The Impact of Environmental Regulations on Exports: A Case Study of Kuwait Chemical and Petrochemical Industry

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1. Introduction

The economic literature on the interface between environmental policies and international competitiveness has grown rapidly over the last decade (Dean 1992). A Major focus of this literature has been the assessment of whether differences in countries environmental regulations have affected the production and exports of pollution intensive products and/or whether do some countries strategically manipulate their environmental policies to confer some competitiveness benefits on their domestic industries. Though theoretically these concerns are well confirmed, unfortunately, there is no conclusive answer to either question and it is rather a case by case issue. For example Low and Yeats (1992) have suggested that "dirty" industries in developed countries have suffered loss of international competitiveness over the last three decades as a result of the relatively high environmental standards in developed world. Whereas, Jaffe et al. (1995) conclude that there is relatively little evidence to support the claim that environmental regulations have adverse effects on competitiveness.

Nonetheless, concerns are growing particularly in developing countries about the possible misuse of environmental measures and standards to discriminate against the penetration of their products into the developed countries markets. These concerns are coupled with growing domestic and international pressures on developing countries to set up measures to protect the environment, which if succeed, may lead to an increase in production costs and reduction in exports particularly from pollution intensive industries. Thus there is an important trade-environment dimension at stake, which warrants further analysis of the issue. Kuwait as a small open economy embarking the road of developing and diversifying its industrial base certainly shares similar concerns and faces similar effects and tradeoffs as other developing countries. The purpose of this study is to shed lights on the possible impacts of domestic and international environmental regulations on Kuwait exports of chemical and petrochemical products.

The rest of the paper is organized as follows: section 2 provides background information on the status of the chemical and petrochemical industry in Kuwait; section 3 presents the domestic and international regulatory regimes affecting the industry; section 4 summarizes the interviews results and sketches the possible regulatory scenarios; section 5 presents methodology and some exploratory results and section 6 concludes.

2. Overview of the Chemical and Petrochemical Industry in Kuwait

Kuwait has focussed very early on the development of its chemical and petrochemical industry with a view to utilize its comparative advantages and diversify its industrial base and exports. This resulted in Kuwait being the first country in the Gulf region to start manufacturing of petrochemicals, when established its fertilizers industry (mainly Ammonia and Urea) in the early sixties (Eltony, 2001). Unfortunately the country's efforts to foster a strong petrochemical industry were not as successful as those of its neighbors, e.g. Saudi Arabia, Qatar and UAE because of the small size of its domestic market and because of its locational disadvantage vis a vis its Gulf competitors with respect to the foreign markets. Thus the country's chemicals and petrochemicals industry remains to be dominated by small size producers, mainly of final petrochemical products, such as Polyster and Alkyd resins, or products derived from them, such as paints, detergents and plastics, and who essentially depend on the importation of their raw materials. This situation continued until 1997, when large scale export-oriented production of Ethylene Glycol and started in the $b2.1 giant petrochemical complex of Equate.

2.1 Production Structure

Table (1) reports the key production and employment statistics in the chemical sector for the years 1985, 1990, and 1999. The table reveals that the industry consists mainly of a few number of small size producers with paints and soap manufacturing accounting for more than 60% of the establishments and with fertilizers manufacturing the only large size producer in the industry, accounting on average for more than 70% of production and value added. In addition, it is also worth noting the large increase in the size of fertilizers industry between 1990 and 1999 with the same level of labor force, hinting the possibility of unexploited economies of scales. Otherwise, except for the emergence of soap manufacturing, the table indicates that the structure and composition of the chemical industry remained largely unchanged over the period 1985-1999. In contrast the structure and composition of the plastic products industry is reflected on Table (2) over the three years 1985, 1990, and 1995. Again, similar to the chemical industry, the main feature is the smallness of the production size, even though, there are more number of establishments in the plastics industry. The second feature is the growth in the industry with the number of establishments increasing by 40% and the output and value added nearly doubling between 1985 and 1995.

Table (1) Key Statistics of the Chemical Industry in Kuwait

	No. of Establishmen t	Employment	Wages KD (000)	Output KD (000)	Valueadded KD (000)
1985					
Basic industrial chemicals	6	276	900	5000	1600
Fertilizers and pesticides	1	1708	14700	25200	15400
Synthetic resin and plastic	0	0	0	0	0
Paints and lacquers	6	364	1400	10800	3700
Drugs and medicine	0	0	0	0	0
Soap and cleaning preparations	0	0	0	0	0
Other Chemicals	5	218	500	2900	1100
1990					
Basic industrial chemicals	6	352	518	7127	3008
Fertilizers and pesticides	1	795	9479	19956	9661
Synthetic resin and plastic	0	0	0	0	0
Paints and lacquers	8	345	763	5969	2296
Drugs and medicine	0	0	0	0	0
Soap and cleaning preparations	4	275	372	3654	1607
Other Chemicals	3	32	187	773	437
1999					
Basic industrial chemicals	6	328	1056	6293	3106
Fertilizers and pesticides	1	1061	15045	42715	31002
Synthetic resin and plastic	0	0	0	0	0
Paints and lacquers	7	222	797	6111	1803
Drugs and medicine	0	0	0	0	0
Soap and cleaning preparations	7	272	735	5202	2378

Source: UNIDO Industrial Statistics.

Table (2) Key Statistics of the Plastics Industry in Kuwait

	No. of Establishment	Employment	Wages KD (000)	Output KD (000)	Valueadded KD (000)
1985	17	1302	2600	17200	7300
1990	23	1112	1295	10306	4702
1995	24	1615	3200	30895	14278

Source: UNIDO Industrial Statistics.

To further understand the productive capacities in the chemical industry, Table (3) reports a time series of output values for selected chemical products (mostly solvants) over the period 1994-1998. It is noticeable that the series shows only minor fluctuations around otherwise constant output levels, indicating more or less full utilizations of the installed capacities. Moreover, the series seems to suggest that most of the products are directed towards the domestic market and the only export capacities available are in the Ammonia and Urea fertilizers.

Table (3) Production of Selected Chemical Products in Kuwait
(in 000 tons unless specified)

	1994	1995	1996	1997	1998
Chlorine	14.4	16.2	15	18	19.4
Caustic Soda	16.3	18.3	16.9	20.3	21.8
Hydrogen Gas (000 cub m)	45.8	50	49	49.8	54.5
Hypoclorite Sodium (000 cub m)	15.8	9.6	7.9	9.1	10.9
Hydrocloric Acid (m gallons)	1.4	1.7	1.9	2.2	2.6
Amonium Hydroxide	474	599.4	501	525.6	550.2
Detergents	0.8	0.9	0	0	0
Urea	681	849.4	774.5	757.6	786

Source: Central Statistical Office, Ministry of Planning, Kuwait.

On the other hand large scale production and export of petrochemical products have started in 1997 with the opening of the Equate petrochemical complex for operations. The complex produces Ethylene (basic petrochemical), Ethylene Glycol (intermediate petrochemical) and Polyethylene (final petrochemical) with initial installed capacities of 650, 350, and 450 thousand tons, respectively. The project employs cutting edge production technologies supported by Union Carbide for Ethylene Glycol and Polyethylene products and by Brown and Roots, Inc. for the Ethylene product. Current production levels for Ethylene Glycol and Polyethylene are respectively, 400 and 600 thousand ton mostly directed to the export market.

2.2 Efficiency

The UNIDO industrial data along with the simplifying assumption that only two factors of production, labor and capital are involved enable us to compute crude estimates of efficiency rates in the chemical industry. The computation uses the linear programing technique DEA, Data Envelopment Analysis (Coelli et al, 2000). Table (4) shows the computed mean efficiency rates for the years 1985, 1990, 1995, and 1999. Even though our computation ignores the technical and allocative efficiency of using raw materials and other inputs in the production process, the results are still supportive of high efficiency rates in the industry. Interestingly, the results confirm to a large extent our observation that production capacities are fully utilized in the industry, which, other things remaining equal, should translate into high technical efficiency rates. The high allocative efficiency rates suggest the presence of good management, which in turn may be explained by the small size of the establishments and by the fact that all establishments, except one, are owned and operated by the private sector. The declining trend in the efficiency rates between 1985 and 1999, on the other hand, may be apt to the age factor that most of the chemical industries were established during the early eighties. Nonetheless, the main conclusion to be drawn from this exercise in relation to our subject in this paper is the clue that there may not be much room for efficiency improvements in the industry to be realized through changing the production processes to comply with environmental regulations.

Table (4) Mean Efficiency Rates in Kuwait's Chemical Industry (%)

	Technical Efficiency	Allocative Efficiency	Economic Efficiency
1985	98	99	97
1990	99	99	99
1995	92	98	90
1999	92	90	85

Source: Author's Calculations Based on UNIDO Industrial Statistics.

2.3 GDP Contribution

The contribution of the chemical industry to the GDP in Kuwait is quite small. Table (5) presents this contribution in the form of percentage shares of the manufacturing sector and of the total GDP over the period 1994-1999. As evident from the table, the share of the sector remains within the 6% range of the manufacturing GDP and less than 1% of the aggregate GDP over the whole period. This implies that the economy wide costs of any policy measures affecting the sector, e.g. environmental regulation, may be quite limited and in a sense would support the partial equilibrium strategy to be followed latter in the paper to study the economic effects of such measures.

Table (5) Contribution to GDP of Chemical Industry in Kuwait

	1994	**1995**	**1996**	**1997**	**1998**	**1999**
% of Manufacturing	6.1	7.0	6.0	4.5	6.6	6.0
% of GDP	0.6	0.8	0.7	0.6	0.8	0.7

Source: Central statistical Office, Ministry of Planning, Kuwait.

2.4 Exports

Important competitiveness aspects of environmental regulations are the effects on exports and trade direction. Table (6) presents the export performance of the Kuwait chemicals industry over the period 1995-1999. In this table column 1 displays the total volume of chemical exports, column 2 displays the dollar value of exports, column 3 its percentage share of total exports, column 4 its percentage share of non-oil exports, columns 5-8 the dollar sales in the major export destinations (Kingdom of Saudi Arabia and United Arab Emirates, India, Singapore, and the United States), and column 9 displays the trade balance in the chemical industry indicated by the ratio of dollar value of exports to the dollar value of imports.

The first point to note is the large jump in exports volume and proceeds after 1997 due to the high value petrochemical exports (which are classified by the source as chemical products) following the commencement of production in the Equate petrochemical complex. In particular the tonnage volume of exports increased by about 50% and the dollar value by nearly 300% between 1997 and 1998. This magnified the contribution of the sector to the total country exports from less than 2% to more than 6% and its contribution to the non-oil exports from the 30% average to more than 60%. The second point to note is the growing importance of the East Asian markets as primary outlets for Kuwait chemicals exports, accounting for more than 30% of the total export market. Nonetheless, the table seems to suggest intense competition in these markets, reflected in the volatility of the individual country shares. In contrast, the Gulf market ranks the second with a limited absorptive capacity of less than 10%, yet is quite stable through out the observed period. The US market, on the other hand, is quite limited absorbing only an average annual value of 3 million dollars. The size of the European market is not reported because of data availability problems but expected to be small. The third point to note is the tremendous improvement in the trade balance in 1998 and 1999 after the marked deterioration during 1995-1997. This is because the expanded petrochemical production after 1997 has substituted for imported raw materials for domestic petrochemical–based manufacturing and at the same time has boosted export levels resulting in a net trade surplus of 6% in 1999.

Table (6) Values and Direction of Kuwait Exports of Chemical Products

Year	Total (000 tons)	Total (m$)	% Of Total Exports	% Of Non-Oil Exports	Flows to Major Destinations (m$)				Trade Balance Exports/Imports
					Saudi Arabia & United Arab Emirates	India	Singapore	United States	
1995	1591	261	2.0	37.9	14	82	na	2.5	0.46
1996	1504	225	1.5	31.3	20	110	na	3.5	0.37
1997	1549	204	1.4	13.5	19	72	na	2.9	0.30
1998	2256	591	6.7	61.9	39	49	123	2.9	0.89
1999	2297	646	5.8	62.1	na	na	na	na	1.06

Source: Country Profile, The Economist Intelligence Unit, UK.

As to the product composition of the exports, the available data is quite scarce and scattered. Table (7) provides breakdown of export volumes for selected chemical products over the period 1994-1998, and Table (8) provides a time series of export proceeds for manufactured fertilizers and Ethylene products over the period 1995-2000. The volume data depicts a fluctuating pattern in Urea exports around an annual average of 750 thousand tons and a fluctuating patterns in Amoina exports around an annual average of 60 thousand tons after an initial large drop from 475.2 to 67.4 thousand tons between 1994 and 1995. An irregular pattern involving small quantities of exports is also apparent for chemical products such as Chlorine, Caustic Soda and Hydrocloric Acid. Table (8), on the other hand, depicts a gradually declining trend in the proceeds from the exports of manufactured fertilizers from 53.8m KD in 1995 to 19.5m KD in 2000. More important, the table marks the great contribution of the new born petrochemical industry to the exports proceeds, manifested in the dramatic growth in the value of Ethylene products exports from 7.7m KD in 1997 to 132.5m KD in 1998 and further to 196.3m KD in 2000.

As for the plastic industry, the available statistics from the central statistical office of Ministry of Planning indicate very little exports ranging between 0.3 to 0.5 thousand tons of plastic pipes.

Table (7) Exports of Selected Chemical Products in Kuwait

(in 000 tons unless specified)

	1994	1995	1996	1997	1998
Chlorine	0	0	0	0	26
Caustic Soda	18.5	1.1	1	2	13
Hydrogen Gas (000 cub m)	0	0	0	0	0
Hypoclorite Sodium (000 cub m)	0	0	0	0	0
Hydrocloric Acid (m gallons)	0	0.9	1	1.6	1
Amonium Hydroxide	475.2	67.4	51.9	87.8	60
Detergents	0	0	0	0	0
Urea	703.8	876.5	794.8	749.6	773.1

Source: Central Statistical Office, Ministry of Planning, Kuwait.

Table (8) Kuwait Exports of Manufactured Fertilizers and Ethylene Products (m KD)

	1995	1996	1997	1998	1999	2000
Manufactured Fertilizers	53.8	44.5	30.3	20	17.2	19.5
Ethylene Products	0	0	7.7	132.5	161.5	196.3

Source: Central Bank Quarterly Bulletin, Kuwait.

3. Domestic and International Regulatory Regimes Affecting Kuwait Chemical Industry

3.1 The Domestic Regulatory Regime

A resolution establishing the Kuwait Environmental Authority (EPA) act was passed in October 2001. The law is expected to come into force in October 2002. Among the articles affecting the chemical and petrochemical industries are:

1. Article 1 requires that an environment impact statement be prepared for each new project or an extension/change of an existing project be submitted to the EPA as a prerequisite for getting the license.
2. Article 7 requires the establishment of an appropriate work environment and specifies maximum work exposures for the various chemical substances.
3. Article 14 specifies the environmental and safety standards for production, transport, export, import, and storage of chemical substances.
4. Article 17 specifies standards for packaging and labeling of chemical substances.
5. Article 57 deals with industrial sewage and its treatment.
6. Articles 78 and 79 specify standards for emissions generated by production processes.

To comply with the provisions in the Act, chemical industries have to install modern technologies and emissions control systems, put better air filtration systems, replace some inputs, e.g., replacing Gasoline, which contains the dangerous Benzol substance with “White Spirit” in machine cleaning, and provide better protection and safety systems to the workers.

3.2 The International Regulatory Regime

Two international regulatory regimes affecting Kuwait exports of chemical products are the existing and future regulatory systems in the export markets, and the multilateral trade and environmental agreements dealing with chemical substances.

3.2.1 Regulations in Export Markets

The largest and the most growing market for Kuwait chemical exports is the Asian market, followed by the Arab market, the EU and the US markets.

The status of the different environmental regulations in the Asian market is summarized on Table (9), which is compiled from the information provided by the US-Asia Environmental Partnership Office (www.usaep.org). The table is self evident in showing various degrees of strictness, compliance, and enforcement across the Asian markets.

EU has the most stringent system of environmental regulations in the world. The EU directives on chemical control include:

(a) Chemical testing and notifications:
   1. Harmonization of Good Laboratory Practice (GLP).
   2. Inspection and Verification of GLP in accordance with OECD recommendations.

(b) Standards for classifications, packaging and labeling of dangerous substances.

(c) Guidelines for the imports and exports of dangerous substances. In the case of prohibitions this is further subjected to the UNEP/FAO Prior Informed Consent (PIC) procedure.

(d) EU directives prohibits the placing on the market and use of detergents where the average level of biodegradability of the surfactants contained there in is less than 90% for the four categories: anionic, cationic, non-ionic, and ampholytic and further provide the test methods for compliance.

(e) The National Chemical Federations estimated that EU chemical industry environmental expenditure has averaged 3% of sales during 1996-1998 mostly in operating cost. This compliance costs are expected to increase with the implementation of a CO_2 program to meet the EU target under the Kyoto agreement (www.cefic.org).

(f) The white paper on the strategy for a future chemicals policy (Feb. 2001) whose objective is to achieve high level of protection for human health and the environment while preserving industry competitiveness includes the following elements:

Table (9) Environmental Regulations Affecting Chemical Products in Asia

Country	Scope	Compliance	Enforcement
Hong Kong	Less comprehensive	Poor	Weak because of uncertainties, economic slow down and concerns about international competitiveness
India	Comprehensive detailed and had been amended in 1994	4000 companies are expected to comply by 1998	Fair
Korea	Comprehensive, in 1996 532 toxic chemicals were subject to regulation, and there is a desire to comply with western industrialized countries standards	High rate of compliance	Increasingly strict
Malaysia	Comprehensive, amended in 1996 to be more stringent and to allow for environmental labeling	High rate of compliance averaging 90%	Enforcement and fines are generally lax compared to developed countries, but more tightened recently
Philippines	Comprehensive	Poor, a survey of industries showed that out of 1025 industries only 20% were equipped with pollution a abatement systems	Weak but expected to improve as a result of the increase in the staff of the Environmental Management Bureau from 170 to 2350
Singapore	The most comprehensive and stringent regulations in the region	High	Strong
Taiwan	Less comprehensive and only dated back to 1988	Poor, but screws are being tightened slowly on industry after the 1992 Green Plan initiative	Weak. Fear of loss of competitiveness generates lax enforecment
Thailand	Less comprehensive. Detailed guidelines for industry pollutions were issued in 1998	Poor	Weak but expected to improve

1. Calling for global harmonization of testing procedures, thereby testing obligations are extended to exporters and a recognition of non-EU tests is achieved.
2. Conformity with EU obligations under WTO by ensuring equal treatment of imports and domestic products in terms of testing requirements.

The US market, on the other hand, has a regulatory regime that is similar to the EU but less stringent. In contrast the Arab countries are at similar stages in terms of regulations, compliance and enforcement compared to those prevailing in Kuwait domestic market. In particular the GCC countries follow common directives for product specifications.[1]

3.2.2 Multilateral Trade and Environmental Agreements

Kuwait is a member of the WTO and a party to many international environmental agreements and thus certainly has to observe its obligations under these agreements in its production and trade of chemical products. Examples of Multilateral Environmental Agreement (MEA) are the 1992 Rio Declaration, the 1992 Framework Convention on Climate Change (FCCC), the 1992 convention on Biodiversity, Montreal Protocol on Ozone Depletion Substances, Basel Convention on Transboundary Movements of Hazardous Wastes, the Convention on the Law of the Sea (LOS), and the 2000 Protocol on Biosafety.

The most important elements of the provisions in these international agreements that are relevant to production and international trade in chemical products are the following:

1. The precautionary principle included in many MEA may be abused to erect trade barriers:

[1]Some interviewees point that these specifications are strictly enforced in the Kingdom of Saudi Arabia but largely not enforced in other Gulf States.

(a) Articles XX and XIV of the GATT/WTO contain general exceptions which may be utilized to impose countervailing environmental measures to protect domestic industry, see Babiker et al (1997). Article 5(7) of the agreement on the application of sanitary and phytosanitary (SPS) measures lays down rules on the procedure to be followed in the event of risk and insufficient scientific evidence.

(b) The agreement on Technical Barriers to Trade (TBT) allows account to be taken of the risks to human health, animal health and environment in regulatory measures.

(c) The Doha declaration allow country to take any measures for protecting human health, animal health and the environment at levels it considers appropriate subject to the requirement that they are applied in non-discriminatory manner.

2. The Chemical Tariff Harmonization Agreement (CTHA) under the Uruguay round calls for harmonization of tariffs on chemical products to rates between 5.5 and 6.5 percent.

3. The Ozone depletion agreements restrict trade in CFCs and other Ozone depleting substances.

4. The UNEP/FAO Prior Informed Consent (PIC) requires exporters to inform importers before the shipping of certain hazardous chemical pesticides to the importing country.

5. There exists an internationally recognized system for product certification which may help manufacturers comply with international environmental product standards. The system is developed by the International Organization for Standardization (ISO), an international group with 140 member countries. In particular ISO14000 is an environmental management certification system that provides comprehensive environmental investigation of products.

4. Interviews and Regulatory Scenarios

4.1 Summary of Interviews

The study has considered interviewing 13 manufacturers: two petrochemical manufacturers, a chemical fertilizers manufacturer, five plastic manufacturers, and five manufacturers of other chemical products, such detergents, industrial solvents, insulation products, paints, and resins. These manufacturers represent 35% of the number of chemical and petrochemical establishments, contribute more than 70% of chemical and petrochemical production and about 90% of exports (Public Authority for Industry, 2002). In addition, officials and research scientists from Kuwait Institute of Scientific Research (KISR), Kuwait Environment Protection Authority (EPA), Kuwait Public Authority of Industry (PAI), and the Kuwaiti Environmental Protection Society (KEPS) were interviewed on issues related to regulations, standards, monitoring, enforcement, and the status on the used and the best available waste treatment and disposal technologies.

In the following a brief summary of the manufacturers interviews is provided:

4.1.1 Awareness

100% of the interviewees are aware that environmental specifications and procedures do limit export of their products into developed countries markets and even into some important Arab countries markets, such as Saudi Arabia. Yet many manufacturers complaint that the Ministry of Commerce and Industry does not provide information on standards and regulations relevant to their products in the different export markets. Further, 40% of the interviewees claim that, whenever there is differentiation in standards across markets, they comply with the highest standards required in all export markets.

4.1.2 Experience with Trade Disputes

None of the interviewees has ever faced an environmentally based trade dispute yet some manufacturers have encountered problems and trade disputes of other forms, such as packaging requirements and custom measures. For example, one manufacturer mentioned that fumigation requirements in certain export markets did cause delays and additional costs.

4.1.3 Perception of Environmental Barriers to Trade and Competitiveness

40% of the interviewees agree that the imposed environmental specifications and procedures in developed countries export markets are enacted for genuine concerns, such as public health and environmental safety, rather than for retaliatory or protectionist motives. In contrast, 20% have expressed fears that the spread of such measures in export markets may potentially constitute real barrier to trade and competitiveness.

4.1.4 National Treatment

Almost all the interviewees feel that there is no discrimination among local producers with respect to the domestic specification and procedures, yet a few think that there is more government support to the exports of public enterprises.

4.1.5 Testing and Certification

Interviewees claim that there is no any form of testing performed by government institutions and that there are no government laboratories to do such testing. However, 60% of the interviewees conduct regular testing of their products using their own laboratories or/and commercial laboratories, such as those of the University of Kuwait and KISR, at costs ranging between 0.02% and 0.5% of the product price. Product certificates provided by some manufacturers to customers in the export market include COA (Certificate of Analysis) and MSDS (Material Safety Data Sheet). Further, in anticipation of more rigorous testing procedures in developed countries markets, 40% of the interviewees are considering international certification of their products through investing in ISO 14000 .

4.1.6 Dispute Resolution Mechanisms

Though most of the interviewees have not encountered trade disputes, many believe that the existing domestic institutional infrastructure is too weak to provide effective mechanisms for dispute settlements. In particular many have mentioned that national specifications and standards to judge product quality are either absent or largely ineffective.

4.1.7 Product Adjustment and Compliance

80% of the interviewees claim that their products and production processes are in compliance given the existing EPA standards. Some manufacturers are considering changing or upgrading their production technologies, investing in labels and packaging, and implementing ISO 14000 to meet future regulations, to improve the image of their products, and to increase their export shares. The control technologies in use are mostly "end of the pipe" type such as smoke stacks, filtration, collection and disposal of solid wastes, and wastewater treatment facilities. Though such processes certainly involve costs, interviewees were very reluctant to reveal the magnitudes or types of the effluents, the inputs responsible for the effluents or their cost shares, or even the current or the expected total cost of control. Since the current control processes are mainly "end of the pipe" treatments, most interviewees agree that given the status quo the regulations may not contribute to either the efficiency of the production processes nor to the quality of the products. On the other hand, 50% of the interviewees are confident that part of the control costs would be passed to domestic consumers in the form of higher prices.

4.1.8 Other Interviewees Concerns

Some of the concerns raised by the interviewees include:

(a) There are more concerns about bureaucratic impediments to exports at the national level than about domestic or international environmental regulations. Particularly, many are concerned about the volume of paper work involved in exports.
(b) Concerns that lack of standards and testing procedures in the local market discourages investment in quality improvements.
(c) Concerns about dumping that lack of standards and enforceability resulted in low quality products being delivered to the domestic market at very low prices.
(d) Lack of coordination among the regulatory agencies.
(e) Complaints that the Public Authority for Industry and the Ministry of Commerce and Industry do not provide timely information on specifications and environmental requirements in export markets.

4.2 Regulatory Scenarios

Our conversations with the EPA and PAI officials indicate that many existing chemical plants may not be in compliance with the current EPA. For example the 1999 annual EPA report reveals that an inspection covering 7% of the chemical plants showed a number of instances of chemical pollutants concentration exceeding the maximum acceptable levels. The offending species were Acrylonitrile with concentration of 2.45 PPM compared to 2 PPM, Sulfur Dioxide with concentration of 3.7 PPM compared to 2 ppm, and Methylene Choride with concentration of 522 PPM compared to 50 PPM. Results of the Public Authority for Industry lab tests for 2001 showed a compliance rate of only 32% for chemical products and even less than 1% for paints (PAI, 2001). A recent study by Ghosn and Al-Muzaini (2001) showed wastewater pollutant concentration levels for a major fertilizers plant that are well above the current EPA maximum acceptable levels, e.g., with COD concentration of (m/1) 475 compared to 200, Ammonia, (NH_3-N) concentration of (m/l) 105 compared to 3, and with temperature of 25-66C° compared to 10. On the other hand there are no available public records on emission levels of air pollutants, yet our conversations indicate that they may pose serious compliance problems for the upstream petroleum industry with clear detrimental concerns for the petrochemical industry.

On the technology side, our conversation with experts from KISR indicate the availability of a wide range of pollution control technologies in the market. These technologies range in efficiency and costs from the simple “end of the pipe” types such as smoke stacks, filtration and oxidation techniques to the more sophisticated build-in physical and chemical treatment technologies. For description of industrial waste treatment technologies see Asfari (1996).

There is a commercially - run waste treatment station to service the Shuiaba industrial area built in 1999 with a laboratory for testing and treating solid wastes and a modern incineration facility. The current fees changed are 35 KD/ton for toxic waste and 5 KD/ton for the non toxic waste. In anticipation of an increased demand for its services as more plants brought into compliance, the station is planning to upgrade its incineration facility and to add a modern liquid waste treatment facility.

At the policy level the EPA law will come into force by October 2002 and the EPA officials are expecting more and more plants to be brought into compliance as a result. In fact, with the date approaching, EPA has already received a number of petitions from major state-owned sources to delay their compliance, signaling a credible trend of enforcement.

Given the preceding discussion and in view of data limitations, we consider for our numerical exercise two regulatory scenarios. The first scenario involves bringing gradually upstream petroleum sources in compliance with prices of petrochemical and fertilizers feedstock increasing, according to some interviewees and experts expectations, by 1%-10%.

The second scenario involves improving solid and liquid waste treatments by 30% leading to 10%-20% increase in costs per ton for a cost – improvement elasticity in the range 0.3-0.7.

5. Methodology and Exploratory Results

5.1 Methodology

A partial equilibrium framework is used in the analysis for the reason that general equilibrium effects of environmental regulations are likely to be quite limited given the small size of the chemicals industry in Kuwait (less than 1% of GDP). The analysis follows, with some modifications, the procedure outlined in Larson (2000). Two types of environmental regulations are considered "end of the pipe" type regulations, such as waste treatment and disposal and regulations on specific inputs in the production process, such as those with respect to content, handling and usage of raw materials.

The basic idea is simple. Environmental regulations increase production costs, e.g., the average cost for the first type of regulations and the specific input cost for the second type of regulations. In the usual demand-supply context, the increase in production costs shift the supply curve to the left and reduce the quantity supplied and hence the quantity exported of the produce. The extent of the supply shifts, however, depends on the stringency of the regulations, the market elasticities and the input cost shares. The task at hand is to quantity these shifts and estimate percentage changes in exports from a given set of regulations and market data.

The market structure facing the Kuwait chemical and petrochemical products is characterized by fairly elastic supply and demand conditions. In the domestic market, though there are few producers, the interviews we had conducted revealed the presence of intense competition from imports in most of these products. To that extent, the ability of chemicals and petrochemicals manufacturers to pass the costs of environmental regulations to the domestic consumer is somewhat limited. At the international scene, on the other hand, the quantities exported are not large enough nor the types of the products are differentiated enough to confer a price-determination power on the Kuwaiti chemical or petrochemical exporter in the international market. Thus it is safe to assume that exports demand is perfectly elastic and the costs of environmental regulations mostly fall on profits.

Provided the market structure situation described above, for each of the two regulatory regimes, i.e., end of the pipe regulations and those with respect to specific inputs, we consider two cases.[2] The first case is the situation in which both export and domestic demands are perfectly elastic and the second case is the situation in which only the export demand is perfectly elastic, i.e., a case in which producers can pass some of the environmental regulations costs to the domestic consumer in the form of higher prices.

5.1.1 "End of the Pipe" Type Environmental Regulations

In this form of regulation, the control cost falls on total production costs, i.e.

$$C = c(w,r,y) + \alpha y \qquad (1)$$

Where α is the control cost per unit of output, w and r are input prices, c is the cost function, and y the level of output.

5.1.1(a) Case 1: Export and Domestic Demands are Perfectly Elastic

In this case the supply function shifts to the left from $Y = y(p,w,r)$ to $Y(p-\alpha,w,r)$, where p is the international price of the product. The reduction in

[2]Given the high efficiency and utilization rates in the chemical industry mentioned earlier, we ignore the case where efficiency improvements result from environmental regulations.

output can be computed along the old supply curve using the price elasticity of supply as follows:

$$\eta_{YP} = \frac{\Delta Y}{\Delta P}\frac{P}{Y} = -\frac{\Delta Y}{\alpha}\frac{P}{Y} \qquad (2)$$

or

$$\%\Delta Y = \frac{\alpha}{P}\eta_{YP} * 100$$

Given the perfect elastic demand assumption, supply to the domestic market remains the same and exports falls by the full amount.[3] In percentage terms the reduction in exports is:

$$\%\Delta E = \frac{Y}{E} * \%\Delta Y$$

where E is the original level of exports.

5.1.1(b) Case 2: Only Export Demand is Perfectly Elastic

In this case the producer can pass some of the regulation cost to domestic consumer. Assuming a Cournot competition in the domestic market, the optimal mark up is given by:

$$m = \frac{\theta}{n\eta_{YP}^{D}} \qquad (3)$$

where θ is the domestic market share of the industry, n the number of domestic producers and η_{YP}^{D} is the positive of the Marshallian demand elasticity in the domestic market.

If α is the domestic unit regulation cost, $m\alpha$ will be passed to the domestic consumer in the form of higher domestic prices. Accordingly the percentage change in domestic demand can be computed from the demand elasticity formulae:

[3]If the change in output is greater than the original exports level, exports become zero and output for the domestic market falls by the differences.

$$\%\Delta D = -\eta_{YP}^{D} \frac{m\alpha}{p^{D}} * 100 \tag{4}$$

where p^{D} is the domestic price.

The effective per unit regulation cost that fall on the producer is $[\beta(1-m)+(1-\beta)]\alpha$, where β is the output portion sold in the domestic market. The percentage change in output can then be computed using the output supply elasticity:

$$\%\Delta Y = -\eta_{YP} \frac{[\beta(1-m)+(1-\beta)]\alpha}{P_0} * 100 \tag{5}$$

where $P_0 = \beta P^{D} + (1-\beta)P$ is the initial supply price.

The percentage change in exports is given from (4) and (5) by:

$$\%\Delta E = \frac{Y}{E}\%\Delta Y - \frac{D}{E}\%\Delta D \tag{6}$$

5.1.2 Input-Specific Environmental Regulations

In this case producer has two options: substitution away from the offending input and/or control of pollution caused by the input. This in effect raises the price of the regulated input. Following Larson (2000) by using the Hotelling's Lemma and the duality properties of the profit function:

$$\frac{\partial Y}{\partial W} = \frac{\partial X}{\partial P} = -\frac{\partial X^{c}}{\partial Y}\frac{\partial Y}{\partial P} \tag{7}$$

where W is the price of the regulated input, X is the profit maximizing input demand, and X^{c} is the conditional input demand.

5.1.2(a) Case 1: Export and Domestic Demands are Perfectly Elastic

This is the case where the full regulation cost falls on profits. Rewriting (7) in elasticity form:

$$\eta_{YW} = -\frac{XW}{PY}\eta_{XY}^{c}\eta_{YP} \tag{8}$$

The percentage reductions of output and exports are then give by:

$$\%\Delta Y = \eta_{YW} \frac{\Delta W}{W} * 100$$

and

$$\%\Delta E = \%\Delta Y * \frac{Y}{E} \quad (9)$$

5.1.2(b) Case 2: Only Export Demand is Perfectly Elastic

This is the case where part of the control cost may be passed to domestic consumer in the form of higher output prices. The change in the total cost due to the regulation is:

$$\Delta C = \frac{\partial C(w,r,y)}{\partial W} \quad (10)$$

Using Sheppard's Lemma:

$$\Delta C \cong X\Delta W \quad (11)$$

With Cournot Competition the proportion of costs charged to domestic price, i.e.,

$$\Delta P^D = m\frac{X}{Y}\Delta W \quad (12)$$

Using the domestic demand elasticity, the percentage change in the domestic demand is:

$$\%\Delta D = -\eta^D_{YP} m \frac{X}{Y}\frac{\Delta W}{P^D} * 100 \quad (13)$$

With Cournot pricing in the domestic market equation (8) becomes:

$$\eta'_{YW} = -\frac{XW}{P_0 Y}\eta^C_{XY}\eta_{YP} \quad (14)$$

where

$$P_0 = \beta P^D + (1-\beta)P$$

Accordingly, the percentage reductions in output and exports in (9) become:

$$\%\Delta Y = \eta'_{YW} \frac{\Delta W}{W} * 100$$

and

$$\%\Delta E = \frac{Y}{E}\%\Delta Y - \frac{D}{E}\%\Delta D \qquad (15)$$

where the $\%\Delta D$ is given by (13).

5.2 Some Exploratory Results

The results in this section are exploratory and largely meant to demonstrate the usefulness of the framework developed in the previous section. Hence, readers are cautioned against drawing any sort of policy recommendations that heavily rely on these results.

Three groups of export products are considered in the analysis: The Petrochemical Products of Ethylene Glycol and Polyethylene, the Petrochemical Fertilizers Ammonia and Urea, and the Chemical resins Alkyd and Polyster.

5.2.1 Ethylene Glycol and Polyethylene

Ethylene Glycol is a key intermediate for polyster fiber and container resins. Polyethylene is used in a broad variety of packaging, agricultural, film, and container modeling applications. The only producer of these two products in Kuwait is Equate, a joint venture between the Kuwaiti PIC and Boubyan companies and the US company Union Carbide. Current production levels are about 600,000 tons per year for Polyethlene and 400,000 tons per year for Ethylene Glycol. 99% of production is exported to markets in Middle East, Far East, Europe, and Africa.

The company uses the state of the art technologies licensed by Union Carbide with specifications meeting the US EPA standards. Control of air pollutants and wastewater treatment are built in the production process. Solid wastes are collected, treated and incinerated. Company officials claim that their current emissions and wastewater quality meet the proposed Kuwait EPA standards. Since we are lacking the details on emissions levels and wastewater quality, we accept the claim and hence our second regulatory scenario does not apply. In contrast the company officials believe that the impact of upstream emissions control on feedstock prices is certainly a legitimate concern.

Based on raw material cost shares reported in Eltony (2000) and adjusting for raw materials other than feedstock and profit margins, we obtain an estimate of 25% for the share of feedstock in total revenues. Given the current levels of capacity utilizations and the recent trends in the petrochemical industry, an input elasticity with respect to output of 1.4 and a price supply elasticity of 0.5 are assumed. Provided the smallness of the domestic market share, only case 1 of section 5.1.2 is considered. The calculation of the impacts of our first regulatory scenario on Ethylene Glycol and Polyethylene exports are shown in Table (10).

Table (10) Impacts of Higher Feedstock Prices on Ethylene Glycol and Polyethylene Exports

	Low	High
% increase in feedstock prices	1%	10%
Output supply elasticity (assumed) η_{YP}	0.5	0.5
Conditional feedstock demand elasticity wrt output (assumed) η^C_{XY}	1.4	1.4
Share of feedstock in total revenues $\frac{WX}{PY}$	0.25	0.25
Exports-output ratio $\frac{E}{Y}$	0.99	0.99
% Change in output $\%\Delta Y$	-0.175%	-1.75%
% Change in export $\%\Delta E$	-0.175%	-1.75%

Hence, our best estimate of the export losses in the petrochemical industry resulting from the enforcement of the Kuwait EPA law is within the order of 0.1%-1.8%.

5.2.2 Ammonia and Urea Fertilizers

Ammonia is a nitrogen-rich fertilizer produced from natural gas. It is the chief raw material for the production of Urea and is used as one of the raw materials for the manufacturing of several other fertilizer products, such as DAP, NP/NPK, ammonia nitrate, ammonia sulphate, and nitrogen solutions. Urea is the most popular and economical of all nitrogenous fertilizers being used world-wide, with a nitrogen concentration of 46%. In addition, Urea is a major raw material for melamine and an important raw material for the manufacturing of other industrial products.

The Petrochemical Industries Co. (PIC), a government owned company, is the only manufacturer in Kuwait with export capacities in these products. The current production level for Ammonia is 700,000 tons per year, of which 600,000 tons go to the production of Urea and 100,000 to the export markets. The current production level for Urea is 1,000,000 tons per year equally divided between Prilled Urea and Granular Urea. 99% of production is exported to international markets. Export markets for Ammonia and Urea include Middle East, East Asia, US, and Europe. Average export prices are around $100 per ton.

Production activities give rise to three classes of pollutants: Air pollutants, mainly, SO_2 , NH_3 and Urea dust; wastewater pollutants such as oil, NH_3 , and Urea; and solid wastes such as inert wood and paper. In response to international demand, specially in developed countries markets, the company is planning to completely move from the production of Prilled Urea into Granular Urea by mid 2003, there by reducing the Urea dust to zero. Hydrolyser is used to treat Ammonia and Urea in wastewater. Used oil and oil mixed with wastewater are collected and sent to Shuabia Station for treatment along with solid wastes.

The latest measurements released by the company show the following levels for the different effluents. The per ton of output discharge rates of Ammonia to the atmosphere and the sea are respectively 0.93 kg and 0.23 kg. In contrast the corresponding discharge rates for Urea are 0.7 kg and 0.07 kg. The discharge rates for used oil and oil mixed with water are respectively one ton per 4000 tons of output and one ton per 750 tons of output. The discharge of non toxic solid waste is at the rate one ton per 2000 tons of output. On the other hand satisfactory data on levels and concentrations of CO_2 and SO_2 pollutants to judge compliance are, however, not available.

The hydrolyser treatment of discharged Ammonia and Urea is built in the production process and the company officials find it infeasible to assess a separate cost for this process. On the other hand, the costs of replacing the technologies of prilled Urea with technologies for Granular Urea may not be attributed to pollution control even though the replacement reduces Urea dust, because they are dictated by market rather than by environmental concerns. Hence we may only consider the impacts of upstream pollution control and the tightening of regulations on wastewater and solid waste treatment at Al Shuaiba Station.

5.2.2(a) "End of the Pipe" Liquid and Solid Waste Treatment

Since 99% of Urea production and 100% of the remaining Ammonia production are for export, this case effectively corresponds to case 1 of section 5.1.1. Our second regulatory scenario entails 10%-20% increase in cost of treatment per ton at Shuaiba Station. Given the preceding company's discharge rates this translates into 0.03$ - 0.06$ increase in cost per ton of output. For 0.8 price supply elasticity, calculations of the impacts of this regulatory scenario on Kuwaiti exports of Ammonia and Urea are reported in Table (11) below.

Table (11) Impacts of Stricter Domestic Regulations of Waste Treatment on Ammonia and Urea Exports

	Low	High
Increase in treatment cost per ton of output α	\$0.03	\$0.06
Output supply elasticity (assumed) η_{YP}	0.8	0.8
Export-output ratio $\frac{E}{Y}$:		
for Urea	0.99	0.99
for Ammonia	0.14	0.14
% Change in output $\%\Delta Y$	-0.02%	-0.05%
% Change in exports $\%\Delta E$:		
for Urea	-0.02%	-0.05%
for Ammonia	-0.15%	-0.34%

The results suggest that tightening regulations on liquid and solid waste discharges have quite small direct effects on the exports of Ammonia and Urea.

5.2.2(b) Upstream Pollution Control Effects

Next, we consider the impacts of the upstream pollution control scenario on the Ammonia and Urea exports. Company officials indicate that the cost share of natural gas in the production of Ammonia ranges between 25% and 30%. Adjusting for profit margins, we consider an estimate of natural gas share in total revenue of 25%. Based on the existing levels of capacity utilization in the industry a conditional demand elasticity for natural gas with respect to Ammonia output of 1.2 is assumed. Using the methodology developed for case 1 of section 5.1.2, the calculations of the impact of this regulatory scenario on Ammonia exports are shown in Table (12) below.

Table (12) Impacts of Higher Natural Gas Prices on Ammonia Exports

	Low	High
% increase in natural gas prices	1%	10%
Output supply elasticity (assumed) η_{YP}	0.8	0.8
Conditional demand elasticity of natural gas wrt output (assumed) η_{XY}^{C}	1.2	1.2
Share of natural gas in revenues $\frac{WX}{PY}$	0.25	0.25
Exports-output ratio $\frac{E}{Y}$	0.14	0.14
% Change in output $\%\Delta Y$	-0.14%	-1.4%
% Change in export $\%\Delta E$	-0.98%	-9.8%

The table suggests that upstream control of petroleum pollution sources may have large impacts on Ammonia exports, reaching 10% for the high impacts case. Nonetheless, since Ammonia exports are only small fraction of the company's exports, the overall level of exports may not be much affected.

5.2.3 Alkyd and Polyesters Resins

Alkyd and polyesters resins are intermediate chemicals used in the production of paints and fiberglass. The Kuwait Chemical Manufacturing Company is the only producer of these resins in Kuwait with current annual production levels of around 800 tons for Alkyd and around 1300 ton for polyester resins and with a domestic market share of about 40%. 5% of production is exported to the GCC and other Arab countries markets. The average domestic price is about $1200 per ton.

Raw materials used in production include White Spirit, Maleic Anhydride, Mono Propylene Glycol, Pentaerythritol Mono Grade, Phthalic Anhydride, Soybean Oil, and Styrene. The production process consists of mixing these materials and boiling them in a specially designed reactor. No air pollutants are emitted in the process. Wastes from the reactor and other solid wastes are treated for active chemicals before discharge. The treatment consists of pumping the liquid waste into an evaporation pit, where its acidity is neutralized by the addition of Caustic solution. In the pit the water is evaporated and solid material remaining is collected in drums for disposal. The solid materials are mostly alkyds, unsaturated polyester and salts. The collected plant waste plus other solid waste are sent to Shuaiba Station for further treatment and disposal. Table (13) presents a breakdown of waste volumes by source and product.

Table (13) Volumes and Composition of Wastes for KCMC

	Alkyd	**Polyester**
Water (Liter/Batch)	310	900
Pentaerythritol (Bag/Batch)	54	-
Phthalic Anhydride (Bag/Batch)	89	147
Maleic Anhydride (Bag/Batch)	2	98
Isophthalic Acid (Bag/Batch)	50	-
Aerosil 200 (Bag/Batch)	-	5

Source: Kuwait Chemical Manufacturing Company (KCMC).

The average bag weight is about 0.3 kg and the average size of the batch is 18 tons. The maintenance and operating costs for the evaporation pit are estimated to be 500 KD/year. The gross disposal charge is 42 KD/ton for hazardous material.

The relevant regulatory scenario for these products is the second scenario that involves tightening control on chemical waste treatment. Since the company has a domestic market share of 40%, the appropriate case to consider is case 2 of section 5.1.1. Assuming a domestic markup, m, of 20% on marginal cost, equation (3) implies a Marshallian demand elasticity of –2. Using the data in Table (13) and the considered regulatory scenario, the incremental regulatory cost per ton of output, α, is calculated to be \$0.13-\$0.26. Further, we make the simplifying assumption that international market is served at a price equals marginal cost, i.e., P=\$1000. Then, using equations (4)-(6), the calculations of the impacts on domestic sales, production, and exports are shown in Table (14) below for an own price supply elasticity of 1.2.

Table (14) Impacts of Stricter Domestic Regulations of Waste Treatment on Alkyd and Polyester Resins

	Low	High
Increase in treatment cost per ton of output α	\$0.13	\$0.26
Output supply elasticity (assumed) η_{YP}	1.2	1.2
The positive of Marshallian demand elasticity (calculated) (η_{YP}^{D})	2.0	2.0
Export-output ratio $\frac{E}{Y}$	0.05	0.05
% Change in domestic sales $\%\Delta D$	-0.004%	-0.008%
% Change in exports $\%\Delta Y$	-0.013%	-0.026%
% Change in exports $\%\Delta E$	-0.17%	-034%

The results suggest that piecemeal levels of domestic control on industrial waste sources may have only small effects on the production and exports of Alkyd and Polyester resins. Nonetheless, in percentage terms, the order of effects on exports certainly signals some future competitiveness concerns.

6. Concluding Remarks

The paper started with raising a number of questions and concerns regarding competitiveness impacts of environmental regulations. In the sequel some of these concerns have been addressed qualitatively and some quantitatively within the context of the Kuwait chemical and petrochemical industry. The findings are, however, somewhat mixed. On one hand, the study does not provide a strong support to the claim that environmental policy is used strategically in some export markets. On the other hand, the study certainly underscores the legitimacy of the concerns that stricter environmental regulations in developing countries have negative impacts on their exports. Ironically, it turns out that the domestic rather than the international regulations seem to pose the more challenging questions to industry competitiveness. For instance, our exploratory exercises suggest that some piecemeal type domestic regulations may cause export losses in the range 1%-10% for some manufacturers. More importantly, pollution control in the upstream petroleum sources may prove to have greater impacts on the exports of the relatively cleaner downstream petrochemical industry than the control of its own pollution. The relevant policy question, however, is then how to minimize the cost of pollution control in the whole manufacturing sector. To help answering this question, the following aspects of pollution control policy architecture are crucial:

1. Availability of an effective communication mechanism between the stake holders and concerned government institutions to address the impacts of environmental regulations on competitiveness.

2. Incentives to companies to invest in cleaner technologies, such as tax breaks and R&D subsidies.

3. Financial support to R&D institutions for research in pollution control technologies.

4. Companies adoption of international standards in labeling and packaging and certification systems such as the ISO14000

5. Movement away from command and control type environmental regulations into more market based regulatory instruments.

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Abstract

The paper raises a number of questions and concerns regarding competitiveness impacts of environmental regulations. In the sequel some of these concerns have been addressed qualitatively and some quantitatively for the Kuwaiti chemical and petrochemical industry. The findings are, somewhat, mixed. On one hand the study does not provide a strong support to the strategic environmental policy hypothesis. On the other hand, the study certainly underscores the legitimacy of concerns that stricter environmental regulations in developing countries have negative impacts on their exports. Further, it turns out that the domestic rather than the international regulations seem to pose the more challenging questions to industry competitiveness in these countries.

Keywords:
Competitiveness, environmental regulations, chemicals and petrochemicals, pollution control, upstream and downstream.