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# Export Performance of Firms in Developing Countries and Food Quality and Safety Standards in Developed Countries[1]

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## Abstract

Turkey changed her economic policy in 1980s towards more liberal economy and higher exports. During this transition, the structure of the exports also changed from agricultural products towards industrial ones. Export of food products, for which the European Union is the largest market, has an important share in total exports. Recently, EU has started to increase the stringency of her regulations related to food quality, safety and environmental standards. This development necessitates the analysis of how Turkish firms exporting into EU should respond to them, and that is what this paper will try to demonstrate. We believe that such analysis is very valuable not only for Turkey but also for other developing countries.


## 1. Introduction

Reports by World Health Organisation and many academic studies indicate that food safety issues are becoming an increasingly serious threat to public health in developing countries. Lack of adequate regulations related to food safety as reflected in many unrecognised cases of food borne illnesses puts especially children and infants at high risk (for example, food borne diarrhea is the most common cause of death in children and infants). Therefore, improving food safety and quality must be an integral part of any policy that aims to reduce poverty and hunger. According to a World Health Organisation study in 1993, 70 percent of the approximately 1,5 billion global episodes of diarrhea occurring annually (which result in 3 million deaths

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among children under five) has been estimated to be caused by biologically contaminated food (Motarjemi et al 1993). Same study also identifies that contaminated food has been recognised as playing a major role in the epidemiology of cholera and other forms of epidemic diarrhea, substantially contributing to malnutrition. Parasites also pose significant health risks; for example, in rural areas of Africa, Asia and Latin America, cysticercosis is endemic with an infection rate of 2 to 15 percent of the population as compared to less than one- hundredth of a percent in the USA (Roberts et al 1994). Analysis of public investment in improving food safety in developing countries must be given adequate importance, and a detailed study on this issue is done by Unnevehr and Hisrchhorn (2000).

In this paper, we will focus on another interesting dimension of food safety issues: the impact of increasing food quality and safety standards in the developed countries on the exporters of food products from developing countries. One consequence of higher economic growth is the increase in the demand for quality and safety in certain commodities, in particular food. In Europe and the USA, the quality and safety standards related to the products in food industry are becoming stricter. As many firms in MENA countries, such as Turkey, are exporting food products into developed countries, it is very important to determine how they should deal with these increased food safety and quality standards in order to protect their market shares. A careful investigation should also be carried out related to the use of these standards as non-tariff barriers. We will try to address these issues in our paper.

## 2. Literature

Quality and food safety standards in the food sector have been an essential component of food consumption parallel to economic development. With the increases in the income in developed countries, consumers started to be selective on the products they use (Mahe and Orlando 1998, Roberts, Josling and Orden 1999). We can define food safety as food being free from chemical and biological danger or from anything else which may generate adverse health effects (Unnevehr 2000). Quality has dimensions related to both production process and final product. Briefly, it can be defined as the satisfaction of consumers in all aspects. Although safety and quality can be thought as two different dimensions, in practice safety is a prerequisite for the quality because a product that causes health problems can not be considered as a quality product.

Food quality and safety is an example of information asymmetry between sellers and buyers. Sellers know the quality and safety attributes of their products much better than buyers, and it is hardly possible for buyers to assess these attributes during the transaction fully. With these features, this issue falls into the boundaries of adverse selection problem (Akerlof 1970). Adverse selection here refers to the fact that buyers may choose low quality or less safe food items because of lack of information.

Existence of asymmetric information increases the transaction costs and hence generates private incentives to decrease such costs (Holleran, Bradahl, and Zaibet 1999). Akerloff (1970) showed that institutional warranties such as quality assurance standards play an important role to solve such problems. Holleran, Bradahl, and Zaibet (1999) state that food quality and safety standards are voluntarily accepted and applied by the firms to improve their competitiveness. This motivation guides the firms towards quality assurance systems. There are various quality and food safety assurance institutions. The common things among all are the documentation, third party control and accreditations. Quality assurance systems (QAS) supply the quality and safety demand by consumers. QASs aim to increase the competitiveness by differentiating on quality in the food production chain (Morris 2000). These structures are accepted as important business strategies for both in agriculture sector and academics, for example, in UK. In this context it will be useful to see how QASs help firms. Transaction costs between buyers and sellers have several dimensions: 1) information search cost for quality assurance and food safety, 2) negotiation cost, 3) monitoring and enforcement cost (Hobbs 1996). Obviously increases in transaction costs make the transaction less likely. Hence the firms are integrating themselves to QASs to reduce the transaction costs, especially related to the first dimension. In addition Mazzocco (1996) and Bredahl and Zaibet (1995) show that most of the firms integrated to QASs have seen not only declines in the cost of transactions but also have experienced improvements related to their production process and final product.
Among these, increases in productivity, better management, improvements in consumer relations, elimination of deficiencies in production processes (discovered during the documentation stage of QAS, for example), better adaptation of new personnel, and the conservation of current customers. Bredahl and Zaibet (1995) showed that total cost of integrating to QASs for the firms they studied was less than the benefits acquired directly or indirectly through the channels mentioned above. Consequently, integrating to QASs with consideration of quality and safety standards is an important strategy for the firms.

ISO 9000, an example of QAS, is in the international platform for more than 10 years. Especially in UK use of ISO 9000 standards is widespread. Nearly half of the certificates given in the world are issued in UK. Firms in food industry are also getting these certificates rapidly. Holleran and Bredohl (1997), Lloyds (1995), and Seddon et al. (1993) investigated the reasons why firms were trying to obtain ISO 9000 (QASs in general) in detail. Firms are trying to get quality assurance certificates for two reasons: one is related to firm driven factors, and the other one is customer and regulation driven. Lloyds (1995) showed 82% of the firms in food sector got ISO 9000 to increase efficiency. Other researches demonstrated that internal motivations were important to get ISO 9000 in non-food sectors as well.

The size of the firms, existing quality assurance systems and complexity of the production processes are also important in mentioned issues. Seddon (1995) indicated that big firms are getting ISO 9000 for internal reasons and small ones are getting for consumer demand and other external factors. The motivation for small firms to get quality assurance systems is mainly related to acquiring new customers and conserving the old ones rather than decreasing the cost of production.

As mentioned above, prerequisite for food quality is the food safety. The risk of morbidity and mortality related to food consumption makes these issues a public policy issue in developed countries (Antle 1999, Unnevehr and Jensen 1999) as consumers can not determine food safety in advance and firms can not warrant food safety completely. State regulations can be in many different forms; command and control (direct regulations) and the market enhancing regulations represent the two general forms of regulations. In the environmental economics literature, the best form of regulations has been studied extensively. Out of these studies, market enhancing regulations such as taxation, tradeable permits, have been shown to be superior to command and control, such as process and performance standards, in general. Nevertheless there are exceptions to this, and food safety seems to be among these exceptions. Performance standards are costly during the inspection process and due to difficulties to measure pathogen standards, they are not suitable. Today trends are towards warranting food safety during the production process. In many countries especially in EU this type of regulation system mostly adopted is HACCP, Hazard Analysis at Critical Control Points.

Although HACCP is a process system, there is also performance standard dimension in it. HACCP obligates demonstration of critical control points and measurable indicators related to them; it replaces expensive measuring methods with moderate ones by changing the focus of measurement. Secondly, it identifies critical control points in the production process, and thus food safety hazards can be prevented, eliminated, or reduced to acceptable levels before they occur. Thirdly, it gives enough freedom to firms on design and implementation, and thus is effective in reducing the cost of compliance.

Recently, an important question is being asked: should we always apply regulations whenever there is a market failure? Such considerations have resulted in the application of regulatory impact assessment technique. In some countries, for example US, its implementation became compulsory. The mentality of this technique is that the agency, supposed to take a regulatory action, must show that total benefits of the regulation will be larger than the total cost. This is an additional measure towards protecting limited public resources. The most common technique used today is benefit-cost analysis (Morall 1997, Ante 1999). Food Safety and Inspection Services (FSIS) in USA has done regulation effect analysis for a period more than 20 years related to HACCP (Roberts et al. 1996). The study showed that total benefits of HACCP regulations range between 7.13 and 26.59 billion dollars and total cost ranges between 1 and 1.2 billion dollars. Thus, application of HACCP turns out to be desirable.

For firms exporting to EU or other high-income markets to conserve their market share, they need to make sure that their products meet certain standards. Firms must bear in mind the possibility of use of these standards as non-tariff barriers. Kramer (1988), Hooker and Caswell (1996), and Henson and Loader (1998) study this aspect of the standards. WTO is trying to prevent the use of standards as non-tariff barriers through the Sanitary and Phytosanitary and Technical Barriers to Trade Agreements. Henson and Loader (1998) showed that entrance into the markets in developed countries by firms based in developing countries (LDC) will be getting difficult in practice. Nimon and Beghin (1999) investigated certificates given by EU to firms showing satisfactory environmental performance; they showed that none of the 48 EU issued certificates related to 249 products were given to firms in developing countries. Thus, the use of standards as non-tariff barriers need to be closely followed. Similar developments have seen in international supply chains. The firms in countries that have high quality and food safety standards are forcing the same standards to firms located in the lower end of the production chain. (Spriggs 1999). Environment, quality and food safety issues are important for competitiveness for the firms. Disregarding these issues will bring irreparable losses to firms.

In this study, export performance of Turkish food industry will be analysed in the context of food quality, safety and environmental standards in EU markets, the biggest food product import market of Turkey. The current situation and measures to improve the competitiveness of Turkish food industry will be investigated by using the firm level data collected from the following five sub-sectors: canned vegetables, tomato products, fruit juices, olive oil, and fish products.

## 3. Data

We have designed a survey to collect firm level data from the firms operating in the food industry in Turkey. Our survey comprised of four main parts: questions on compliance with quality and safety standards, on vertical integration, on environmental performance, and on exports. The data is collected from firms operating in five different sectors in Turkish food industry and exporting into European Union: olive oil, tomato products, canned vegetables, fish products and fruit juices. Face to face interviews are carried out with 100 firms. By using the collected data, indices for compliance with quality and safety standards, vertical integration and environmental performance have been constructed. Then, we analysed the impact of quality and safety index on the export performance of the firms along with the impact of vertical integration, environmental performance, and some other firm specific factors such as experience in export markets.

## 4. Model

We make use of the literature on the firm level determinants of the export performance. Recent surveys of this literature have been carried out by Katsiekas et al. (1996) and Zou and Stan (1998). Zou and Stan (1998) show that many different indicators of export performance such as level of exports, growth rate (financial indicators) and goal achievement, perceived success (non-financial indicators) have been used. They identify 33 different independent variables thought to have impact on the export performance. These variables are grouped into several categories such as external-internal factors and controllable—uncontrollable by the firm. Their meta analysis of the empirical studies in the literature shows that the evidence on the impact of these 33 variables on export performance is mixed. Among these variables, quality and safety standards were not specifically listed, and product specification was the closest variable in the list. Thus, we decided to construct an index for the compliance with quality and safety standards and to identify its impact on the export performance. Similar indices are also developed for the vertical integration of the firms and their environmental performance. We now explain the details related to the construction of these variables.

The compliance with quality and safety standards, represented by quality index, is derived from 23 questions in the survey. Among these questions, there were ones related to the existence of quality control systems in the raw-material, production and final product stages; others on the existence of periodical education for the employees on standards and general operations. Other items included the existence of quality assurance certificates such as ISO 9000 and HACCP certification, of the research and development department, whether the firm investigates the customers' satisfaction, and new investments on improving the production process. Positive responses are scored as 1 and negative responses as 0; then a total score is obtained for each firm. This makes up the quality index variable. For a similar approach, one can look at, for example, Dasgupta et. al. (1995), and Eliste and Fredriksson (1998). A higher value of quality index indicates a better compliance with quality and safety standards.

The environmental index measures the importance given to the compliance with environmental standards by the firm and it is a measure for the environmental performance. The index is based on the questions such as the existence of cleaning-up facilities if the production generates pollution, whether there are recent investments to improve environmental performance, whether the product has any eco-labels, whether the energy source is coal or natural gas, and whether the firm considers better environmental performance as a factor to increase the exports.

The vertical integration index is a proxy for the control of the firm on the production process starting from the purchase/production of raw material till the product is reaches the final destination. It has been constructed by summing the scores regarding the control of the firm on each of the following stages: (i) procurement of the raw material, (ii) production of the final product, (iii) marketing, and (iv) distribution. A higher score indicates stronger vertical integration.

Finally, the experience of the firms in the export market is also included in the model (which is measured by the number of years of exporting into the European Union). Existence of the HACCP certification is the last factor considered as it is being increasingly applied/requested in the European market.

Export performance is measured by the value of exports in dollars. These numbers are taken from the firms themselves in the survey. Some of the firms were reluctant to give this information and thus, number of observations in the regressions below are less than the number of firms interviewed.
Our model is as follows:

Value of Exports = f(Quality Index, Environmental Index, Vertical Integration,
Experience, HACCP)

This relationship is analysed by both linear regression and the non-parametric regression. One advantage of non-parametric regression is that it does not require a linear relationship and additionally, it does not specify any functional form to start with. Thus, our approach will result in very general indications. We start with the least squares regression estimates of our data.

**4.1. Estimation with Parametric Least Squares Regression**

We combined our survey results for 1997, 1998 and 1999 and estimated the following model:

$$\text{Log(Exports)} = \text{á} + \text{â}_1 \text{Qind} + \text{â}_2 \text{ Envind} + \text{â}_3 \text{ Hist} + \text{â}_4 \text{ Verint} + \text{â}_5 \text{ HACCP} + \text{Error}$$

Due to the differences in the magnitudes of the dependent and independent variables, better results are obtained with logarithm of exports. Estimated values for the coefficients are given in Table I below.

Table I.

Dependent Variable is LOG(Exports)
Included observations: 256

| Variable | Coefficient | Std.Error | t-Stat. | P-value |
|---|---|---|---|---|
| C | 9.286059 | 0.603540 | 15.38600 | 0.0000 |
| QIND | 0.103405 | 0.030075 | 3.438281 | 0.0007 |
| ENVIND | 0.175316 | 0.060219 | 2.911301 | 0.0039 |
| HIST | 0.033930 | 0.011207 | 3.027663 | 0.0027 |

| | | | | |
|---|---|---|---|---|
| VERINT | 0.135666 | 0.036654 | 3.701268 | 0.0003 |
| HACCP | 0.227943 | 0.265455 | 0.858687 | 0.3913 |

| | | | |
|---|---|---|---|
| R-squared | 0.227520 | Adjusted R-squared | 0.212070 |
| Log likelihood | -502.0284 | F-statistic | 14.72657 |
| Prob(F-statistic) | 0.000000 | | |

Overall regression is significant, and except HACCP variable, all independent variables are also individually significant. Value of exports is positively related to each of the 5 independent variables; that is to say, better compliance with quality and safety standards, better environmental performance, stronger vertical integration, higher experience, and application of HACCP principles all result in higher exports. The European food market gives positive premium to compliance with food safety and environmental standards.

The same analysis is repeated for each of the three years to see whether the relationship between export performance and the independent variables of our model shows differences across years. Qualitatively, the results are same, but quantitatively some differences are observed. Given that our independent variables are constructed in an ordinal manner, what matters is only the qualitative impact. The estimation results for each of the three years are given in the appendix. It should be noted that the significance of variables changes across years.

After the analysis of our data across years, a natural and interesting extension is the behaviour of our model across the five sectors included in our study; that is to say, it is of interest to identify the impact of our independent variables on the export performance in olive oil, tomatoes products, canned vegetables, fish products and fruit juices sectors. Nevertheless, the number of observations was very heterogenous across these five sectors, and in most of the cases it was very limited (26 in olive oil, 84 in tomatoes products, 97 in canned vegetables, 32 in fish products and 17 in fruit juices when all three years are combined). We estimated the same model across each sector by using least squares regression and the results are given in the appendix; however, number of observations are very small in some cases and thus, regressions results are not very reliable. To overcome this problem, a non-parametric regression method has been applied. Moreover, estimation with this method is also very useful from other angles which will be summarised below.

## 4.2 Across Sectors Analysis — Non-Parametric Regression

The data is analysed by both parametric (ordinary least squares) and non-parametric techniques (non-parametric kernel estimation). The use of non-parametric techniques was very important in comparing the impact of quality and safety index, vertical integration and other variables on the export performance of the firms across five sectors. This could not be done by parametric techniques reliably due to small sample sizes in some sectors (100 firms overall, not equally divided across sectors).

Non-parametric kernel estimation technique used in this study has several advantages. First, the estimates of the coefficients are not constrained by any a priori assumption about the functional relationship between the dependent and independent variables. Given the lack of theoretical model describing the relationship between export performance and our list of independent variables related to the compliance with standards, the specification of linear regression above can not be justified easily. Second, with this non-parametric kernel estimation method, it is possible to obtain point estimates of the coefficients for each of the independent variables for *each observation* in the sample. Therefore, if we can identify each of the five sectors in our sample (which can be done by ordering the observations across sectors initially), we can obtain the impact of independent variables on the export performance across sectors. A brief description of the non-parametric kernel method is given in appendix 2. The estimation results with this method are in Table II below.

Table II.

| | Olive Oil | Fish Products | Canned Vegetables | Tomato Products | Fruit Juices |
|---|---|---|---|---|---|
| Quality Ind. | 0.094 | 0.129 | 0.093 | 0.096 | 0.092 |
| Environmental Ind. | 0.113 | 0.099 | 0.114 | 0.113 | 0.114 |
| Experience | 0.037 | -0.013 | 0.039 | 0.035 | 0.040 |
| Vertical Integration | 0.104 | 0.045 | 0.106 | 0.101 | 0.107 |
| HACCP | 0.305 | 0.425 | 0.300 | 0.311 | 0.298 |

The values in Table II represent the average gradient of export performance with respect to the independent variables (i.e., the change in export performance per change in the level of the given independent variable). Firstly, estimates of each gradient for each of the sample observation are obtained, then the averages of these values are taken (only the statistically significant observations are used in the calculation of the averages). As seen in Table II, the impact of each variable on the export performance is positive (except the experience variable in the Fish Products sector). The estimation results in Table I and Table II are very similar to each other (qualitatively), thus the assumption of linearity is not very strong. Again as seen in Table II, the behaviour of export performance with respect to standards and vertical integration and other variables is very similar across sectors with the exception in fish products mentioned above.

## 5. Conclusions

Our analysis of the survey data at the firm level shows that the vertical integration, environmental performance and quality and safety index have significant positive impact on the export performance of the firms. The results were similar across sectors. With this evidence on Turkish firms, we suggest that firms based in MENA countries should try to improve their products with respect to quality and safety features; this will have positive impact on their exports into developed countries. Moreover, the current trends in food quality and safety standards in developed countries indicate that products with deficiency in regards to these standards will be banned. White Paper (2000), prepared as a new guideline for food products in European Union includes raising standards to very high levels by 2004. The European Food Authority recommended in White Paper (2000) has already been established before the end of 2000. In light of all these developments and our empirical findings, firms should take required steps towards products with improved quality and safety features. Governments will also have important role in such a transition. Finally, steps towards food products with higher quality and safety should be taken not only for preserving export markets but also for public health considerations. Our paper will indicate the new developments related to technical issues (such as HACCP—Hazard Analysis of Critical Control Points) and government policy making on this subject.

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## Appendix I

Year: 1997

Table III

Dependent Variable is LOG(EXPORTS)
Included observations: 78
White Heteroskedasticity-Consistent Standard Errors & Covariance

| Variable | Coefficien | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| C | 9.685378 | 1.166457 | 8.303242 | 0.0000 |
| QIND | 0.098229 | 0.053098 | 1.849961 | 0.0684 |
| ENVIND | 0.075736 | 0.134443 | 0.563335 | 0.5750 |
| HIST | 0.028097 | 0.018528 | 1.516448 | 0.1338 |
| VERINT | 0.155783 | 0.067918 | 2.293685 | 0.0247 |
| HACCP | 0.215321 | 0.623446 | 0.345372 | 0.7308 |

| | | | |
|---|---|---|---|
| R-squared | 0.164215 | Adjusted R-squared | 0.106174 |
| Log likelihood | -156.5541 | F-statistic | 2.829302 |
| Prob(F-statistic) | 0.021762 | | |

Year: 1998

Table IV

Dependent Variable is LOG(EXPORTS)
Included observations: 87

| Variable | Coefficient | Std.Error | t-Statistic | Prob. |
|---|---|---|---|---|
| C | 8.139000 | 1.061063 | 7.670609 | 0.0000 |
| QIND | 0.130547 | 0.052530 | 2.485175 | 0.0150 |
| ENVIND | 0.271706 | 0.108410 | 2.506283 | 0.0142 |
| HIST | 0.036572 | 0.019965 | 1.831798 | 0.0707 |
| VERINT | 0.146614 | 0.065854 | 2.226343 | 0.0288 |

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| HACCP | 0.224455 | 0.454016 | 0.494377 | 0.6224 |

| | | | |
|---|---|---|---|
| R-squared | 0.302045 | Adjusted R-squared | 0.258961 |
| Log likelihood | -172.1789 | F-statistic | 7.010659 |
| Prob(F-statistic) | 0.000017 | | |

Year:1999

Table V

Dependent Variable is LOG(EXPORTS)
Included observations: 91

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| C | 10.15175 | 0.904338 | 11.22561 | 0.0000 |
| QIND | 0.081519 | 0.049398 | 1.650237 | 0.1026 |
| ENVIND | 0.160260 | 0.091147 | 1.758258 | 0.0823 |
| HIST | 0.035854 | 0.017546 | 2.043367 | 0.0441 |
| VERINT | 0.101132 | 0.057706 | 1.752519 | 0.0833 |
| HACCP | 0.341811 | 0.416569 | 0.820541 | 0.4142 |

| | | | |
|---|---|---|---|
| R-squared | 0.236411 | Adjusted R-squared | 0.191494 |
| Log likelihood | -169.6844 | F-statistic | 5.263293 |
| Prob(F-statistic) | 0.000293 | | |

## Sectoral Analysis

Olive Oil Sector:

Table VI

Dependent Variable is LOG(EXPORTS)
Date: 12/14/00 Time: 12:32
Sample(adjusted): 41 254
Included observations: 26 after adjusting end points

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| C | 15.06897 | 1.762098 | 8.551723 | 0.0000 |
| QIND | 0.339718 | 0.125340 | 2.710368 | 0.0135 |
| ENVIND | -0.311812 | 0.204153 | -1.527340 | 0.1423 |
| HIST | 0.028470 | 0.022517 | 1.264390 | 0.2206 |
| VERINT | -0.211964 | 0.120863 | -1.753752 | 0.0948 |
| HACCP | 0.550754 | 0.756530 | 0.728000 | 0.4751 |

| | | | |
|---|---|---|---|
| R-squared | 0.440429 | Adjusted R-squared | 0.300536 |
| Log likelihood | -36.93756 | F-statistic | 3.148332 |
| Prob(F-statistic) | 0.029500 | | |

Fish and fish products sector:

Table VII

Dependent Variable is LOG(EXPORTS)
Date: 12/13/00   Time: 14:54
Sample(adjusted): 11 250
Included observations: 32 after adjusting end points

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| C | 11.64704 | 1.537291 | 7.576345 | 0.0000 |
| QIND | 0.112049 | 0.075161 | 1.490777 | 0.1481 |
| ENVIND | 0.392326 | 0.152174 | 2.578145 | 0.0159 |
| HIST | -0.078189 | 0.023843 | -3.279287 | 0.0030 |
| VERINT | -0.041125 | 0.072026 | -0.570972 | 0.5729 |
| HACCP | 1.094165 | 0.790211 | 1.384649 | 0.1779 |

| | | | |
|---|---|---|---|
| R-squared | 0.463529 | Adjusted R-squared | 0.360361 |
| Log likelihood | -47.66070 | F-statistic | 4.492970 |
| Prob(F-statistic) | 0.004392 | | |

Canned vegetables sector:

Table VIII

LS // Dependent Variable is LOG(EXPORTS)
Date: 12/13/00   Time: 16:04
Sample: 1 258
Included observations: 97

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| C | 9.749507 | 0.936749 | 10.40781 | 0.0000 |
| QIND | 0.155761 | 0.053035 | 2.936953 | 0.0042 |
| ENVIND | 0.022249 | 0.092074 | 0.241644 | 0.8096 |
| HIST | 0.009810 | 0.022715 | 0.431884 | 0.6668 |
| VERINT | 0.112784 | 0.062130 | 1.815284 | 0.0728 |
| HACCP | 0.818877 | 0.478954 | 1.709721 | 0.0907 |

| | | | |
|---|---|---|---|
| R-squared | 0.224777 | Adjusted R-squared | 0.182182 |
| Log likelihood | -187.1981 | F-statistic | 5.277101 |
| Prob(F-statistic) | 0.000266 | | |

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Tomato products sector:

Table IX

LS // Dependent Variable is LOG(EXPORTS)
Date: 12/14/00 Time: 12:38
Sample(adjusted): 2 245
Included observations: 84 after adjusting end points

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| C | 7.646589 | 1.013290 | 7.546297 | 0.0000 |
| QIND | 0.068864 | 0.040740 | 1.690350 | 0.0950 |
| ENVIND | 0.422214 | 0.115805 | 3.645910 | 0.0005 |
| HIST | 0.055470 | 0.015036 | 3.689074 | 0.0004 |
| VERINT | 0.152739 | 0.062128 | 2.458466 | 0.0162 |
| HACCP | 0.437271 | 0.469898 | 0.930566 | 0.3549 |

| | | | |
|---|---|---|---|
| R-squared | 0.450122 | Adjusted R-squared | 0.414874 |
| Log likelihood | -151.4323 | F-statistic | 12.76995 |
| Prob(F-statistic) | 0.000000 | | |

Fruit juices sector:

Table X

LS // Dependent Variable is LOG(EXPORTS)
Date: 12/13/00 Time: 14:08
Sample(adjusted): 14 251
Included observations: 17 after adjusting end points

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| C | 3.847341 | 1.891891 | 2.033595 | 0.0668 |
| QIND | 0.178517 | 0.061927 | 2.882689 | 0.0149 |
| ENVIND | 0.012625 | 0.077860 | 0.162149 | 0.8741 |
| HIST | 0.028619 | 0.036669 | 0.780478 | 0.4516 |
| VERINT | 0.531548 | 0.101799 | 5.221555 | 0.0003 |
| HACCP | -2.941645 | 0.510207 | -5.765595 | 0.0001 |

| | | | |
|---|---|---|---|
| R-squared | 0.968839 | Adjusted R-squared | 0.954675 |
| Log likelihood | -8.083798 | F-statistic | 68.40180 |
| Prob(F-statistic) | 0.000000 | | |

## Appendix 2.

### Nonparametric Kernel Method

One can look at Pagan and Ullah (1999) for detailed description on non-parametric kernel method used in our analysis. Yucel and Mahmud (2000) present a compact introduction to this technique. Consider the stochastic process $\{y_t, x_t\}$, $t = 1,2,...,n$; where $y_t$ is a scalar and $x_t = (x_{t1}, x_{t2},..., x_{tq})$ is $(1\times q)$ vector which may contain the lagged values of $y_t$. The regression model is $y_t = m(x_t) + u_t$, where $m(x_t) = E(y_t \mid x_t)$ is the true but unknown regression function and $u_t$ is the error term such that $E(u_t \mid x_t) = 0$ and $Var(u_t \mid x_t) = s^{2}$.

A Local Linear Least Squares (LLLS) estimator of the dependent variable is obtained by taking first order Taylor series expansion of $m(x_t)$ around $x$:

$$y_t = m(x_t) + u_t = m(x) + (x_t - x)m^{(1)}(x) + v_t \quad (2.1.a)$$

$$= a(x) + x_t b(x) + v_t = X_t d(x) + v_t, \quad (2.1.b)$$

where $a(x) = m(x) - xb(x)$,

$d(x) = [a(x)b(x)']'$, and

$b(x) = m^{(1)}(x)$.

Solving the problem:

$$\min \sum_{t=1}^{n} v_t^2 K_{tx} = \min \sum_{t=1}^{n} (y_t - X_t d(x))^2 K_{tx} \quad (2.2)$$

the LLLS estimator is obtained as:

$$\bar{d}(x) = (X'K(x)X)^{-1} X'K(x)y \quad (2.3)$$

The LLLS estimators of $a(x)$ and $b(x)$ is calculated as $\bar{a}(x) = [1 \quad 0]\bar{d}(x)$ and $\bar{b}(x) = [0 \quad 1]\bar{d}(x)$. The kernel function $K_{tx} = K((x_t - x)/h)$ is a decreasing function of the distances of $x_t$ from $x$. The window width, $h$, goes to zero as $n$ tends to infinity. It is the smoothing parameter which determines the speed of decrease of weights as the distance between $x_t$ and $x$ increases.

Regarding linear $m(x) = x_1 b_1 + ... + x_q b_q$, $b_j = \partial m(x)/\partial x_j$ is the j-th regression coefficient, or first partial derivative, reflecting the change in $y$ due to a unit change in $x_j$. When $m(x)$ is nonlinear, then $\partial m(x)/\partial x_j$ varies with $x$. The response coefficient of $Y$ with respect to a change in one of the regressors $x_j$ can be expressed as:

$$b_j(x) = \frac{\partial m(x)}{\partial x_j} = \lim_{h \to 0} (2h)^{-1} \left[ m(x + e_j h) - m(x - e_j h) \right] \qquad (2.4)$$

where $e_j$ is a $(q \times 1)$ vector with a one in the j-th position. A consistent estimator of $b_j(x)$, when $h$ approaches zero as $n$ tends to infinity, is given as:

$$b_j(x) = \frac{1}{2h} \left[ m(x + e_j h) - m(x - e_j h) \right] \qquad (2.5)$$

Since $m(x \pm e_j h)$ is unknown, we can use the modified estimator:

$$\tilde{b}_j(x) = \frac{1}{2h} \left[ \hat{m}(x + e_j h) - \hat{m}(x - e_j h) \right] \qquad (2.6)$$

where $\hat{m}(.)$ denotes the estimates of regression surface as described in Ullah and Pagan (1999).