AN ECONOMIC ANALYSIS OF THE IMPACTS

OF CHANGING PETROLEUM PRICES

ON SOVIET GRAIN IMPORTS

By

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PREFACE

The purpose of this study was to examine the impact of selected variables on Soviet grain imports. Linear regression techniques were employed to develop single equation explanatory models which tested and quantified the relationship between the price of Soviet export commodities and the quantity of grain imported. The price of petroleum was identified as the most statistically significant independent variable and was used to estimate equations explaining Soviet grain imports. The equations consistently showed high explanatory power.

I wish to express my sincere appreciation to Dr. James Russell, my major advisor, for his guidance and support throughout my Master of Science program. His patience and humor helped me through the many traumatic experiences of "grad-life". Also, I would like to thank my committee members, Dr. David Henneberry and Dr. Leo Blakley, for their helpful comments in preparation of the final manuscript.

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as well as the good times. Someone once told me that we are who we are because of all our experiences and the people we have known along the way. Each of you has made a special mark on my life, without which my life would have been incomplete. Thanks for "being there" and thanks for the memories.

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CHAPTER I

INTRODUCTION

The Soviet Union has been regarded as a key indicator of world food trade and grain prices since its reentry into world markets as a major grain importer in 1972. After being a net grain exporter for several years, the U.S.S.R. shifted abruptly to being a large net importer without advance indication to foreign governments or the grain trade. Two major reasons are advanced to explain this increase in demand: (1) a Soviet policy decision directed towards improving the dietary standard of the country and (2) an increase in the price of Soviet export commodities, especially petroleum. Before 1972, it was customary for Soviets to slaughter livestock in years of poor grain harvest. The policy decision to increase production and consumption of meat and dairy products required that imports of grain be maintained to offset domestic shortages and to avoid the practice of necessary slaughter.

Soviet grain supply has grown to meet demand, but only in part. Figure 1 depicts Soviet grain production from 1955-1985. Average annual grain production grew from 129.4 million metric tons in the 1955-67 period to 188.6 million metric tons in the 1968-80 period, a 46 percent increase. This was more than sufficient to supply today's population at the consumption level of 1955, but not enough to improve food consumption on a broad scale (Clayton, 1985). To improve the

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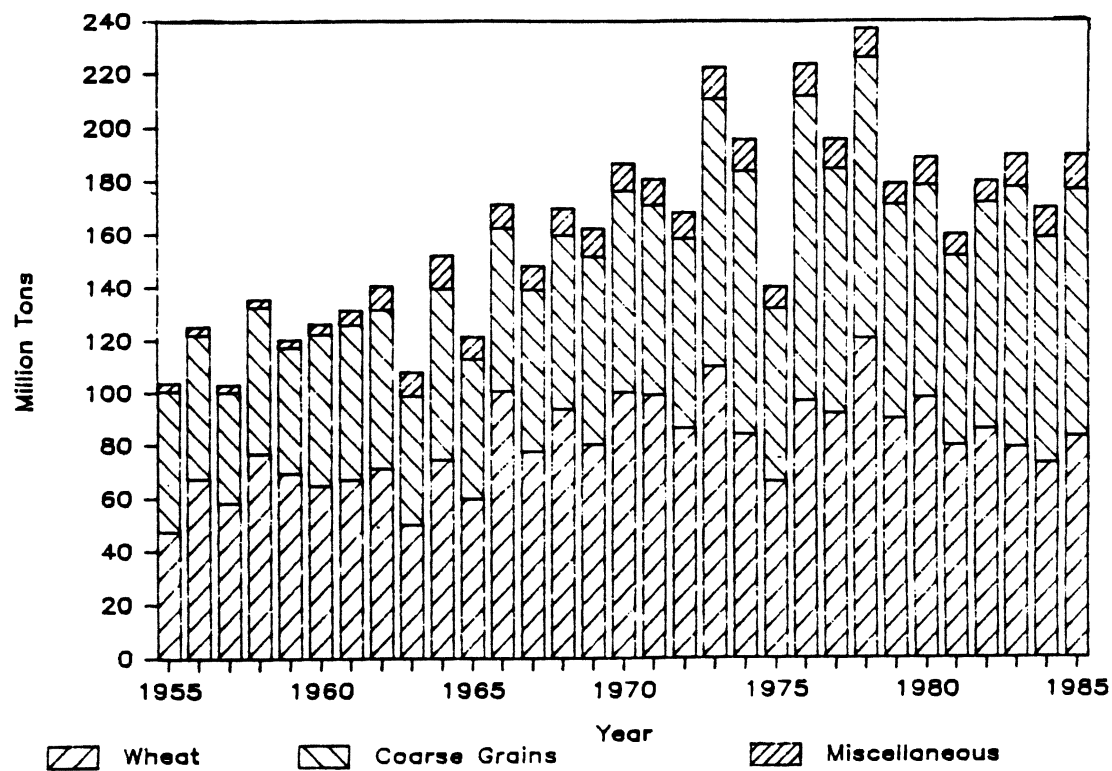
Source: U.S.S.R. Grain Policies and Data, USDA, ERS, 1986.

Figure 1. U.S.S.R. Grain Production, 1955-1985

standard of living has required not only more domestic grain production but also more grain imports, particularly of feed grain.

Variability in Soviet crop production is extreme and obvious as depicted in Figures 2 and 3. Large year-to-year variations in Soviet crop production are often blamed for fluctuations in grain imports. Steep swings in grain production are often caused by fickle and unreliable weather conditions. As Soviets experienced poor crop production and stocks were depleted, they were forced to choose between curtailing livestock herds or entering world grain markets. Their decision to maintain livestock inventories and increase dietary standards has boosted imports of food and feed grains.

While Soviet imports have not been large in relation to Soviet grain production (Figure 4) they are substantial in relation to world grain trade. Soviet imports in 1972-1973 accounted for 18 percent of the world trade in wheat and coarse grains, and world grain prices rose sharply with the unexpected increase in trade. In the next nine years, Soviet imports fluctuated widely from year to year and accounted for 4 to 22 percent of global trade in wheat and coarse grains.

Increased population and simultaneous increases in incomes are also considered major reasons behind the increase in demand. The Soviet Union ranks third in terms of size of population after China and India. Between the census of 1959 and 1979, the Soviet Union added about 54 million people to its population. It is estimated that an additional two to three million have been added each year since that time (Clayton, 1985). During this same time frame, average monthly wages more than doubled in the industrialized sector and
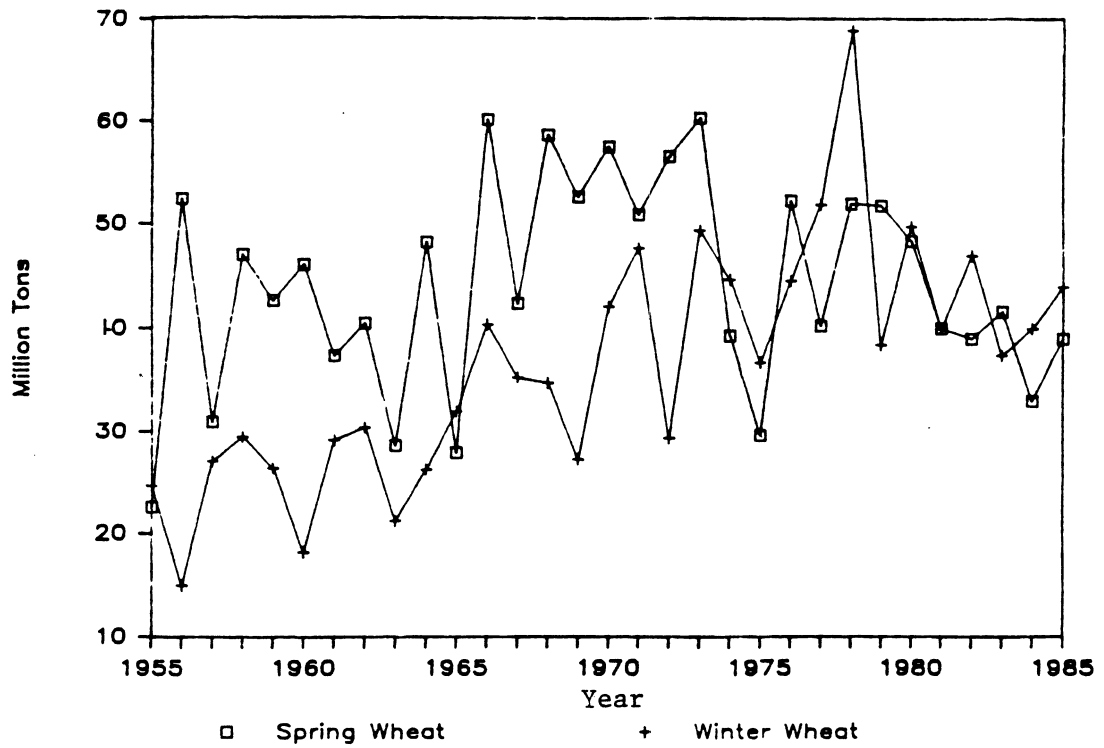
Source: U.S.S.R. Grain Policies and Data, USDA, ERS, 1986.

Figure 2. U.S.S.R. Wheat Production, 1955-1985
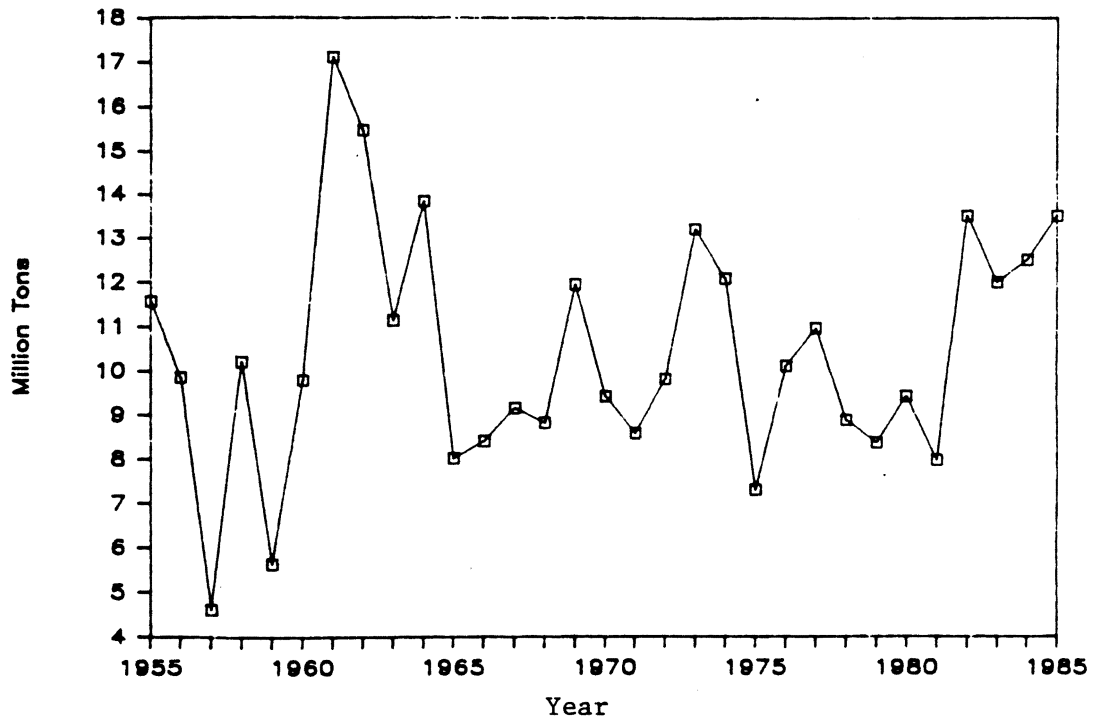
Source: U.S.S.R. Grain Policies and Data, USDA, ERS, 1986.

Figure 3. ·U.S.S.R. Corn Production, 1955-1985

Y 1

275 +

250 +

225 +   Q

                                              Q   Q

200 +   Q

                                   Q   Q   Q
                                      Q   Q   Q   Q
175 +   Q   Q
                          Q   Q   Q   Q
                                         Q   Q
150 +   Q   Q   Q

                           Q
125 +   Q   Q   Q

Million Tons   Q

100 +   Q

75 +

50 + .   M   M
                                                              M   M
                                                          M   M
25 +   M   M   M   M   M   M
                                      M   M
                                   M   M   M
                          M   M   M   M
0 +   M   M   M   M   M   M   M
    ----+-------+-------+-------+-------+-------+-------+-------+-------+-------+-------+-------+-------+-------+----
       1960   1962   1964   1966   1968   1970   1972   1974   1976   1978   1980   1982   1984   1986
                                              Year
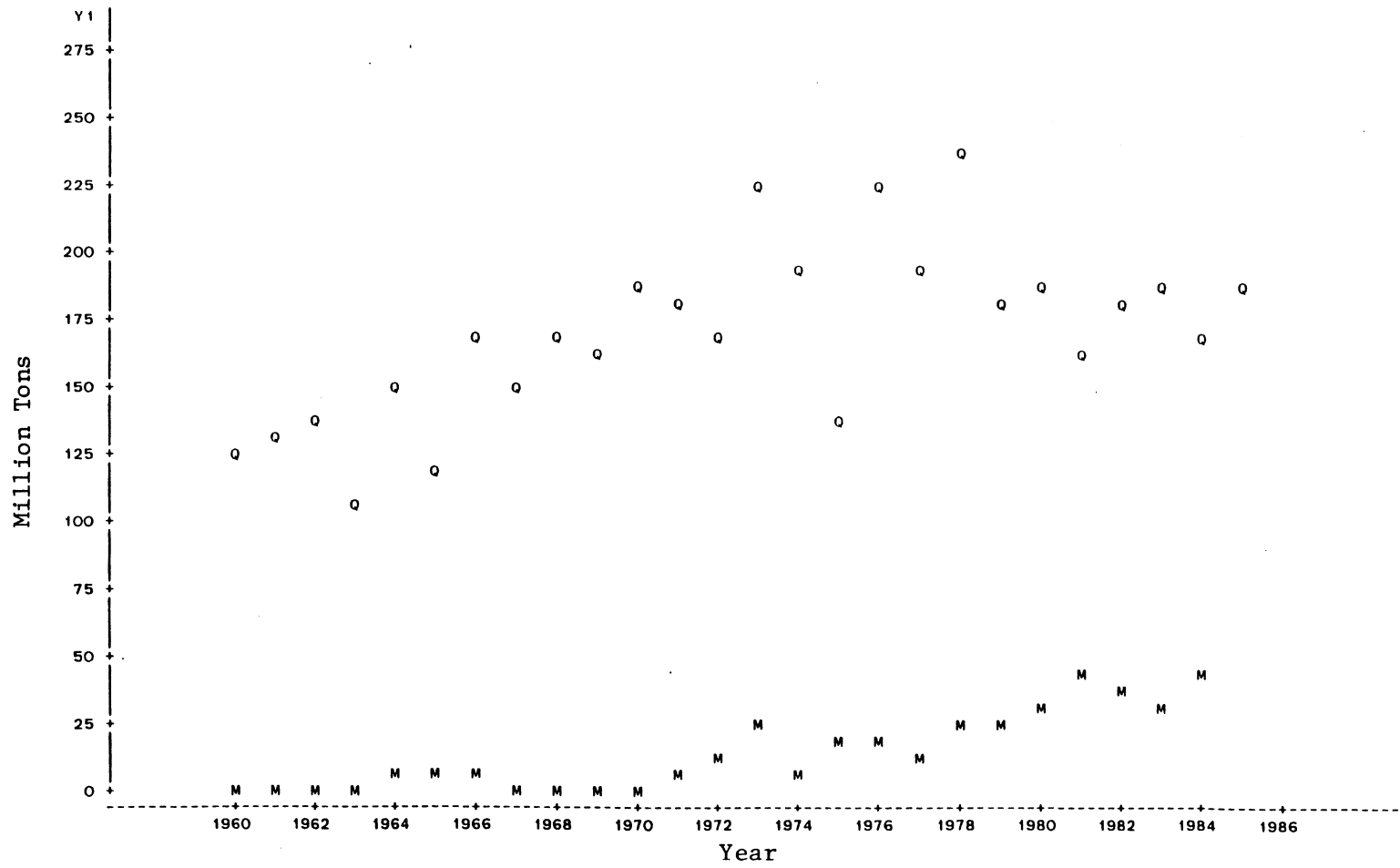
Legend: Q = Soviet Grain Production
          M = Soviet Grain Imports

Figure 4.   Soviet Grain Production and Soviet Grain Imports, 1960-1986

collective farm wages grew even faster. Growing incomes have expanded the effective demand for meat.

Problem Statement

U.S. farmers have become more reliant on international demand as a basis for growth. Historically, the U.S. has been one of the world's leading exporters of agricultural commodities. From 1951 through 1981 the U.S. share of world agricultural exports averaged 16 percent annually (Mackie, 1983). Agricultural exports have accounted for one-fourth of cash receipts for all farm products and one-fifth of total U.S. exports (Sharples, Webb and Holland, 1984). The U.S. currently exports the products of 40 percent of total harvested acres.

Agricultural exports are not only significant to domestic farmers and ranchers, but also to the U.S. labor force and millions of domestic and foreign consumers. U.S. agricultural exports generate jobs in the U.S. farm supply industry, in processing, transportation, financing, merchandising, insurance and other areas of work involved in producing and marketing the nation's agricultural goods. Farm export earnings helped to pay for the nation's imports of petroleum, automobiles, electronic goods, textiles and other products purchased from abroad. Staggering deficits in net foreign trade would have resulted without large farm exports.

Demand shifts affecting U.S. farmers are more likely to arise from international rather than domestic sources. Volatility in international food trade is often due to weather and normal market forces, but many of the more pronounced swings may be attributable to changes in various governments' policies with respect to food imports

and exports. Reliance on agricultural exports by U.S. farmers makes the farm sector sensitive to fluctuations in international demand.

Oklahoma's economy is heavily dependent on revenues from oil and gas production. Also, wheat is a major source of income for many Oklahoma farmers. Obviously, if the price of oil decreases, Oklahoma's state revenues decline. Less obvious, however, is how these same price fluctuations affect Oklahoma farmers. A decrease in the price of oil is likely to mean less hard currency available for the Soviet Union to purchase wheat and other grains, which may result in declining revenues for Oklahoma wheat farmers.

Explaining Soviet demand is especially important to U.S. producers because of the direct impact on the agricultural sector created by large fluctuations in Soviet purchases over recent years. The Soviet Union is one of the world's largest importers of grain, currently accounting for almost 20 percent of all international trade (Moore, 1986). In 1986, the value of U.S. grain and feed exports fell from $11.9 billion to $8.6 billion. Much of this decline stemmed from a 15.9 million ton decline in export volume, most of which represented lower exports to the Soviet Union. Tumbling oil prices in 1986 cut U.S.S.R. hard currency earnings and made importing less attractive. U.S. grain sales to the U.S.S.R. fell 11.6 million tons. U.S. wheat exports to the U.S.S.R. dropped to zero and corn exports to 2.7 million tons as the U.S.S.R. harvested one of its best grain crops in nearly a decade.

Fluctuations in Soviet grain production and imports have a major influence on the volume of grain traded in world markets and have considerable impacts on world grain prices. For this reason, grain

merchants throughout the world keep a vigilant watch on factors which might alter Soviet purchases such as weather and political developments. If terms of trade can be proven effective in evaluating such fluctuations, it may be used to explain Soviet imports of grain, thus facilitating appropriate policy decisions by the U.S.

General Objective

The overall objective of this study is to examine the relationship between the price of selected Russian export commodities and quantities of grain imports to the Soviet Union.

Specific sub-objectives are:

1. To describe price patterns of selected Russian export commodities;

2. To describe Soviet grain import quantities and policies; and

3. To quantify and test for the relationship between selected Russian export commodities and its grain imports.

Hypothesis

Fluctuations in the price of Russian export commodities, specifically gold, oil, natural gas and coal, have a quantifiable impact on Russian grain imports.

Procedures

1. Objective one will be achieved by:

    a. Identifying the types and respective prices of export commodities;

    b. Reviewing the literature regarding the reliability of

alternative data sources; and

c.   Using statistical tools such as regression to examine trends

and seasonal components of selected Russian export commodity

price series.

2.   Objective two will be achieved by:

Conducting an extensive literature review on Soviet import

and export policy.

3.   Objective three will be achieved by:

Using linear regression to develop single equation

explanatory models which test and quantify the relationship

between the price of varied Soviet export commodities and the

quantity of grain imported. Separate models will be developed

with the quantity of coarse grains, wheat and total grain

imported as the dependent variables. Explanatory variables could

include, but not be limited to, the prices of oil, natural gas,

coal and gold. Other explanatory variables could include the

size of the Soviet grain harvest and Soviet livestock

inventories.

Thesis Organization

A brief history and general background of the Soviet Union is

presented in Chapter II. Emphasis in this chapter will be placed on

agricultural policy and how those policies evolved. Chapter III will

consist of a review of the relevant theory and terms of trade.

Chapter IV will consist of the analysis of the data. Chapter V will

be the summary and conclusions as well as the limitations of the

study.

CHAPTER II

UNION OF SOVIET SOCIALIST REPUBLIC

General Background

The Union of the Soviet Socialist Republic encompasses one-sixth
of the total land surface of the earth, the largest territorial entity
in the world since the 17th century. It is approximately two and one
half times the size of the U.S. (Figure 5) and enjoys enormous wealth
in natural resources.

The U.S.S.R. possesses coal deposits amounting to about half of
the world's known reserves (Hill, 1985). Natural gas and oil are
available in abundance as the U.S.S.R. possesses the world's greatest
natural gas and petroleum deposits (Harris in Cracraft, 1983). Almost
60 percent of the world's peat, enormous forests for lumber
production, plus tremendous potential for hydro-electricity on the
great and swift-flowing rivers of Siberia contribute to Russia's
natural resource base (Schwartz, 1968).

In addition to basic energy resources, valuable minerals also
exist in abundance. With some 40 percent of the world's iron ore, the
U.S.S.R. possesses more than the whole Western world. The U.S.S.R.
also possesses half of the world's potassium, and almost 90 percent of
its manganese (Hill, 1985). The Soviet Union is the second largest
producer of gold, only after South Africa and also has an array of

N. LATITUDE

NORTH POLE

70°

60°

170°/10°

50°

150°/30°

NORWAY

70°

60°/0°/180°

50°

30°/150°

WEST LONGITUDE (NORTH AMERICA)

| 120° | 90° | 60° |
| 60° | 90° | 120° |

0°

0°

EAST LONGITUDE (U.S.S.R.)

CDH-83
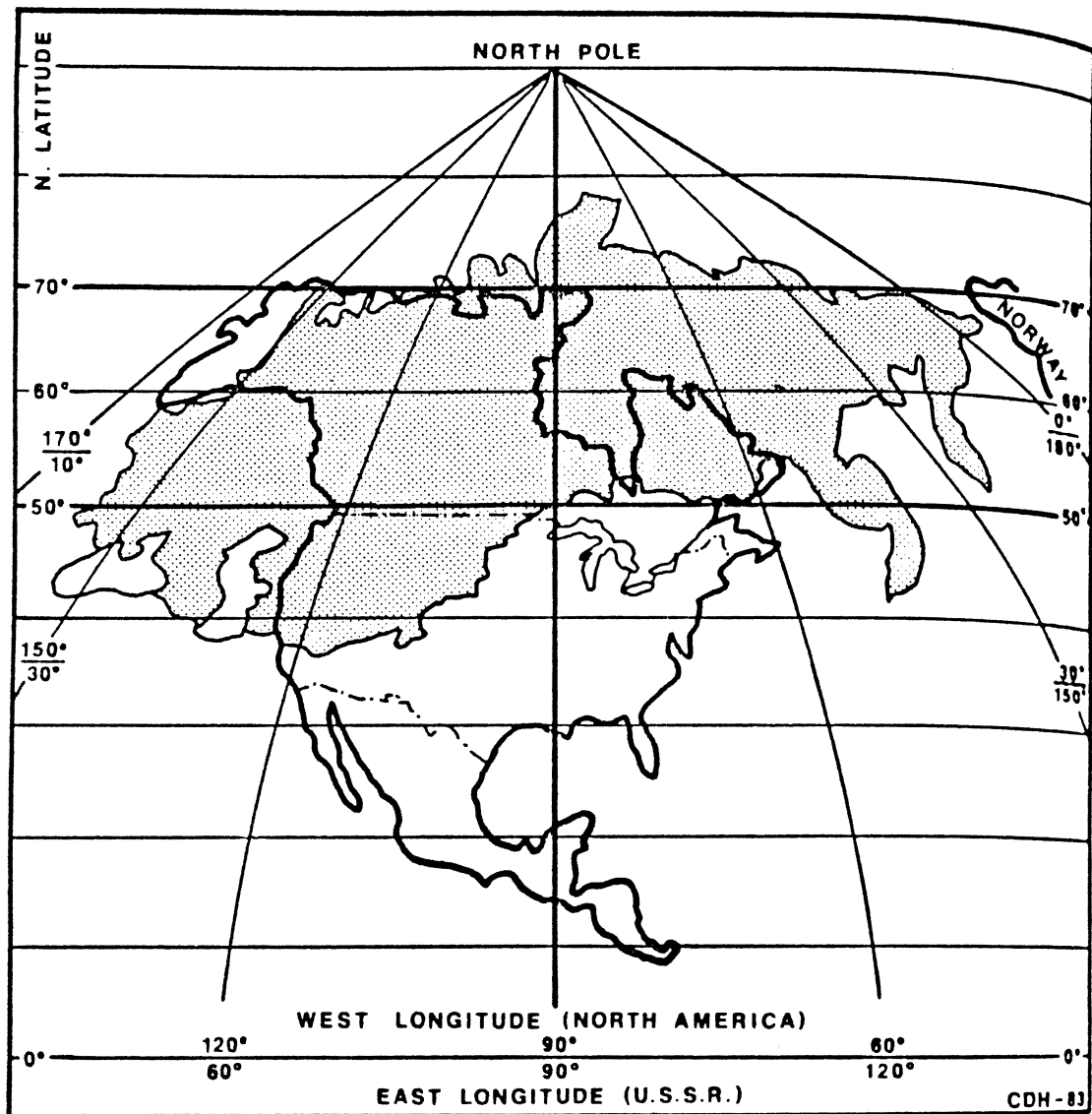
Source: <u>Soviet Union Today</u>, 1983.

Figure 5. Relative Size and Location of the Soviet Union and North America

other mineral stocks vital to the modern industrial economy (Hecht, 1982).

Diamonds and other gemstones complete the impressive list of mineral resources. The Soviet Union has become one of the world's major producers of industrial and gemstone diamonds (Mathieson, 1975). Diamonds, after fossil fuels and precious metals, were the most significant foreign exchange earnings export of the U.S.S.R. (Bureau of Mines, Mineral Yearbook, 1982).

The climate is continental: hot summers, cold winters, extremes of heat and cold, with fickle, unreliable weather patterns (Hill, 1985). Climatic limitations impose severe restrictions on agricultural land use and many other economic activities throughout the Soviet Union. The majority of land is climatically comparable with Canada. Only one-third of the land in the Soviet Union lies south of the 49th parallel, while all of the U.S. except Alaska lies south of this line. Inadequate growing seasons or excessive winters, drought or excessive rainfall give rise to a series of landscapes, marshlands, steppes, permafrost zones and taiga, and create an inhospitable and sometimes unmanageable environment for a large portion of the country.

History

The Soviet Union is the inheritor of an established political system of considerable antiquity, but one which has been isolated from world developments throughout much of its existence. Russia's history can be seen as a repeating cycle: periods of stagnation followed by a discovery of the country's backwardness and frantic efforts to catch

up with its Western neighbors, often at the expense of the peasantry or agricultural sector.

Peter the Great attempted to raise Russia to the standard of the already great nations of his time by establishing textiles, paper, iron, shipbuilding and other industries. By the time of his death, Russia had attained a level of administrative, industrial and military modernity equivalent to that of the power which she emulated. In his vigor to establish Russia as a modern industrialized nation, he assigned thousands of peasants to work in his newly formed mines and industries. As a result, Russian technical, industrial, and military capabilities leapt forward, leaving the peasantry in ignorance.

During the reign of Empress Catherine the Great, the arts and literature flourished in Russia. However, the Russian people were little affected by these advances. The bulk of the population consisted of private or state-owned serfs; most of the populous, illiterate.

A surge in Russian industrialization occurred in the 1890's when Serge Witte became the Czars Minister of Finance and assumed leadership for modernization. He believed that Russia needed an up-to-date industry to retain its independence. His greatest single accomplishment was the Trans-Siberian Railroad. This provided a great stimulus for industrial development. Between 1890 and 1900, Russian production of coal, oil, iron and steel roughly tripled and the country's rate of economic growth became the wonder and envy of much of the world (Schwartz, 1968).

The initial reaction to Lenin's seize of power in 1917 was one of ludicrousy. It seemed incredible to Russia's affluent that Lenin, his

Marxists theorists, and inexperienced followers could govern such a complex state and economy and for advocates of a "workers state" to think of ruling what was primarily peasant Russia. Lenin, however, confounded the skeptics and maintained Bolshevik power despite numerous difficulties as well as civil war. He proved to be a master politician and his associates showed themselves to be adept organizers. During his reign, the struggle for food became a key economic factor. Grain was needed to feed his armies and when farmers withheld he resorted to force to obtain the crops.

Lenin blueprinted what has become known in history as War Communism. At its peak, War Communism brought everybody and everything in Bolshevik-controlled areas at the direct service of the Soviet state's fight for military and economic survival. All banks were nationalized. Private ownership of large houses was abolished. All factories were nationalized and all trade became a state monopoly, and all people were liable to labor service. The normal processes of the market place based on the use of money were largely wiped out.

In 1921, Soviet economic conditions had been so bad and Communist party control of the population so shaky that Lenin found it necessary to make a major retreat by endorsing the New Economic Policy (NEP). Lenin introduced the NEP in which private trade and private industrial production was reintroduced. NEP virtually junked the idea of War Communism and encouraged individual initiative as an incentive. The NEP sought to restore free markets, competition and incentives of the old private enterprise system. The NEP catapulted the economy into flourishing years once again. However, the NEP was met with outrage by many Communists and was put to an end at Lenin's death in 1924.

The main issues of industrialization and economic development were decided by Joseph Stalin. Stalin was dictator of the Soviet Union for a quarter of a century (1928 until his death in 1953). His forced industrialization and modernization of the U.S.S.R. was so successful that at his death, the country was the second most powerful nation in the world and a serious economic, scientific and military rival of the United States. Upon the death of Stalin, the Soviet Union had atomic bombs, intercontinental missiles and space rockets. But, the Soviet people still lived in relative poverty.

Stalin's economic development strategy consisted of large and continual investment in those branches of Soviet industry that contributed directly or indirectly to Soviet military strength, at the expense of other areas of the economy such as transportation, communications, housing and agriculture. The result was highly lopsided industrial development, with underdevelopment of the other areas.

The heart of Stalin's problems, however, was the 25 million peasant families who made up most of the Soviet population. They grew the grain that Stalin so desperately needed to feed the expanding urban populous and for exportation in payment for foreign machinery and expertise. Collectivization of the peasantry was Stalin's answer to the agricultural problem.

By 1950, Soviet agriculture had recovered from World War II except for the greatly reduced farm labor force - a result of extreme wartime casualties. During the 1950's, the farm labor force consisted largely of women, older men and children. Given this composition, agricultural production in that period was remarkable. Output grew by

about four percent annually, nearly double the rate of growth in Western Europe or North America. With the death of Stalin in 1953, the rapacious exploitation of rural people by their government was largely brought to an end.

By the time Stalin died, however, tensions resulting from the sacrifices he had extorted from the Soviet people made his heirs nervous about the security of their power. Khrushchev appeared in public as the apostle of a better standard of living for Soviet people. Khrushchev hastened the release of slave laborers from Soviet concentration camps and increased minimum wages and pensions of Soviet workers. Khrushchev's de-Stalinization campaign argued for more investment in agriculture and the bringing in of new land into production. Prices paid to farmers were increased several fold. Investment financed by the state increased, as did output of farm equipment and of fertilizer. The gap between rural and urban incomes was greatly narrowed. The exploitation of the agricultural sector, or the pumping out of resources for the benefit of industrial investment, was halted.

Krushchev campaigned for ploughing up virgin and fallow land, expansion of cultivated acreage of maize, and to "overtake America in production of meat and milk." He hoped that more wheat from the East would release land for fodder crops in European Russia, including his favorite, maize (Nove, 1980). The corrective measures taken by Krushchev in the 1950's such as higher prices paid to producers, increased investment in the agricultural sector and the New Lands program had substantial if short-lived positive consequences. Overzealous efforts of plan fulfillment resulted in inefficiencies in

agricultural production such as ploughing up of lands which were unsuitable for cultivation, so as to overfulfill the virgin lands plan; and resistance to agronomically sound measures to conserve soil by increased fallowing and crop rotation. As for maize, it was cultivated, by order, to areas in which it could not flourish or would do so only if more fertilizer and equipment were available than actually existed (Nove, 1980).

Six months after Krushchev's ouster, Leonid Breshnev outlined a comprehensive new farm policy, stressing increased farm prices for products and massive capital investments in agriculture. Breshnev was chosen to replace Krushchev because his colleagues believed he would be a more conservative leader than Krushchev. And he was. But, his refusal to contemplate significant economic reform was accompanied by a declining growth rate during his later years of leadership (Brown, 1984).

Andropov came into power in 1982, committed to stamping out complacency and corruption, determined to impose discipline, receptive to ideas of economic reform, and conscious of the need for rejuvenation of the party and state. In 1982, the party leadership had responded to the stagnation of the agricultural sector by adopting the U.S.S.R. Food Program. Like Breshnev's policy to improve agriculture, the Food Program dealt mostly with the need to increase investment in the agricultural sector and virtually ignored the underlying structural problems. By the end of 1983, Andropov had become incapacitated.

One measure mentioned in the U.S.S.R. Food Program adopted by Andropov has seemed to hold promise for Soviet agriculture. This is

the "collective contract brigade," which ensures a close connection between earnings of personnel and final results of agricultural production. The collective contract brigade addresses two major structural problems: it motivates farm workers to exert the extra effort and attention needed to ensure efficient use of available resources; and it reduces interference from government in the details of agricultural production. This measure is seen by some Soviet leaders as the best way to achieve the goal of increased agricultural productivity.

Chernenko succeeded Andropov in 1984. His thirteen months in office were little more than an extension of the Andropov administration. His policies focused on economic problems but made no provisions for agricultural reform.

Agriculture plays an important role in Mikhail S. Gorbachev's plans to modernize and improve efficiency of the Soviet economy. Gorbachev has a history of supporting agricultural reform. As First Secretary of Stravropol Kraikom from 1970-1978, he was responsible for fulfilling agricultural quotas. He actively supported reform and authored several articles stressing the importance of "progressive experience" and use of progressive forms of organization and wages of kolkhoz members. He was later named Central Committee secretary responsible for agriculture. In 1980, he became a full member of the Politburo. Since becoming General Secretary, Gorbachev has moved very quickly to consolidate his power and to shake up the agro-industrial complex in order to improve agricultural performance, thus indicating his seriousness and commitment to reform and the agricultural sector (Gagnon, 1987).

Economic Planning

The most important fact about the Soviet economy is that the Soviet government occupies a monopoly or near monopoly position in many sectors. It effectively owns and operates virtually all of Soviet industry, mass transportation, communications, banking, foreign trade, education and social services, and much of Soviet agriculture.

The basic planning period in the U.S.S.R. is five years. The first Five-Year-Plan lasted from 1928-1932 and was initiated as one of the first acts of Stalin for collectivization. Not all Five-Year-Plans run for five years. Several terms lasted only four years when the quotas were fulfilled a year early. And at least one Five-Year-Plan was extended due to war. The overall plan is devised by the Party and is under total central control. Historically, the chief goal of Soviet planning has been to facilitate the most rapid possible growth of the Soviet State's military-economic power (Schwartz, 1968).

The first Five-Year-Plan in 1928 wrought various changes. Private trading that had developed under Lenin's New Economic Policy (NEP) was eliminated. The drive to collectivize farms was begun in 1929. In all phases of the economy, an intensification of centralization and control became the rule.

The primary purpose of the monopoly of foreign trade was that of protecting and supporting the industrialization program of the U.S.S.R. The import and export policies of the U.S.S.R. limit imports to those goods that contribute to socialist development and exports to those necessary to pay for needed imports. In early years this was

interpreted to include only imports of equipment and materials vitally needed by the U.S.S.R. More recently, however, this interpretation has been broadened to include the import of certain consumer goods needed as a part of the Soviet industrial incentive program.

The element of surprise is often the most intriguing facet in Soviet import policy. A centralized planning agency performs all purchases and sales, and all imports are determined by this branch of government. Determinants of this policy are different from capitalistic countries. Demand and supply factors have less influence on government pricing or import policies. Internal prices for nearly all goods are established by planners and do not consistently represent demand, supply, relative scarcity or actual costs. Prices serve more as an auditing tool for plan achievement than for allocative purposes in the U.S.S.R. (Jabara, 1981).

Planners may be viewed as performing two functions: allocation of resources so as to promote economic growth and the allocation of resources so as to maintain some measure of equilibrium between the supply of and requirements for individual commodities. In a market economy, decisions reflected in the volume of grain imports are made by many independent agents who seek to maximize welfare in an environment of scarce or limited resources. In a planned economy, such behavior is not initiated by individuals in response to price signals, rather such behavior reflects policy decisions made by planners. Planners, rather than prices, tend to be equilibrators of supplies and requirements. Thus, efforts to understand grain imports from planned economies rest on our ability to understand the behavior of a small number of planners.

In theory, the concept of a closed economy is used to describe an economy with no external trade and which will be completely self-sufficient and insulated from external forces. A truly closed economy is virtually nonexistent. However, the Soviet Union strives for self-sufficiency and is often considered a closed economy. Its currency, the ruble is not exchanged on world markets. Thus, the Soviets depend heavily on barter and income generated by exports of natural resources for purchase of much needed imports. The more commonly recognized export commodities of the U.S.S.R. are oil, natural gas, gold, and coal.

Soviet Agriculture

Agriculture has not kept pace with the rest of the Soviet economy. This area of the national economy has been a political sore spot for decades. Numerous officials, even including the minister of agriculture and a member of the Politburo, have lost positions because of failure of the agricultural areas to feed the country. There are numerous reasons why this is such a weak area.

Physical or geographical limitations to production are the most obvious obstacles to successful agricultural achievement. Although the U.S.S.R. is immense in size, most of the country is covered with forests, mountains, deserts and other natural barriers to production. Only 20 percent of the total land is conducive to cultivation, considerably less in comparison with the U.S. (Hetch, 1982).

Very often the areas with the richest soils have the worst climatic conditions (Moore, 1986). In regions where soil is suitable for agriculture, rainfall is undependable. When rainfall is adequate,

the crops are rich. Every few years, however, little or no rainfall occurs and crops are very poor. In the other extreme Southern areas of the Soviet Union, an arid desert is also unsuitable for agricultural purposes. The great length and severity of winters prohibit the growing of many crops for a large proportion of the Soviet Union. Since the 1950's, arable land in the U.S.S.R. has been expanded into marginal areas. Grain production, in particular, has been expanded into high risk regions. Heavy reliance on marginal lands makes weather an extremely important factor in determining grain yields (Moore, 1986).

Inadequate investment in the agricultural sector also hinders productivity. Expensive draining operations are necessary in areas where rainfall is excessive. By the same token, costly irrigation equipment is necessary in drought-prone regions. A low priority of agriculture relative to industry in most planning periods has prohibited growth in the agricultural sector.

The resistance of farmers to collectivization may also be a factor in low productivity in agriculture. Most peasants were forcefully collectivized in the late 1920's and 1930's. Stalin reportedly exploited the rural farmers by forcing them to sell their produce at prices well below production costs, while selling those goods at much higher prices. The profits extracted from the agricultural sector were used to finance the industrial and military sectors. Since then, much has been done to improve the standard of living of rural people. However, little personal involvement and/or inadequate incentives for the collective farmers has caused noticeable differences in yields (quality as well as quantity differences) on

collective farms versus private plots. The collective contract brigade, if endorsed, would help alleviate some of this problem, as it is a means of linking responsibility of the farmer to the final outcome of yield of the crop.

There are three means of agricultural production in the Soviet Union:

The collective farm (Kolkhoz): the average kolkhoz has approximately 6500 hectares of land with approximately 600 families living on it. Although the ground belongs to the State, all the property on it belongs to the members of the Kolkhoz (Hecht, 1983). The Kolkhoz contracts with the State to provide certain incentives and set quotas of a variety of commodities. If quotas are surpassed the Kolkhoz members can sell excess to the State at higher prices or sell on the open market at a considerable profit. Should production be below that promised to the State, members of the Kolkhoz will receive relatively little for their work and will undergo a period of deprivation, despite the minimum compensation law recently extended to collective farmers.

The State Farm (Sovkhoz): The State farms are usually at least three times the size of Kolkhoz and contrary to collective farms, specialize in one product. All property on Sovkhoz belongs to the State. Farmers are paid a straight salary, independent of the size of the harvest. Most of the major land reclamation drives have contributed to the formation of Sovkhoz.

Personal Plots: All members of both Kolkhoz and Sovkhoz are permitted to work a small parcel of land, usually one-half acre to one and one-quarter acres, depending on the quality of the land, for their

own private purposes. The owners of these plots may use the produce themselves, sell it to the State, or sell it on the open farmer's markets in urban centers.

It is difficult to describe agriculture without mentioning the large grain shipments from the U.S. to the U.S.S.R. in the 1970's when a new phase of Soviet grain trading policy began. This new policy sought to improve the welfare of Soviet consumers by increasing the supply of meats and animal products. Up until this time, grain imports as well as livestock inventories were dictated by crop harvests. A poor harvest meant imports of grain and livestock numbers which would have to accommodate grain shortages.

Chapter Summary

The Soviet Union encompasses a tremendous land mass and enjoys enormous wealth in natural resources. However, its agricultural sector lags in productivity. Physical limitations such as geographic, topographic and climatic conditions, as well as inadequate investment in agriculture, are in part responsible for the often unmet goals set for the Soviet agricultural sector. Increased cultivation on marginal croplands renders the Soviet Union vulnerable to extreme weather fluctuations.

Throughout most of its history, Russian politics has favored industrialization while ignoring the importance of its agricultural sector. More recently, however, policies have been incorporated to improve the well-being of the rural dwellers, such as increased incentives to collective farmers and increased investment in the agricultural sector, with positive results. Gorbachev's background

and experience in agriculture provides an interesting changeup in the

Soviet agro-industrial sector.

CHAPTER III

THEORY

Terms of Trade

International trade in the field of economics is concerned with

the causes and benefits of trade between countries. Economic theory

helps us to understand what determines trade patterns or why countries

benefit from trade. Recently, fluctuating commodity prices,

accompanied by swaying petroleum prices have revitalized the interest

in the importance of international trade and its effects on trading

partners.

The study of international trade emerged in Europe around the

16th through the 18th century in the era of mercantilist economics.

The doctrine of mercantilism had many modern features: it was highly

nationalistic, it viewed the well-being of the own nation to be of

prime importance, it favored the regulation and planning of economic

activity as an efficient means of fostering the goals of the nation,

and it generally viewed foreign trade with suspicion (Soderston,

1970). It was felt that each nation's self-interest was served best

by encouraging its exports and discouraging its imports.

Adam Smith emphasized the importance of free trade in increasing

the wealth of all trading nations. He simplified his point by

comparing nations to households. Since every household finds it

worthwhile to produce only some of its needs and buy others with the products it can sell, the same should apply to nations. His theory of absolute advantage was a powerful argument for trade. However, profitable international trade does not necessarily require an exporter to have an absolute advantage.

David Ricardo strengthened the case for trade by introducing the concept of comparative advantage. A country need not have an absolute advantage in all or any goods to participate in and benefit from trade. The concept of comparative advantage suggests that trade will be beneficial as long as the country specializes in the activity where its absolute disadvantage is least pronounced or where it is "least worst". Ricardo showed that the gains from trade will accrue to both countries even if one has no absolute advantage whatsoever. As long as the price ratios differ between countries in the absence of trade, every country will find some good which it can produce at a lower relative cost disadvantage than other goods. His emphasis on comparative costs reflects a more refined but sometimes less obvious concept of specialization.

Yet, while Ricardo showed which goods should be exported and imported he failed to answer the question: on what terms goods will be traded. John Stuart Mills is credited with how terms of trade are determined, part of which can be inferred from Ricardo's theorem. Mill's contribution was determining imports and exports, not in terms of cost differences in the production of a given output, but in terms of different output produced at a given cost. The basis for trade exists in the differences in comparative costs. One country may be more efficient than another, as measured by factor inputs per unit of

output, in the production of every possible commodity but so long as it is not equally more efficient in every commodity a basis for trade exists. The law of comparative advantage says that it will pay the country to produce more of those goods in which it is relatively more efficient and to export them in return for goods in which its relative advantage is least.

Any review of terms of trade would be incomplete without mentioning the argument of Raul Prebisch that LDC's face a long term secular decline in their terms of trade. The primary argument is that international trade has been more beneficial for developed countries than for LDC's. This argument is based on the reasoning that prices received by non-oil producing LDC's for their exports of primary goods over the last several decades have been declining, while their import prices have been increasing. Therefore, the developing countries terms of trade have deteriorated with the result that real incomes in these countries have not increased, and their capacity to import has remained low.

The traditional technique for determining the trade-equilibrium price ratio is by the intersection of the Marshallian offer curves of two countries. The offer curve can be derived by two methods, the locus of excess supplies and excess demands for commodities that are generated at different commodity price ratios, or through the derivation of the production possibilities curve and the domestic price ratio.

In a two-country, two-commodity model, before trade starts, one distinct domestic price ratio exists for each of the two countries. These pre-trade price ratios are determined by labor requirements in

the production of each of the two commodities. The production function represents various technical production possibilities available to a country and shows the maximum output in physical terms for each level of the inputs in physical terms (Figure 6). Using the concept of a product transformation curve or production possibilities curve the production function can be represented in two-dimensional space. A product transformation curve can be defined as the locus of output combinations that can be obtained from a given amount of a variable factor (Figure 7). Price ratios or domestic cost ratios can then be determined by the slope of the production possibilities curve. Each line exactly equals the slope of the production possibilities curve corresponding to that country (Figure 8). At different price ratios the offer curves can be established. Each point represents the amount of X1 offered at various prices for a given amount of X2. With the opening up of trade relations, these two different price ratios will be replaced by a single ratio. This international price ratio is generally referred to as the terms of trade.

The terms of trade are determined at the point of intersection of the two offer curves (Figure 9). The shape of the offer curves is determined by both supply and demand conditions in the respective countries. The limits within which they will fall are given by the autarkic terms of trade in the two countries. With improving terms of trade, a country is willing to offer more and more of its exports for imports. Shifts in the offer curve result in changes in the terms of trade. For example, if the U.S. terms of trade were to improve via a shift in the offer curve from U.S. to U.S.' the new terms of trade line would be OB (Figure 10). Originally, the U.S. would be able to
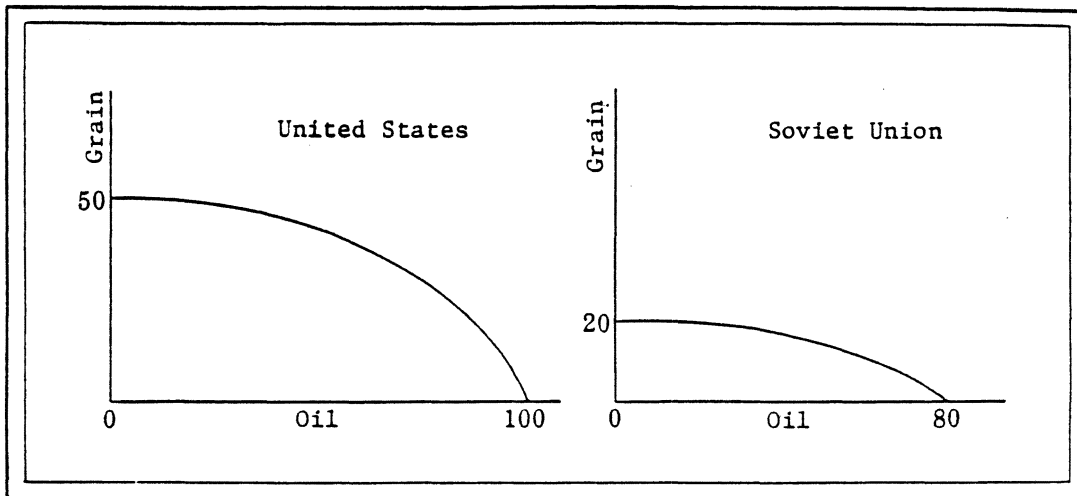
Figure 6. Production-Possibilities Curves (Increasing Cost)
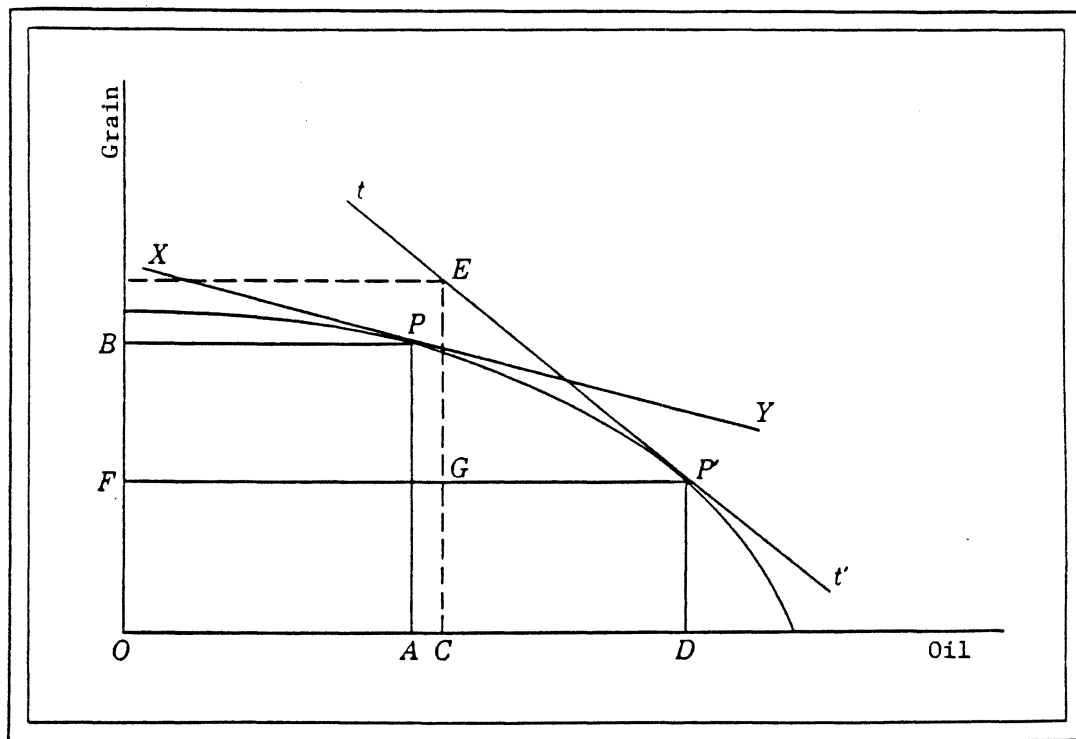
Figure 7. Possible Gains from Trade (Soviet Union)
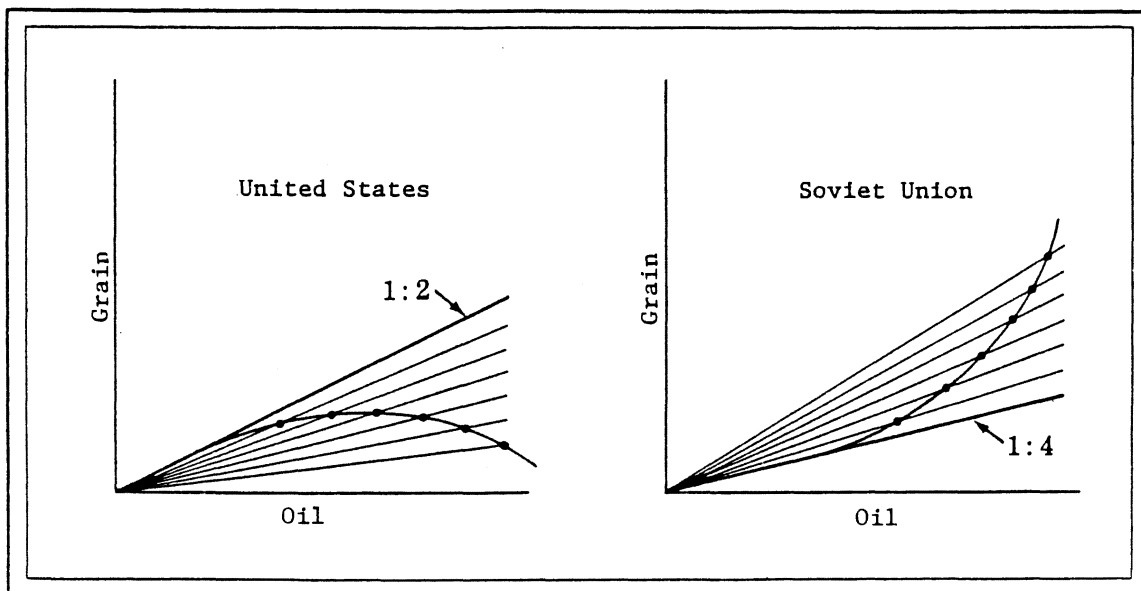
Figure 8. Offer Curves of the United States and the Soviet Union
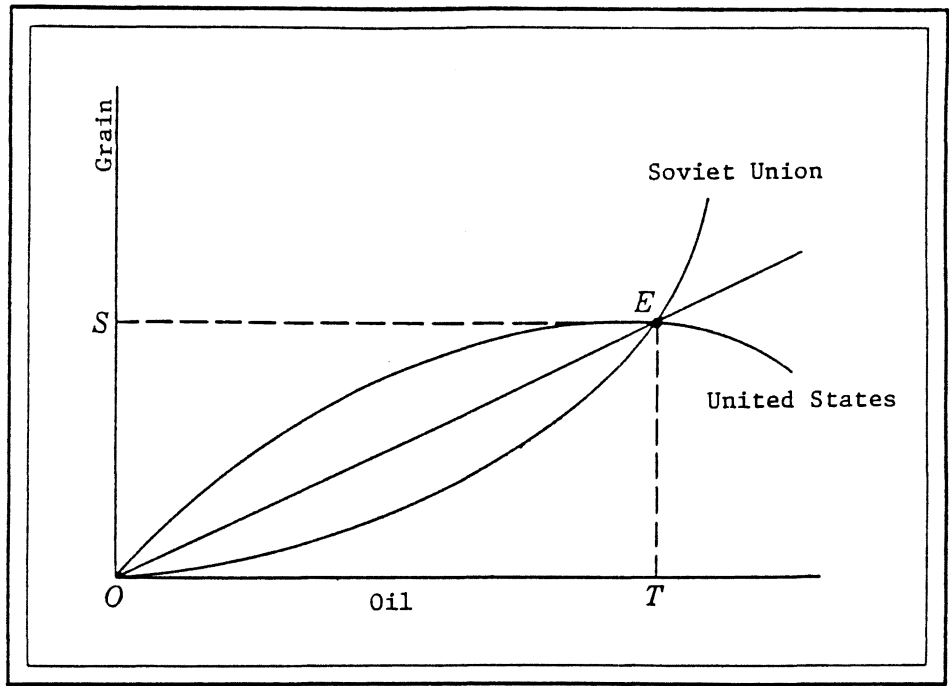
Figure 9. Determination of the Terms of Trade

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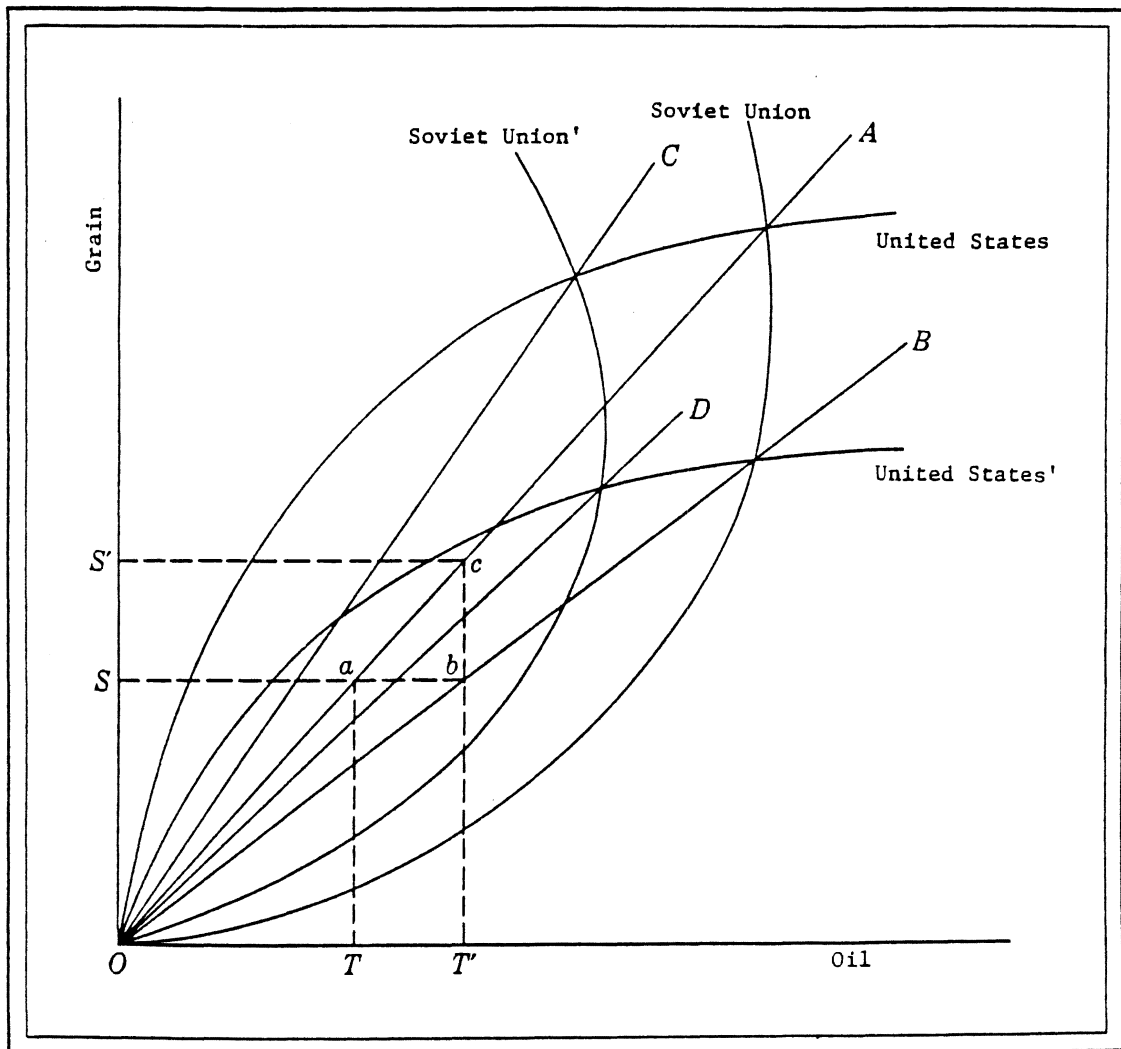
Figure 10. Changes in the Terms of Trade

buy T amount of oil for S amount of wheat, while at the new terms of trade line the same amount of wheat (S) would purchase T' amount of oil.

The causes behind such shifts in the offer curve are the forces that determine quantities offered and demanded by each country at different price levels. Those conditions which effect demand and supply are the primary motivators for these shifts in the offer curve. Aside from changes in demand and supply, the willingness of a country to export also impacts the terms of trade. The terms of trade, however, are not solely under a country's own control. Other things that might affect terms of trade are global patterns of demand, the market power of producers, and policy decision of other countries, i.e. tariffs or quotas.

Some of the problems associated with trying to measure welfare through the use of terms of trade are that terms of trade merely record changes in relative prices of exports and imports. Terms of trade reflect nothing about the reasons behind such changes, such as quality of imports, the state of a country's balance of payments, or transportation costs.

Implications for the Soviet Union

Because of its monopolistic structure in foreign trade, the Soviet Union is often perceived as having a superior bargaining position in an otherwise competitive world grain market. The secrecy surrounding Soviet buying intentions allows it to split major purchases among several sellers in such a way as to keep the price of grain from rising until its purchases have been consummated. This,

combined with high oil prices has improved the terms of trade for the Soviet Union, enabling them to increase grain purchases.

In Batra's model (1976), Soviet planners conduct domestic production and international trade such that they maximize a planner's preference function: $U = U(X,G)$ where X is the composite export and G is grain subject to domestic production possibilities and trade. If both the Soviet Union and the U.S. exercise some market power, then we have the situation shown in Figure 11 where OC_s represents the Soviet offer curve and OC_u represents the offer curve of the U.S. If neither country tries to exploit its market power, trade will occur at point F, with the US exporting OG_f of grain and importing OX_f of Soviet export good. Prices of the two goods in trade are given by the slope of the line TT_f. Soviet traders could increase their gains from trade at the expense of the U.S. by offering to exchange OX_t of X for OG_t of grain and thus trading at point T. By doing so they would move to trade indifference curve U1, the highest attainable indifference curve given the U.S offer curve of OC_u.

Wolf (1978) has criticized the Batra model as requiring assumptions that are not necessarily consistent with the reality of Soviet planning and foreign trade decision making. Specifically, Wolf raises two objections. First, since Soviet production is planned there is unlikely to be any significant response either in annual plans or Five-year plans to changes in terms of trade. Second, Wolf disputes Batra's formulation of the planner's welfare function. In Wolf's view, planners are unlikely to substitute more of one good for less of another once production and consumption targets are set (Figure 12).
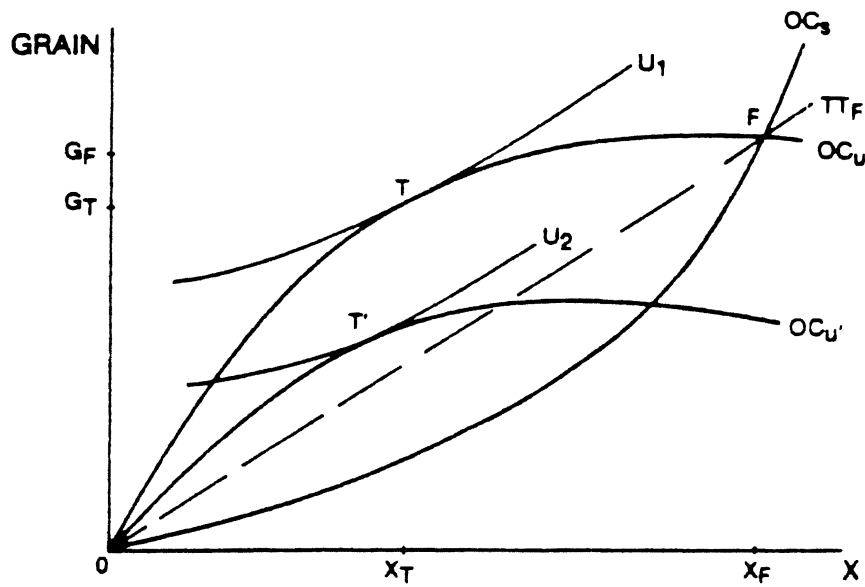
Figure 11. Soviet and American Offer Curves if
            the Soviets Follow Optimal Trade
            Policies
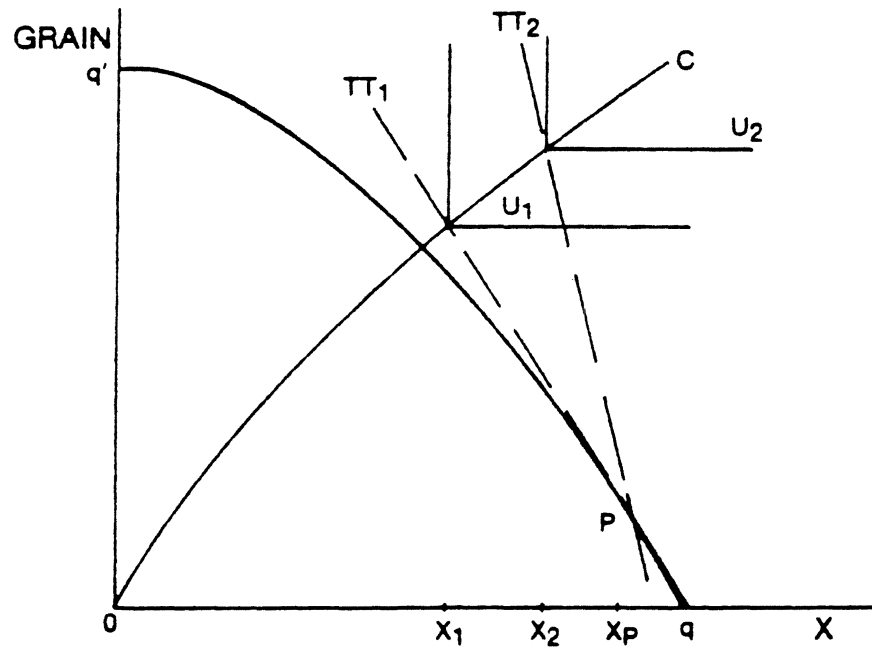
Figure 12. Soviet Production, Consumption, and Trade
with Inflexible Production and
Consumption Plans

Wyzan (1981) employed production function analysis to examine a number of pivotal issues concerning the Soviet agricultural sector. Estimates of production functions for five Soviet agricultural commodities were presented. In general, his findings were supportive of the appropriateness of Soviet decisions; large farms seem to be more efficient, land-labor substitution is possible, and the outlook for output growth of most crops is good. He concludes that the technology of production does not account for the dismal performance of Soviet agriculture, and that weather alone may be the single most important explanation for variations in crop production.

Desai (1982) estimated Soviet import demand for the years 1981-1985 by using three different methodologies. First, he predicted wheat imports during 1981-85 as the difference between total supplies and requirements with the major components of the two categories estimated from simple regressions. Secondly, he modified his first methodology of forecasting grain output by fitting a Cobb-Douglas production function with constant returns to scale to alternative data sets, instead of from past trends. Thirdly, he predicted grain imports using an import demand function where explanatory variables were domestic production of grain, meat production, livestock inventories, a time trend, and from 1971 a dummy variable representative of policy decision to import grain to keep inventories of livestock steady. Among his major conclusions are: The USSR will import up to 32 million tons of grain in below average years, with wheat imports constituting 14 million tons. And, Soviet planners would be able to meet the foreign exchange costs of these imports.

Figure 13 illustrates the use of Soviet welfare criteria for choosing between Soviet grain production and Soviet imports of grain. L-shaped isosocial welfare curves assume that Soviet grain imports and Soviet grain production are perfect substitutes. The production possibility curve is represented by line AB. This line represents the quantities of domestic grain and imports of grain available given available resources. Point A represents the amount of domestic production that would be available if all resources were put into domestic production and imports were zero. This point would be a function of all physical constraints such as land availability, water resources, weather conditions and input availability. Point B represents the amount of grain that would be imported if domestic production were zero. This point would be a function of financial limitations such as the price of wheat, the prices of Soviet export commodities, credit availability and transportation costs.

If originally the Soviets were producing Q amounts of domestic grain and purchasing M amounts of imports, and if the terms of trade shifted in favor of the Soviets (for example the price of wheat declined or the price of petroleum increased) then the production possibilities curve would rotate from AB to AB_1. This shift would move Soviets to a higher isosocial welfare curve, from U to U_1. Assuming the rotation was due to an increase in the price of petroleum, exchange earnings would increase, allowing Soviets to purchase more imports, from M to M_1 and also purchase more grain domestically from Q to Q_1.

However, if the price of oil declined we would expect the changes to occur in the opposite direction. The production possibilities
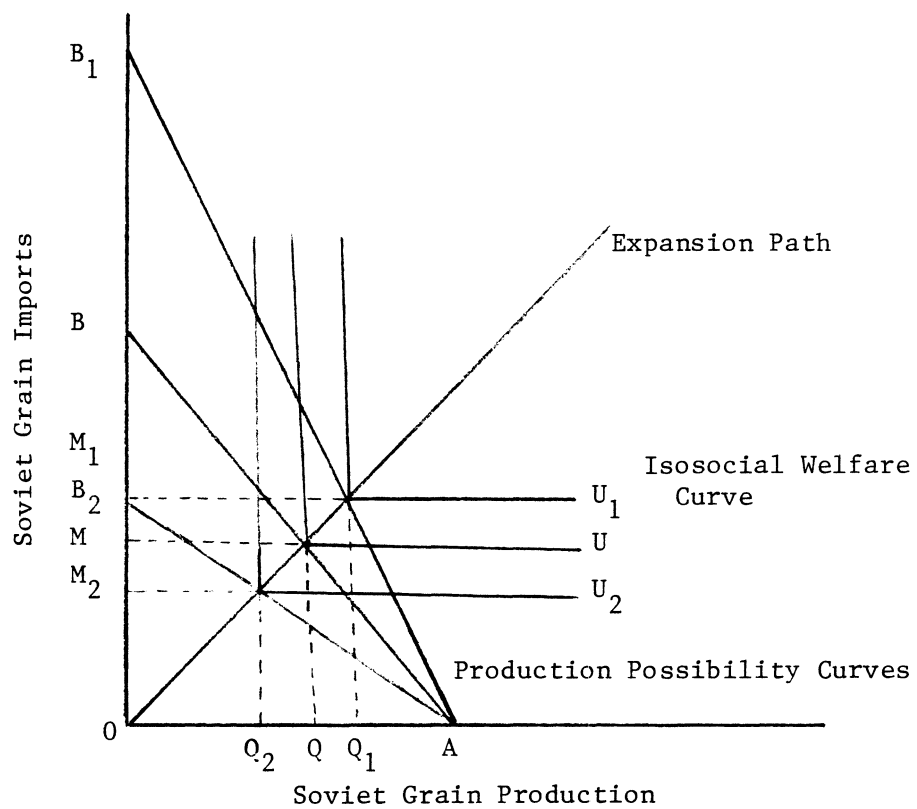
Figure 13. Social Welfare Criteria of Soviet Economy

curve would rotate from AB to AB_2, and Soviets would be forced to a lower isosocial welfare curve, U_2. Imports would be expected to decline from B to B_2 and Soviet grain production would decline from Q to Q_2.

The Soviet Union is a special case in that it extracts benefits from the collusion tactics of the OPEC cartel. The cartel is a group of potentially competitive firms that coordinates its output and pricing decisions to reduce industry output below competitive levels and to raise prices and profits. The U.S.S.R. benefits from the efforts of the cartel by selling at the high price.

In a free market economy, price is established through the forces of demand and supply, where many independent agents seek to maximize utility in the face of insatiable wants and limited resources. In a planned economy, planners rather than prices tend to be equilibrators of supplies and requirements. Planners seek to maximize social welfare, establish their own prices for goods and services, and determine what and how much is needed by the country. The question is what criteria is used to determine prices and quantities? Could the price of exports, the price of imports, or terms of trade be good indicators of what and how much is imported to the Soviet Union?

Chapter Summary

The study of international trade emerged in Europe around the sixteenth through the eighteenth century in the era of mercantilism. The importance of free trade was emphasized with the case strengthening through the concept of comparative advantage. Terms of

trade play an important and possibly increasing role in the determination of trade patterns.

Because of its monopolistic structure in foreign trade, the Soviet Union is often perceived as having a superior bargaining position in an otherwise competitive grain market. In a free market economy price is established through the forces of demand and supply. In contrast, the planners of Centrally Planned Economies tend to be equilibrators of supplies and requirements.

CHAPTER IV

ANALYSIS

Data Requirements and Description

Several potential variables were chosen to explain Soviet grain imports. These variables were ascertained through economic relevance and statistically tested for explanatory power of Soviet grain imports. Among these variables were Soviet grain production, Soviet livestock inventories, price series for petroleum, gold, coal and natural gas, Soviet population, and a dummy variable to account for Soviet policies concerning grain imports. Annual time series data were gathered for the 1960-1986 period.

Soviet production data were acquired from U.S.S.R. Grain Policies and Data, by Emily Moore, International Economics Division, Economic Research Service, 1986. Annual Soviet grain production for all grain is reported in million tons for the years 1960-1985. From 1955 to 1975 substantial information was published on Soviet grain production, areas and yields. However, in 1976 the Soviets largely stopped releasing such information. After 1980, data on grain production at the national level were no longer published (Moore, 1986). Therefore, actual production data are documented through 1980, while 1981-1985 are USDA estimations, based on analysis. Soviet grain production data were gathered for wheat, barley, rye, oats and corn.

The Soviet definition of grain is in terms of bunker weight. Therefore, it can include excess moisture, pieces of straw, weeds and other forms of dockage. Grains include wheat, rye, oats, barley, corn, millet, grain sorghum, rice, buckwheat and pulses.

Annual Soviet livestock inventories are reported in thousands of head. This information came from various issues of the Soviet Trade Yearbook and was generously provided by the Eastern Europe and Soviet Branch of the Economic Research Service. Included in the livestock data are cattle, cows, hogs, poultry and sheep.

The price of gold is quoted at London in dollars per fine ounce, 99.5 percent fine, average daily rates. These data were obtained from the American Bureau of Metal Statistics, Samuel Montagy Company, Ltd. Petroleum prices are reported in dollars per barrel for Saudi Arabian light crude petroleum, 34-39 degrees gravity, average official f.o.b. Ras Tanuna. These data were obtained from International Financial Statistics for petroleum. Coal prices for anthracite and bituminous coal were obtained from various issues of the Commodity Yearbooks. These were quoted in U.S. domestic dollars per ton. Gold and petroleum prices are plotted in Figure 14.

Annual Soviet grain imports are reported in millions of tons. Included in total Soviet grain imports are wheat, corn, barley, rye, and oats. Total Soviet imports, wheat imports and coarse grain imports were treated as separate dependent variables. Total Soviet imports in million tons and petroleum prices were plotted together in Figure 15 to demonstrate their correlation.

A dummy variable was created to reflect emotionalism in the grain market created by sporadic Soviet grain purchases. This variable was

X7

900 +

800 +

700 +

600 +

500 +

Dollars

400 +

300 +

200 +

100 +

0 +

1960 1962 1964 1966 1968 1970 1972 1974 1976 1978 1980 1982 1984 1986

Year
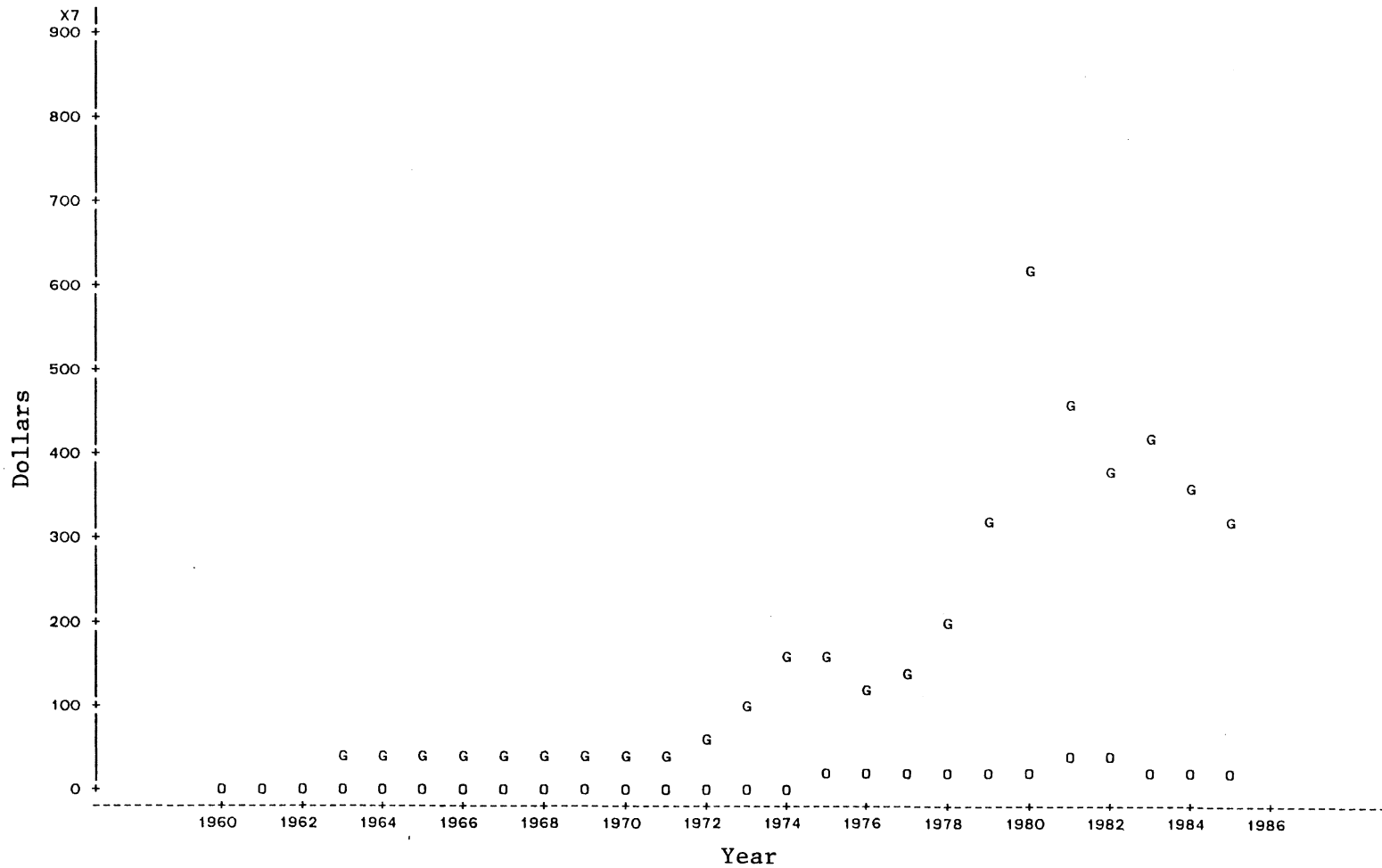
Legend: G = Gold Prices
        O = Petroleum Prices

Figure 14. Average Annual Gold and Petroleum Prices, 1960-1985

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```
Y1 |
45 +                                                                    M
                                                                   M
40 +                                                                 M
                                                               0   0   M
35 +
                                                          M
                                                          0      0
30 +                                                                  0   0
                                                     M
25 +                                 M              M
                                              M
20 +                              M
                                                0
                                          M
15 +           M            M       0   0
                                    0   0
                                0   M
10 +                    M       0
              M       M         M
5 +                    M
        0        M   0
        0 M 0 0 0 0 0 0 M 0 0
      M         M        M 0
0 +
   ----+-------+-------+-------+-------+-------+-------+-------+-------+-------+-------+-------+-------+-------+----------
     1960    1962    1964    1966    1968    1970    1972    1974    1976    1978    1980    1982    1984    1986
                                                   Year
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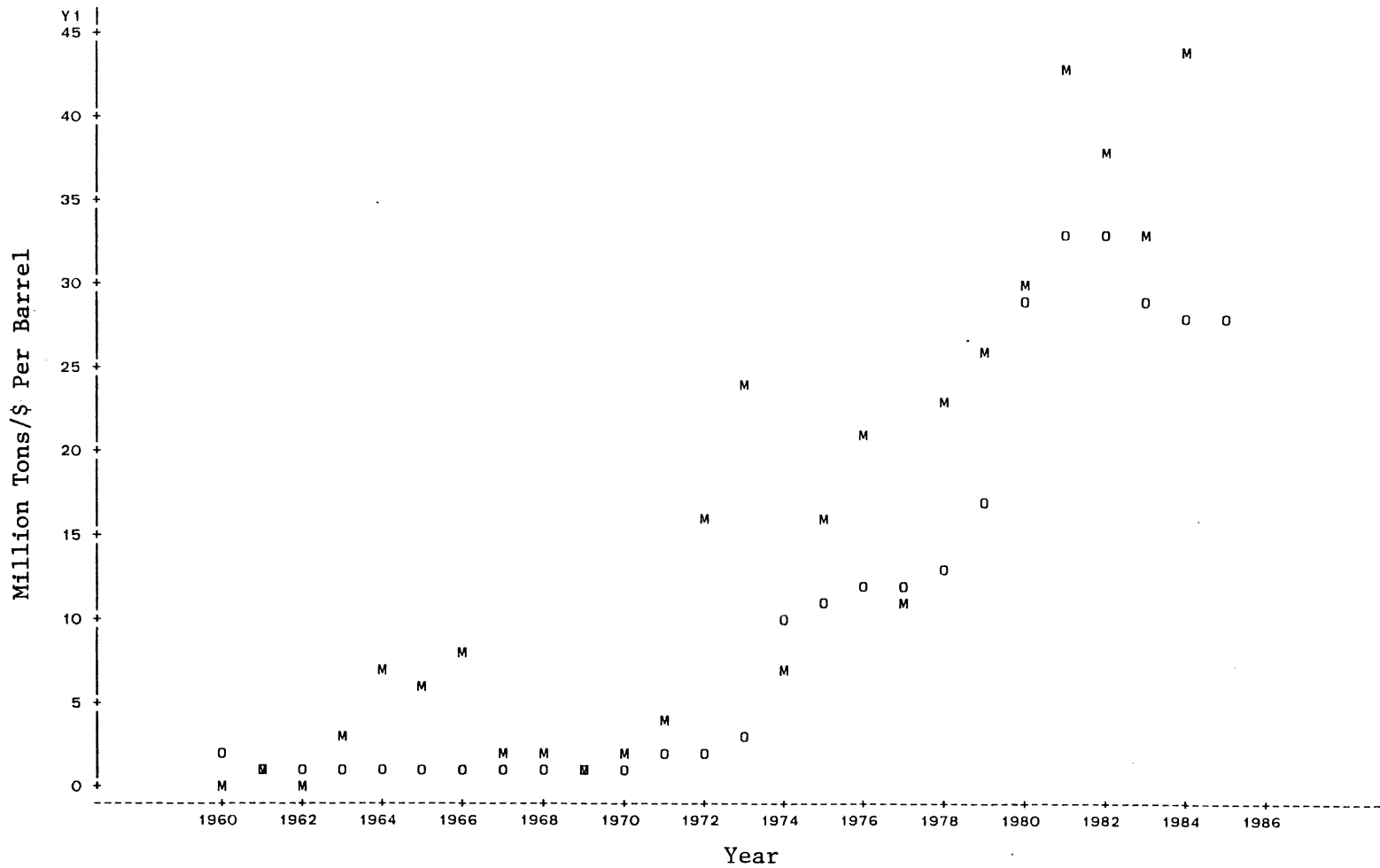
Legend: M = Total Soviet Grain Imports
          O = Petroleum Prices

Figure 15.   Annual Soviet Grain Imports and Petroleum Prices, 1960-1985

Million Tons/$ Per Barrel

designated by a one in the year 1973 and all other years contained a zero. Before the change in Soviet import policy had become apparent, the Soviets were able to purchase what amounted to about one-quarter of the U.S. wheat crop in 1972. Because of western ignorance of Soviet buying intentions and competition among western sellers to dispose of surplus grain, the Soviets were able to purchase grain at favorable prices. The U.S. extended a 750 million Commodity Credit Loan to the U.S.S.R. and USDA subsidized exports so as to maintain a low selling price. This led to much criticism of the government's handling of grain sales and to efforts to prevent its repetition by requiring grain exporters to report sales to a single destination in excess of 100,000 tons per day or 200,000 tons per week to any single destination. The American public and the U.S. government appeared to be concerned that the events of 1972 might be repeated and this emotionalism spilled into the grain market. The dummy variable used in this model is therefore representative of the outlying circumstances surrounding Soviet purchases and market emotionalism in the world grain market for this unusual year.

The accuracy of any research depends on the reliability of the data used. Much of the data in this research was supplied by ERS and parts are estimations by the USDA. Credibility for information from Soviet Trade Yearbooks is difficult to establish, however it is the best available, as many of their records are becoming less available.

A summarization of the information for all dependent and independent variables is presented in Table 1. The first column reports each variable used. The following column reports the units. The next column reports the standard deviation and the final

TABLE I

MEAN, STANDARD DEVIATION, AND RANGE
FOR ALL VARIABLES, 1960–1986

Variable	Units	Mean	Standard Deviation	Minimum	Maximum
X_1 (Total Grain Production)	million ton	170.69	32.14	107.50	237.46
X_2 (Soviet Wheat Production)	million ton	83.86	16.25	49.70	120.96
X_3 (Soviet Barley Production)	million ton	37.84	14.71	13.30	69.50
X_4 (Soviet Rye Production)	million ton	12.79	2.55	8.10	17.00
X_5 (Soviet Oat Production)	million ton	13.19	4.28	3.90	18.60
X_6 (Soviet Corn Production)	million ton	10.82	2.53	7.30	17.10
X_7 (Price of Gold)	$/fine oz.	180.12	172.08	35.00	618.00
X_8 (Price of Oil)	$/barrel	10.62	11.85	1.28	33.47
X_9 (Population)	thousands	245528.67	17201.26	214400.00	272308.00
X_{10} (Soviet Cattle Inventory)	thousands	102.37	13.95	74.20	121.00
X_{11} (Soviet Cow Inventory)	thousands	40.80	2.70	33.90	43.90
X_{12} (Soviet Hog Inventory)	thousands	65.20	10.19	40.90	78.70
X_{13} (Soviet Sheep Inventory)	thousands	138.84	4.87	125.20	145.30
X_{14} (Soviet Poultry Inventory)	thousands	750.04	240.68	449.10	1160.00
X_{15} (Price of Anthracite Coal)	$/ton	33.85	24.84	12.82	82.54
X_{16} (Price of Bituminus Coal)	$/ton	13.39	8.90	4.75	28.32
Y_1 (Total Soviet Grain Iports)	million ton	14.62	14.28	0.00	44.00
Y_2 (Soviet Wheat Imports)	million ton	8.15	7.78	0.00	28.20
Y_3 (Soviet Coarse Grain Imports)	million ton	6.48	7.44	0.00	25.60

two columns report the minimum and maximum values over the time period analyzed.

Correlation between Independent Variables

Another consideration when selecting variables for inclusion in the model is the presence of correlation between certain independent variables. Correlation between variables exists anytime one of the variables is functionally related to the other or jointly related to a same third variable. Perfect correlation exists if unit changes in one variable result in constant proportional changes in the other.

The correlation matrix (Table II) shows the coefficients of correlation for all pairs of dependent and independent variables. Perfect correlation exists if unit changes in one variable result in constant proportional changes in the other.

Those variables which showed a high correlation are gold and petroleum prices with a coefficient of correlation of 0.94. Interestingly, many variables showed a high correlation to petroleum prices: prices of coal 0.97 and 0.92, Soviet grain imports 0.911, wheat import 0.84, and coarse grain imports 0.867. Petroleum had very low correlation to crop production.

Countless equations were estimated testing the statistical significance of all variables to Soviet grain imports. The objective was to ascertain the equation which had the highest explanatory power with statistically significant, correctly signed explanatory variables. The criteria used for eliminating certain variables from the model were R^2 values and observed significance levels of the

TABLE II

CORRELATION MATRIX

	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}	X_{13}	X_{14}	X_{15}	X_{16}	Y_1	Y_2	Y_3
X_1	1.000	0.890	0.911	-0.227	0.831	-0.057	0.242	0.335	0.679	0.662	0.608	0.277	0.377	0.475	0.385	0.538	0.418	0.322	0.466
X_2		1.000	0.664	-0.263	0.656	-0.227	0.063	0.104	0.514	0.444	0.436	0.102	0.126	0.224	0.145	0.330	0.229	0.129	0.304
X_3			1.000	-0.345	0.842	-0.114	0.381	0.486	0.803	0.797	0.722	0.421	0.559	0.623	0.564	0.713	0.558	0.446	0.604
X_4				1.000	-0.369	0.447	0.207	-0.225	-0.556	-0.501	-0.509	-0.302	-0.437	-0.316	-0.285	-0.427	-0.354	-0.253	-0.416
X_5					1.000	-0.156	0.485	0.561	0.795	0.792	0.695	0.481	0.589	0.704	0.613	0.714	0.578	0.459	0.628
X_6						1.000	0.111	0.032	-0.293	-0.214	-0.285	-0.009	0.045	0.016	-0.047	-0.181	-0.070	0.033	-0.168
X_7							1.000	0.943	0.827	0.811	0.813	0.689	0.602	0.881	0.883	0.859	0.851	0.761	0.819
X_8								1.000	0.828	0.811	0.735	0.705	0.638	0.749	0.978	0.925	0.911	0.841	0.867
X_9									1.000	0.986	0.928	0.649	0.658	0.921	0.875	0.932	0.849	0.765	0.824
X_{10}										1.000	0.950	0.721	0.709	0.901	0.839	0.896	0.824	0.734	0.813
X_{11}											1.000	0.557	0.617	0.780	0.752	0.779	0.729	0.661	0.708
X_{12}												1.000	0.673	0.833	0.688	0.718	0.692	0.634	0.663
X_{13}													1.000	0.719	0.664	0.705	0.593	0.477	0.639
X_{14}														1.000	0.963	0.978	0.918	0.8473	0.879
X_{15}															1.000	0.965	0.918	0.855	0.866
X_{16}																1.000	0.890	0.784	0.881
Y_1																	1.000	0.940	0.935
Y_2																		1.000	0.757
Y_3																			1.000

coefficients in question. The best model attained used petroleum prices and a dummy variable as independent variables.

Statistical Results

Three equations were estimated to explain Soviet grain imports. These equations were used to incorporate three dependent variables, annual Soviet imports of all grain, annual Soviet imports of wheat, and annual Soviet imports of coarse grains. In all three equations, the same independent variable, the price of petroleum and the dummy variable were used. The explanatory power of these variables was significant enough to render them solely in an estimation of Soviet grain imports. Therefore, the equations used in the statistical analysis were:

$$Y_1 = a + bX_8 + cD_1 \qquad (1)$$

where Y_1 = Annual Soviet imports of all grains, X_8 = Price of petroleum, and D_1 represents import policy change.

$$Y_2 = a + bX_8 + cD_1 \qquad (2)$$

where Y_2 = Soviet wheat imports and

$$Y_3 = a + bX_8 + cD_1 \qquad (3)$$

where Y_3 = Soviet coarse grain imports.

Results of Estimated Equation (1)

The results of the ordinary least-square regression estimation of Equation (1) for the specified variables are reported in Table III.

The estimated coefficient for the price of oil on total Soviet imports is 1.17. The sign is positive and consistent with economic theory. This coefficient has a t-value of 13.61 and is significant at the .001 probability level. The estimated coefficient for the dummy variable is 18.45 and has a t-value of 3.72 and is significant at the .001 probability level. The calculated F-value for Equation (1) is 94.59 and is significant at the .001 probability level. The coefficient of determination (R^2) value is .896. This indicates that the estimated Equation (1) accounts for 89.6 percent of Soviet grain import variation over the analyzed time period. The Durbin-Watson D-value for autocorrelation for 25 observations in Equation (1) was 2.093 which indicates that at the .01 significance level no evidence of autocorrelation existed. The actual Soviet grain imports were plotted with the predicted values for the estimated Equation (1) in Figure 16. Predicted imports appear to follow the trend of actual imports for the analyzed time period.

Results of Estimated Equation (2)

The results of the ordinary least square regression estimation of Equation (2) for the specified variables are reported in Table IV. The estimated coefficient for the price of oil on Soviet wheat imports is .59, has a t-value of 9.12 which is significant at the .001 probability level. The sign is positive and consistent with economic theory. The parameter estimate for the dummy variable is 11.81, the t-value is 3.14 and is significant at the .005 probability level. The calculated F-value for Equation (2) is 43.53 and is significant at the .001 probability level. The R^2 value is .789. Actual Soviet wheat

TABLE III

STATISTICAL RESULTS OF SPECIFIED VARIABLES
REGRESSED ON Y_1, TOTAL SOVIET
GRAIN IMPORTS (EQUATION 1)

Equation (1)	$Y_1 = f(X_8, D_1)$
Estimated Equation	$Y_1 = 2.290 + 1.169X_8 + 18.453D_1$
(t-values)	(2.739) (13.613) (3.724)
Probability > t	0.096 0.001 0.012

Selected Model Results

---

n	= 25
F-value	= 94.590
Probability > F	= 0.001
R^2	= 0.896
Adjusted R^2	= 0.886
Durbin/Watson	= 2.093
First Order Autocorrelation	= -0.131

Soviet Grain Import Quantity

45 +

40 +

35 +

30 +

25 +

20 +

15 +

10 +

5 +

0 +

```
                                                                        A
                                                              A
                                                                   P
                                                              P
                                                                   A
                                                                        P
                                                         P              P    P
                                                         A
                                                    A
                                             R
                                        A
                                   A         A    P
                         A              A  P
                                        P   P   P
                         P                  A
                              A
                A                      A
           A
P  P  P  P  P  P  P  P  P  P  R    P
      A
      A   A      A    A
   A     A          A
```

1960   1962   1964   1966   1968   1970   1972   1974   1976   1978   1980   1982   1984   1986

Year
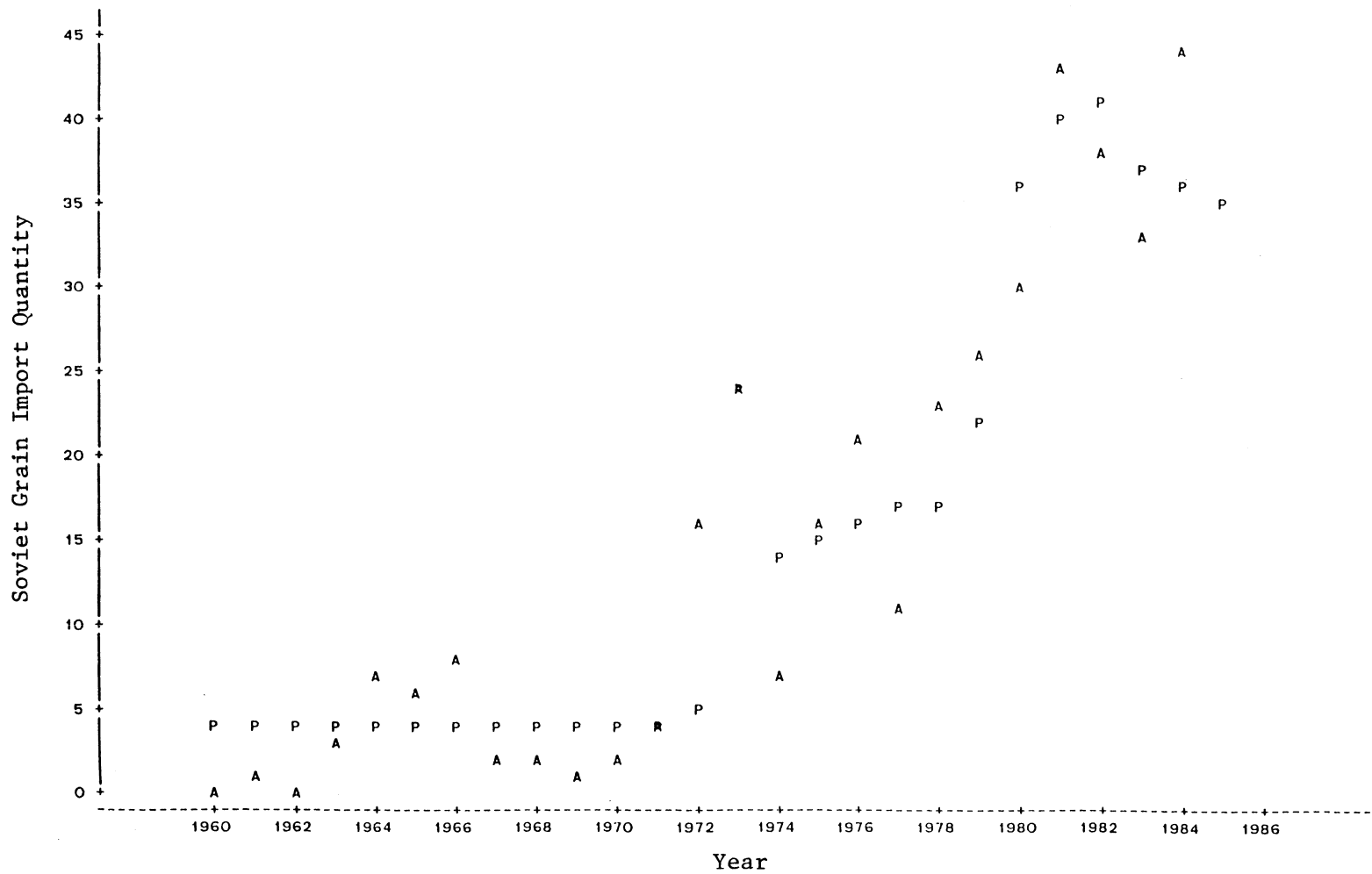
Legend: A = Actual Values
          P = Predicted Values

Figure 16.   Actual Soviet Grain Imports and Predicted Soviet Grain Imports, 1960-1985

imports were plotted with the predicted values for Soviet wheat
imports for the estimated Equation (2) in Figure 17. Predicted values
for wheat seem to follow the same pattern as for total grain imports.
Actual values seem more varied. The Durbin-Watson calculated D-value
is .920 for 25 observations in Equation (2). This indicates that the
error terms were positively autocorrelated. Because autocorrelation
was apparent in the estimated Equation (2), corrective measures were
taken and a new equation (Equation 2a) was estimated.

Results of Estimated Equation (2a)

The results of the estimation of Equation (2a) corrected using
generalized least squares for positive autocorrelation are reported in
Table V. The parameter estimate for the price of petroleum is .60,
has a t-value of 6.752 and is significant at the .001 probability
level. The parameter estimate for the dummy variable is 11.70, has a
t-value of 3.66 and is significant at the .002 probability level. The
total R^2 value is .84. Actual Soviet wheat imports were plotted
with predicted values for Soviet wheat imports for the estimated
Equation (2a) which was corrected for autocorrelation (Figure 18).
Predicted values appear to be closer to actual value than in the
estimated Equation (2).

Results of Estimated Equation (3)

Table VI reports the results of the estimated Equation (3), where
petroleum prices and a dummy variable were regressed on Y_3 - Soviet
coarse grain imports. The estimated parameter for the price of
petroleum is .57, has a t-value of 8.90 and is significant at the .001

TABLE IV

STATISTICAL RESULTS OF SPECIFIED VARIABLES
REGRESSED ON Y_2, SOVIET WHEAT
IMPORTS (EQUATION 2)

Equation (2)	$Y_2 = f(X_8, D_1)$
Estimated Equation	$Y_2 = 1.787 + 0.593X_8 + 11.809D_1$
(t-values)	(1.790) (9.120) (3.144)
Probability $>$ t	1.0872 0.001 0.005

Selected Model Results

n	= 25
F-value	= 43.529
Probability $>$ F	= 0.001
R^2	= 0.798
Adjusted R^2	= 0.780
Durbin/Watson	= 0.920
First Order Autocorrelation	= 0.374

Soviet Wheat Imports

```
      |
27.5 +                                                                    A
      |
25.0 +
      |
22.5 +                                                              A
      |                                                        P
20.0 +                                                     P  A
      |                                              P           P
17.5 +                                                    A           P      P
      |
15.0 +                    R                           A
      |
12.5 +                                        ,  P
      |
10.0 +                              A     P  P  A
      |                          P  P     A
 7.5 +        A     A         A        P      A
      |           A                       A
 5.0 +
      |                                                                        .
 2.5 +     P  P  P  P  P  P  P  P  P  P  P R     P                    A
      |              A     A     A
      |           A           A
 0.0 +     A     A              A
      +----+-------+-------+-------+-------+-------+-------+-------+-------+-------+-------+-------+-------+-------+------
        1960   1962    1964    1966    1968    1970    1972    1974    1976    1978    1980    1982    1984    1986
```
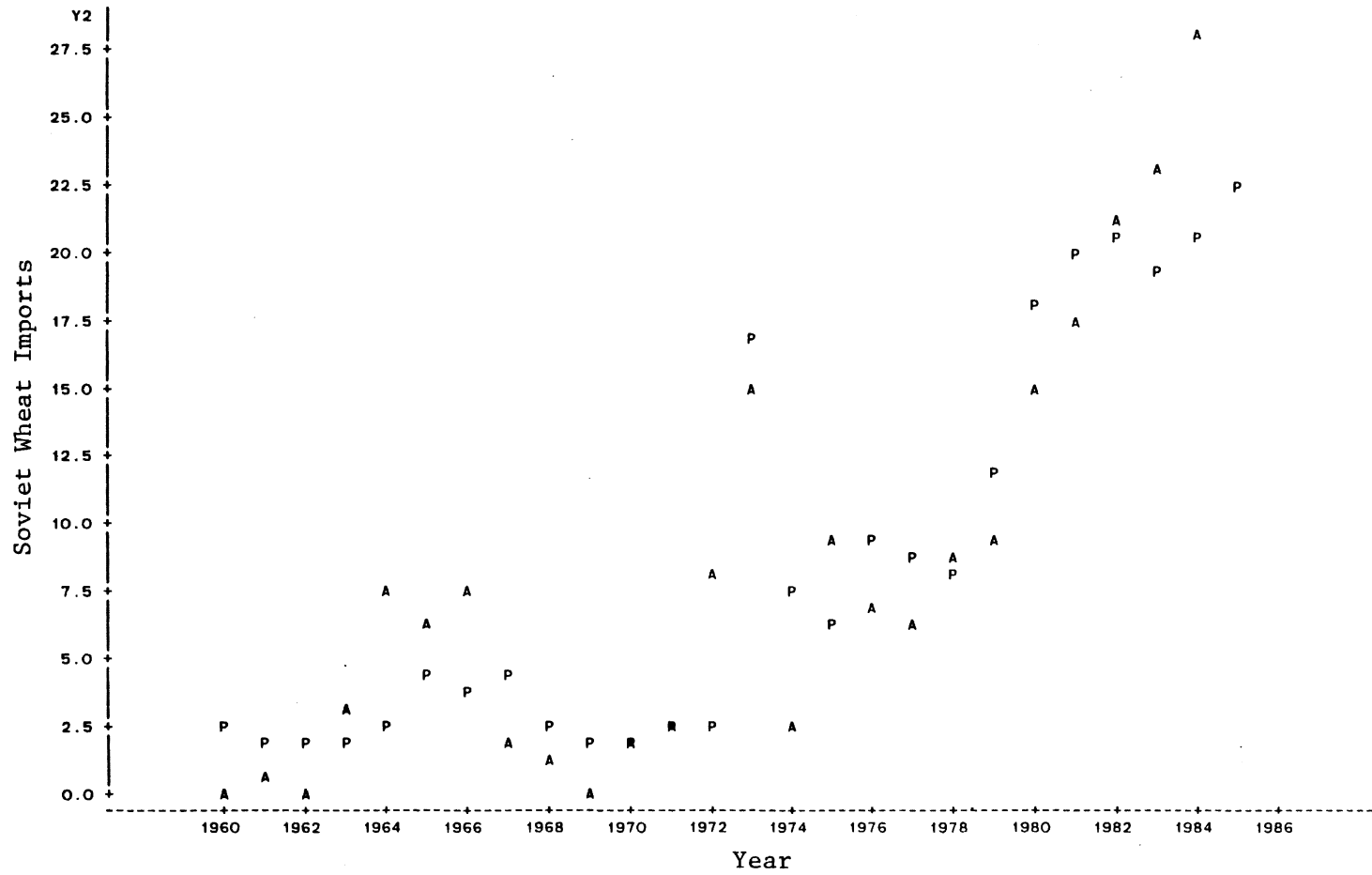
Year
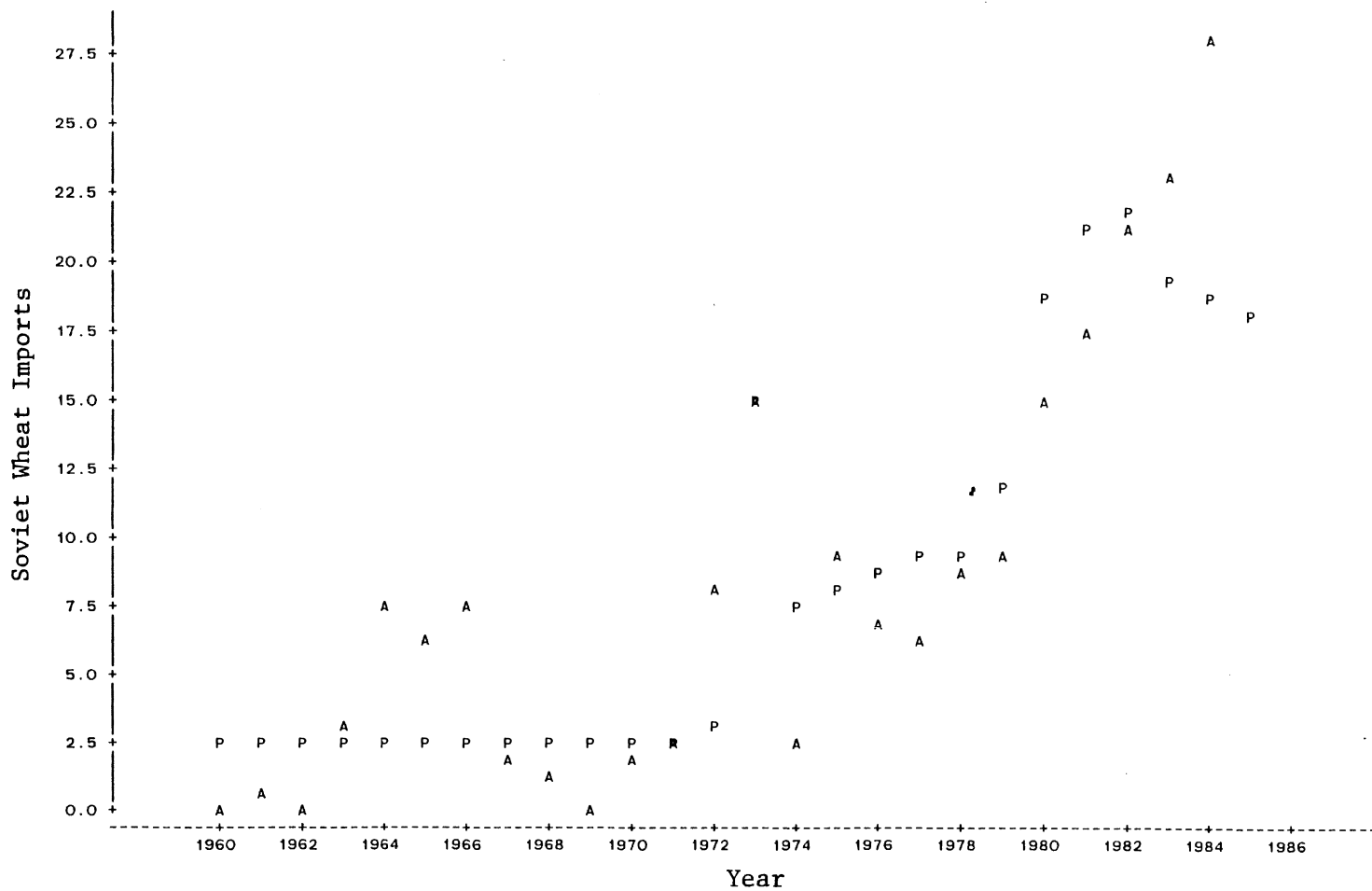
Legend: A = Actual Values
         P = Predicted Values

Figure 17. Actual Soviet Wheat Imports and Predicted Soviet Wheat Imports, 1960-1985

TABLE V

STATISTICAL RESULTS OF SPECIFIED VARIABLES
REGRESSED ON Y_2 (EQUATION 2a)
CORRECTED FOR AUTOCORRELATION

Equation (2)	$Y_2 = f(X_8, D_1)$
Estimated Equation	$Y_2 = 1.839 + 0.604X_8 + 11.704D_1$
(t-values)	(1.309) (6.752) (3.656)
Probability > t	0.204 0.001 0.015

Selected Model Results

n	= 25
R^2	= 0.836
Adjusted R^2	= 0.718

Y2

27.5

25.0

22.5

20.0

17.5

15.0

12.5

10.0

7.5

5.0

2.5

0.0

Soviet Wheat Imports

1960 1962 1964 1966 1968 1970 1972 1974 1976 1978 1980 1982 1984 1986

Year

Legend: P = Predicted Values
         A = Actual Values

Figure 18. Actual Soviet Wheat Imports and Predicted Soviet Wheat Imports Corrected
            for Autocorrelation, 1960-1985

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TABLE VI

STATISTICAL RESULTS OF SPECIFIED VARIABLES
REGRESSED ON Y_3, SOVIET COARSE
GRAIN IMPORTS (EQUATION 3)

Equation (3)	$Y_3 = f(X_8, \dot{D}_1)$
Estimated Equation	$Y_3 = 0.523 + 0.574X_8 + 6.630D_1$
(t-values)	(0.529) (8.903) (1.780)
Probability $>$ t	0.602 0.001 0.089

Selected Model Results

n	= 25
F-value	= 39.828
Probability $>$ F	= 0.001
R^2	= 0.784
Adjusted R^2	= 0.764
Durbin/Watson	= 2.115
First Order Autocorrelation	= -0.062
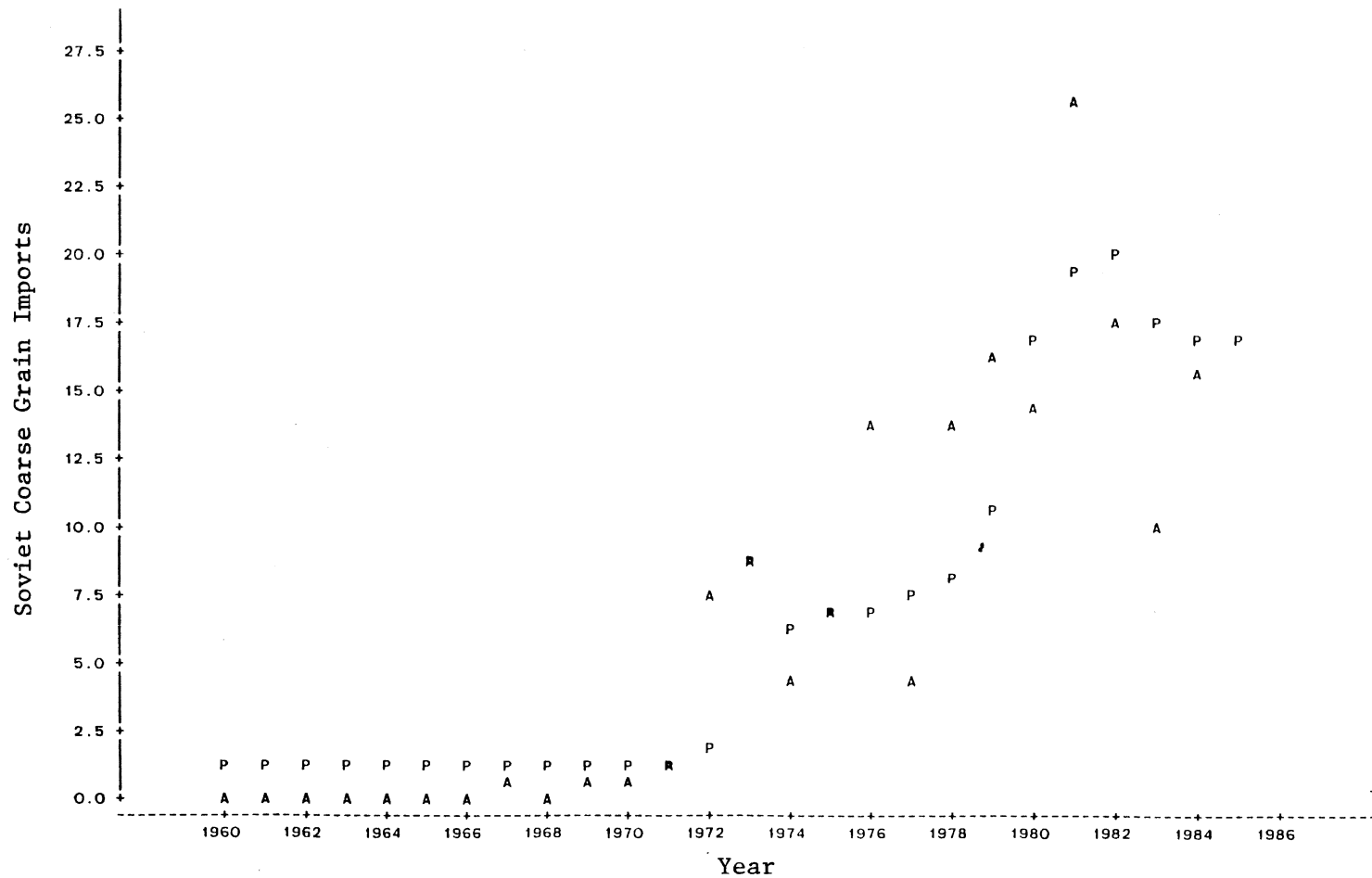
Legend: A = Actual Values
        P = Predicted Values

Figure 19. Actual Soviet Coarse Grain Imports and Predicted Soviet Coarse Grain
           Imports, 1960-1985

probability level. The estimated parameter for the dummy variable is 6.63, has a t-value of 1.78 and is significant at the .089 probability level. The sign of the coefficient is positive and consistent with economic theory. The calculated F-value for Equation (3) is 39.82 and is significant at the .001 level of probability. The R^2 value is .78. The Durbin-Watson D-value is 2.115 and indicates no autocorrelation. Actual Soviet coarse grain imports were plotted with predicted values of coarse grain imports for the estimated Equation (3) in Figure 19. Predicted values appear to closely follow the trend of the actual values.

Chapter Summary

Three equations were determined best to explain Soviet grain imports. Two independent variables, price of petroleum along with a dummy variable were used to predict describe Soviet grain imports, Soviet wheat imports and Soviet coarse grain imports. The explanatory power of these independent variables were high in all three equations. This indicates that the price of petroleum is useful in explaining Soviet grain imports.

CHAPTER V

SUMMARY AND CONCLUSIONS

The importance of the Soviet Union as a grain importer is exemplified by its power to affect grain prices in world markets. Over the past fifteen years, Soviet imports have fluctuated dramatically from year to year accounting from 4 to 22 percent of world trade in wheat and coarse grains. As Soviet purchases increase or decrease, the effects of price changes are felt world-wide. Grain traders around the world keep a close watch on factors which might indicate changes in Soviet imports.

The Soviet Union encompasses a tremendous land mass and has an abundance of natural resources. Petroleum, natural gas and coal are among their basic energy resources. Minerals such as iron ore, potassium, manganese, gold, silver, platinum and uranium also exist in abundance. The Soviet Union has become one of the world's major producers of industrial and gemstone diamonds.

The climate is continental: hot summers, cold winters, with fickle and unreliable weather patterns. Inadequate growing seasons coupled with extreme weather conditions, excessive winters, drought and rainfall impose severe restrictions on agricultural land use.

Soviet agriculture is hindered by a series of maladies. The most obvious is physical limitations. Although the U.S.S.R. is immense in size, most of the country is covered with forests, mountains, deserts

and other natural obstacles to production. In regions where soil is suitable for agriculture, climatic conditions often prohibit productivity. The great length and severity of winters prohibit the growing of many crops for a large proportion of the Soviet Union.

Inadequate investment in the agricultural sector also hinders productivity. Throughout most of its history the Soviet union has favored industrialization as a means of growth while ignoring the significance of its agricultural sector. There seems to be a rising awareness of the importance of agriculture in the U.S.S.R. as more investment in agriculture seems to be taking place.

The U.S. has historically been one of the world's leading exporters of agricultural commodities. However, the significance of agricultural exports is not limited to farmers and ranchers. U.S. agricultural exports generate jobs that extend to many areas of the economy, such as the farm supply industry, processing, transportation, financing, merchandising and insurance.

Reliance of U.S. farmers on international demand as a basis for growth has led to volatile prices and incomes for U.S. farmers. Oklahoma's economy is primarily dependent on agriculture and petroleum production for revenues and is very much affected by happenings abroad such as fluctuating petroleum prices which affects Soviet capacity to import. Thus, when the price of oil declines, Oklahoma suffers not only from lost petroleum revenues, but, also from the potential threat of a decline in international demand for grain imports, especially from Soviet sources.

The Soviets do not exchange the ruble in world markets and rely heavily on exchange earnings generated by the exportation of natural

resources or other export commodities. Among the major export commodities of the Soviet Union are petroleum, gold, natural gas and coal. Time and price series data were collected for these variables as well as for Soviet crop production and livestock inventories. These variables were tested for statistical significance and explanatory power of Soviet grain imports, Soviet wheat imports, and coarse grain imports. Of these variables, the price of petroleum repeatedly proved highly significant for Soviet total grain imports, as well as for wheat and coarse grain imports. The equations estimated consistently showed high explanatory power and predicted import values trended towards actual import values. The results were consistent with economic theory.

A dummy variable was introduced in the equations to reflect market emotionalism in response to a Soviet policy option to increase imports to meet the needs of increasing dietary standards. This decision meant maintaining livestock inventories instead of mandating livestock slaughtering in years of poor crop harvests. This variable, when included in the equations, increased explanatory power of the model.

Theoretically, as the price of an export commodity such as petroleum increases, exchange earnings are increased making imports look more attractive. Therefore, when the price of petroleum increases, the production possibility curve shifts outward, and moving to a higher isosocial welfare curve allows an increase in the amount of imports that the country can afford. Domestic production is also likely to increase because of the increased funds available to invest in the agricultural sector. However, if the price of a major export

commodity declines, we can expect the opposite movement to occur: less exchange earnings, less purchasing power of the country, a decline in imports and domestic productivity.

This seems to be a fairly good representation of Soviet actions concerning import policy. As the price of petroleum has fluctuated over the years, imports have also increased and decreased correspondingly. Thus it is the conclusion of this paper that petroleum prices have a significant impact on Soviet grain imports and can be used in an explanatory capacity.

Suggestions for Further Research

Other variables which might be tested for explanatory power of Soviet grain imports would be other foreign exchange earners. Diamonds are the second leading foreign exchange earner after mineral fuels. They were not used in this study because of a lack of data. Other suggestions for research would be to separate the time frame of data sets into two separate periods, for example before and after 1973.

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