	1631.5	2220.4
Petrochemical		76.8	82.2	66.5	66.3	84.6	73.0	78.2
Number of Workers		58175	56507	54308	58969	58490	62145	63244
Total Manufacturing		11515	10659	7340	8321	8871	9104	9479
Petrochemical		19.8	18.9	13.5	14.1	15.2	14.6	15.0

* Values are in millions of Kuwaiti Dinars.

Figure 1
Kuwait Manufacturing Industry: Value of Output



Another measure of relative size of the manufacturing sector is employment.

Manufacturing industries employed 63,244 workers in 1997, including 9,479 workers in the petrochemical manufacturing industry as shown in Table 1.

Petrochemical industry is generally observed as the most competitive industry in Kuwaiti manufacturing industrial sector. However, most firms of this manufacturing industry are relatively small to achieve the economics of scale associated with larger production. There are two large petrochemical firms, one is owned by the government and the other is a joint venture between the government and Union Carbide (U.S.). The other firms

are mainly private sector owned and are usually small in size and produce mostly for the local market.

Table 2, shows that in 1997, the total number of firms in the petrochemical manufacturing industry was 56 firms including 2 large-sized firms and 54 small-sized firms (96.4%). The value added (measured as total inputs minus intermediate inputs) of the petrochemical manufacturing industry in 1997 was 864 million (KD). The contribution of large-sized firms was KD 784.5 million while small-sized firms contributed only KD 79.6 million. Such statistics show that on average, the large-sized firms contributed about 90% of the total value added of the petrochemical manufacturing industry.

Figure 2
Kuwait Manufacturing Industry Employment

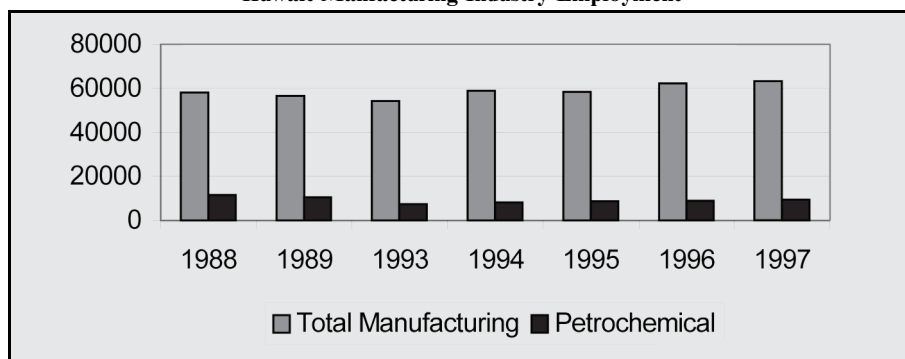


Table 2
Firms, Employment and Value Added of Petrochemical
Manufacturing Industry: 1988-1997

Item	Year	1988	1989	1993	1994	1995	1996	1997
<u>Number of Firms</u>								
Aggregate		62	60	52	54	56	55	56
Large-sized		1	1	1	1	1	2	2
Small-sized		61	59	51	53	55	53	54
<u>Real Gross Output*</u>								
Aggregate		570.4	791.9	315.2	396.7	541.5	643.1	864.0
Large-sized		502	708	291	362.6	488.4	602.6	784.5
Small-sized		68.4	83.9	42.2	34.1	53.1	40.5	79.5
<u>Number of Workers</u>								
Aggregate		11539	10680	7355	8334	8899	9123	9500
Large-sized		9600	8811	6325	7101	7440	8238	8085
Small-sized		1939	1869	1030	1233	1459	885	1415

* Values are in millions of Kuwaiti Dinars.

In 1997, the total number of labour employed in the petrochemical industry was 9500 workers, 90.3% of that number was employed by the 2 large sized firms while 54 small-sized firms employed only 9.7%.

A breakdown of various inputs' costs, as a percentage of value of output, for both large and small-sized firms in the petrochemical industry are shown in table3. In general, small-sized firms had higher labour and energy costs than the large-sized

Table 3
Input/Output Ratios in Kuwait Petrochemical
Manufacturing Industry: 1988-1997

Ratio / Year	1988	1989	1993	1994	1995	1996	1997
<u>Aggregate</u>							
K/Q	7.95	9.24	10.68	10.93	11.43	12.79	12.90
L/Q	18.21	19.79	20.88	20.39	20.64	19.09	19.83
E/Q	1.61	2.07	1.91	1.88	1.93	1.48	1.81
M/Q	62.46	57.17	56.83	57.45	56.10	55.43	57.57
E/Q + M/Q	64.07	59.24	58.74	59.33	58.03	56.91	59.38
<u>Large-sized Firms</u>							
K/Q	8.89	10.21	11.44	11.84	12.54	13.46	13.49
L/Q	17.01	18.51	19.96	19.83	20.01	18.86	19.03
E/Q	1.16	1.55	1.44	1.49	1.46	1.34	1.41
M/Q	64.01	57.50	57.24	57.64	56.09	55.91	58.07
E/Q + M/Q	65.17	59.05	58.68	59.13	57.55	57.25	59.48
<u>Small-sized Firms</u>							
K/Q	1.09	1.00	1.57	1.37	1.25	2.66	2.49
L/Q	26.95	30.57	31.89	26.22	26.46	22.55	27.44
E/Q	4.86	6.48	7.58	5.94	6.17	3.59	5.77
M/Q	51.07	54.40	51.89	55.48	56.20	48.18	52.87
E/Q + M/Q	55.93	60.88	59.47	61.42	62.37	51.77	58.64

Where: K = capital services; L = labour wages; E = energy; M = intermediate inputs; and Q = gross output.

firms which enjoyed relatively low labour and energy costs. The average labour cost in large-sized firms accounted for 19.03% of the gross output, compared with 27.44% for small-sized firms. This indicates that small-sized firms were more dependent on the rarest production factors in the Kuwaiti economy, namely labour. On the other hand, the average energy share was 1.41% of the gross output of the large-sized firms, while that for small-sized firms was 5.77%, which

shows how efficient were the large-sized firms regarding the energy consumption per unit of output. However, the large-sized firms were significantly more capital intensive, which is characteristic of the Kuwaiti manufacturing industries.

Evaluating the Performance of the Petrochemical Industry (The Model):

In this section, the model which will be used to measure the perfor-

mance in Kuwaiti petrochemical manufacturing industry is discussed. The model is based on Denny and Fuss (1983) and Gollop (1983, 1987) and takes into account the recent theoretical advance in productivity measurement in an open economy. A growth accounting approach (Star, 1974 and Gollop, 1987) and the index number framework were utilized in the model's derivation (Jorgenson, 1971 and Diewert 1976, 1987).

This application focuses on measuring and analyzing labour productivity growth rate and its two major components: (1) the changes in the production function (pure productivity); (2) the movement along the production function (factor intensities, FI). (Sachs, J. and Worner, A., 1997).

Thus, the relationship between the growth rate of labour productivity and that of its decompositions can be specified as follows: (Yamada, H. and Toda, H.Y., 1998).

$$\log_e(q_t/q_{t-1}) = \log_e(a_t/A_{t-1}) + [K^* \log_e(K_t/K_{t-1}) + M^* \log_e(M_t/M_{t-1})]$$

Where:

$q_t = Q_t/L_t$: this average share of one unit of labour (L_t) in the total output (Q_t),

(A_t): the index of Pure Productivity (PP),

$i = (1/2) \cdot (S_{i,t} + S_{i,t-1})$, S_i = the average share of i^{th} input in total output, $i = K_t$, and M_t , and $\sum S_i = 1$,

$K^* = K_t/L_t$: the average share of one unit of labour (L_t) in the capital input (K_t), and

$M^* = M_t/L_t$: the average share of one unit of labour (L_t) in the intermediate inputs (M_t).

The left hand side of the equation, stands for the growth of labour productivity, which can be seen as the sum of the pure productivity growth rate and the growth rate of the non-labour-input intensities. (Zpatee, H. and Rombaldi, A, 1997) Using these two components will help understand and analyze the growth rates of labour productivity and the overall performance in the Kuwaiti petrochemical manufacturing industry.

The assumptions underlying this model (production function) are: (1) Constant return to scale; (2) Hick's neutral technical change; and (3) Perfect competition in the inputs and output markets. (Rogers, M., 1997)

The Empirical Results:

The data used for estimating this model were obtained from the publication of the Central Statistical Office, the official data source in Kuwait. The statistics compiled relate to the

calendar years from 1988 to 1997. Specifically, output and inputs data were collected from the Annual Survey of Establishments-Industry of the Central Statistical Office - Ministry of Planning; while the data for the deflators were obtained from the Annual Statistical Abstract of the same source.

The wholesale price index was used to obtain the value of total output. For intermediate inputs, the wholesale price index (stage of processing, intermediate products) was used. The capital input was deflated by wholesale price index (end-use stages, capital goods). Wages were deflated by the consumer price index. Base year was 1988.

The annual and average growth rates of labour productivity (LP), pure productivity (PP), factor intensities (FI), and real total value of output in Kuwaiti petrochemical manufacturing industry are presented and discussed in this section.

Table 4, shows the annual and average growth rates of labour productivity over the time period from 1988 to 1997. The average growth rate of labour productivity in the aggregate level of the petrochemical manufacturing industry was 76% a year. While, throughout the period 1988 to 1997 the annual rate of growth was positive except for 1994 and 1996.

The large-sized firms experienced a positive average annual growth rate of labour productivity. However, the lowest labour productivity growth rate of -13.22% and a negative average growth rate over the period of six years were experienced by the small-sized firms.

It is worthy to recall that the pure productivity can be seen as any increase in output that can be produced without any change in the amount of inputs. This is a result of an improvement in the utilization of the available resources in the production process.

Table 4, also demonstrates the trends in the annual and average growths rate of pure productivity (PP). The empirical results indicate that the petrochemical industry and its two disaggregate levels had experienced a negative average growth rate of pure productivity during the time period 1988 to 1997, and this is mainly due to the distraction to the industry caused by the war period. However, it also shows that the small-sized firms had the lowest average growth rate of pure productivity, while the highest growth rate of pure productivity was achieved in 1988 by the large-sized firms. It is worth mentioning that the negative values of productivity in the case of small-sized firms is mainly due to the fact that they rely, generally, on

Table 4
Average Growth rates of Labour Productivity, Pure Productivity, and Factor Intensities in Kuwait Petrochemical Manufacturing Industry: 1988-1997

Performance / Year	1988	1989	1994	1995	1996	1997
<u>Labour Productivity</u>						
Aggregate	4.09	-1.35	3.65	-4.30	2.44	0.76
Large-size	6.66	-2.35	3.51	-3.68	-1.40	0.46
Small-size	-13.22	-11.04	10.17	-2.00	10.02	-1.01
<u>Pure Productivity</u>						
Aggregate	1.24	-4.46	-0.77	-0.15	1.19	1.49
Large-size	3.04	-4.26	-0.95	-0.01	0.55	1.77
Small-size	-8.89	-7.53	2.02	-0.45	1.01	-2.31
<u>Factor Intensities</u>						
Aggregate	2.85	3.11	4.42	-4.16	1.26	1.25
Large-size	3.62	1.91	4.46	-3.67	-1.94	0.73
Small-size	-4.32	-3.51	8.15	-1.55	9.01	1.30

old methods of technology and unskilled labour.

The effect of factor intensities on labour productivity growth rate can also be analyzed from table 4. The average growth rate of factor intensities in the petrochemical industry was 1.25% a year. In general, the average growth rate of factor intensities at the disaggregate levels was positive. However, it was not unexpected to find that the small-sized firms had the highest average growth rate of factor intensities. This reflects, mainly the inability of small-sized firms to fully utilize available resources when compared with the large firms.

The average and the annual growth rates of the real value of total

output are given in table 5. The annual growth rate of output ranged between 1.7 to 8.2 percent for the large-size firms and -8.7 in the small-size firms. The relatively low growth rate of the real value of output at the aggregate level in 1997 is mainly attributed by the small-size firms' negative growth rate of -8.7 percent in that year. One reason for the variation in productivity of the small-sized firms may be explained by drop in output due to drops in demand, in which case, companies do not lay out labor to match the drop in production as such a mechanism is lacking in Kuwaiti labor market (unlike the usual behavior in capitalist economies such as the U.S. labor market dynamics of downsizing and laying off excess labor in times of

Table 5
Output Growth Rates in the Kuwaiti Manufacturing Industry: 1988-1997

Year	1988	1989	1994	1995	1996	1997
Aggregate	4.44	2.42	2.77	-0.57	3.99	4.17
Large-size	6.06	5.64	1.70	-1.85	7.84	8.23
Small-size	08.30	-29.92	14.78	12.13	-40.85	-8.69

depressions or slow demand. Added to this is the fact of price variations of petrochemical products due to world-wide demand and price dynamics and which are also tied to crude oil and its product prices as well as natural gas prices which are also closely tied together.

The Energy Requirements of the Petrochemical Industry:

The industrial sector in Kuwait mainly encompasses oil based industries. These industries are directed toward exports and are the main sources for income generation in the country. They include oil and gas production, petroleum refining, petrochemicals, LPG plant and electricity and water. In view of their importance the energy consumption behaviour of each of these industries has been analyzed separately in this section. However, the approach is quite similar for each of them. Energy has been viewed as a factor of production within the context of the neo-classical "theory of the firm". The demand for energy has been treated as a function of industrial output of

the corresponding industry along with some other variables that influence the production decisions.

However, two points must be mentioned here. First, since the oil based industries are the backbone of the export revenues of the country and are totally owned and operated by the public sector in general, no domestic prices were used in explaining the energy consumption patterns by the petrochemical industry. Second, because appropriate data is not available regarding the consumption of electricity by the petrochemical industry level, we did not estimate the electricity demand.

The petrochemical industry uses also one type of energy that is natural gas. It also uses natural gas as a feed-stock input into the production of urea and ammonia among other products. However, this latter use is included in the non-energy use sector. Total energy demand (lnPICI) has been specified as a function of output (lnUREA) which is largely dominated by the production of fertilizers; i.e. urea. Also, a dummy variable for the occupation and war period (DUM1)

was included. The results of the estimation are as follows :

$$\ln PICI = 1.4672 + 0.4950 \ln UREA - 0.33992 DUM1$$

(2.96) (13.6) (-3.38)

$$D.W. = 1.9233 \quad S.E.R = 0.15 \quad R^2 \text{ Adj.} = 0.95$$

The equation fits the data reasonably well. All the coefficients have the correct signs and are statistically significant. The consumption of energy in this industry is dependent on the output level. It gives a short-run elasticity to changes in output of about 0.49. The dummy variable is also significant and negative reflecting the stoppage of the production activities during the Iraqi occupation and the liberation war period.

Summary and Conclusions

The analysis of this study indicated that the small-sized firms were relatively more labour intensive, and consume a higher level of energy. On average, small-sized firms account for 95 percent of the total number of firms, employed about 15% of the total number of workers, and contributed only 9.2% of the value of output of petrochemical manufacturing industry. All the small-size firms are owned by the private sector, while the large-size firms are mainly owned by the public sector.

The empirical results point out that the growth rates of the labour

productivity at the small-sized firms were disappointing, and the growth rate of total output was (-8.69%) per year over the time period 1988 to 1997. On the other hand, the performance indicators showed that the large-sized firms were the more productive and gave a significantly higher growth rate of output.

Therefore, based on the economic characteristic of Kuwait, small-sized firms appear to be inefficient and not capable to contribute significantly in the process of development and diversification of the Kuwaiti manufacturing industrial sector.

Low cost feedstocks afford Kuwait considerable variable cost advantages in the operation of a petrochemical plant. In Kuwait, domestic naphtha prices are below international trade levels, natural gas liquids are fixed 30 percent below export sales prices and methane and ethane prices have been maintained at 50 cents/million Btu. There are also fixed costs advantages in the form of large-scale bulk petrochemical and polymer plants using state-of the-art technology, while capital costs have been low due to subsidized loan rates. These advantages have provided tremendous export opportunities to the Kuwaiti producers (given the lack of domestic demand and consequently, export-to-production ratio in the Gulf is 80 percent

compared with approximately 25 percent globally.

Over 90 percent of the Gulf's LLDPE and methanol output is exported compared with 43 percent for both products globally, 97 percent of EG against 39 percent globally, and 69 percent of styrene against 22 percent globally.

Although Kuwait has capitalized on these advantages, it needs to further develop the petrochemical industry to ensure that today's strengths do not transform into weaknesses tomorrow. While PIC was able to sell one-third of its products domestically, and a further 8 percent in the Middle

East and Africa, the general trend among the GCC producers is a growing dependency on exports. This strategy does raise long-term concerns given the saturation of West European and North American markets and the rapid rise in Asian capacity.

Ironically, the one area that has yet to receive prominence is import substitution. The domestic market in the Gulf may be limited but petrochemical products still account for a sizeable portion of the total import bill. This provides an opportunity for Kuwait to establish plants that, in addition to exporting products, will substitute imports.

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الملخص

التحليل الهيكلي والأداء للصناعات البتروكيماوية في الكويت

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كان نمو الطاقة الإنتاجية في الصناعات البتروكيماوية مذهل في السنوات الخمس عشرة الأخيرة. ويبدو بأن هذا الاتجاه سوق يستمر لسنوات طويلة قادمة. ومع زيادة الاهتمام الدولي بسياسات التجارة الحرة، فإن أهمية قطاع الصناعات البتروكيماوية ستزداد بزخم أكبر، خاصة في دولة الكويت. قامت الدراسة بتحليل قطاع الصناعات البتروكيماوية في دولة الكويت، بالنسبة لإجمالي حجم الإنتاج وحجم العمالة خاصة. على أساس التمييز بين الشركات الصغيرة والكبيرة الحجم. وقد تم استخدام نموذج طوره كل من ديني وفوس جلوب لقياس الكفاءة الإنتاجية. أظهرت النتائج التجريبية أن الشركات صغيرة الحجم كانت ذات كثافة عمالية أكثر، كما أنها تستهلك كميات أكبر من الطاقة مقارنة بالشركات الصغيرة. كما تبين بأنها تمثل ٩٥ بالمائة من إجمالي الشركات الصناعية في دولة الكويت. أظهرت النتائج كذلك بأن الإنتاجية العمالية في الشركات الصغيرة كانت منخفضة ومتناقصة. وفي الوقت نفسه بينت مؤشرات الأداء أن الشركات كبيرة الحجم كانت أكثر إنتاجية وكان إنتاجها بنسب أعلى فيما يخص المخرجات.

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