9-1994

Oil Prices and Agricultural Policy in Iran

Ahmad Yazdanpanah
Iowa State University

Oil Prices and Agricultural Policy in Iran

Abstract

The geo-political economy of oil exporting countries in the Middle East and North Africa are mainly affected by abundant oil resources, semi-arid climate, and rapidly growing population. The interplay of agricultural policies for self-sufficiency, food imports, and oil prices have shaped the food security situation in the Islamic Republic of Iran. This paper explores the dynamic and causality linkage between external factors (e.g. oil prices) and internal factors (e.g. domestic food production). In particular, the causality relationships among domestic wheat production, wheat imports, and oil prices in Iran for 1964 to 1991 are examined. The results show that there is a unidirectional "Granger Causality" relation from oil price to wheat imports. This suggests that "past and present" history of oil prices and domestic production of wheat are useful information to improve prediction of wheat imports. But the past history of domestic production of food (wheat) alone cannot improve prediction of food imports.

The implications of these results are significant in the context of food availability in Iran. Also, the expected agricultural policy reforms under GATT will further expose Iranian agriculture to instability from its macroeconomy as well as from the world economy. The findings in this study about the dynamic interaction of external and internal variables with food security might by useful in predicting possible consequences of GATT reform.

Keywords

oil price, food security, food self-sufficiency, GATT, wheat imports

Disciplines

Agricultural Economics | Economic Policy | Economics | Food Security

Oil Prices and Agricultural Policy in Iran

Ahmad Yazdanpanah

Working Paper 94-WP 123
September 1994

Center for Agricultural and Rural Development
Iowa State University
Ames, Iowa 50011

Ahmad Yazdanpanah is a CARD/FAPRI research assistant and received his Ph.D. in economics from Iowa State University.

This material is based upon work supported by the Cooperative State Research Service, U.S. Department of Agriculture, under Agreements No. 92-34149-7136 and 92-34149-6972.

ABSTRACT

The geo-political economy of oil exporting countries in the Middle East and North Africa are mainly affected by abundant oil resources, semi-arid climate, and rapidly growing population. The interplay of agricultural policies for self-sufficiency, food imports, and oil prices have shaped the food security situation in the Islamic Republic of Iran. This paper explores the dynamic and causality linkage between external factors (e.g. oil prices) and internal factors (e.g. domestic food production). In particular, the causality relationships among domestic wheat production, wheat imports, and oil prices in Iran for 1964 to 1991 are examined. The results show that there is a unidirectional "Granger Causality" relation from oil price to wheat imports. This suggests that "past and present" history of oil prices and domestic production of wheat are useful information to improve prediction of wheat imports. But the past history of domestic production of food (wheat) alone cannot improve prediction of food imports.

The implications of these results are significant in the context of food availability in Iran. Also, the expected agricultural policy reforms under GATT will further expose Iranian agriculture to instability from its macroeconomy as well as from the world economy. The findings in this study about the dynamic interaction of external and internal variables with food security might be useful in predicting possible consequences of GATT reform.

Key Words: oil price, food security, food self-sufficiency, GATT, wheat imports

OIL PRICES AND AGRICULTURAL POLICY IN IRAN

Iran, with an area of 1,468,195 square kilometers, has a total farmland area of 17 million hectares (11 percent of the country), of which about 32 percent or 5.5 million hectares was not cultivated in 1990. Of the 11.5 million hectares under cultivation, about 50 percent or 5.6 million hectares are irrigated, including one million hectares in orchards (Kavossi, 1991). Given climate constraints, agricultural policies in Iran can be viewed as important economically and politically in the economic development of the country. The agricultural sector employs a large portion of the population and is an important source of food for the people. The objectives of agricultural policies after the Islamic Revolution in 1979 were to increase output, improve productivity and achieve food self-sufficiency. These are different from pre-revolution objectives not only in direction but also in means.

After 1979, the agricultural sector of Iran—in spite of remarkable increases in the use of inputs such as fertilizers and farm machinery, and government emphasis on self-sufficiency (especially in wheat, Table 1)—experienced disappointing performance. The average annual growth rate in gross domestic product (GDP) of agriculture for 1965-80 was 4.5 percent and for 1980-90 was 4.0 percent. Also, the population growth rate for those periods were 3.2 percent and 3.4 percent (World Bank 1987, 1992). Iran is not an exception in the region for the poor performance in agricultural policies. Rapidly escalating food demand and sluggish supply response in Middle Eastern and North African countries have made the area one of the least food self-sufficient regions in the world. The emergence of this "food gap" does not mean (as some have implied) that agricultural supply has stagnated, although this has happened in some cases. Rather, it means the measures taken to reduce the inequality between the rate of growth of demand and domestic supply and to restore food self-sufficiency have failed (Richards and Waterbury, 1990) (Table 2).

In searching for the causes of this "food gap" in Iran, we select wheat as a strategic agricultural product and as a proxy for food to analyze pricing policy and to explore the incentive role of producer prices in the wheat production-consumption gap. A major point of contention in the agricultural policy debate in Iran centers on the influence of oil prices on food production, consumption, imports, and self-sufficiency in food. On the one hand, it is argued that oil price

Table 1 Iranian government subsidies by Commodities for 1980/81 to 1989/90

Commedity	1980/81	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87	1987/88	1988/89
				(billions of Iranian rials)					
Fertilizer	14.6	20.0	27.0	25.3	27.8	22.0	20.5	19.0	18.3
Wheat	3.7	24.0	37.0	24.3	27.0	51.0	68.3	40.2	39.0

SOURCE : The Ministry of Economy and Finance, Iran (1990).

Table 2 Characteristics of grain imports, production, and food self-sufficiency

Oil Exporting Countries	1966-80 growth in		1981-85 growth in		Self-sufficiency ratio			
	Imports	Production	Imports	Production	1970	1975	1980	1985
	Percent per year				Percent			
Algeria	13.1	1.5	7.6	8.3	77	79	48	45
Egypt	2.7	1.5	9.2	2.2	79	59	49	42
Iran	8.3	1.8	1.3	0.1	90	79	65	59
Iraq	20.8	-2.2	9.8	-2.3	89	52	44	28
S. Aarabia	14.1	-3.6	8.9	48.5	46	25	7	28*
Syria	8.7	6.7	7	-5.9	54	97	107	66
Tunisia	6.5	7.1	-7.4	12.9	56	78	54	85

* Saudi Arabia was self-sufficent in wheat by 1984.
SOURCE : Shapouri and Rosen, 1986.

increases lead to increased food imports, which in turn causes an adverse impact on domestic production. Others argue that shortfalls in domestic production, independent of oil price changes, are the cause of the increasing trend in food imports. In a later section, the empirical evidence for the direction of causality and dynamic linkages between variables influencing the wheat consumption-production gap are examined.

Oil Prices and Wheat Gap

To analyze the implication of the "oil shocks" in the wheat sector, we examine the domestic supply and demand and then turn to the consequences of the resulting escalating of wheat imports. After the first oil shock in 1973-74, the Iranian government relied on oil revenue to finance agricultural imports and the share of agriculture in total government investment was reduced. In 1974, Iran produced 4.6 million tons of wheat and imported 789,000 tons. This wheat consumption-production gap was party due to the Shah's land reform program, and was expected. This gap continued to widen and was mostly met through an increase in imports (Figure 1).

There are two ways to increase agricultural production: (1) increase planted area (bring new land into cultivation), and (2) raise the productivity of the existing planted area. Increasing yields have played an important role in expanding the domestic supply of wheat in Iran and the entire region. For the 1970s and 1980s in the Middle East and North Africa, some 55 percent of the growth in food output was the result of increased yields, whereas extension of cultivated area explains the remaining 45 percent. During the era of oil boom (1973-80), some 88 percent of output growth was caused by higher yields (Khaldi 1984).

In Iran, wheat production had an upward trend (except for 1978 and 1981), in spite of a decrease in area under wheat production from 6,325 hectares in 1974 to 6,192 hectares in 1983. This inverse trend indicates that the decrease in area was more than compensated by the increase in yield from 727 kilograms per hectare in 1974 to 1,076 kilograms per hectare in 1983. The yield increase was partly due to the use of improved seed and fertilizer that were made available to the farmers at subsidized prices, which were largely financed by oil revenues. From 1974 to 1991, wheat production in Iran increased from 4.7 million tons to 8.315 million tons. As Table 3 reports, wheat production, which grew steadily before the Revolution, has experienced some fluctuation since 1979, mainly due to severe drought in 1979-80 and 1983, and to unusually favorable weather conditions in 1985-86. From the food security point of view, the variation of agricultural production in general, and cereal production in particular, was high during oil shock periods, such as 1973-85. The

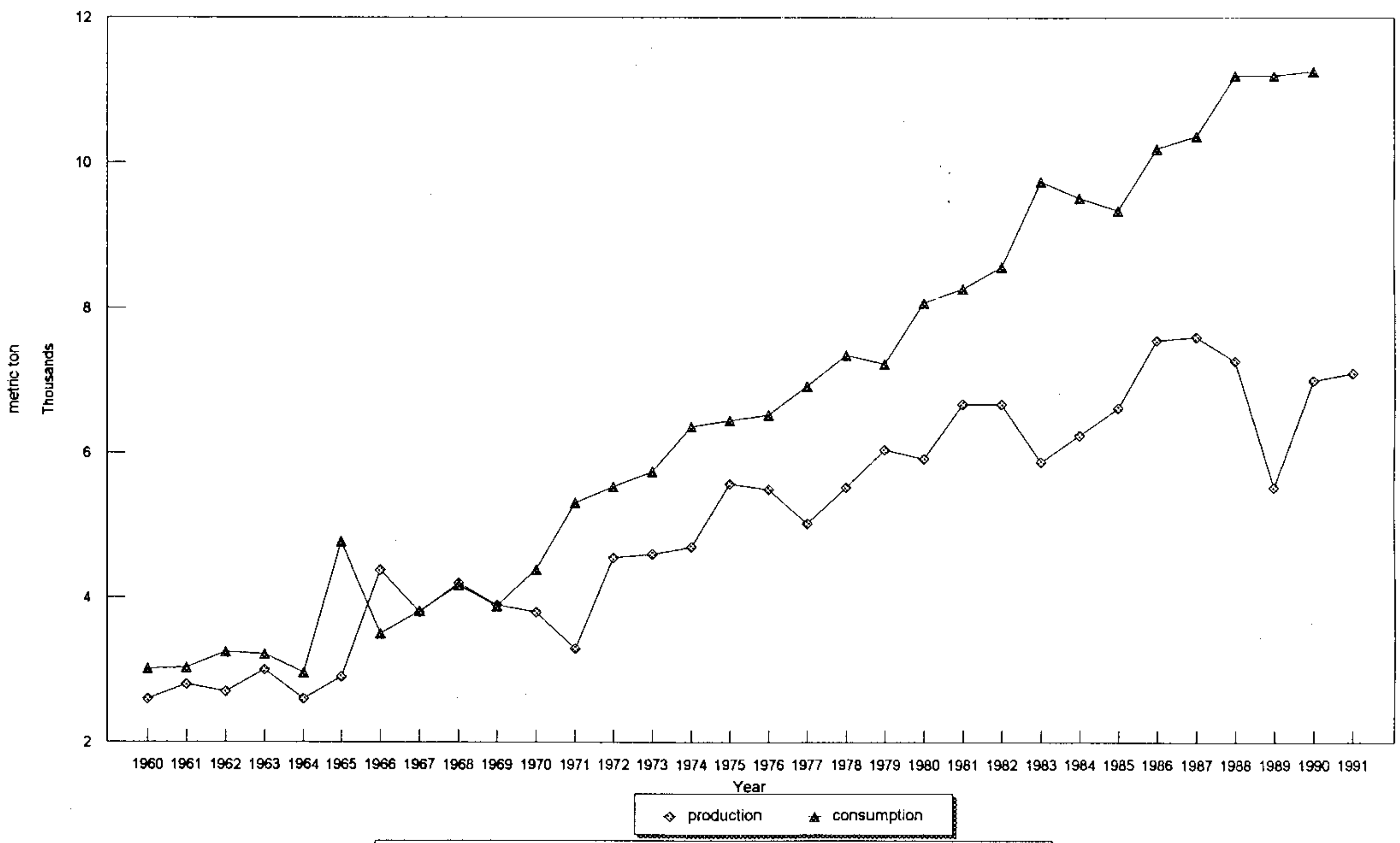

Figure1. Wheat production-consumption gap in Iran

Table 3 Iranian wheat production, consumption, and Imports

Year	Production	Consumption	Per Capita Consumption	Imports
	.... mmt	....	Kg	mmt
1974	4.700	5.750	180	1.452
1975	5.500	5.790	176.4	1.466
1976	5.965	5.349	158.7	0.737
1977	5.500	5.926	168.5	1.159
1978	5.526	5.926	162.8	0.73
1979	5.946	5.884	155.6	0.4
1980	5.744	6.148	156.5	0.871
1981	6.610	7.131	174.7	1.615
1982	6.660	8.162	192.4	1.769
1983	5.956	7.878	178.8	2.683
1984	6.706	7.533	164.4	2.618
1985	6.630	8.276	173.8	2.144
1986	7.577	8.482	171.6	1.831
1987	7.600	11.031	200.8	3.712
1988	7.265	10.715	200.2	3.423
1989	5.511	10.610	199.7	5.312
1990	7.000	11.750	200	4.818
1991	8.315	12.746	200	4.521

SOURCES : Ministry of Agriculture (Iran). Extracted from Haqverdi (Farsi) 1992
The data for 1989 to 1991 were obtained from FAO sources.

average growth rate for cereal was 3.71, and the standard deviation was 10.98. In per capita terms they were .67 and 10.67, respectively. Wheat production in the 1987 to 1991 period showed remarkable growth (except for 1989/90), but with accompanying high fluctuation due to scant rainfall in many parts of the country during the late 1980s. In the same period, despite the limited availability of cultivable land, the area under food grains production, of which 73 percent is devoted to wheat, increased by about 2.5 percent annually. In addition, more resources were allocated to agriculture after the Iran-Iraq war. And other institutional factors, such as incentives provided through producer price policy, also may have contributed to this upward trend in wheat production in the most recent period. Indeed, the growth of agricultural output in Middle Eastern countries is better than that of some other developing countries. But the point is that the agriculture sector still lags behind in relation to the growth in the demand for agricultural products. In other words, the problem in the region is not of stagnation or declining output, as is often the case in other developing countries, but rather a demand growth that exceeds the supply growth.

All estimates of the food demand-supply balance in the region agree that demand will continue to grow rapidly (see, for example, FAO, and Khaldi). On the demand side, Khaldi found that total annual staples consumption grew at 4.8 percent from 1973 to 1980, while the rate for oil exporting countries in the region was 6.2 percent per year. Among others, there are three major determinants of demand growth: population growth, per capita income growth, and the income elasticity of demand. Due to data limitation for individual countries, this analysis focuses on food consumption of oil exporting countries in the region. Apart from sub-Saharan Africa, the Middle Eastern and North African countries have the highest population growth rate of any region in the world. Rapid population growth did make a substantial contribution to increased demand for food. However, much of the growth in demand has been caused by expansion of per capita incomes (Richards, 1987) (Table 4). The population effect was compounded during the oil boom decades by rapid income growth. Even for cereals for direct food consumption in the region, income growth accounted for roughly 25 percent of the growth of consumption. Cereal demand as a whole grew much more rapidly, largely as a result of soaring demand for feeding animals. The changing composition of diets in the region came from higher incomes from the oil boom. Based on structural changes in food consumption and some political considerations, there is some evidence (Shapouri and Rosen, 1986; Gardner, 1986) that food consumption in oil exporting countries in the region continues to increase despite a decline in income. So there is unlikely to be any reduction in the food consumption-production gap, at least in short run, from the demand side. Wheat consumption in Iran increased from 5.75 mmt in 1974/5 to

Table 4 Source of food consumption growth, by commodity group for the oil exporting countries in MENA

Staples		Food		Feed		All Uses	
		g	% y	g	% y	g	% y
	Region	3.6	25	6.8	60	4.8	44
	Oil Exp.	5.1	39	9.4	67	6.2	50
Cereal							
	Region	3.6	25	6.9	61	4.9	45
	Oil Exp.	5.1	39	9.4	67	6.2	52
Animal Products		Total		Chicken		Milk	
		g	% y	g	% y	g	% y
	Region	6.8	60	14.0	81	5.1	47
	Oil Exp.	12.7	76	20.8	85	9.3	66

Notes:
g = growth of consumption
% y = percent of growth of consumption caused by income growth,using the formula
g = n + y e, where n = poplation growth rate , and e = income elasticity of demand.
Oil exporting countries are : Algeria, Iran, Iraq, Kuwait, libya, Oman, and Saudi Arabia.
Annual population growth rate in oil exporting countries is 3.1 percent.

SOURCE : Richards, 1986.

12,746 mmt in 1991/2. Even after oil prices started to decline in 1986, the consumption trend continued upward.

The first response to this food production-consumption gap by governments was to increase food imports. For two decades, from 1960 to 1980, the region's food imports increased about 12 percent per year. There were four economic reasons for the import boom in the region. First, domestic production was (and is) highly unstable because of erratic rainfall. Second, the barter terms of trade moved sharply in favor of oil exporters/food importers. In 1970 a barrel of oil would buy roughly one bushel of wheat; by 1980 the same barrel could buy six bushels. Even in 1986, after the drop in oil prices, a barrel of oil was worth three bushels of wheat. Third, most MENA countries had ample supplies of foreign exchange; in other words, the balance of payments did not constrain food imports in the 1970s. Fourth, since most wheat importers in the region are small relative to the size of the international market, increased purchases have no impact on world price. Finally, in some countries urban-consumer tastes shifted away from local grains toward bread wheat, whose production was sometimes locally difficult (Richards and Waterbury, 1990).

In all countries in the region increases in export earnings and/or credit led to increased imports of agricultural products during the 1970s. After 1980, the situation changed. The annual rate of increase in export earnings decreased from 21.0 to -1.9 in Algeria, from 20.4 to 1.6 in Iran, and from 31.1 to -28.8 in Saudi Arabia, between the 1966-80 period and the 1981-85 period. Total imports declined almost 2 percent annually during 1981-85, while food imports continued to increase but at a slower rate than previously (4 percent per year). According to Shapouri and Rosen (1986), four primary reasons account for this trend: variation in export earning, growth in credit, government policies, and slow production growth. They found, among other things, that import capacity was the most significant variable in explaining the level of food imports and, in turn, it depends on export earnings and the availability of credit. They also found that cereal imports have become a significant contributor to the overall levels of availability.

In the case of Iran, the increasing dependency on food imports over domestic production to meet food demand can be traced back to the influence of oil revenues in agricultural and food policy. The relationship between changes in oil export earnings and agricultural imports during the 1970s and 1980s was analyzed by the U.S. Department of Agriculture for 1969 to 1988 for selected oil exporting countries. The results are reported in Table 5. For Iran, a 1 percent increase (decrease) in the price of oil implies a 0.889 percent increase (decrease) in agricultural imports. The study also indicated that changes in the price of crude oil alone accounted for about 90 percent of the change in

Table 5 Elasticity of agricultural imports with respect to nominal oil prices

Country	Elasticity	R - squar
Algeria	0.827*	0.95
Indonesia	0.552*	0.89
Iran	0.889*	0.94
Iraq	0.968*	0.94
Mexico	0.824*	0.89
Nigeria	0.846*	0.87
Saudi Arabia	1.011*	0.89
Venezuela	0.673*	0.92

* Denotes statistical significance at $p < 0.001$.
SOURCE : USDA , 1986.

value of agricultural imports for all the countries in the study. This strong link between agricultural imports and oil price suggests the proclivity of oil exporting countries to satisfy their domestic food demand more with imports rather than domestic production. Consequently, the need to expand agricultural production is significantly reduced. Moreover, in the case of Iran, the government was under no political pressure from established large landlords to provide the means to increase agricultural production. The oil revenues allowed the government to defuse the power of landlords by purchasing their land for redistribution to landless farmers under a land reform program of the 1960s (Shafaeddin, 1988). Figure 2 shows the trend and fluctuations of Iranian wheat production and imports for 1960 to 1991.

However, this response of the government to imbalances in food supply and demand cannot be sustained over a prolonged period. The variability in oil revenues presents a major challenge to policy makers in managing the food supply (domestic production + imports) in the country. Oil revenues in Iran in 1990 were 10.6 percent more than targeted, and were 14.4 percent less in 1989, 9.1 percent less in 1991, and 20.6 percent less than targeted in 1992. An even more serious problem is the possibility of future foreign exchange constraints. Furthermore, too much dependence on foreign suppliers for basic commodities like food may subject the country to food embargoes for political reasons. For these economic and political considerations, the government of Iran attempted other alternatives to reduce or ultimately eliminate the food production-consumption gap by intervening in the agriculture sector both to boost and stabilize production. The major forms of intervention included direct investment in agriculture and pricing policies intended to provide production incentives.

Agricultural Price Policy in Iran for Wheat

Government intervention in agricultural price policies has a long history in MENA. For example, the Iranian government instituted wheat and barley price controls in 1916. The aim of the intervention was to prevent severe fluctuation in the prices of these commodities in the interest of the city dwellers. In fact, like many developing countries, Iran's price policies were consumer-oriented until recently. Some governments have impeded the output growth for cereals through their output pricing policies. Indeed, some believe that this is the cause of the food gap. The argument holds that if only government could "get the prices right"—specifically, permit cereal prices to rise to the world level—the food gap would shrink dramatically (Richards, 1987). But, finding the right producer and

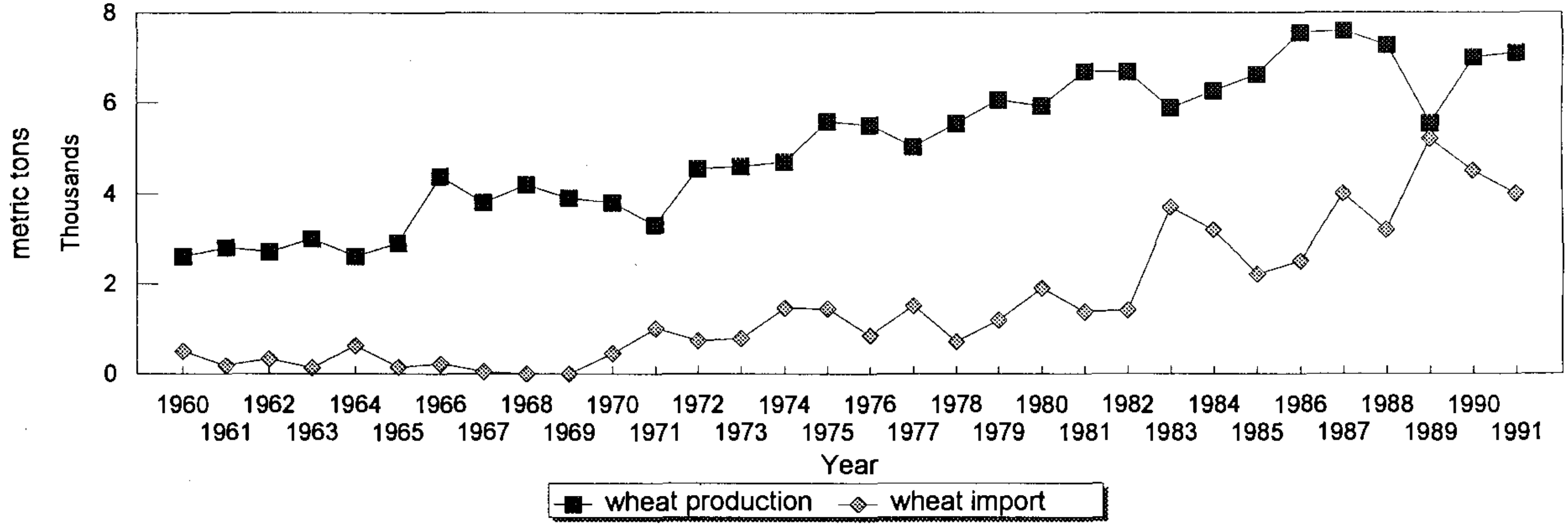

Figure 2. Wheat production and imports in Iran

consumer price is a difficult challenge. For one, the government has to balance conflicting objectives and interests and the informational requirements are tremendous.

The actual result of the pricing policies in Iran indicates some bias towards the consumer at the expense of turning the terms of trade against agriculture. Agricultural products are sold for a fixed price that is determined by the government while the price of nonagricultural goods are determined in the market and are free to rise in response to market forces. A study by Shafaeddin (1988) covering the 1965 to 1977 period, indicates that the terms of trade deteriorated against wheat and this deterioration was exacerbated by government wheat trade policies. For instance, whenever the wholesale wheat price (WPIW) declined, as in 1966-68, due to a good harvest, the government did not make any attempt to support it by increasing its purchase. Ironically, it even exacerbated the situation by increasing supply, mainly from subsidized wheat imports. In contrast, whenever the wholesale price tended to rise, as in 1963-65 and 1972-74, it supplied wheat to the market in relatively large quantities (Table 6), causing the wheat price to increase less than it would have otherwise. Table 6 also demonstrates that the increase in the official sale price was sluggish compared with the wholesale price of wheat (WPIW), and that the government's sale price rose 30 percent against 100 percent for the WPIW, from 1959 to 1977).

When considering the importance of the government sale in relation to production, the government sale policy (unlike its purchase policy) has had a significant dampening effect on the wholesale price. Wheat purchased by the government as a percentage of total production in 1974 reached only 2.5 percent but the net government sale represented a larger share in relation to wheat consumption, 22 percent in 1974. The wholesale price of wheat is constructed on the basis of prices generated in the private trading of wheat (representing the part of demand not satisfied by government's sale). The nominal protection coefficient (NPCs) is often used to show the degree of producer price support by government. In the MENA region only four countries (including two oil exporting countries) had a wheat NPC greater than 1 in the 1971 to 1981 period (Table 7). Specifically, in late 1976 in Iran, farmers received approximately 10 rials a kilogram for wheat, an amount mildly regarded as adequate to cover the cost of cultivation. At the same time, the government was paying 18 rials a kilogram for imported wheat (Looney, 1983). Also, the prices set by the government did not reflect the higher prices of factors of production such as fertilizer and machinery. For example, between 1970 and 1977, the price of fertilizer rose by about 28 percent and that of tractors by 51 percent (Central Bank, 1978).

Table 6 Data on wheat domestic purchase and sale by the Iranian government 1955-77

Year	Purchase	Sale	Official prices purchase	Official prices sale	wholesale price index of wheat (WPIW)
	(1000 tons)		(rial/tons)		
1959	36.5	162.5	5000	6200	100
1960	12.2	177.7	5000	6200	105.8
1961	127.4	263.5	5000	6200	105.4
1962	56	201.7	5000	6200	113.2
1963	133.9	161.7	5000	6200	103.9
1964	7.1	257.7	5000	7510	121.9
1965	15.5	334	5000	7510	130.8
1966	197.2	241.9	5000	7510	114.6
1967	246.3	400	5000	7510	93
1968	244.7	53.3	5500	7500	86.5
1969	9.3	101.6	5500	6730	101.1
1970	3.7	310.6	5500	7510	122.2
1971	0.8	804.4	5500	7510	138.4
1972	5	524.8	6300	7510	118.5
1973	3.1	593.7	6500	7510	127.1
1974	116.2	1370.8	8000	7510	204.1
1975	496.7	1553.8	9000-10000	7510	166.9
1976	793.9	1641.8	9000-10625	7510	171.4
1977	980.5	2000	11000-1200	8008	200.9

SOURCE : Shafaeddin(1988).

Table 7 Currency overvaluation and average producer prices for wheat 1971-1981

Country	Index of Currency Overvaluation	Average Producer Official Exchange Rate (US$/ton)	Price of Wheat Using Market Exchange Rate (US$/ton)
Algeria	178	127	71
Egypt	174	79	45
Iran	120	110	92
Iraq	118	88	74
Jordan	101	102	101
Libya	143	165	115
Morocco	104	141	136
S.Arabia	99	235	237
Sudan	181	137	76
Syria	107	93	87
Tunisia	115	103	90
Turkey	125	91	73

SOURCE : Richards and Waterbury, 1990.

After the Islamic Revolution in Iran, the government's setting of wheat price was the most important ingredient of its agricultural price policy. The objectives of wheat pricing were to encourage production by increasing the producer price on the one hand, and to subsidize bread for the urban population on the other hand. It is expected that this policy will help the country to achieve self-sufficiency in wheat for food and national security goals.

As in many other countries, the Iranian government's control over agricultural prices is partial and lopsided. At one extreme, wheat price is effectively controlled by the government, while at the other extreme, fruit and vegetable prices are left to market forces. This structure in government pricing and the presence of inflation has led to wheat prices lagging behind other prices. Therefore, not only has agricultural profitability declined, but also the relative prices (internal terms of trade) within agriculture have turned against staple food grains. This may lead to more variation or to a decline in domestic grain production.

The governments in food-deficient developing countries, and especially when there is a decline in foreign exchange reserve and/or possible long-run instability of export earnings and inflation, may be forced to raise the administered prices of grains (wheat) to offset increases in farm production cost and to restore production incentives and stabilize domestic production. However, more often than not, inflation quickly erodes the incentives, and the cycle repeats itself.

This cycle in grain pricing policy can be clearly seen in the case of wheat prices in Iran. Before the Revolution, particularly after the first oil shock in 1974, when wheat imports almost doubled, the government increased the price of wheat substantially. But since the price was kept constant for the next two years despite high inflation rates, the real price of wheat declined sharply. Then the imports that had decreased in 1976 began to rise again in 1977. In response, the government increased prices by about 20 percent, but this was too little, too late, and the real price of wheat continued to decline. After the Revolution, the price of wheat was raised again, but the increases could not match ongoing inflation. So, by 1980, the relative price of wheat was falling and imports were rising. In 1981 and 1983, the price of wheat was increased by 40 percent and 30 percent, quickly restoring profitability in wheat, but each time the price increase was followed by an effective price freeze, so that relative gains were quickly lost to inflation (Mojtahed and Esfahani, 1989). The relative price index in Table 8 indicates that the price of wheat has been lagging behind other agricultural prices. To provide adequate incentives it is vital for the price policy in Iran not only to avoid the stop-and-go scheme, but also to consider the profitability of production. For example, under two different methods of wheat production—semi-mechanized and traditional—the yield and production costs are different.

Table 8 Farmgate price of wheat offered by the Iranian government

Year	Farmgate nominal price of wheat	Index of price of wheat relative to : consumer prices	Wholesale prices
	(rials/kg)		(rials)
1973	5.5	63.3	n.a.
1974	10	100	100
1975	10	91	98.1
1976	10	78.2	79.7
1977	12	75	82.2
1978	14	79.3	81.9
1979	18	91.6	80
1980	20	82.1	61.6
1981	28	94	72.5
1982	30	84.5	68.5
1983	40	95.7	76.5
1984	40	86.6	62
1985	40	83.2	57.1
1986	46	79.5	n.a.
1987	48*	n.a.	n.a.

* In 1987, in addition to the price of 48 rials per kilogram, in-kind prizes were also offered to farmers for delivering their wheat to the government.
SOURCE : Mojtahed and Esfahani, 1989.

Therefore, in 1984 when the administered price of wheat was 30 rials, the traditional producer lost 2 rials per kilogram, while other producers made 9 rials profit.

Finally, two factors have become important in recent years in wheat production: (1) increasing price (e.g., the official wheat price ranged from 53.0 rials per kilogram in 1988 and had increased to 225.0 rials per kilogram by 1992), and (2) reforming the price policy system from fixed price to guarantee price (the government guarantees to purchase wheat and agricultural products at prices that are announced every year).

In comparing the performance of price policies in pre-revolution and post-revolutionary Iran, Mojtahed and Esfahani indicate that, after the revolution, the overall terms of trade have turned in favor of agriculture. However, these grain price policies are the main cause of cereal production fluctuations much more than total crop production in recent years. Moreover, Richards mentioned that domestic production fluctuation, not price instability, is the main source of food insecurity both globally and in the MENA region.

A Causality Analysis of Oil Price, Wheat Production, and Wheat Imports in Iran

According to the Food and Agriculture Organization (FAO), "food security has three specific aims: ensuring production of adequate food supplies, maximizing stability in supplies, and securing access to available supply on the part of those who need them." Internal and external factors influence food availability and, thus, food security at the national and regional levels. In this section we consider and test the relationship between two important components of food security, wheat production and imports, and the price of oil, which plays a vital role in all major oil exporting countries.

Formal investigation of the relationship among variables affecting food security is necessary for policy purposes. Causal relationship cannot be determined from standard statistical methods. For example, finding a high correlation among variables does not necessarily imply the presence of a causal linkage among them. It can be spurious—that is, their correlation may actually be due to a third factor. On the other hand, functionally (in a nonlinear fashion) related variables may be uncorrelated (a linear measure of functional relationship). Hence, we explore the causal relationship between wheat imports, as a important component in food availability, and wheat domestic production and oil prices in Iran. The method employed for analyzing causal relationship is based on the concept of Granger Causality, developed by Granger (1969) in his paper entitled "Investigating Causal

Relations." The idea is: a time series process X "causes" another time series {Y} if, by incorporating the past history of X, one can improve a prediction of Y compared to a prediction based on the history of Y alone.

This notion of causality has spawned a vast and influential literature. For example, macroeconomic studies of Granger causality have included investigation of the causal relationships between money and income, between wages and prices (see Feige and Pearce for a review of these studies), and between GNP and energy consumption (for instance, Abosedra and Baghestani, 1991).

Since *cause* is a loaded term, to avoid misunderstanding some people use other terms such as *precedent* as suggested by Leamer (Maddala, 1988), and interpret Granger Causality as meaning knowledge of X (t) increases one's ability to forecast Y(t + 1) in a least squares sense (Conway et al., 1984). About ten years after his initial paper, Granger introduced a distinguishing title for his definition and concept of causality, which is quite different from the general use and logically correct, from alternative terms, by suggesting that be called *Granger Causality* (Granger, 1980).

Assessments of Granger Causality have both practical and theoretical value (Freeman, 1982). Indeed, in economics, tests for this kind of causality are becoming recognized as essential steps in building a model (Sargent, 1981).

Operationalization and Testing

For a bivariate case, consider jointly stationary processes X and Y. Let all past values of X_t and Y_t be denoted by $\bar{x}, \bar{y}$ and all past and present values of X_t and Y_t be represented as $\bar{\bar{x}}$ and $\bar{\bar{y}}$. Also, define σ^2 as minimum prediction variance[1]. There are number of ways to define causality. Four of the most popular cases are presented here:

Y Causes X : $\sigma^2 (X_t \mid \bar{y}_t , \bar{x}_t) < \sigma^2 (X_t \mid \bar{x}_t)$

Y Causes X instantaneously : $\sigma^2 (X_t \mid \bar{\bar{y}}_t , \bar{x}_t) < \sigma^2 (X_t \mid \bar{y}_t , \bar{x}_t)$

Feed Back : Y Causes X and X Causes Y.

Independence : $\sigma^2 (X_t \mid \bar{y}_t , \bar{x}_t) = \sigma^2 (X_t \mid \bar{x}_t) = \sigma^2 (X_t \mid \bar{\bar{y}}_t , \bar{x}_t)$ and

$\sigma^2 (Y_t \mid \bar{y}_t , \bar{x}_t) = \sigma^2 (Y_t \mid \bar{y}_t) = \sigma^2 (Y_t \mid \bar{\bar{x}}_t , \bar{y}_t)$

Three tests of causality have been proposed within Granger's definition of causality: (1) the Direct-Granger test,which is based on his definition and applied as a one-sided distributed lag; (2) the Sims (1972) approach, based on a two-sided distributed lag; and (3) a cross-correlation between the residual series method suggested by Pierce and Haugh (1977).

The Granger and Sims tests are theoretically equivalent (Doan, 1992), and as Freeman pointed out, the Pierce-Haugh technique is really a test for independence only. The properties of variants of these three tests of causal direction have been studied by, for instance, Geweke, Meese, and Dent. All studies indicate the Direct-Granger test is preferable to the Sims and Pierce-Haugh tests of causality (Abosedra and Baghestani, 1991).

Among the problems associated with the Direct-Granger method, however, is the need to choose a sufficient lag length for the right side of the autoregressive representations of a bivariate system:

$$Y_t = \sum_{1}^{m} \alpha_i Y_{t-1} + \sum_{1}^{n} \beta_j X_{t-j} + \varepsilon_{1t} \tag{1}$$

$$X_t = \sum_{1}^{m} \lambda_i Y_{t-i} + \sum_{1}^{n} \delta_j X_{t-j} + \varepsilon_{2t} \tag{2}$$

If an insufficient number of lags is chosen, there is likely to be serial correlation in the residuals and therefore, a biased hypothesis test (Feige and Pearce, 1979). Another difficulty with this technique is that estimated residual in the test equations (1) and (2) are assumed to be independent. If this is not the case and ϵ_{1t} and ϵ_{2t} are contemporaneously correlated, the Zellner-Aitken generalized least squares regression estimating simultaneously these two equations provides results that are similar to those of the Direct-Granger method (Cuddington, 1980).

Empirical Evidence

To use the standard Direct-Granger causality test, we specify a set of two unrestricted equations. We explore the causal linkage between oil price (OP) and wheat imports (M) by using equations (3) and (4). And equations (5) and (6) are used to detect the causal relationship between domestic wheat production (Q) and wheat imports (M).

$$M_t = \sum_{1}^{m} \alpha_i M_{t-i} + \sum_{1}^{n} \beta_j OP_{t-j} + \varepsilon_{1t\varepsilon} \tag{3}$$

$$OP_t = \sum_{1}^{m} \lambda_i OP_{t-i} + \sum_{1}^{n} \delta_j M_{t-j} + \varepsilon_{2t} \tag{4}$$

$$M_t = \sum_{1}^{m} \alpha_i M_{t-i} + \sum_{1}^{n} \beta_j Q_{t-j} + \mu_{1t} \tag{5}$$

$$Q_t = \sum_{1}^{m} \lambda_i Q_{t-i} + \sum_{1}^{n} \delta_j M_{t-j} + \mu_{2t} \tag{6}$$

To test for stationarity of these four time series we applied a Dicky-Fuller test. The results indicate that only domestic production of wheat (Q) is a stationary process. To eliminate the problem of time series serial correlation and "spurious regression" all three nonstationary processes are transformed into first-order difference form. We use the domestic production level of wheat, both with and without a time trend.

We applied these unrestricted equations to the Granger causality test for the two pairs of variables for Iran covering the period 1964 to 1991. Since our data are annual, such test equations might be misspecified if there is a significant causal relationship with a lag length of less than one year between the variables. To overcome this possible problem, it is more appropriate to use the Direct-Granger test in the form suggested by Feige and Johannes; that is, we add the current value of independent variable in right side of test equations (run for $j > 0$).

The null hypothesis that oil price (OP) does not cause wheat imports (M), OP M, is tested by examining the joint significance of the coefficients on N past OP in equation (3). To test OP does not cause (M) at all (i.e., including contemporaneously), we examine the joint significance of coefficients on OP and N past OP in equation (3). To test whether wheat imports do not cause oil price we use equation (4) in the same manner. A lag length of 2 for independent variables is chosen ($n = 2$) for equation (4). This is deemed adequate since annual data are used, and to ensure enough degrees of freedom for better precision of estimates. However, in Tables 10 and 11, since Q needed no differencing, the lag length can be increased up to 3 to accommodate more dynamics in the model (different lag lengths are tested, but not reported here).

Table 9 reports the calculated F-value for (a) OP (M) does not cause M (OP), (b) OP (M) does not cause M (OP) "at all." Note that F(A) refers to the F-statistics for the "at all" causality test (i.e., when considering both the lagged and the contemporaneous variables), and F(S) refers to strict causality test; that is, when one just considers the lagged variables.

Table 9 Direct - Granger causality F -test

Causality : From oil price to wheat import

no. of lags in ind. variables	null hypothesis	F(A)[a]	F(S)[a]	$\bar{R}^2$	D-h / t[b]
[1]	OP not cause M	3.28 (2, 23)**	4.40 (1, 24)*	.23	1.08/ -
[2]	OP not cause M	2.24 (3, 21)[c]	2.71(2, 22)**	.21	NC / 1.82[d]

Causality : From wheat import to oil price

no. of lags in ind. variables	null hypothesis	F(A)[a]	F(S)[a]	$\bar{R}^2$	D-h / t[b]
[1]	M not cause OP	1.50 (2, 23)	.98 (1, 24)	.03	NC / .53
[2]	M not cause OP	.91 (3, 21)	.58 (2, 22)	.07	NC / .78

[a] F(A) refers to the causality F- statistics for the " at all " causality and F(S) refers to the strict causality test. Degrees of freedom are given in parantheses.
[b] Adjusted R-squared and D-h (Durbin- h) and t-values are from the unrestricted test equations.
[c] F- critical value at 10% level is 2.36.
[d] NC indicates that the Durbin- h statistic can not be computed.
* Significant at the 5 percent level.
** Significant at the 10 percent level.

An examination of F(A) and F(S) in the first panel in Table 9 indicates the presence of a unidirectional causality from oil price to wheat imports ($OP \Rightarrow M$). In other words, the past and current and also past history of oil price help predict wheat imports in Iran. The latter appears to have a stronger causal linkage than the former. Examination of the second panel suggests no relationship between oil price and wheat imports when the past and present information is considered, but there is a unidirectional causal relationship from oil price to wheat imports when we consider past information of oil price only.

The results of the Direct-Granger test, relating domestic wheat production (with a time trend) and wheat imports for alternative lag lengths, are summarized in Table 10. These results suggest the presence of strong linkage from wheat production to wheat imports when both the contemporaneous and lagged variables are considered. Examination of F(S), however, suggests no causation between the two variables, for all different lag structures. The current effect from Q to M seems to be significant in all cases. The structure of Table 10 is the same as Table 11, except the level of Q is detrended.[2]

Again, the examination of F(A) indicates the presence of a strong bidirectional (feedback) causality from Q to M. In comparing Tables 10 and 11, on the basis of the F-statistic values, the effects from domestic production of wheat to wheat imports appear to be more pronounced than when we use a detrended time series value of Q.

Since the data for oil price includes three shocks—1973, 1979, and 1983—we apply the Chow test to explore whether there are any structural changes in the coefficients. The results indicate that causality tests are not sensitive to sample periods. For testing serial correlation, since the test equations include lags, Durbin-h is used. In any case where this test could not be computed, we applied an alternative test called m-test. Based on the reported D-h or t-value for the m-test, in Tables 9, 10, and 11 there are no serial correlation problems in the unrestricted test equations.

Conclusion

Using the Direct-Granger causality test, we have presented evidence that there is a unidirectional causality relation from oil price to wheat import in the strict and instantaneous sense in Iran. In other words, the past and present history of oil prices are useful information to improve the prediction of wheat imports. The past and current history of domestic production of wheat (with and without a time trend) is useful to improve the prediction of wheat imports, but this is not the case when we just consider the past history of domestic wheat production. As Feige and Johannes

Table 10 Direct - Granger F- Test : Domestic wheat production process with time trend

Causality : From Wheat Production to Wheat Import

no. of lags in ind. variables	null hypothesis	F(A)[a]	F(S)[a]	$\bar{R}^2$	D-h /t[b]
[2]	[Q not cause M]	5.04 (3, 20)**	2.14 (2, 21)	.51	-1.00
[3]	[Q not cause M]	4.44 (4, 17) *	1.60 (3, 18)	.53	NC/ 1.14

Causality : From Wheat Import to Wheat Product

no. of lags in ind. variables	null hypothesis	F(A)[a]	F(S)[a]	$\bar{R}^2$	D-h /t[b]
[2]	[M not cause Q]	3.40 (3, 20)	.37(2, 21)	.78	NC / .14
[3]	[M not cause Q]	3.16 (4, 17)**	.47(3, 18)	.70	NC /.59

* Significant at 5 percent level

** Significant at 1 percent level

Table 11 Direct - Granger causality F -Test : Domestic wheat production process without time trend

Causality : From wheat production to wheat import

no. of lags in ind. variables	null hypothesis	$F(A)^a$	$F(S)^a$	$\bar{R}^2$	D-h /t^b
[2]	[Q not cause M]	4.62 (3, 20)*	1.72 (2, 21)	.49	NC /0.19
[3]	[Q not cause M]	3.52 (4, 17)*	.99 (3, 18)	.48	NC / 2.17

Causality : From wheat import to wheat production

no. of lags in ind. variables	null hypothesis	$F(A)^a$	$F(S)^a$	$\bar{R}^2$	D-h /t^b
[2]	[M not cause Q]	3.91 (3, 20)**	.96(2, 21)	.27	NC /0.91
[3]	[M not cause Q]	2.98 (4, 17)**	.52(3, 18)	.31	NC / 2

* Significant at the 5 percent level

** Significant at the 1 percent level

ENDNOTES

1. Prediction variance. Given a two variables regression model, $Y_t = \alpha + \beta X_t + \in_t$ $t = 1, 2$ .....,T and $\in_t \sim N(0, o^2)$. If assume α and β are known, the appropriate forecast for Y_{T+1} is given by $\underline{Y}_{T+1} = E(Y_{T+1}) = \alpha + \beta X_{T+1}$, the prediction (forecast) error is $\underline{e}_{T+1} = \underline{Y}_{T+1} - Y_{T+1})$. This prediction error has two desirable properties: (a) $E(\underline{e}_{T+1}) = E(\underline{Y}_{T+1} - Y_{T+1}) = (-\in_{T+1}) = 0$ and (b) the prediction error variance is the minimum variance among all possible forecasts based on linear equations (see Pindyck and Rubinfeld, 1991).

2. The time series Q, is a trend-stationary process (TSP) (not a difference-stationary process (DSP). A TSP can be represented as $Y = \alpha + \beta t + \in_t)$. Deterending involves subtracting a (linear) trend ($Y - \beta t = \alpha + \in_t$), in order to obtain a stationary process (Lloyd and Rayner, 1993).

REFERENCES

Abosedra, S., and H. Baghestuni. 1991. New evidence on the causal relationship between United States' energy consumption and gross national product. Journal of Energy and Development (spring) :285-292.

Conway, R.K., B. Swamy, F. Yanagida, and P van Zur Mueunhlen. The impossibility of causality testing. Ag. Econ. Res 36:1-19.

Cuddinton, J.T. 1980. Simultaneous equation tests of the natural rate and other classical hypotheses. Journal of Political Economy 88(June):539-549.

FAO. 1981. Agriculture: Toward 2000. UN-FAO, Rome.

Feige, E.L., and J.M. Johannes. 1981. Testing the causality relationship between the domestic credit and reserve components of a country's monetary base. Journal of Macroeconomics (winter):55-76.

Freeman, T.R. 1983. Granger causality and the time series analysis of political relationship. American Journal of Political Science 27:337-358.

Granger, C.W. 1969. Investigating causal relations by econometric models and cross spectral methods. Econometrica 37(May):405-418.

Granger, C.W. 1980. Testing for causality: A personal viewpoint. J. Econ. Dynam. Control 2:329-352.

Kavoossi, M. 1991. Agriculture policy and development in Iran: An overview. Journal of International Food and Agribusiness Marketing 3(3):19-41.

Khalds, N. 1984. Evolving Food Gaps in the Middle East, North Africa: Prospects and Policy Implications. Research Report No. 47. IFPRI, Washington, D.C.

Lloyd, A., and A.J. Rayner. 1993. Co-integration analysis and the determinants of the land prices: Comment. Journal of Agricultural Economics 44(1):148-156.

Looney, R.E. 1983. Inefficiency in agriculture: Pre-revolution of Iran. The Journal of Energy and Development 10(3):61-71.

Maddla, G.S. 1988. Introduction to econometrics. Macmillan, New York.

Mojtahed, A., and H. Esfahani. 1989. Agricultural policy and performance in Iran: The Post-Revolutionary Experience. World Development 17(6):839-860.

Pierce, D.A., and L.D. Haugh. 1977. Causality in temporal systems: Characterizations and a survey. Journal of Econometrics (May):265-293.

Pindyck, Robert S. and Daniel Rubinfeld. 1991. Econometric Models and Economic Forecasts. New York: McGraw-Hill.

Richards, A., and J. Waterbury. 1990. A Political Economy of the Middle East: State, Class, and Economic Development. Westview Press, Inc., Boulder, Colorado.

Richards, A. 1987. Food problems and state policies in the Middle East and North Africa. In W.L. Hollist and F.L. Tullis. Pursuing Food Security Strategies and Obstacles in Africa, Asia, Latin America, and the Middle East. Lynne Rienner Publisher, Inc., Boulder, Colorado.

Sargent, T. 1981. Interpreting economic time series. Journal of Political Economy 89(April):213-248.

Shafaeddin, M. 1988. Agricultural price policies and the oil boom: Wheat and Meat in Iran, 1962-78. Food policy :185-98.

Shapuri, S., and S. Rosen. Food Import Demand in North Africa and the Middle East. Outlook and Situation Report, USDA/ERS, RS-86-4:44-48.

Thurman, W.N., and M.E. Fisher. 1988. Chickens, eggs, and causality, or which came first? American Journal of Agricultural Economics (May):237-238.

USDA. 1986. Middle East and North Africa: Situation and Outlook Report. USDA/ERS, Washington, D.C.