INSTITUTIONAL CHANGE IN POLAND AND HUNGARY: AN ANALYSIS OF WHEAT MARKET IMPACTS

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PREFACE

This study was conducted to provide new information regarding the economic transformation that is occurring in Eastern Europe. This evolution of economic systems is of particular interest due to both the agricultural importance of the area and the unprecedented nature of the conversion process. The specific objectives of this research were to (1) explain and analyze the process of institutional change, (2) determine the wheat production behavior of Poland and Hungary, (3) determine the wheat import behavior of Poland and the wheat export behavior of Hungary, and (4) determine what impacts the behaviors exhibited may have on the world wheat market.

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CHAPTER I

Introduction

During the decade of the 1990's unprecedented changes occurred in Eastern Europe and the former Soviet Union. Although the process of change has taken many forms and has advanced at different speeds the desired end results are the same, economic systems that respond to free market forces. This type of economic conversion has not occurred on this scale in the era of quantitative economic analysis. Therefore the area is essentially a laboratory for economists to test theories about the pace and methodology of economic and institutional change. This unique opportunity should be utilized to obtain a greater knowledge of the complexity of specific economic systems and the factors that interact within the system to produce the observable results.

The objectives of this study are to determine the impacts of the institutional change occurring in Eastern Europe on the wheat markets of Poland and Hungary. In addition, the impact on the world wheat market will also be examined.

In order to accurately model and study this phenomenon a description of the conditions which existed prior to the implementation of the conversion process is necessary. This information is especially valuable in the study of the institutional evolution which is occurring. In the process of institutional change the path to the desired end is as important as the end itself. Although many different paths may ultimately lead to the same end, the process of building new institutions and adapting existing old ones to new uses is dependent on both the path chosen and the initial starting point.

To provide the historical information necessary to describe the centrally planned command system that existed prior to the conversion process a description of the Soviet Type Economy (STE) and the problems is creates will be undertaken, along with a description of the economic conditions prior to 1990 in Eastern Europe. In addition, the bureaucratic structure of the STE will be discussed.

The Sellers Market[1]

The process of converting a sellers market, or planned economy, to a buyers market, or market economy, is not merely a change in economic philosophy. It requires a complete change in the institutional mechanisms used to provide information to coordinate the system, an overhaul of the property rights and ownership structures, and a change in the previous incentive structure, the three mail elements in a true economic conversion.

The sellers market is an economic phenomenon characterized by persistent and pervasive shortages in both

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[1]The information contained in this section comes from class notes from a course on The Soviet Economy, taught by Susan Linz at Michigan State University in 1991.

the firm and consumer level markets. Despite this similarity, different effects are observable in each sector of the economy. At the firm level a deterioration in product quality is observed. Due to the lack of raw materials or high quality intermediate inputs, substitutions are made, using whatever resources are available in order to meet production quotas. Since the quantity demanded by definition exceeds quantity supplied, quality is not a major concern of producers. Everything that is produced is sold due to 1) the severe shortage of consumer goods, and 2) the lack of reasonably priced substitutes.

A second observable result is a severe limitation in new product or process innovation. Since achievement of target production levels is the primary motivation driving management decisions, new product development or process innovation becomes too risky. Failing to achieve the target level of production would result in the denial of bonuses, which may equal up to 40% of a laborer's or manager's annual salary. Few managers are willing to accept this level of risk. The third consequence is the reliance on self supply in many large industries. Due to the uncertain supply of raw materials and other inputs, many industries vertically integrate. This results in the loss of specialization, increased capital requirements, unbalanced throughput, and reduced flexibility, generally reducing the efficiency of the sector in question (Buzzell).

The problems of the consumer sector are quite different. Due to the shortage of goods, including the staples necessary for life, 2 to 5 hours per day are spent in ques, mostly during work time. This has a negative impact on labor supply and productivity, further reducing the already insufficient supply of goods.

Another product of this system is hoarding behavior. Whenever an adequate supply of a good exists, those who are first in the ques buy as much as they can afford to insure availability in future shortages or to sell on the black market to increase household income. This additional income then allows for additional purchases of desired goods which may be available on the black market.

The causes of the sellers market are varied, but an examination of the Principal-Agent model can shed some light on this phenomenon. In this situation the planning sector of the government is the principal and the industry managers are the agents. The goal of the principal is to maximize production. This results in taut plans, with very little slack or no slack included and production targets at or near industry capacity. Since the current target is based on past production, a ratchet effect is created, with future target levels being based on past production, discouraging excess production, since target levels will be raised based on past production. The production bonus was also dependent upon meeting the production goal and was discontinuous. If the goal was not met, even by a small amount, no bonus was received.

On the agent or managerial side of the equation, the goal was to maximize the bonus for each year and therefore over his entire career. This situation results in an adverse selection problem, where the goals of the principal and the agent conflict. Since no restraints are put on the manager's requests, it in their best interest to over order inputs and under report productive capacity. This results in bribes to inspectors, falsification of documents, and production of inferior goods. Since quantity and not quality is the standard that determines bonus achievement, many of the higher quality resources were diverted to the production of products for sale on the black market while the principal's product contained inferior inputs.

The "soft" budget constraint, or assurance of government subsidies for inefficient enterprises, also contributes to the adverse selection problem described above. Since no firm faces the possibility of bankruptcy, cost reducing or input saving technologies are not adopted to keep factories competitive with the rest of the world.

Economic Conditions Prior to 1990

Due to the various degrees of central authority that existed in the countries of Eastern Europe over the past seventy years, wide variations in economic conditions were evident in many countries. Attention will be concentrated on the agricultural sector of each country and this information will be integrated into a general description of the economic trends of the region.

Hungary

Hungary remained essentially a feudal agrarian society through the first four decades of this century. This system resulted in 60% of the population being involved in agriculture and land holdings averaging less than 6 hectares (Volgyes). However, despite the fragmented land holdings and low labor productivity Hungary was a net agricultural exporter during this period.

World War II devastated the country, with one half of the livestock herd being destroyed and nearly one third of capital assets, excluding land. Additionally, 400,000 Hungarians were killed (Fekete). During this post war period with the onset of Communist rule, land reform was implemented, further fragmenting land holdings. By 1949 a drive for collectivization or consolidation of land holdings under government control, was begun. Compulsory quotas were established and the price of not meeting the quota level was confiscation of the land and other productive assets. This process ultimately failed and by 1950 agricultural production was only 89% of the pre-war level.

In 1958 a successful collectivization of agriculture was initiated and by 1960 90% of arable land had been socialized and over one million farmers were members of collectives (Kovrig). Although production recovered to pre war levels by 1959 it remained stagnant at that level until 1968 due to poor leadership, lack of capital inputs, and low morale among cooperative members (Kovrig).

In 1968, a reform of the entire economic system was undertaken. This "New Economic Mechanism" contained some elements of a market economy, decentralized planning, and an emphasis on managerial expertise, productivity, and competitiveness. Many prices were also deregulated and allowed to find market equilibrium levels. These changes spurred rapid economic growth in the country. Grain production more than doubled during the 1970's and meat and vegetable production also experienced substantial growth (Agricultural Statistics).

Since the late 1970's production has once again been stagnant. One of the main causes of the current problem is the lack of capital and the shortage of hard currency. This results in the use of outdated equipment and production methods contributing to low productivity in most sectors of the economy.

In the Hungarian reform process most of the original institutional framework was left intact, although the functions of the bureaucracy were revised. That is, the structure of the institutions was left unchanged while their purposes were changed. The intent was to improve the methods of implementing socialist systems, not to reform the system. This process has not been entirely successful. Although productivity has been increased, macroeconomic instability still exists and high levels of foreign debt have been accumulated. By early 1983 the gross foreign debt had accumulated to $11 billion or 57% of gross domestic product and servicing this debt required 47% of hard currency exports (OECD, 1991). By 1989 this debt had grown to 75% of GDP (Boote and Somogyi). On the positive side of the situation, Hungary has been able to service this debt, avoiding the problems incurred by other countries who have defaulted on loans. Hyperinflation has also been avoided. However, this may no longer be the case as consumer prices rose 44.9% in 1990 and in excess of 60% in both 1991 and 1992 (International Financial Statistics).

Poland

The agricultural history of Poland prior to WWII is quite similar to that of Hungary, although the country has a spatially dictated pattern of development. The western half of the country followed the European development pattern of industrialization while the east was left to it's feudal agrarian roots. This resulted in the adoption of labor intensive production techniques and the production of little marketable surplus in the country.

With the Soviet takeover following WWII, radical agrarian reform occurred. All the land holdings in the western part of the country, annexed from Germany, along with any land holdings over 50 hectares, were confiscated by the government for redistribution. Of the 9.8 million hectares obtained in this fashion, 6.1 million were redistributed to the peasants, and the remainder retained in state farms (Kostrowicki). New farmers could own no more than 5 hectares of land. This process created 814,000 new farms and enlarged 254,000 (O'Hagan). However, this reform also made it nearly impossible for Polish farmers to capture the economies of scale that exist in agriculture. This condition is unique to Poland where over 50% of the farms are less than 12.5 hectares today (Kania).

Poland is also unique in that 75% of the arable land is privately owned.

During the post war period, when the production of agricultural products was increasing in most countries, production in Poland was level and actually decreased in some areas. Production of wheat and potatoes, two staples of the Polish diet decreased 4% and 20% respectively between 1972 and 1985 (Agricultural Statistics). This situation led to food price increases, riots, and eventually led to the collapse of the communist regime in the country.

The macroeconomic situation inherited by the reformers in 1990 was not an enviable one. The problems included triple digit inflation, stagnant output, and a huge foreign debt. Food prices and supplies were of major concern for two reasons. First, in 1989 it was estimated that the average consumer spent 65% of his income on food (Penn). Second, less severe conditions had led to revolts earlier. By 1989, hard currency debt had risen to $39.7 billion, requiring 74% of foreign exchange earnings to service this debt (USDA, 1991).

Romania

Prior to the twentieth century, agriculture in Romania also held tightly to it's feudal roots. An attempt at land reform was made in the 1920's when 6 million hectares of land were expropriated and redistributed to 1.5 million small farmers. This was a significant occurrence since it reduced the power, both economic and political, of the nobles of the country, and introduced conditions that were favorable for the development of capitalism. However, since no other necessary economic or social institutions were established, much of the land reverted back to large estates as debt ridden peasants sold out to reduce their debt load (Dimitru).

In the late 1940's collectivization began after another failed reform was implemented the early 1940's. Following the Communist takeover, only 5% of the land remained in private hands. This high degree of government control resulted in yields in both livestock and grain production that are much below the European average and substantially below other socialist countries. This continued to be the case up until 1990.

Although these are not the only countries in Eastern Europe they do paint a clear picture of the conditions that existed and caused the eventual overthrow of Communist rule. The need for reform may be summed up in twelve steps which both describe the system and the problems it creates.

> "First, labor, which is an instrumental factor of production, was viewed as a non-human entity that would mechanically respond to commands and directives.
>
> Second, planned essential goods shortages led to worker dissatisfaction and frustration. Low morale resulted in low productivity.
>
> Third, wages were budget determined in advance, irrespective of labor's marginal value productivity and divorced from either need or rationale for work incentives. Workers maximized personal utility-by minimizing effort.
>
> Fourth, overfulfillment of production quotas meant bonuses and profit sharing. Quantity production superseded quality considerations, so competitiveness abroad eroded over the decades while domestic consumer's were served with inferior quality products.
>
> Fifth, low labor productivity adversely affected capital efficiency-sufficiently below planners'

expectations.

Sixth, tightly planned schedules from production to delivery left little room for delays, errors, or shortfalls, and since state enterprises were permitted minimal inventory reserves, failure on the part of one key producer or distributor would quickly result in an uncalculated, forward-linked chain reaction.

Seventh, since the circulation channels of goods and services were forcibly reduced to state-determined parameters, the coordination of production, distribution, and consumption for the entire economy became inflexible, arbitrary, and artificial.

Eighth, lack of latitude in decision making by enterprise management stymied plant managers' roles and functions. Little room was left for management initiatives or entrepreneurial innovativeness. Dynamism, keeping abreast of factor-saving and productivity-enhancing techniques or technologies, would have meant risk taking without the prospect of due material awards.

Ninth, the passive role assigned to monetary instruments effectively dychotomized the potential contribution of financial assets in monitoring, coordinating, and allocating scarce resources.

Tenth, investment credits were centrally allocated, thus denying financial resources their inherent ability in identifying highest returns for maximizing social benefits.

Eleventh, state-determined factor costs and product prices vitiated the system's ability to objectively measure relative scarcity and abundance. Factor payments did not reflect real costs. Product prices reflected neither costs of production, nor value to consumers. Central determinations ignored the economic reality of opportunity costs in alternative decisions. Material balance-considered an equilibrium condition by planners-did not and could not correctly signal the persistent presence of surpluses and shortages, so surpluses and shortages persisted. Economic coordination resulted in perennial dislocations and consumer dissatisfaction.

Twelfth, centralized economies became inward-looking, locking COMECON members into long-term trade commitments with each other." (Shen p.66-67)

The Economic Bureaucracy

As described above, the economic activity of any Soviet

Type Economy (STE) is governed by a highly complex bureaucratic system that employs a top down planning method. At the top of this bureaucracy is a council of economic ministers which governs the actions of the lower units and coordinates with the Communist party to jointly determine and control all economic activity. The actual planning of the economy is accomplished through a series of state committees which handle the actual administrative details of the plan. The state planning committee is the main architect of the actual operational plans, both the non-binding five year target plans and the binding, single year plans.

A number of lesser, subordinate committees are employed by both the council and the planning committee to actually oversee and monitor the performance of individual sectors of the economy and the larger individual industries. These include separate committees to regulate prices, technology, the money supply, finance, etc. These committees are the institutions of the STE system, establishing the "rules of the game" under which both firms and consumers operate (North). The actual planning for individual enterprises is performed by the industrial ministries. The ministries are given the sectoral plan by the state planning commission and then establish enterprise plans designed to achieve the stated goals. The industrial ministries also allocate the resources to individual enterprises, from a fund provided by the planning committee.

Although this is a highly simplified version of the STE system, it is possible to see how the principal-agent problem may be applied to each stage of this process. The compounding of this problem through each bureaucratic level can and does have real effects on the productivity of the economy.

The process of institutional change, which is induced by either macroeconomic conditions or political motives, is a map of the general equilibrium conditions that exist between resource endowments, cultural endowments, technology, and institutions that exist in a specific economy (Hayami and Ruttan). This type of recursive relationship among a number of resources, some of which are difficult to quantify, make empirical testing a challenge. However, to accurately model an economic system that is in the process of radical change, quantification of the institutional influences is essential.

The main focus of this project is to estimate the impact of the economic conversion in Eastern and Central Europe on the wheat markets in Poland, Hungary, and the rest of the world. More specifically, an analysis of the institutional changes which are occurring will be conducted to determine how the economic climate in the region influences the behavior of these countries in the new economic environment. The factors which are essential to institutional change will be quantified and included in an econometric analysis of Polish and Hungarian participation in the world wheat market. To accomplish these goals, a two part analysis of the situation will be employed. First, an institutional analysis of the changes in the economic system will be conducted. The results of this analysis will then be introduced into an econometric model of Polish import demand for wheat and Hungarian wheat export behavior. This is the second part of the project.

In order to accomplish these two goals, the following methodology will be employed. In chapter two, the relevant literature behind institutional change models and import demand analysis will be explored. Chapter three will contain a discussion of the theories which support both methods of analysis. Chapter four will then focus on the data necessary for each analysis and how the two approaches may be merged into one study, a process similar to new industrial organization theory. Chapter five will contain the results of the econometric analysis. Chapter six will then contain the conclusions which may be drawn from the results obtained in the study and what impacts may be expected from continued change. Opportunities for future research will also be explored.

CHAPTER II

Literature Review

The literature relevant to this study fall into two distinct categories, 1) import demand models, and 2) institutional change models. These two subjects will be dealt with separately and a rationale for combining these two different modeling approaches will be explored.

In the first section import demand models will be discussed. This subject will be divided into three sections: perfect substitute models, imperfect substitute models, and models which explicitly incorporate government intervention. General treatments of import demand models were undertaken by Gardiner and Carter, Leamer and Stern, and Thursby and Thursby. The latter are credited with distinguishing between perfect and imperfect substitute models.

Perfect substitute models are those that may be described as deriving the net trade of a country as a residual between domestic supply and demand. Supply and demand are separately determined and net trade is the difference between the two estimates. The sign of the net trade amount determines whether commodities are imported or exported. Perfect substitute models have the luxury of allowing trade elasticities to be directly derived from domestic supply and demand elasticities (Thursby and Thursby). However, since these models assume that no outside distortions exist and efficiency is achieved in international markets, they may be inappropriate choices to model actual structural situations (Abbott).

As mentioned above, trade elasticities may be estimated from the domestic supply and demand functions. However, they may also be directly estimated. In perfect substitute models, imported and domestic commodities are homogeneous and have a common price. Therefore, the import demand function should contain both supply and demand shifting variables (Leamer and Stern). To capture the effects of changes in domestic supply on import demand, a domestic production variable is usually included in this type of model. This approach was taken by Halbrendt and Gempesaw (1990) in their analysis of the Chinese economy. Production, consumption, and import demand models were developed. Import demand was modeled as a function of wheat production, the world rice/wheat price ratio, and foreign exchange earnings.

A similar approach was pursued by Konandreas, Bushnell and Green in their estimation of export demand for U.S. produced wheat. U.S. wheat imports into a specific area were modeled as a function of per capita wheat production in the area, U.S. concessional exports to the area, the real price of U.S. wheat in the area, and the real purchasing power per capita of the consumers in the area. Weights were assigned to each importer based on their share of U.S. imports, with heavier weights being assigned to those importing larger quantities. In this way effective income and prices may be more accurately calculated.

A similar approach was employed in modeling Japanese demand for U.S. broilers by Leong and Elterich. Imports were a function of U.S. wholesale broiler prices. Japanese wholesale beef and pork prices, domestic broiler production, per capita GNP, and an exchange rate ratio. Dummy variables were also included to reflect seasonal variations in import demand.

As Gardiner and Carter point out, the difference between perfect and imperfect substitute models is that imperfect substitute models contain separate functions to model import and export behavior. These functions may be directly estimated by deriving a function which relates net trade to import prices, domestic prices and income-simplest formulation (Thursby and Thursby). Using this approach, elasticities may no longer be derived from domestic supply and demand functions. They are instead directly derived from the parameters of the estimated import demand function.

Unlike the perfect substitutes case, in this type of model, import and domestic prices are not the same since the products may be differentiated (Leamer and Stern). Therefore the impact of domestic production on import demand must be transmitted through a domestic price variable. This type of model may be employed where consumers are able to differentiate between domestic production and imports easily, such as in contrasting grass fed domestic beef and imported grain fed beef. These products may be viewed as substitutes, with the theoretical relationships between such products being known.

Models of this type have been employed by Salas to estimate the structure of the Mexican import market. In this study import demand was modeled as a function of national income, the price of imported goods, and the prices of potential domestically produced substitutes. A similar approach was used by Melo and Vogt in an analysis of Venezuela.

To insure that the effects of domestic economic policies on import demand are incorporated, modifications must be made to the model. To include the effects of price distortions resulting from trade restrictions, tariffs and quotas, both international and domestic prices must be included in the model (Abbott). To accurately model the real world conditions that exist, models should include variables which describe the behavior of consumers, producers, and governments.

In 1982 Jabara studied 19 middle income countries using a reduced form model and cross-sectional data from 1976-1979. The main assumption of the model was that the wheat imports of the countries were controlled by state agencies. In this study commercial and concessional wheat imports were regressed against population, real foreign exchange rate availability, stocks, domestic wheat price, world wheat price, wheat production, and concessional wheat amounts.

Arnade and Davison studied the world wheat market in 1987. Seventeen country specific equations were estimated, along with a rest of the world residual. Data from 1961-83 were employed and Seemingly Unrelated Regression was the estimation method chosen. The major factors in the determination of wheat imports from the U.S. were, in order of significance, 1) foreign wheat production, 2) foreign income, 3) U.S. wheat price, 4) Australian wheat price, 5) exchange rates. P.L. 480 shipments, livestock production, and freight also had measurable, but less significant, impacts on export levels. Country specific variables were also included in each equation to capture the effects of specific events or policies that may also influence demand. Elasticities were calculated for prices, income, and exchange rates. The price and exchange rate elasticities were both found to be in the inelastic range, -.17 and -.06 respectively. Income elasticity was reported as .48. All of these estimates are within the range of estimates compiled by Gardiner and Dixit.

In a subsequent analysis, Davison examined the corn, soybean, and wheat markets. Country specific import demand equations were estimated for seven corn markets, four markets and a rest of the world residual for soybeans, and eleven markets for wheat. The results of these equations were then aggregated to obtain a U.S. export demand function. All of the systems of equations were estimated using Seemingly Unrelated Regression (SUR). Other markets were also included in all three commodity analyses but were estimated with other methods due to problems with data availability. The conclusions drawn from this study were that the most significant factors in the determination of

U.S.wheat exports, foreign production and foreign income levels, were factors outside the control of U.S. producers and policy makers. The aggregate price elasticity for U.S. wheat was also calculated at -.17, suggesting that low price strategies were not tools that could expand export volumes in the short run. However, since some of the individual markets were price elastic, credit or price subsidy programs, such as EEP, could make U.S. produced commodities more competitive in some price sensitive markets. The time period covered in the study was 1960 to 1985. Significant changes have occurred in both the grain markets and the world economy since then.

Institutional Change Models

As mentioned earlier, the inclusion of certain variables to account for institutional changes in an economy is a common practice in import demand modeling. However, the formulation or construction of these variables may not be clearly explained. This is due to the fact that institutional change models are more ambiguous in both their formulation and derivation of results. That is to say that there is no set formula or structure to follow in order to obtain a desired set of results. Since this process is difficult to quantify, a more qualitative type of analysis will be employed.

As previously mentioned, the process of institutional change is a complex web of macroeconomic and political conditions that define the structure of a given economy at a particular point in time and how the evolution of the institutional structure occurs. This type of recursive relationship among a number of resources, some of which are difficult to quantify, make empirical testing a challenge.

Historical and case study approaches have been the preferred methods employed in institutional analysis. If, as North contends, the starting point of a change in institutional structure directly impacts the end result, then a combination of these two approaches should be the most appropriate method. The justification for this belief comes from an examination and comparison of the different results that may be observed in the United States and some of the Latin American democracies. Although a common set of rules was imposed on different societies, quite different institutional structures evolved in each situation. These differences can be directly linked to the cultural endowments of each society and the type of society that existed prior to the introduction of the new laws. The United States, evolving from the English common law system, developed an institutional framework which permits the complex impersonal exchanges necessary in a market economy to capture the gains from technological advances.

Most of Latin America, evolving from the highly bureaucratic Spanish system, retained a system where kinship, political influence, and family prestige are essential tools in successfully conducting business. This process leads to political instability and the loss of potential technological gains. The business environment in Eastern Europe is very similar to that of Latin America.

The political system has spawned a highly centralized, bureaucratic situation where political influence is the most important factor in business advancement. Great care must be exercised so as to avoid the pitfalls encountered in the Latin American experience. This comparison of the results obtained in these two situations does not imply that the same ends would be obtained by other countries attempting a conversion process. This is merely a comparison of these two specific situations and the institutional structures that evolved due to the influence of the different starting points and cultural endowments that existed at the beginning of the evolutionary process.

Analysis of this type falls into the realm of industrial organization. The basic model to be employed is the SCP, or structure, conduct, performance paradigm conceived by Mason and elaborated upon by Scherer. The basic model consists of an examination of the basic conditions which exist in an economy- the cultural, resource, and technological endowments of Hayami and Ruttan, the market structure, or institutions that exist, the conduct or behavior of the institutions in this framework--and the economic performance that results. This is a recursive process with feedback loops linking the first three phases of the process to allow for alteration of specific elements in the model to induce the desired changes in institutions, their behavior, and finally, improve economic performance.

A model of this nature supports both the historical approach to adequately describe the basic conditions, and the case study approach to describe the outcome of a specific example. Such a model could develop policy recommendations that may be implemented to improve economic performance or to alter market structure to achieve some desired goal. This paradigm was developed to analyze the behavior of industries or individual companies in an economy. Therefore, it's use in the analysis of the agricultural sector in Eastern Europe, where there is essentially a process of large scale demonopolization is occurring and a new economic environment is being constructed, is entirely appropriate. This approach is similar to that employed by Houck, Ryan, and Subotnik in their description and analysis of the soybean market. In that study, regional demand functions were derived for soybean oil, meal, and raw soybeans. Each of the equations include variables which attempt to quantify nonprice effects which influence the soybean market.

Harrison et al. also used the subsector approach to analyze the food marketing systems in Latin America. This was strictly a descriptive analysis of the marketing system without an attempt to quantify the data and construct an econometric model of the system. A combination of the descriptive and analytic approaches described above should yield institutional variables capturing the relevant information, thus enabling a more accurate description of the market to be depicted in the econometric model.

This type of study falls into the realm of New

Industrial Organization, where the SCP description of an industry is combined with an econometric analysis, answering the fundamental question: What form does competition take in the market? (Jacquemin). This results in a more dynamic type of model where consumer and industry behavior influence decision making and the institutional change process. In this process some participants attempt to alter the institutional framework while others simply react to the changes they observe.

New Industrial Organization

Much of the work using this approach has been in the area of industry concentration studies, or determining the factors which influence the market concentration of a particular industry. This type of analysis is very similar to institutional change modeling in that variables describing the firm concentration ratio or firm pricing behavior are included in the econometric model to more accurately depict the market being analyzed. Construction of similar variables is the focus of this institutional analysis.

Caves and Porter (1980) investigated the dynamics of changing seller concentration and the quality of the models that were used in this area. Their contention was that prior literature was flawed due to incorrect construction of right hand side (independent) variables. They believed that many of these variables could be directly related to seller concentration through an identity. Their solution to this problem was to use a first-differenced version of the model, an approach taken in similar studies of firm exit and entry and mergers. In this way changes in concentration may be related to changes in the level of some influential variable.

Saunders (1980) attempted to construct a comprehensive model of the Canadian manufacturing industry, explicitly including variables that indicate the degree of insulation afforded Canadian industries by tariffs. These variables were designed to capture the influence of foreign competition, both actual and potential, on the behavior of the protected firms. In this study a variable was constructed to reflect the minimum efficient size of plants in the market, another attempt to introduce institutional factors into econometric analysis. The conclusions from this study indicate that this institutional variable did influence the survivability of small businesses.

Masson and Shaanan also used Canadian data to examine oligopoly pricing behavior under threat of new firm entry. Again, institutional variables describing firm concentration, the existence and level of entry barriers, and international market conditions were included in the model. All of these were determined to be significant influences on pricing behavior in this study.

Institutional factors describing market structure were also employed by Henley in 1986 in his analysis of the influence of trade unions, market concentration, and income distribution on U.S. industry. The conclusions of this analysis stated that the structure and conduct of firms in an industry directly and significantly influences income distribution in the industry.

Geroski, Masson, and Shaanan, in a 1986 study of the dynamics of market structure, determined that concentration level and speed of adjustment, both institutional factors, greatly influence the achievement of long run equilibrium. They also concluded that failure to include the effects of these factors results in serious bias in determining how quickly a market returns to its long run equilibrium level. They believe that separating the effects of these two factors and using non-linear estimation methods is essential to accurate modeling.

Levy (1986) attempted to include an explicit adjustment process into a market structure-performance model. Expectations about future profits are also explicitly included in the model. The conclusions of this study suggest that adjustments in market structure variables should be considered in the analysis. Initial market structure conditions, as well as expected structural changes should be considered separately since they have differing influences on future profit levels. Also, industry specific institutional variables were determined to be important in explaining expected profit levels.

A review of the previous studies cited above gives a short history of the inclusion of institutional variables in econometric analysis. In each of the previously mentioned studies a description of each industry is required to establish a baseline to which changes may be compared. This is the SCP element of the New Industrial Organization type of analysis. The second element is the econometric analysis of the industry, including the institutional variables derived previously. This combination allows for a more complete and accurate description of the starting point of an industry and the predictions of where it is headed. This is the same approach utilized in this study of Eastern Europe. A description of the initial conditions will be combined with an econometric model of the changes that have occurred and others that are expected to occur. As cited in the prior studies, projects of this magnitude are common in economic studies so that an analysis of the agricultural sector of a single country is not beyond the scope of the chosen methodology. Studies of the industrial sectors of both Canada and the United States have both been conducted using this methodology. Therefore, a choice of any, or all of the formerly centrally planned countries is likely to be a project of a smaller scale than many that have previously been studied.

CHAPTER III

Theory

The theory to be applied in this analysis may be divided into two distinct categories, international trade theory and institutional change theory. For the purposes of this study trade theory will be discussed first and then a digression into institutional change will expound on the importance of the proper selection, construction, and inclusion of institutional variables in econometric models of dynamic economic systems.

Trade theory will be approached in two ways. First, the classic three panel diagram will be used to present a graphical description. Following this, a mathematical presentation of the equations underlying the model will be used to provide an analytical examination of the theory.

Institutional change theory is more qualitative and therefore more difficult to quantify. Although the inclusion of institutional variables is not a new development, the theory behind construction of such variables is less developed than trade theory. Therefore, a variety of approaches will be examined and combined. This approach will then be used to explain the construction and selection process for variables to be used in this analysis.

International Trade Theory[2]

In order to simplify the economics of world trade a two country, one commodity world with excess supply and excess demand functions will be employed. As a starting point the model is static and no government intervention exits.

In order for gains from trade to exist, one country must be a low price producer, in this example Country A. This situation may be the result of resource endowments, technological advances, or simply because of insufficient domestic demand. Da represents the domestic demand in Country A, and Sa is domestic supply in A. If autarky exists, the domestic price would be determined by the intersection of the domestic supply and demand functions, or Pa in this example. At prices above the equilibrium point production would exceed domestic demand. This fact allows for the construction of an excess supply function, or Es, for Country A, which is the supply of exports into the world market. It should be noted at this point that at prices below Pa Country A would be an importer. In order to simplify the analysis this portion of the function will be ignored.

Country B is a higher cost producer or has a greater domestic demand relative to domestic supply. Db and Sb are the domestic supply and demand functions in B. If autarky exists, the domestic price in B is Pb, a price greater than

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[2]Agricultural Policies and World Markets by Alex McCalla and Timothy Josling.

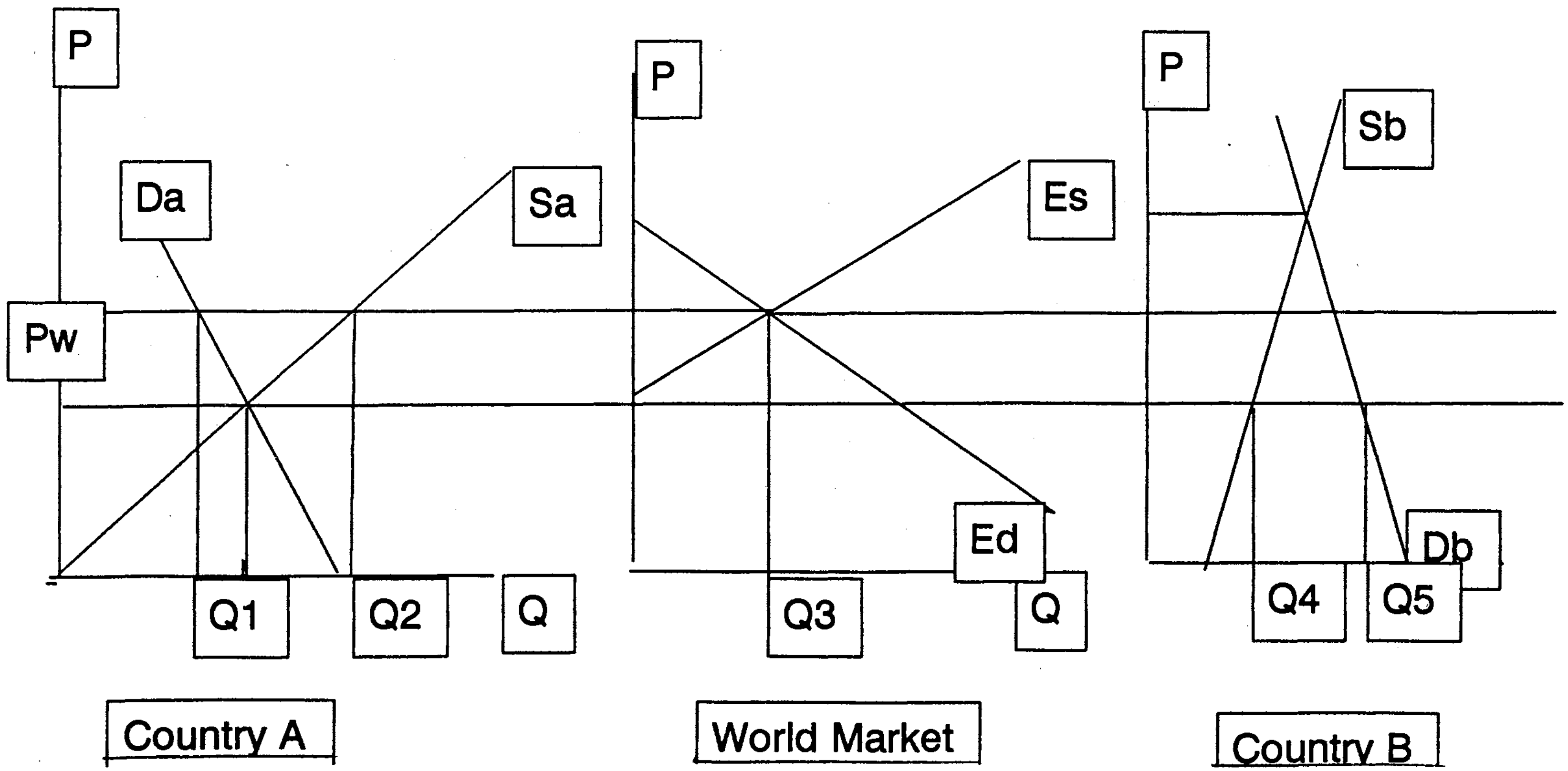
Pa. At prices below Pb, domestic consumers demand more than is produced in B. As the price decreases, this differential increases, mapping out an excess demand function, or Ed. This is the demand for imports from the rest of the world.

If trade occurs between the two countries, the equilibrium world price would be determined by the intersection of the Es and Ed functions in the world market. This world price will be designated as Pw, at a level between Pa and Pb, and the amount traded between the countries will be determined by (Q2-Q1) to be exported by Country A and (Q5-Q4) to be imported by Country B. In this system (Q2-Q1)=(Q5-Q4)=Q3, or the total volume of world trade, implying that in this system exports equal imports and the world market is in equilibrium.

The slopes of the excess supply and excess demand functions depend directly upon the slopes of the domestic supply and demand functions in each country. The slopes of the excess functions are equal to the absolute value of the sums of the domestic functions. Given this relationship, at any price, the elasticities of the excess functions are a weighted average of the elasticities of the original functions.

This model may be expanded to include more participants by simply adding the excess supply and demand schedules of additional exporters and importers. The addition of more countries will reduce the slopes of the world export supply and demand functions relative to the functions of individual countries.

Two country one commodity model of international trade



In order to fully understand the empirical results obtained from this model the equations underlying the graphical analysis are necessary. These equations include the identities which describe the equilibrium conditions as well as the behavioral equations (which describe the actions of the participants in the market). As in the simple graphical model, we begin with the identity describing the equilibrium condition:

$$S_W \equiv D_W \tag{1}$$

stating the identity that world supply exactly equals world demand, if carryovers are not allowed in the system. Since we are considering an open system where trade can occur, then supply or demand for either country may differ by the amount traded:

$$S_A + M_A \equiv D_A + X_A \tag{2}$$

with M_A being imports into Country A and X_A being exports from A. In this equation the left-hand side describes total availability in the country and the right-hand side depicts total disappearance. The above identities will always hold in ex post examinations, subject to measurement errors. The market clearing or ex ante equilibrium conditions may also be described by these same relationships. For countries who are trading partners the relationship may be stated as:

$$S_A - D_A \equiv X_A - M_A \equiv M_B - X_B \equiv D_B - S_B \tag{3}$$

If we let Country A be the exporter and Country B be the importer then we can simplify the identities to:

$$S_A - D_A \equiv X_A \equiv M_B \equiv D_B - S_B \qquad 4$$

To these identities we can now add the behavioral equations which describe the actions of the participants in the market. In this presentation all non-price variables will be represented by x's. These relationships may then be represented as:

$$S_i = S_i(P, x_1, \ldots, x_n) \qquad 5$$

$$D_i = D_i(P, x_1, \ldots, x_n) \qquad 6$$

Using these equations exports and imports may then be stated as functions of price:

$$X_A = X_A(P, x_1, \ldots, x_n) = S_A(P, x_1, \ldots, x_n) - D_A(P, x_1, \ldots, x_n) \qquad 7$$

$$M_B = M_B(P, x_1, \ldots, x_n) = D_B(P, x_1, \ldots, x_n) - S_B(P, x_1, \ldots, x_n) \qquad 8$$

In order to restore stability to the system after a disturbance has occurred it is necessary to determine the sensitivity of quantity changes to changes in prices. This is accomplished by taking the derivatives of the import and export equations, which leads to:

$$\frac{dX_A}{dP} = \frac{dS_A}{dP} - \frac{dD_A}{dP} \qquad 9$$

$$\frac{dM_B}{dP}=\frac{dB_B}{dP}-\frac{dS_B}{dP} \qquad 10$$

The most common approach is to convert these derivatives into elasticities:

$$E_{X_A,P}=\frac{dX_A}{dP}\cdot\frac{P}{X_A} \qquad 11$$

$$E_{M_B,P}=\frac{dM_B}{dP}\cdot\frac{P}{M_B} \qquad 12$$

The next step in this process is to convert the elasticities into domestic elasticities of supply and demand with respect to price. These equations are as follows:

$$E_{X_A,P}=(\frac{dS_A}{dP}\cdot\frac{P}{X_A}\cdot\frac{S_A}{S_A})-(\frac{dD_A}{dP}\cdot\frac{P}{X_A}\cdot\frac{D_A}{D_A})=E_{S_A,P}\cdot(\frac{S_A}{X_A})-E_{D_A,P}\cdot(\frac{D_A}{X_A}) \qquad 13$$

$$E_{M_B,P}=(\frac{dD_B}{dP}\cdot\frac{P}{M_B}\cdot\frac{D_B}{D_B})-(\frac{dS_B}{dP}\cdot\frac{P}{M_B}\cdot\frac{S_B}{S_B})=E_{D_B,P}\cdot(\frac{D_B}{M_B})-E_{S_B,P}\cdot(\frac{S_B}{M_B}) \qquad 14$$

The terms S_A over S_A and D_A over D_A are included to arrive at a weighted elasticity without changing the equations since both terms are equal to one. The S_A over X_A and D_B over M_B are the weights applied to the domestic elasticities in order to obtain the elasticity of trade with respect to price.

The X's in both the import and export equations are the most critical factors in the determination of trade volumes. These are the factors that directly influence the participants' decision as to the amounts to import or export. The selection of these variables is immensely important in the construction of an econometric model which accurately depicts the actual variations that may be observed in world markets.

To select the variables which exert the most influence on the market being studied, both basic economic theory and trade theory is employed. Economic theory tells us that the factors influencing the price of a given good or product are 1) the price of the product, 2) the prices of substitutes for the product, 3) prices of complementary products, 4) the income of the consumers in the market, 5) the population or size of the market, and 6) the amount of the product that is available, and 7) tastes and preferences. Although this list is not complete since each market has its own unique set of influential factors, it does cover the elements that are common to most econometric studies of trade.

We must also employ trade theory to include the other factors which have little influence on domestic markets. These would include the influence of exchange rates, stock volumes and release behaviors, and the behavior or institutional arrangements of each trading partner. Some of these factors are more influential than others so great care must be taken in the selection process.

The main reason that all possible factors may not be included in the model is the availability of data. As a result of the problems created by data sets of relatively short length or those with questionable or missing observations we must be aware of the degree of freedom problems that can occur when too many variables are included in an equation. Even though variables may meet the theory requirement for inclusion, they may be excluded if tests show that they are not significantly different from zero. The effects of these variables is then transferred to the intercept term when they are excluded from the equation. When this approach is taken goodness of fit is sacrificed for confidence in test results that may not be accurate at lower degrees of freedom. That is, R^2 may sacrificed to have parameters significant at at more restrictive level of significance.

Institutional Change Theory

The process of developing or inventing new institutions may be analyzed through the use of noncooperative games models. In this setting, the role of the designer is to find game rules that will give equilibrium outcomes that satisfy specific social goals or desires (Hurwicz). These rules are the laws which outline the legal options that players in a specific market may exercise to reach the goals specified by the institutional designers, usually the government. The rules that are established also determine the outcomes that are achieved. The functional relationship which associates the outcomes with each strategy chosen is called the game form or outcome function. In economic models this may be the allocation of resources or the production of an amount of output from a given amount of inputs. The payoff function of the game, a combination of the utility and outcome functions, specifies the players' utilities of the outcomes as functions of the chosen strategies (Hurwicz).

To thoroughly understand the theory of institutional change, we will digress from the formal arguments presented above and undertake a more general and qualitative explanation of the process and the theory which underlies it. Society, as a general definition, may be described as a set of institutional systems, with each system being a prescribed set of institutions. In this context institutions may be defined as a set of socially prescribed patterns of correlated behavior (Bush). In a more general sense they are "the rules of the game" for society (North). Socially prescribed behavior emerges from social choices, and the critical history of any culture is the story of how these choices evolved in the history of the community (Bush). This is one of the central tenets of institutional change theory, that the end results directly depend upon the starting point and the path chosen. This is the "path dependency" referred to by Douglass North in his analyses of economic history.

The definition of an institution stated previously contained the phrase "patterns of correlated behavior". The use of this phrase implies two very important concepts: 1) that the behavior of individuals in dealing with institutions is not random but calculated and correlated, and 2) that values function as the correlators among the many behavior patterns induced by the institutions. Values serve as the standards of judgement that correlate or modify behavior patterns. The value system of the institution or society in question provides the framework for all relationships and behaviors observed in the institutional or societal system. Therefore, for true institutional change to occur, a change in the entire value structure of the society is required.

For the purposes of this analysis, only "progressive" institutional change will be dealt with to simplify the modeling process. Progressive change occurs when, for a given knowledge base, ceremonial or traditional values are displaced by instrumental values, or those induced by technological advances. This process requires a decreased reliance on ceremonial values, changing the value system by making it more dependent on the newer values dictated by a more industrial, impersonal society. This is the first phase of institutional adjustment, the integration of new behavioral patterns into the collective knowledge of the community. This process then changes the problem-solving processes and provides new standards of judgement which are then adopted, diffused, and employed to solve an ever widening scope of problems. This results in the further reduction of ceremonial standards, employing the new standards in areas not previously considered. This is the second phase of institutional adjustment.

One of the most critical factors in instituting progressive institutional change is to educate the community about the process and create a widespread belief that change is needed. In the case of Eastern Europe this was a relatively simple task. A brief examination of the differentials in income levels and standards of living between East and West was all that was required to convince the populace that change was needed. However, the willingness of the community to consider alternative institutional structures can be enhanced through the disruption of traditional patterns. This also occurred in Eastern Europe with the fall of communist domination. The breakdown of a seventy year old system allowed the free thinkers of the area to realistically consider viable alternatives. The opening up of the more restrictive regimes also allowed for the rapid inflow of new ideas.

"Progressive" institutional change has been described as change that "provides for the continuity of human life and the noninvidious recreation of community through the instrumental use of knowledge" (Tool). The use of language in this case describes the replacement of traditional behavior by instrumental (induced) patterns of behavior and that social values are key to the process. Selection criteria for new institutions is also provided since the stated purpose of the process is to provide genuine progress in the problem-solving process of the community. This progress may be described by more efficient resource allocation, more equitable income distribution, or whatever economic standard is chosen to depict progress.

The theory of institutional change presented here achieves two goals: 1) it provides an explanation of the process of institutional change, and 2) the social values inherent in the process are revealed. Although institutional change is a continuous process, it should not be concluded that this process is a result of conscious choices in social policy formation. The only argument that may be supported is that cultural change directly results from conscious choices to adopt or not to adopt innovative technologies or institutions. The progressive institutional changes that have brought modern cultures to their present stage of development may have appeared to have been quite unremarkable at the time of their occurrence (Bush). However, the compounding of a series of seemingly minor changes can have a major effect after years of evolution. Even with minor changes, the options chosen define the evolutionary process of the culture.

In institutional economics the unit of analysis is the institution, since the main concern of institutionalists is the long run process of institutional change, not the behavior of individuals. Although the behavior of participants within a given institutional framework is important, institutional economics is more concerned with explaining the evolution of institutions than individual choice patterns. This emphasis on the process of change is very important in understanding the differences between neoclassical and institutional economics.

Comparing Neoclassical and Institutional Economics

The philosophical foundations of neoclassical and institutional economics come from very different areas. The neoclassical school has its roots grounded in the physical sciences. This tradition was carried over from the classical economists Adam Smith and David Ricardo. Samuelson, in the foreword to his *Foundations of Economic Analysis* uses the concepts of physics to explain his analysis of comparative statics. Marshall, in his description of economic science, also couches his explanation in terms of physical science:

> "The harder the task, the greater the need for steady patient inquiry, for turning to account the experience, that has been reaped by the more advanced physical sciences; and for framing as best we can well thought out estimates, or provisional laws, of the tendencies of human action". (Marshall pp.32-33)

The foundations of neoclassical economics, as in the physical sciences, are mechanism and formism. Mechanism provides the analytical tools used in neoclassical analysis. The basic concept of equilibrium is based on the mechanistic view of the world as a celestial clock, operating perfectly in ceaseless, balanced motion. Neoclassical microtheory also paints the individual as a hedonistic maximizing machine (Dugger). The use of this concept allows neoclassicists to rigorously analyze supply and demand.

The mechanistic foundations are complemented by the formism of neoclassical theory. This concept strongly influenced Marshall in his construction of the ideal or normal case. This process involves the construction of a normal form (ideal form) and the deduction of the normal (ideal) action that results. Supply and demand are then molded into an analytical framework to explain market behavior of individuals. It is then possible to rigorously analyze markets and predict the results of changes in consumer demand or factor prices.

The views of institutionalists are not shaped by the mechanism or formalism of the physical sciences. They are influenced by the organicism of evolutionary biology and the contextualism of history (Dugger). They work with the organic human in a constantly evolving society attempting to determine the effect of institutions on behavior. The focus of analysis for the institutionalist is not the individual but the institutions that shape the individual's behavior. This focus also changes the time window of analysis. The neoclassicist is concerned with the short run maximizing behavior of the individual while the institutionalist is interested in the very long run process of institutional evolution. This difference in focus also changes the main objective of study. Instead of concentrating on the neoclassical concept of equilibrium the focus is shifted to the organistic concept of "process". Just as mechanism and formism complement each other in neoclassical theory, process also has a complementary factor, contextualism. While formism concentrates on consistency and similarity, contextualism stresses change, novelty, time, and place.

The emphasis on processes of change is crucial to understanding the differences between institutional and neoclassical economics (Dugger). These differences may also be emphasized by examining the type of explanations used in each analytical method. Neoclassical economics with its concentration on formism and mechanism, is concerned with explaining market behavior. This process uses deductive and probabilistic explanations, both very formal and mathematically rigorous. Institutional economics with its focus on institutional change uses functional-teleological and genetic explanations. The use of these approaches implies that the process is difficult or impossible to model with mathematics. The functions of the institution or the desired objectives behind the implementation of a process are the focus of analysis.

Another major difference between these two theories is in the type of models each builds. The institutionalist builds pattern models which explains behavior within a carefully constructed institutional and cultural structure. In neoclassical economics, predictive models explain behavior by stating assumptions and deducing implications. In this context, a prediction is a logical deduction based on the assumptions or postulates of the theory employed. Therefore, the predictive value of the model is based on the empirical accuracy and validity of the deductions. This is one area where the two schools of thought diverge. To construct predictive models, neoclassicists de-emphasize structural reality to enhance predictive power. The model is then tested by comparing deductions with actual observations. Institutionalists take the opposite approach. Their approach to model construction is to make each as structurally realistic as possible. These models are then tested by comparing the modeled (hypothesized) institutional structures with those that may be observed.

Although the approaches are quite different each school of thought tries to keep their unit of analysis as realistic as possible. Institutionalists, with their concern for descriptive realism, continuously question how accurately their hypothesized structures fit real world situations. The models constructed are very detailed. Neoclassicists also attempt to keep their unit of analysis realistic. However, since their main concern is predictive power, they question the empirical accuracy of their models.

The neoclassical modeling process needs to more accurately depict the actual process being studied and the institutional approach needs to employ an empirical facet to generate results that are more easily examined than the comparison of hypothesized and actual institutional patterns. An additional element in this argument is that convincing evidence supporting the view that structure and market conduct of firms bears an important relationship to how income is distributed within industries (Henley). In most cases the structural variables describing the institutional relationships within an industry are composed of ratios depicting the capital intensity of the industry, the four firm concentration ratio that exists, the degree of unionization, profitability, or advertising divided by sales to name a few. These variables attempt to capture the effects of barriers to entry, the relationship between advertising and profitability, and the ability to collude or gains in efficiency from economies of scale (concentration ratio) (Levy). Profitability is then estimated using a partial adjustment model to determine variable levels as changes occur in subsequent time periods. The above discussion is useful for two reasons. First, it establishes a precedent for including institutional variables as valuable explanatory tools in econometric analyses, and second, the construction of these variables is discussed. This is likely the more important factor. The construction of institutional variables is not a simple process and may proceed down many different paths. As is illustrated above, institutional factors may be represented in many different ways. Although there is a history of using constructed variables in analyses, the problem is in the justification of the variable. The construction of a variable which consistently represents a situation which is an important explanatory factor in an econometric equation is a difficult task, especially in a changing economic climate.

This "construction" problem may be the most important problem to be solved in the inclusion of institutional factors in econometric equations. In many instances the degree of economic development may be included in the equation by using per capita income or GDP per capita. Use of this information solves two problems, 1) the variable construction problem, and 2) data is usually available to calculate this number. This may be one solution to part of the institutional problem, but some other measure of the speed of change or degree of governmental economic control is also necessary to accurately depict the process of economic change. The solution to this problem is the key to combining institutional and neoclassical economic theory.

CHAPTER IV

Data and Methodology

The methodology used in the estimation of systems of equations is commonly referred to as Zellner estimation Three-Stage Least Squares (3SLS), or Seemingly Unrelated Regression (SUR). The estimations in this study will be performed using the econometrics program SHAZAM. Since this specific program is being employed, a general explanation of the estimation process will be undertaken, as well as a more specific presentation of the actual process employed in SHAZAM.

Three Stage Least Squares

The three stage least squares method of estimation is an improvement upon the two stage method. In two stage least squares the estimation of a structural equation takes place in two distinct steps. The first estimates the moment matrix of the reduced-form disturbances. When this process is completed the coefficients of the structural equation are then estimated after the jointly dependent variables are "purified" using the previously determined moment matrix. Three stage least squares improves upon this method by using the moment matrix to simultaneously estimate all of the coefficients in the structural equation (Zellner and Theil). This method makes two improvements over two stage least squares. First, if the moment matrix is not diagonal, then the estimation of any identifiable equation in the system may be more efficient as soon as there are other equations in the system which are over-identified. Second, restrictions can be placed on parameters in each of the different structural equations in the system.

Throughout this explanation it will be assumed that we are dealing with a system of M linear equations with M jointly dependent variables and A exogenous variables. It is also assumed that the reduced form of the equations exists, that is the system can be solved for the jointly dependent variables and that the disturbance (or error) terms of the equations are independent and have finite and constant variances and contemporaneous covariances through time (Zellner and Theil).

If we let T be the number of observations, then any of the structural equations may be written as:

$$y_\mu = Y_\mu \gamma_\mu + X_\mu \beta_\mu + u_\mu = Z_\mu \delta_\mu + u_\mu \qquad 15$$

where y_μ is the column vector of observations on one of the jointly dependent variables; Y_μ is a $T \times m_\mu$ matrix of dependent variables; γ_μ is the vector of coefficients; X_μ is a $T \times l_\mu$ matrix of exogenous variables; β_μ is the coefficient vector; u_μ is a column vector of disturbance terms; and

$$Z_\mu = [Y_\mu X_\mu] ; \delta = \begin{bmatrix} \gamma_\mu \\ \beta_\mu \end{bmatrix} \qquad 16$$

We can also rename the TxA matrix of exogenous variables X and assume that it has rank A. The objective is to estimate the vector of parameters, δ_μ . It is also assumed that all equations are identifiable. This implies:

$$A \geq \eta_\mu = m_\mu + l_\mu \, (\mu = 1, \ldots, M) \qquad 17$$

where η_μ is the total number of coefficients to be estimated in the μth equation. In order to accurately demonstrate the superiority of 3SLS over 2SLS it is necessary to first derive the 2SLS estimator.

Two Stage Least Squares

The first step in this process is to premultiply equation **15** by X′. This leads to:

$$X'y_\mu = X'Z_\mu \delta_\mu + X'u_\mu \qquad 18$$

This leads to a just identified system of A equations with n_μ parameters and a disturbance or error vector of $X'u_\mu$ with a mean of zero. In a just identified system the number of exogenous and endogenous variables in the equation minus 1 is equal to the total number of exogenous variables in the system. In the special case of $A = n_\mu$, when the system is just identified, δ_μ is estimated as:

$$d_\mu = (X'Z_\mu)^{-1} X'y_\mu \qquad 19$$

In this equation δ_μ is replaced by its estimator, d_μ , and $X'u_\mu$ is replaced by its expected value. Then, assuming that the exogenous variables are all fixed we find the disturbance vector covariance matrix:

$$V(X'u_\mu)=E(X'u_\mu u'_\mu X)=\sigma_{\mu\mu}X'X \qquad \mathbf{20}$$

Aitkin's method of generalized least squares is then applied to equation **18** and we obtain:

$$Z'_\mu X(\sigma_{\mu\mu}X'X)^{-1}X'y_\mu=Z'_\mu X(\sigma_{\mu\mu}X'X)^{-1}X'Z_\mu d_\mu \qquad \mathbf{21}$$

From equation **21** we can then derive the 2SLS estimator:

$$d_\mu=[Z'_\mu X(X'X)^{-1}X'Z_\mu]^{-1}Z'_\mu X(X'X)^{-1}X'y_\mu \qquad \mathbf{22}$$

Having derived the 2SLS estimator we can now apply 3SLS to a complete system of equations.

Application of 3SLS

In 3SLS equation **18** may be written as follows for all the equations involved:

$$\begin{bmatrix} X'y_1 \\ X'y_2 \\ \cdot \\ \cdot \\ \cdot \\ X'y_M \end{bmatrix}=\begin{bmatrix} X'Z_1 & 0 & \dots & 0 \\ 0 & X'Z_2 & \dots & 0 \\ \cdot & \cdot & \dots & \cdot \\ \cdot & \cdot & \dots & \cdot \\ \cdot & \cdot & \dots & \cdot \\ 0 & 0 & \dots & X'Z_M \end{bmatrix}\begin{bmatrix} \delta_1 \\ \delta_2 \\ \cdot \\ \cdot \\ \cdot \\ \delta_M \end{bmatrix}+\begin{bmatrix} X'u_1 \\ X'u_2 \\ \cdot \\ \cdot \\ \cdot \\ X'u_M \end{bmatrix} \qquad \mathbf{23}$$

which is a system of *AM* equations with

$n=\sum_{\mu=1}^{M} n_\mu$ parameters. In order to estimate this system we also need the covariance matrix of the disturbance vectors of equation **23**:

$$V\begin{bmatrix} X'u_1 \\ X'u_2 \\ \cdot \\ \cdot \\ \cdot \\ X'u_M \end{bmatrix}=\begin{bmatrix} \sigma_{11}X'X & \sigma_{12}X'X & \dots & \sigma_{1M}X'X \\ \sigma_{21}X'X & \sigma_{22}X'X & \dots & \sigma_{2M}X'X \\ \cdot & \cdot & \dots & \cdot \\ \cdot & \cdot & \dots & \cdot \\ \cdot & \cdot & \dots & \cdot \\ \sigma_{M1}X'X & \sigma_{M2}X'X & \dots & \sigma_{MM}X'X \end{bmatrix} \qquad \mathbf{25}$$

We also need the inverse of the covariance matrix:

$$V^{-1}\begin{bmatrix} X'u_1 \\ X'u_2 \\ \cdot \\ \cdot \\ X'u_M \end{bmatrix} = \begin{bmatrix} \sigma^{11}(X'X)^{-1}\sigma^{12}(X'X)^{-1}\ldots\sigma^{1M}(X'X)^{-1} \\ \sigma^{21}(X'X)^{-1}\sigma^{22}(X'X)^{-1}\ldots\sigma^{2M}(X'X)^{-1} \\ \cdot \quad \cdot \quad \cdots \quad \cdot \\ \cdot \quad \cdot \quad \cdots \quad \cdot \\ \sigma^{M1}(X'X)^{-1}\sigma^{M2}(X'X)^{-1}\ldots\sigma^{MM}(X'X)^{-1} \end{bmatrix} \qquad 26$$

Generalized least squares is then applied resulting in the following: the 2SLS column vector on the left side of equation **21** is replaced by:

$$\begin{bmatrix} \sigma^{11}Z_1'X(X'X)^{-1}X'y_1+\ldots+\sigma^{1M}Z_1'X(X'X)^{-1}X'y_M \\ \cdots\cdots\cdots\cdots\cdots\cdots \\ \sigma^{M1}Z_M'X(X'X)^{-1}X'y_1+\ldots+\sigma^{MM}Z_m'X(X'X)^{-1}X'y_M \end{bmatrix} \qquad 27$$

and the right side of equation **21** is replaced by the nxn matrix:

$$\begin{bmatrix} \sigma^{11}Z_1'X(X'X)^{-1}X'Z_1\ldots\sigma^{1M}Z_1'X(X'X)^{-1}X'Z_M \\ \vdots \\ \sigma^{M1}Z_MX(X'X)^{-1}X'Z_1\ldots\sigma^{MM}Z_M'X(X'X)^{-1}X'Z_M \end{bmatrix} \qquad 28$$

These matricies both contain $\sigma's$ which are usually unknown. They are generally replaced by their 2SLS estimates. After this replacement is made the 3SLS estimator is then defined as:

$$\hat{\delta} = \begin{bmatrix} s^{11}Z_1'X(X'X)^{-1}X'Z_1\ldots s^{1M}Z_1'X(X'X)^{-1}X'Z_M \\ \vdots \\ s^{M1}Z_1MX(X'X)^{-1}X'Z_1\ldots s^{MM}Z_M'X(X'X)^{-1}X'Z_M \end{bmatrix} x \begin{bmatrix} \sum s^{1\mu}Z_1'X(X'X)^{-1}X'y_\mu \\ \vdots \\ \sum s^{M\mu}Z_M'X(X'X)^{-1}X'y_\mu \end{bmatrix} \qquad 29$$

3SLS Estimation using SHAZAM

The SHAZAM procedure for estimating systems of simultaneous equations is the same as the method described above. The set of equations is estimated by using a joint generalized least squares procedure using the covariance matrix of residuals across equations. In SHAZAM linear restrictions may be applied within or across equations. In addition, linear or nonlinear hypotheses may also be tested.

Empirical Equations to be Estimated

For the purposes of this study two countries of Eastern Europe were chosen in order to compare and contrast the influence of the different institutional structures existing within countries of the former Eastern Bloc. The countries chosen to highlight the effect of institutional structure are Poland and Hungary. These countries were chosen for two main reasons. First, they have very different agricultural sectors due to the differing degrees of government involvement. In Poland collectivization was never very successful and 75% of the agricultural land remained in private hands. This led to a more market responsive government that was forced to respond to consumer demand. Hungary was highly collectivized with little land left in private hands and a more rigid government structure. Second, these two countries chose different paths to establish market economies. Hungary chose a slow, incremental process that has been in effect since 1968. They have attempted to force institutions to evolve slowly to create a process of controlled gradual change. Poland, in stark contrast to this gradualism, chose to jump to a market in one bold step. Prices were rapidly decontrolled and borders opened to trade. This process resulted in hyperinflation and severe economic hardship for consumers in the short run. However, the process has seemed to allow a more complete economic conversion. The comparison of these two systems should generate some more definite results about which path to marketization should be chosen, given a definite set of beginning conditions and end goals.

Each country will be modeled by a pair of simultaneous equations. The first will describe the wheat production behavior in each country while the second will model import behavior in Poland and export behavior in the Hungarian case. The equations and variable definitions for the Polish case are as follows:

Production

PPROD=PAREA+PFERT+PAPOP+PSTKS

where:

PPROD= annual wheat production in Poland, metric tons

PAREA= annual hectares of wheat in Poland

PFERT= annual gross fertilizer use, metric tons

PAPOP= the percentage of the Polish population involved in agriculture

PSTKS= carryover stocks of wheat at the beginning of each year, metric tons

Imports

PIMP=PPOP+PPROD+PRATE+DPGDP+WPRIC

where:

PIMP= annual Polish wheat imports, metric tons

PPOP= total population in Poland, thousands

PPROD= annual wheat production, metric tons

PRATE= the foreign exchange rate, zlotys/dollar

DPGDP= the deflated Polish gross domestic product, billion zlotys

WPRIC= world price of wheat, $/1000 kg

The equations used to estimate Hungarian production and export behavior are as follows:

HPROD=HAREA+HAPOP+HFERT+WPRIC

where:

HPROD= annual wheat production, metric tons

HAREA= annual hectares of wheat produced annually

HAPOP= percentage of the population involved in agriculture

HFERT= annual gross fertilizer use, metric tons

WPRIC= world price of wheat, $/1000 kg

Exports

NHEXP=HPROD+HRATE+HGDPD+DHCAPF+HLIB

where:

NHEXP= net wheat exports, metric tons

HPROD= annual wheat production, metric tons

HRATE= foreign exchange rate, forint/dollar

HGDPD= deflated gross domestic product, billion forint

DHCAPF= deflated gross capital formation, billion forint

HLIB= the degree of consumer price freedom, % of all consumer prices

The selection of the variables to be included in this estimation process was not a chance occurrence. Basic economic theory was employed so that only variables that have a measurable influence upon production, imports, and exports would be included in the system. These variables were then used in preliminary regressions and only those that had significant, measurable influence on the left hand side variables were included in the final equations.

Twenty years of annual data are used in the estimation process and two different equations are estimated for each country. The following section will detail the sources of data used in the estimation process.

Justification of Variable Choice

When modeling the production behavior of an entity in the agricultural sector it is traditional to describe production as a function of land, labor, and capital. This is the standard approach which has been chosen in this study. The production models for both Poland and Hungary model wheat production as a function of land, labor, and capital or, more formally:

$$HPROD=f(HAREA,HAPOP,HFERT,WPRIC) \tag{30}$$

The expected relationships between these variables and wheat production is as follows.

HAREA, which represents land use, is expected to have a positive relationship with production. That is, as the area planted to wheat increases, production is also expected to increase. Although there is an increase in production, the marginal productivity of the new acreage is expected to be lower since this new land is likely to be of lower quality and therefore less productive than the original base acreage.

HAPOP represents the labor employed in wheat production. In this case the variable being used is the percentage of the Polish labor pool that is employed in agricultural production. This variable is expected to have an inverse relationship with production. As the number of people involved in agriculture decreases, production is expected to increase. This is due to the adoption of new, labor saving technology which frees up skilled labor which may then be put to more a efficient use in other areas.

HFERT is used to represent the use of capital in wheat production. This variable is expected to have a positive relationship with production. As the use of appropriate capital, such as fertilizer, herbicides, pesticides, and machinery is increased, production is also expected to increase.

WPRIC is the price of wheat on the world market, in dollars/1000kg. This variable is also expected to have a positive sign. As the price of wheat increases, rational producers will increase their production in response to this new opportunity to increase returns and profit.

The variables included in the Polish production equation are slightly different than those explained above. In the Polish case wheat area (PAREA), fertilizer use (PFERT), and agricultural population (PAPOP) are included in the production equation, but instead of using the world price of wheat (WPRIC) as an additional explanatory variable, carryover stocks (PSTKS) are substituted into the equation. This change is made for two reasons. First, in many situations carryover stocks, or the amount of wheat left on hand at the beginning of a new year, can greatly influence farmers' production decisions during the current year. In general, the higher the level of stocks, the greater the downward pressure they place on the price of wheat. This would indicate that stock levels would be negatively related to production. The second reason to make this substitution is the significance of price in the system. Preliminary runs of different versions of this model have indicated that price is not a significant variable in the Polish production decision. This is probably due to the traditional mind set of Polish farmers that there will always be a market for whatever product they produce. As farmers become more responsive to market signals this situation may change.

Traditional demand analysis would include demand shifters such as the population of the country in question, the income level in the country, the prices of complementary and substitute products, tastes and preferences of the population, and the future expectations of the population. Since the analysis in question is of an international nature, the foreign exchange rate, or the price of foreign currency should also be included in the equation. Specifically, the Polish import equation is:

$$PIMP=f(PPROD, PRATE, PGDP, WPRIC) \qquad 31$$

This equation specifically states that Polish imports of wheat (PIMP) are a function of wheat production in Poland (PPROD), the foreign exchange rate between Poland and the United States (PRATE), the deflated Gross Domestic Product of Poland (PGDPD), and the world price of wheat (WPRIC).

In theory, production, PPROD, and imports should have an inverse relationship. As production increases, the need or demand for imports should decrease as more of the demand for wheat is satisfied through domestic production.

The same type of relationship would exist between the demand for imports and the exchange rate. As the zloty strengthens, it takes fewer zlotys to purchase each dollar, imports should increase as they are relatively cheaper in zloty terms. In more general terms, as the exchange rate decreases, wheat imports increase.

In contrast to the previous variables, PGDPD and imports have a positive relationship. As gross domestic product increases (a proxy for income) purchases of imported wheat should also increase. The inference here is that as the country becomes more affluent, demand for food products, such as wheat, increases.

WPRIC, or the world price of wheat, in theory should have a negative relationship with imports. As the price of wheat increases, rational consumers would be willing to buy less of it, assuming that wheat is a normal good and not a Giffen good.

The export equation for Hungary also contains elements that may be interpreted as traditional supply shifters. These factors include technology, price expectations, costs of production, storage costs, and the length of time involved. In addition to these factors, research has also shown that the influence of institutional factors also has an impact on export decisions. Variables that model these factors will also be included in the model. Specifically, the model to be estimated is:

$$NHEXP=f(HPROD,HRATE,HGDPD,DHCAPF,HLIB) \tag{32}$$

In this equation net Hungarian wheat exports (NHEXP) are a function of wheat production, the foreign exchange rate, the deflated Gross National Product, deflated Gross Capital Formation, and the degree of consumer price liberalization.

HPROD or Hungarian wheat production would be expected to have a positive relationship with exports. As production increases and consumption remains constant, or increases less than production, more wheat is available for export.

The foreign exchange rate, HRATE, would theoretically have an inverse relationship with exports. As the forint (Hungarian currency) strengthens Hungarian wheat becomes relatively more expensive on the world market, lowering exports from Hungary.

HGDPD, the deflated Gross National Product, is expected to have a positve relationship with exports. As consumer incomes increase tastes may change or alternative products become more affordable, freeing up more wheat to move into the export market.

The deflated Gross Capital Formation (DHCAPF) is one of the institutional variables included in this equation. The expectation is that as capital formation increases, more productive assets are constructed, a disproportionate amount of this new capital will be funneled into industrial uses.

If this assumption is correct then this variable would be inversely related to exports. Agriculture, by receiving less capital, would have reduced productivity due to using older, less efficient capital in wheat production.

HLIB, or the degree of consumer price liberalization in the Hungarian economy is another of the institutional variables in this model. This variable represents the percentage of Hungarian consumer prices which have been freed to respond to market forces. Theory would say that this variable would be inversely related to exports. As more prices are allowed to rise to world levels, domestic wheat appears to be relatively cheaper than before so more is purchased on the domestic market, leaving less to export.

DATA

The data for this study was derived from a variety of sources. Each of these sources will be specified and the data from each will be identified.

Data concerning trade and other international commercial activity came from the FAO Trade and Commerce Yearbook. This includes the import and export figures for both Poland and Hungary and the world price of wheat. The wheat price was also taken from this source in order to have a long term, consistent series.

Figures on production, total population, farm population, and arable land amounts are from the FAO Production Yearbook. These figures were cross checked against other data sources in order to verify their accuracy. Production amounts and land use prior to 1985 were checked against USDA data contained in Agricultural Statistics of Eastern Europe and the Soviet Union, 1965-85. Total population figures were also gleaned from International Financial Statistics. Data were also checked against unofficial data from the USDA database. At this point a comment about the agricultural population figures is necessary. Data for 1983 and 1984 could not be located. To fill this gap figures were extrapolated from 1982 and 1985. The change between these years was calculated and divided by two in order to fill these two gaps. This same process was also used to provide data for 1973 and 1974. This process was necessary due to gaps in the data series.

The financial data employed, gross national products, consumer price indices, exchange rates, and capital formation all came from various issues of International Financial Statistics.

The source of the fertilizer use figures was the FAO Fertilizer Yearbook. This data was also checked against the data sources mentioned proviously to insure accuracy.

CHAPTER V

Empirical Results

To explain the empirical results of these two systems of equations they will be dealt with individually in this chapter, beginning with the Polish system.

The output of 3SLS using SHAZAM includes two test statistics that determine the validity of the model. These are a Wald test (of the null hypothesis that the slope coefficients are jointly zero) and a Lagrange multiplier test (of the null hypothesis that the covariance matrix is diagonal). Each of these statistics will be examined separately in the following paragraphs.

The Wald test is performed by constructing an equivalent statistic, a Chi-square statistic that is equivalent to performing a likelihood ratio test to determine whether all of the slope coefficients in a multiple regression model are zero. This statistic is calculated as:

$$\chi^2=-N(\log(1-\tilde{R}^2)) \qquad 33$$

The critical value for this statistic at the .025 level of significance is 16.0128 with seven degrees of freedom. The calculated Chi-square for this statistic is 68.848. Therefore, it can be concluded that the slope coefficients in the model are not jointly equal to zero.

The second statistic calculated is a Lagrange Multiplier test for a diagonal covariance matrix. In SHAZAM this is computed as:

$$\lambda = N\sum_{i=1}^{M}\sum_{j=1}^{i-1} r_{ij}^2 \qquad 34$$

Under the null hypothesis that a diagonal covariance does exist, this statistic has an asymptotic Chi-square distribution: $\chi^2_{(M(M-1)/2)}$ 35

If the covariance matrix is not diagonal, meaning that the variance is not minimized by the estimation process, the resulting parameter estimates will be biased. The critical value for this statistic at the .025 significance level is 5.02389. Since the calculated value is 2.1176 the null hypothesis cannot be rejected and the assumption of a diagonal covariance matrix is accepted. The R^2 for the system is also reported although it must be interpreted carefully since it is usually very high. The R^2 for this system is .968. However, recent studies have shown that R^2 should only be considered a consistent estimator of explained variation in the dependent variable, not as a gauge of the adequacy of the model specification (McGuirk and Driscoll). Since the system R^2 falls into the latter category it should not be viewed as a factor by which to judge the system.

As reported in the previous chapter the Polish system consists of two separate equations, a wheat production equation and an import demand equation. Since the results of the production equation are included in the import demand equation it will be dealt with first.

The production equation that was actually estimated is:

$$PPROD=\alpha_1+\alpha_2 PAREA+\alpha_3 PFERT+\alpha_4 PAPOP+\alpha_5 PSTKS \qquad 36$$

In this equation Polish wheat production is a function of the planted area, fertilizer use, the percentage of the population involved in agriculture, and the level of carryover stocks present at the beginning of the year. The actual estimated parameters are:

$$PPROD=-2008+4.6401PAREA+1.9103PFERT-40.084PAPOP -0.55532PSTKS \qquad 37$$

The R^2 for this equation is .882, meaning that over 88% of the variability in Polish wheat production is explained by this model (Table 1). Each of the variables will be examined as to correct sign, magnitude, and significance in the following paragraphs.

PAREA, or the area planted to wheat annually in Poland is 4.6401, implying that for each additional hectare of land allocated to wheat production in Poland total wheat production would increase by 4.6401 metric tons. The sign on this variable is theoretically expected to be positive, and it is. The magnitude of this parameter is also of an

TABLE 1. RESULTS OF POLISH WHEAT PRODUCTION REGRESSION

DEPENDENT VARIABLE= PPROD

VARIABLE	ESTIMATED COEFFICIENTS EQUATION 1
PAREA	4.6401 (8.412)***
PFERT	1.9103 (1.272)
PAPOP	-40.084 (-2.144)***
PSTKS	-0.55532 (-0.983)
CONSTANT	-2008 (-1.516)

n=20

R^2 EQUATION 1= .882

VARIABLE DEFINITIONS

PPROD= annual wheat production in Poland

PAREA= hectares of wheat produced annually in Poland

PFERT= total annual fertilizer use in Poland

PAPOP= percentage of Polish population involved in agriculture

PSTKS= carryover stocks at the beginning of the year

numbers in parenthesees are t ratios

* =significant at p=.1
** =significant at p=.05
***-significant at p=.025

acceptable level since the long run average yield for Polish wheat is very near this figure. This parameter also has a high level of significance, p=.025, implying that we can be 97.5% sure that this parameter is different from zero.

PFERT, or the gross use of fertilizer in Poland is 1.9103, implying that for each additional metric ton of fertilizer applied production would increase by 1.9103 metric tons. The expected sign on this variable was also expected to be positive, and it is. However, this variable is not significant at an acceptable level, being accepted at a level of less than p=.1. Although the variable is not significant it was left in the equation for theoretical reasons.

PAPOP the percentage of the Polish population involved in agriculture is -40.084. This implies that as the percentage of the Polish labor force involved in agriculture decreases 1%, wheat production will increase 40,084 metric tons. This reflects the theoretical relationship that was expected to exist, that as more people leave the small plots that exist in Poland production will increase. This migration off the farm allows the remaining farmers to accumulate farms of a size that will allow for specialization and adoption of modern production methods. This variable is also highly significant, being accepted at the p=.025 level of significance.

PSTKS, or the carryover stocks that are held in the country is also included in the model, although it is not significant at an acceptable level. This variable is also left in the model for theoretical reasons since the amount of wheat on hand should have some degree of influence on future production decisions. Although the variable is not significant its magnitude is of an acceptable size. Although only two of the variables included in the equation were found to be significant the equation was accepted because of its theoretical soundness and high R^2.

The import demand equation estimated is:

$$PIMP=\alpha_1-\alpha_2 PPROD-\alpha_3 PRATE+\alpha_4 PGDPD+\alpha_5 WPRIC \qquad 38$$

Two versions of this equation were estimated to determine the significance of the world price of wheat in the Polish import decision. Since the price of wheat was not significant in the first equation, this variable was omitted in the final version of the model. The final empirical equation estimated is:

$$PIMP=2308.5-.0463PPROD-0.068872PRATE+0.00026637PGDPD \qquad 39$$

This equation has an R^2 of .8584, explaining nearly 86% of the variation in Polish wheat imports (Table 2). Also, all of the variables included have the theoretically expected signs and are all significant.

PPROD or the production of wheat in Poland has the theoretically expected negative sign. That is, as wheat production increases one metric ton imports decrease 0.48556 metric tons. This parameter appears to be of an acceptable magnitude, that imports and domestic production have an

TABLE 2. RESULTS OF POLISH IMPORT REGRESSIONS

DEPENDENT VARIABLE= PIMP

VARIABLE	ESTIMATED COEFFICIENTS EQUATION 1	ESTIMATED COEFFICIENTS EQUATION 2
PPROD	-0.463 (-4.745)***	-0.48556 (-5.608)***
PRATE	-0.068872 (-2.522)***	-0.064903 (-2.478)***
PGDPD	.00026637 (5.173)***	.00026797 (5.18)***
WPRIC	2.1072 (0.5011)	
CONSTANT	2308.5 (2.322)***	2742.6 (5.468)***

n=20

R^2 equation 1= .8614
R^2 equation 2= .8584

VARIABLE DEFINITIONS

PIMP= annual Polish imports of wheat

PPROD= annual Polish wheat production

PRATE= foreign exchange rate, zlotys/dollar

PGDPD= deflated Polish Gross Domestic Product

WPRIC= world price of wheat

numbers in parenthesees are t ratios

* = significant at p=.1
** = significant at p=.05
***= significant at p=.025

approximate .5 to 1 relationship. This parameter is also significant at the p=.025 level, making production a significant factor in Polish wheat import decisions.

PRATE, the exchange rate between the Polish zloty and the U.S. dollar, also has the theoretically expected negative sign and is highly significant. As the exchange rate, zlotys/dollar, decreases or the zloty becomes stronger, wheat imports will increase 0.064903 tons for each zloty per dollar gain in the strength of the zloty. This parameter is also significant at the p=.025 level, making the exchange rate another major factor in the level of Polish wheat imports.

PGDPD or the deflated annual Polish GDP is the final variable in this equation. This variable also has the theoretically expected sign, a positive relationship with imports. This relationship implies that as GDP increases by one billion zlotys wheat imports will increase by 267.97 metric tons. The magnitude of this parameter is also in the expected range. In 1990 the Polish GDP was 606,726 billion zlotys while wheat imports were 985,300 metric tons.

The model diagnostics for this system are calculated as explained previously. The Wald test statistic is a Chi-square of 53.588 with 8 degrees of freedom. This is well above the critical value of 17.5345 at the 0.025 significance level. It may then be concluded that the estimated slope coefficients are not jointly equal to zero. The Lagrange Multiplier statistic is also accepted in this case. The calculated statistic is .96929 and the critical value is 5.02389. Again the null hypothesis cannot be rejected and the assumption that there is a diagonal covariance matrix is accepted.

The Hungarian system that is estimated in this analysis is similar to the Polish model. It is also a two equation system with one equation modeling production behavior and the second modeling wheat export behavior. As with the Polish system information from the production equation is included in the export equation so it will be dealt with first in the explanation process. The actual equation estimated is as follows:

$$HPROD=\alpha_1+\alpha_2 HAREA-\alpha_3 HAPOP-\alpha_4 HFERT \qquad \textbf{40}$$

In this equation Hungarian wheat production is modeled as a function of planted acreage, the percentage of the population involved in agriculture, and total fertilizer use in the country. The world price of wheat was included in a preliminary version of the model but was not significant and was dropped from the final version of the equation. The estimated parameters of the final equation are:

$$HPROD=-2248.4+9.966HAREA-251.81HAPOP-2.9155HFERT \qquad \textbf{41}$$

This equation has an R^2 of .8574, explaining nearly 86% of the variation in wheat production (Table 3). The only troubling factor in this equation is the negative sign on the fertilizer variable. This will be dealt with in the following paragraphs.

TABLE 3. RESULTS OF HUNGARIAN WHEAT PRODUCTION REGRESSIONS

DEPENDENT VARIABLE= HPROD

VARIABLE	ESTIMATED COEFFICIENT EQUATION 1	ESTIMATED COEFFICIENT EQUATION 2
HAREA	10.568 (7.723)***	9.966 (7.627)***
HAPOP	-262 (-8.197)***	-251.81 (-7.988)***
HFERT	-3.4153 (-2.216)***	-2.9155 (-1.914)**
WPRIC	4.3928 (1.061)	
CONSTANT	-3352.5 (-2.094)**	-2248.4 (-1.733)*

n=20
R^2 equation 1 = .8658
R^2 equation 2 = .8574

VARIABLE DEFINITIONS

HPROD= annual Hungarian wheat production

HAREA= hectares of wheat produced annually in Hungary

HAPOP= percentage of the population involved in agriculture

HFERT= total annual fertilizer use in Hungary

WPRIC= world wheat price (in dollars)

Numbers in parenthesees are t ratios.

* =significant at .1
** =significant at .05
*** =significant at .025

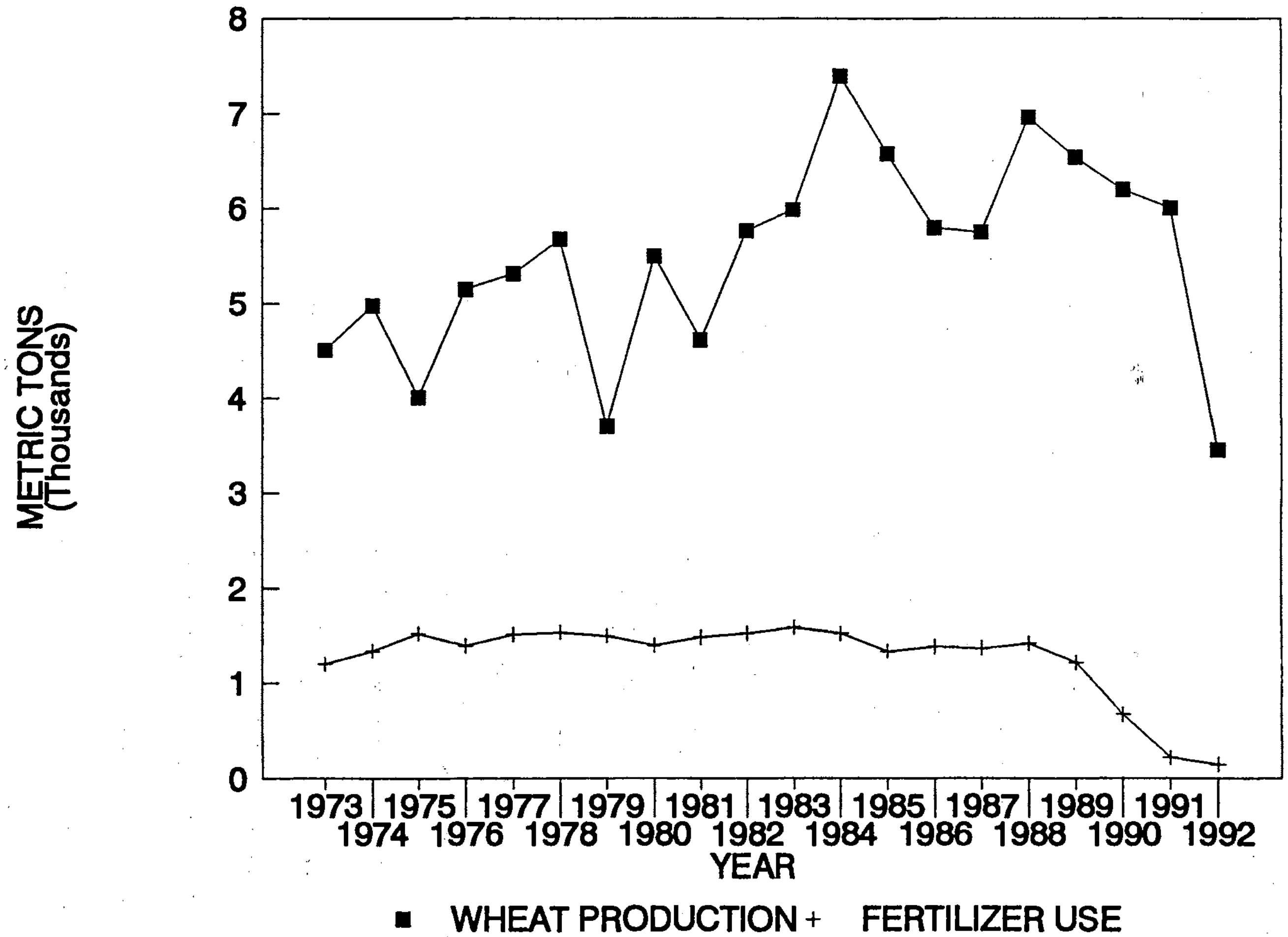
HAREA, the actual number of hectares planted to wheat each year in Hungary, has the theoretically expected positive sign, indicating a positive relationship with production. As wheat acreage increases by one hectare production increases by 9.966 metric tons. This parameter is also of a reasonable magnitude although it is slightly above the average wheat yield in Hungary. This parameter is significant at the p=.025 level.

HAPOP or the percentage of the population involved in Hungarian agriculture also has the expected negative sign, indicating that as fewer people are involved in production agriculture specialization occurs and modern technology is adopted, increasing yields. The magnitude of this parameter indicates that as the percentage of the population engaged in agriculture decreases by one percent, exports increase 251.81 metric tons. This parameter is also significant at the p=.025 level.

HFERT is the annual total fertilizer use in Hungary. However, this parameter does not have the theoretically expected positive sign, although it is significant at the p=.05 level. This negative relationship may be explained by examining a graph of fertilizer use and wheat production (Figure 2). The high level of volatility in wheat production may be observed while fertilizer use remains relatively constant. This fact would lead to the conclusion that factors other than fertilizer use, such as weather or management skills, have a larger impact on production levels than does fertilizer use. The fertilizer variable was left

WHEAT PRODUCTION AND FERTILIZER USE

HUNGARY 1973-1992



in the equation for theoretical reasons even though the sign is wrong.

As mentioned previously the price of wheat was not included since it proved not to be significant in previous versions of the model. This final version of the equation was chosen because of the high R^2 and the theoretical soundness of the equation.

The Hungarian export equation is quite different from traditional export demand equations in its inclusion of two institutional variables to model the changes that have occurred in the Hungarian economy over the past twenty years and how these changes have impacted the export behavior in the country. The equation to be estimated is:

$$NHEXP=\alpha_1+\alpha_2 HPROD+\alpha_3 HGDPD-\alpha_4 DHCAPF-\alpha_5 HLIB \quad 42$$

This equation states that net Hungarian exports of wheat are a function of wheat production, the level of the deflated Hungarian gross domestic product, the deflated level of gross capital formation in the economy, and the degree of consumer price liberalization. The exchange rate, forint/dollar was also included in previous versions of the model but was dropped from the final equation due to its lack of significance.

The estimated parameters for this equation are:

$$NHEXP=2051200+17.349HPROD+2830.5HGDPD-11406DHCAPF-1606400HLIB \quad 43$$

The production variable is the only traditional variable that remains in the export equation. Although this equation only explains about 60% of the variation in Hungarian wheat exports, R^2 of .6029, it does demonstrate how influential institutional factors can be in tightly controlled economies (Table 4). As may be observed by an examination of the results of the regression, all of the institutional variables are significant at the p=.025 level. In addition, production is found not to be a significant factor in Hungarian export behavior. Each of these variables will be dealt with individually in the following paragraphs.

As mentioned previously the production variable, HPROD, is not a significant factor in wheat exports. This variable was left in the equation for theoretical reasons, since logically the level of production should have some degree of influence on export behavior.

HGDPD, the deflated gross domestic product in Hungary has the theoretically correct positive relationship with exports. The results here suggest that as HGDPD increases by one billion forint (Hungarian currency) exports will increase 2830.5 metric tons. The magnitude of this change is reasonable since this is approximately a one third increase in GDP and also close to a one third increase in exports. This variable is also significant at the p=.025 level, making it a very influential factor in wheat exports.

The deflated gross capital formation in the Hungarian economy, DHCAPF, is another significant factor in wheat exports. It is also significant at the p=.025 level. The

TABLE 4. RESULTS OF HUNGARIAN EXPORT REGRESSIONS

DEPENDENT VARIABLE= NHEXP

VARIABLE	ESTIMATED COEFFICIENTS EQUATION 1	ESTIMATED COEFFICIENTS EQUATION 2
HPROD	17.349 (0.2111)	35.602 (.4319)
HRATE		-2230.7 (-.2486)
HGDPD	2830.5 (2.524)***	2530.1 (2.08)**
DHCAPF	-11406 (-3.247)***	-11373 (-3.039)***
HLIB	-1606400 (-2.215)***	-1532500 (-2.105)**
CONSTANT	2051200 (2.179)***	2309300 (1.509)*

n=20
R^2 equation 1 = .6029
R^2 equation 2 = .6047

VARIABLE DEFINITIONS

NHEXP= net wheat exports from Hungary

HPROD= annual wheat production in Hungary

HRATE= currency exchange rate, forint/dollar

HGDPD= deflated Hungarian gross domestic product

DHCAPF= deflated gross capital formation in Hungary

HLIB= degree of consumer price liberalization in Hungary

numbers in parenthesees are t ratios

*= significant at .1
**= significant at .05
***= significant at .025

relationship estimated here is that as gross capital formation increases by one billion forint exports will decrease by 11,406 metric tons. This relationship semms to be of a reasonable magnitude as Hungarian exports of wheat in 1990 was 1,160,100 metric tons and the gross capital formation was 370 billion forint.

HLIB, the degree of consumer price liberalization, is the final variable in this equation. This variable has the theoretically expected negative sign, indicating that as Hungarian prices rise to near world prices exports will decrease. The relationship indicated here is that as prices are liberalized 1%, exports will decrease 1,606,400 metric tons. This would suggest that as Hungary continues to move toward total price freedom it will move out of the export market and become a net importer of wheat.

Elasticities were not calculated in this study due to the fact that prices were not found to be significant factors in either Polish import or Hungarian export behavior.

CHAPTER VI

Summary and Conclusions

The purpose of this research has been to examine the economic changes occurring in Poland and Hungary and to determine the effects of these institutional changes on the domestic wheat markets of each country. A second objective is to extrapolate these results to determine what effects may be observed in the world wheat market.

The two systems of equations employed in this analysis have conceptualized and estimated the inter-related factors which determine production and import behavior in Poland and production and export behavior in Hungary. The main purpose of this examination has been to include a variety of institutional variables in the analysis to demonstrate their impact on decisions that have traditionally been modeled as price or income driven. These factors will be the focus of this final chapter.

Poland

Although the Polish system follows a very traditional path, institutional variables are significant in both equations. Production is modeled as a function of planted area, fertilizer use, carryover stocks, and the percentage of the population involved in agriculture. PAPOP is one institutional variable in this equation although, the fertilizer use variable also has an institutional dimension. As was reported before, PAPOP is significant at the p=.025

level and is an important factor in wheat production. For each 1% decrease in the percentage of the population involved in agriculture, production of wheat increases 40.084 metric tons. This implies that there are gains to be made from increasing farm sizes and the adoption of modern technology. However, there is a limit to these gains as there must be some level of farm workforce to insure adequate production.

The fertilizer variable, PFERT, may also be viewed as having an institutional dimension. This variable may be a proxy for change in the input delivery system. Although this variable is not significant in this equation it could gauge the efficiency of input delivery and allocation as the old command system of input distribution is replaced with a market driven system.

In the second equation of this system Polish wheat imports are modeled as a function of Polish wheat production, the exchange rate, and the level of the deflated Gross Domestic Product. This equation explains over 85% of the variation in wheat imports. Each of the individual variables is significant at the p=.025 level, making each variable individually important when attempting to predict Polish import behavior. In addition, the magnitude of each of the parameters is of a reasonable or expected size.

Although the variables included in this equation are not entirely institutional in nature they do have institutional dimensions. The institutional factors that were included in the production equation are carried into this equation through the production variable, PPROD. This includes all the information contained in both PFERT and PAPOP about the institutional influences of these variables. In addition, the exchange rate, PRATE, is determined through an institutional decision. Whether this rate is market determined or set by the government the decision is a conscious choice of the government.

The Gross Domestic Product, PGDPD, is also determined by the government. Formerly in Poland income was determined by the government since it set all wage rates and allocated resources to industry. Increases in GDP could then be viewed as a loosening of government control in this area.

The system diagnostic tests performed also bolster the contention that this model is a good representation of the actual behavior exhibited by Poland in the wheat import market. The tests confirm that the estimated parameters are indeed jointly different from zero, just as the t statistics for the individual parameters have shown. The hypothesis that a diagonal covariance matrix exists is also accepted, confirming one of the basic assumptions needed to use linear regression as an estimation tool.

The conclusions that may be drawn from this system are as follows. The production equation states that as area planted to wheat increases and the population involved in production agriculture decreases, Polish wheat production will increase. This is logical since as acres devoted to wheat production increase and as modern, efficient production methods are adopted production should increase.

The model does predict this behavior. Therefore, as the agriculture industry responds to market signals it should be expected that production will increase.

In the import equation wheat imports are modelled as a function of domestic production, the exchange rate, and the GDP level. Two of these variables have negative relationships with imports, PPROD and PRATE. These variables state that as production increases imports will decrease and as the zloty strengthens against the dollar imports will decrease. Both variables have the theoretically expected relationship with imports. As the economy is allowed to respond to market forces production should increase and the zloty should strengthen as confidence in the Polish economic transformation continues.

PGDPD, or the deflated Polish GDP has a positive relationship with imports. This result is also consistent with theory. As income increases and inadequate domestic production exists, imports will therefore increase to satisfy the existing excess demand. This variable will likely have less influence as the economic conversion continues and domestic production is increased.

Hungary

The Hungarian production equation is also traditional with production a function of planted area, fertilizer use, and the agricultural labor force. This equation explains over 85% of the variation in annual Hungarian wheat production. All three of the variables in this equation are significant at acceptable confidence levels. The one troubling factor in this equation is the sign on the fertilizer variable, which is negative instead of the theoretically expected positive sign. This may be explained by observing the graph of Hungarian wheat production and fertilizer use. As may be observed from the graph fertilizer use has been fairly constant from 1973 to 1989. During this time wheat production was highly volatile. It has only been in the past 3 years that fertilizer use and production appear to be correlated.

The explanations for the planted area and agricultural labor force are the same as for Poland. Production and acreage have the theoretically expected positive relationship. Planted acreage increases with production. Also, as the percentage of the labor force involved in agriculture declines, production increases. This result is consistent with theory. As modern production methods are adopted and land holdings move toward a more economically efficient size production is expected to increase.

The institutional dimensions of the variables is significant in the model. HAPOP, the percentage of the labor force involved in agriculture is the main institutional variable in this equation. This percentage is directly controlled by government decisions about the desired mix of agriculture and industry in the Hungarian economy. Although governmental control will lessen as the economy becomes more market oriented, influence can still be exerted through agricultural or industrial policy decisions. Unfortunately, since the sign on the fertilizer variable is not consistent with theoretical expectations no conclusions may be drawn as to the institutional influences of this variable.

The export equation for Hungarian wheat does not explain as much of the variation in wheat exports as the other equations in the system, 60.29%, although it does demonstrate the impact of institutional variables. Three of the four variables in this equation have strong institutional links and all three are significant factors in Hungarian wheat exports. All three variables, deflated GDP, deflated fixed capital formation, and the degree of consumer price liberalization are significant at the p=.025 level and have the theoretically expected signs. Each of these variables is closely controlled in a command economy and the relaxation of that control has significant impacts on behavior in all sectors of the economy.

The first observation that may be made about this equation is that production is not a significant determinant in the Hungarian export decision. This would imply that there are other institutional arrangements which will be honored despite production levels, such as bilateral trade agreements.

As GDP increases, as a proxy for income, exports are expected to increase. This is predicted by theory and the magnitude of the parameter is acceptable. The implication here is that as Hungarian income increases consumers will switch away from wheat consumption making more available for export.

Gross capital formation and the degree of price liberalization both have the theorized negative relationship with exports and of acceptable magnitudes. These parameters imply that as capital formation increases, and prices are allowed to respond to market signals, wheat exports will decrease. This is due to the lowering of agricultural subsidies, making domestic wheat relatively cheaper than other substitutes, increasing consumption. The negative sign on capital formation implies that agriculture will receive less productive capital than industry, lowering exports as industry increases in importance in the economy.

Conclusions

The main conclusion drawn from this system is that as the Hungarian economy moves to a market based system, less wheat will be exported. Although Hungary is a small exporter this withdrawal from the export market should have a small, but positive effect on world wheat prices.

The second conclusion is that as the Polish economic conversion continues imports of wheat will decline. Production increases will replace imports and Poland will become self sufficient in wheat, impacting the world market in a slight, but negative manner.

Although neither of these countries are large enough players in the world wheat market to have major impact on price levels they do provide an opportunity to study the impact of institutional change in evolving market economies. As time passes, and more data becomes available a closer examination of the success of the conversion methods employed will be possible.

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APPENDIX

Table 5. POLISH WHEAT PRODUCTION, FERTILIZER USE, WHEAT AREA, CARRYOVER STOCKS, AND AG LABOR FORCE

YEAR	WHEAT PRODUCTION (1000 MT)	FERTILIZER USE (1000 MT)	PLANTED ACREAGE (1000 HA)	CARRYOVER STOCKS (MT)	AG LABOR FORCE (% OF TOTAL)
1973	5807	442.23	1962	300	36.49
1974	6408	448.29	2022	600	33.53
1975	5207	422.46	1842	900	34.6
1976	5745	447.13	1832	100	33.7
1977	5310	437.85	1834	170	32.8
1978	6029	445.34	1852	169	32
1979	4187	369.89	1549	330	31.2
1980	4200	391.49	1609	334	28.5
1981	4203	332.75	1418	397	29.5
1982	4476	328.58	1456	308	28.7
1983	5165	330.29	1537	268	26.9
1984	6010	394.44	1706	20	25.62
1985	6461	418.53	1885	130	24.4
1986	7502	466.21	2025	21	23.7
1987	7942	515.23	2132	570	22.9
1988	7582	482.78	2179	720	22
1989	8462	539.04	2195	702	21.5
1990	9026	500.47	2281	672	20.8
1991	9720	290.13	2437	748	20.1
1992	7368	185.68	2405	714	19.5

Source: FAO Production Yearbook
FAO Fertilizer Yearbook

TABLE 6. POLISH GROSS DOMESTIC PRODUCT, EXCHANGE RATE, CONSUMER PRICE INDEX, WHEAT IMPORTS

YEAR	GROSS DOMESTIC PRODUCT (BIL ZLTY)	EXCHANGE RATE (ZLTY/$)	CONSUMER PRICE INDEX (1985=100)	WHEAT IMPORTS (1000 MT)
1973	1,065,148	3	16.7	1,619.689
1974	1,209,202	3	17.9	1,758.23
1975	1,350,158	3	18.3	1,477
1976	1,593,143	3	19.1	2,311.638
1977	1,736,113	3	20.1	2,593.485
1978	1,903,138	33	21.7	2,271.5
1979	2,207,175	39	23.2	2,927.421
1980	2,511,164	46	25.4	3,384.218
1981	2,753,177	56	30.8	3,448.337
1982	5,546,161	86	61.9	3,787.22
1983	6,924,158	98	75.5	2,413.6
1984	8,576,153	126	86.9	2,098.06
1985	10,367,138	148	100	1,809.4
1986	12,953,115	198	117.7	1,661.1
1987	16,940,114	316	147.7	2,341.6
1988	29,629,146	503	236.1	2,316.9
1989	118,319,171	6,500	828.9	2,242
1990	606,726,137	9,500	5,684.3	985.3
1991	825,265,129	10,957	9,680.2	-196
1992	1,149,442,151	15,767	13,846.8	5.2

Source: International Financial Statistics
FAO Trade and Commerce Yearbook

TABLE 7. HUNGARIAN WHEAT PRODUCTION, FERTILIZER USE, PLANTED AREA, AND AG LABOR FORCE

YEAR	WHEAT PRODUCTION (1000 MT)	FERTILIZER USE (1000 MT)	PLANTED AREA (1000 HA)	AG LABOR FORCE (% OF TOTAL)
1973	4502	280.06	1294	21.52
1974	4971	320.64	1324	20.7
1975	4007	344.58	1251	19.9
1976	5148	335.89	1325	19
1977	5312	365.66	1311	18.2
1978	5677	378.59	1324	17.3
1979	3709	318.21	1135	16.5
1980	5500	334.36	1276	15.7
1981	4614	320.76	1151	14.9
1982	5762	377.42	1310	14.2
1983	5985	406.02	1355	14.3
1984	7392	391.67	1361	14.4
1985	6573	342.53	1358	14.5
1986	5793	344.36	1318	13.9
1987	5748	337.76	1301	13.3
1988	6962	343.15	1281	12.7
1989	6540	286.93	1242	12.1
1990	6198	142.25	1121	11.5
1991	6008	48.18	1152	11
1992	3453	24.94	848	10.5

Source: FAO Production Yearbook
FAO Fertilizer Yearbook

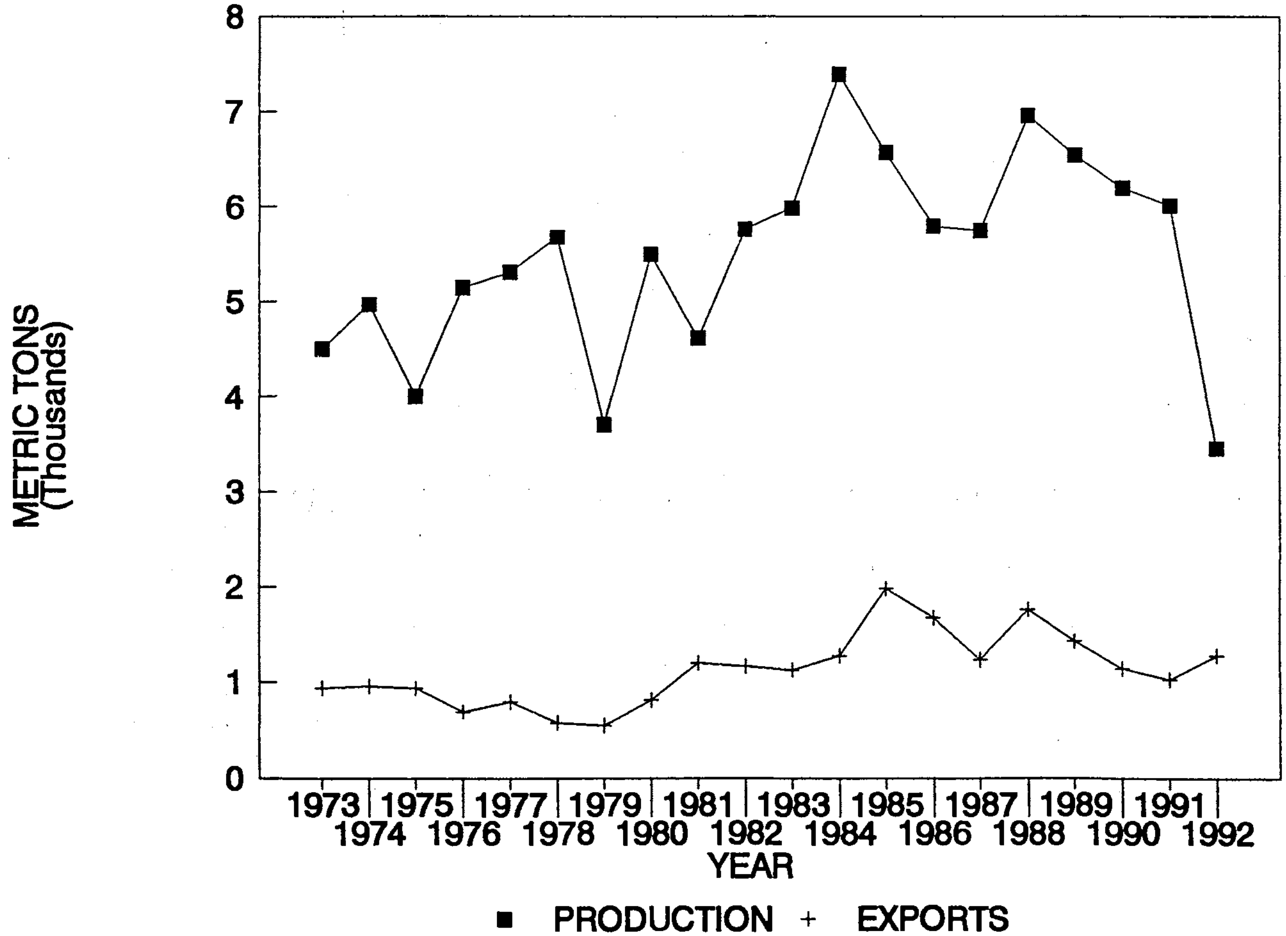
TABLE 8. HUNGARIAN GROSS NATIONAL PRODUCT, EXCHANGE RATE, CONSUMER PRICE INDEX, GROSS CAPITAL FORMATION, AND DEGREE OF CONSUMER PRICE LIBERALIZATION

YEAR	GROSS DOMESTIC PRODUCT (BILLION FORINT)	EXCHANGE RATE (FORINT/ DOLLAR)	CONSUMER PRICE INDEX 1985=100	GROSS CAPITAL FORMATION (BILLION FORINT)	CONSUMER PRICE LIBERALIZ ATION (% OF TOTAL)
1973	429	48.966	50.2	139.2	23
1974	448.9	46.752	51.1	161	23
1975	482.7	43.971	53	161	23
1976	528.9	41.575	55.8	168.2	23
1977	582	40.961	58	197.7	23
1978	629.7	37.911	60.7	214.4	23
1979	682.3	35.578	66.1	220.8	23
1980	721	32.532	72.3	207.7	55
1981	779.9	34.314	75.5	206.7	55
1982	847.9	36.631	80.8	213.9	56
1983	896.3	42.671	86	220	57
1984	978.5	48.042	93.5	225.4	56
1985	1033.7	50.119	100	232.1	57
1986	1088.8	45.832	105.3	261.2	61
1987	1226.4	46.971	113.9	303.5	68
1988	1408.8	50.413	132.5	295.6	62.5
1989	1730.4	59.066	154.8	345	77
1990	2076.5	63.206	199.5	370	90
1991	2308.4	74.735	279.5	440.9	90
1992	2805	78.988	331.2	571	90

Source: International Financial Statistics
FAO Trade and Commerce Yearbook
Economic Reform in Hungary Since 1968. IMF Occasional Paper no. 83, July 1991.

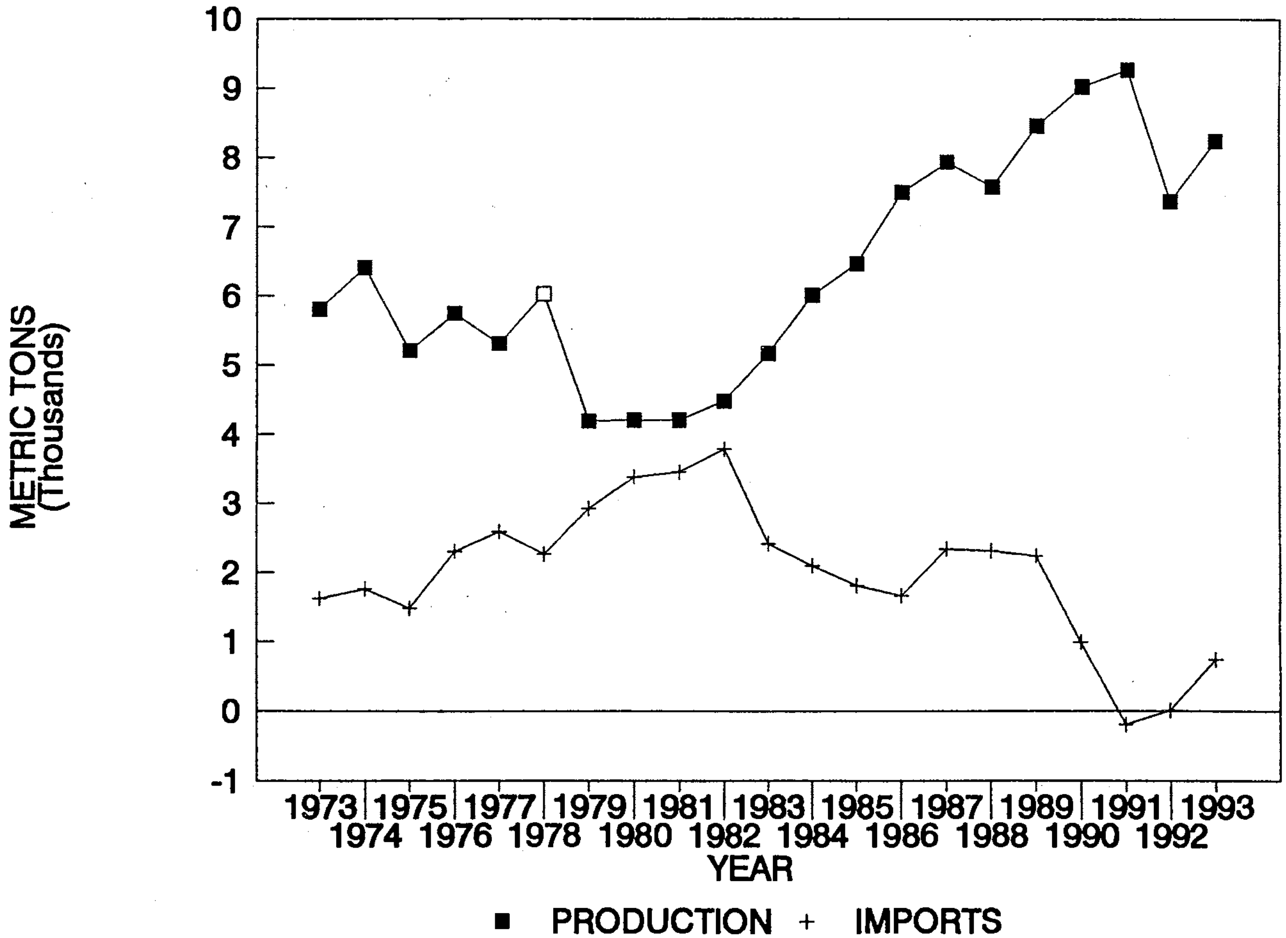
WHEAT PRODUCTION AND EXPORTS

HUNGARY 1973-1992



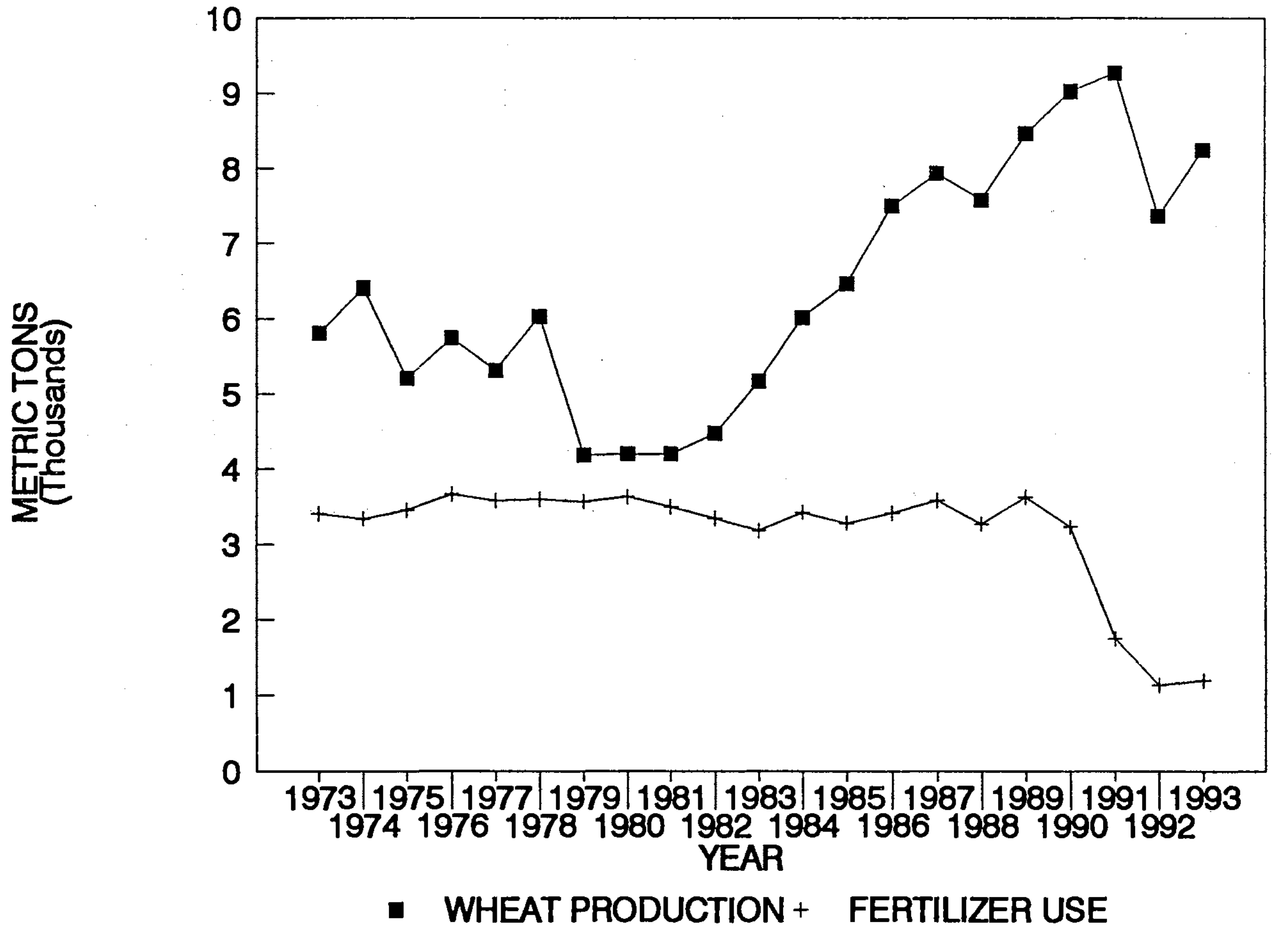
WHEAT PRODUCTION AND IMPORTS

POLAND 1973-1993



WHEAT PRODUCTION AND FERTILIZER USE

POLAND 1973-1993



```
SAMPLE 1 20
READ YEAR PIMP PPOP PPROD PRATE PGDP

     1973   1619.689      33360        5807      3       1065148
     1974    1758.23      33690        6408      3       1209202
     1975       1477      34022        5207      3       1350158
     1976   2311.638      34360        5745      3       1593143
     1977   2593.485      34698        5310      3       1736113
     1978     2271.5      35010        6029      33      1903138
     1979   2927.421      35225        4187      39      2207175
     1980   3384.218      35578        4200      46      2511164
     1981   3448.337      35900        4203      56      2753177
     1982    3787.22      36227        4476      86      5546161
     1983     2413.6      36571        5165      98      6924158
     1984    2098.06      36910        6010      126     8576153
     1985     1809.4      37203        6461      148     10367138
     1986     1661.1      37456        7502      198     12953115
     1987     2341.6      37664        7942      316     16940114
     1988     2316.9      37860        7582      503     29629146
     1989       2242      37960        8462      6500    118319171
     1990      985.3      38119        9026      9500    606726137
     1991       -196      38245        9720      10957   825265129
     1992        5.2      38365        7368      15767   1149442151

READ HIMP HEXP HPOP HPROD HRATE HGDP WPRIC
 902       940918     10430     4502     48.966        429   148
3994       965351     10480     4971     46.752      448.9   202
30536      967990     10532     4007     43.971      482.7   158
58458      748884     10600     5148     41.575      528.9   143
4344       803731     10650     5312     40.961        582   113
   0       573612     10685     5677     37.911      629.7   138
1689       550799     10710     3709     35.578      682.3   175
1090       822049     10707     5500     32.532        721   164
99899     1307190     10700     4614     34.314      779.9   177
 970      1172110     10702     5762     36.631      847.9   161
 660      1132210     10685     5985     42.671      896.3   158
 140      1280070     10620     7392     48.042      978.5   153
28100     2010400     10580     6573     50.119     1033.7   138
 300      1675700     10631     5793     45.832     1088.8   115
52300     1284600     10613     5748     46.971     1226.4   114
34600     1794200     10597     6962     50.413     1408.8   146
 100      1431200     10400     6540     59.066     1730.4   171
19500     1160100     10361     6198     63.206     2076.5   137
68700     1096000     10344     6008     74.735     2308.4   129
1400      1277200     10323     3453     78.988       2805   151


READ PAREA PFERT PAPOP HCORAT HCPI PSTKS
1962        442.23     36.49     .658    50.2    300
2022        448.29     33.53     .687    51.1    600
1842        422.46      34.6     .697    53      900
1832        447.13      33.7     .682    55.8    100
1834        437.85      32.8     .673    58      170
1852        445.34        32     .679    60.7    169
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```
1549        369.89      31.2     .692    66.1    330
1609        391.49      28.5     .715    72.3    334
1418        332.75      29.5     .714    75.5    397
1456        328.58      28.7     .707    80.8    308
1537        330.29      26.9     .716    86      268
1706        394.44     25.62     .711    93.5     20
1885        418.53      24.4     .729    100     130
2025        466.21      23.7     .745    105.3    21
2132        515.23      22.9     .738    113.9   570
2179        482.78       2.2     .736    132.5   720
2195        539.04      21.5     .698    154.8   702
2281        500.47      20.8     .723    199.5   672
2437        290.13      20.1     .82     279.5   748
2405        185.68      19.5     .816    331.2   714
READ HAREA HFERT HAPOP HCAPF HLIB
1294        280.06     21.52   139.2   .23
1324        320.64      20.7   161     .23
1251        344.58      19.9   161     .23
1325        335.89        19   168.2   .23
1311        365.66      18.2   197.7   .23
1324        378.59      17.3   214.4   .23
1135        318.21      16.5   220.8   .23
1276        334.36      15.7   207.7   .55
1151        320.76      14.9   206.7   .55
1310        377.42      14.2   213.9   .56
1355        406.02      14.3   220     .57
1361        391.67      14.4   225.4   .56
1358        342.53      14.5   232.1   .57
1318        344.36      13.9   261.2   .61
1301        337.76      13.3   303.5   .68
1281        343.15      12.7   295.6   .625
1242        286.93      12.1   345     .77
1121        142.25      11.5   370     .9
1152         48.18        11   440.9   .9
 848         24.940     10.5   571     .9
READ DPGDP DHGDP WPROD PCPI
 63.77246   8.545817  371.6   16.7
  67.5419   8.784736  356     17.9
 73.77049   9.107547  349     18.3
 83.40314   9.478495  413.4   19.1
 86.36816   10.03448  382.8   20.1
 87.69585   10.37397  447.7   21.7
 95.12931   10.32224  419.7   23.2
 98.85827   9.972337  442.1   25.4
 89.38312    10.3298  449.2   30.8
 89.59612   10.49381  479.7   61.9
 91.70861   10.42209  489.4   75.5
 98.68815   10.46524  511.5   86.9
   103.67     10.337  499.2   100
  110.051   10.33998  529.1   117.7
 114.9254   10.76734  502     147.4
 125.4934   10.63245  495     236.1
 142.7422   11.17829  533     828.9
 106.7372   10.40852  587.9   5684.3
 85.25289   8.259034  542.5   9680.2
```

```
83.01138   8.469203  560    13846.8
106.5985   8.234331  569.5  14597.3

GENR NHEXP=HEXP-HIMP
GENR HCPI=HCPI/100
GENR HGDPD=HGDP/HCPI
GENR DHCAPF=HCAPF/HCPI
GENR PCPI=PCPI/100
GENR PGDPD=PGDP/PCPI
SYSTEM 2  PRATE PGDPD PAREA PFERT PAPOP WPRIC PSTKS /DN
OLS PPROD PAREA PFERT PAPOP PSTKS
OLS PIMP PPROD PRATE PGDPD WPRIC PSTKS
SYSTEM 2 PRATE PGDPD PAREA PFERT PAPOP PSTKS WPRIC/DN
OLS PPROD PAREA PFERT PAPOP PSTKS
OLS PIMP PPROD PRATE PGDPD WPRIC
SYSTEM 2 PRATE PGDPD PAREA PFERT PAPOP PSTKS/DN
OLS PPROD PAREA PFERT PAPOP PSTKS
OLS PIMP PPROD PRATE PGDPD
SYSTEM 2 HRATE HGDPD HAREA HFERT HAPOP DHCAPF HLIB/DN
OLS HPROD HAREA HFERT HAPOP
OLS NHEXP HPROD HRATE HGDPD DHCAPF HLIB
SYSTEM 2  HGDPD WPRIC HAREA HFERT HAPOP HLIB DHCAPF/DN
OLS HPROD HAREA HFERT HAPOP WPRIC
OLS NHEXP HPROD HGDPD DHCAPF HLIB
END
```

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Welcome to SHAZAM - Version 7.0  -  APR 1993 SYSTEM=MS-DOS   PAR=   103

|_SAMPLE 1 20
|_READ YEAR PIMP PPOP PPROD PRATE PGDP
   6 VARIABLES AND       20 OBSERVATIONS STARTING AT OBS       1

|_READ HIMP HEXP HPOP HPROD HRATE HGDP WPRIC
   7 VARIABLES AND       20 OBSERVATIONS STARTING AT OBS       1

|_READ PAREA PFERT PAPOP HCORAT HCPI PSTKS
   6 VARIABLES AND       20 OBSERVATIONS STARTING AT OBS       1

|_READ HAREA HFERT HAPOP HCAPF HLIB
   5 VARIABLES AND       20 OBSERVATIONS STARTING AT OBS       1

|_READ DPGDP DHGDP WPROD PCPI
   4 VARIABLES AND       20 OBSERVATIONS STARTING AT OBS       1

|_ 106.5985   8.234331  569.5  14597.
UNKNOWN COMMAND...234331
...CHECK OUTPUT CAREFULLY
|_GENR NHEXP=HEXP-HIMP
|_GENR HCPI=HCPI/100
|_GENR HGDPD=HGDP/HCPI
|_GENR DHCAPF=HCAPF/HCPI
|_GENR PCPI=PCPI/100
|_GENR PGDPD=PGDP/PCPI


|_SYSTEM 2  PRATE PGDPD PAREA PFERT PAPOP WPRIC PSTKS /DN
|_OLS PPROD PAREA PFERT PAPOP PSTKS
|_OLS PIMP PPROD PRATE PGDPD WPRIC PSTKS

THREE STAGE LEAST SQUARES--    2 EQUATIONS
```

```
  7 EXOGENOUS VARIABLES
  2 POSSIBLE ENDOGENOUS VARIABLES
  9 RIGHT-HAND SIDE VARIABLES IN SYSTEM
MAX ITERATIONS =        1          CONVERGENCE TOLERANCE =   0.10000E-02
      20 OBSERVATIONS
DN OPTION IN EFFECT - DIVISOR IS N

ITERATION     0 COEFFICIENTS
   4.5994       2.2127       -39.723      -0.52261      -0.50520
-0.61519E-01
  0.28662E-03  0.68800      0.13864

ITERATION    0 SIGMA
  0.30319E+06
   68252.      0.13703E+06

BREUSCH-PAGAN LM TEST FOR DIAGONAL COVARIANCE MATRIX
   CHI-SQUARE =    2.2425     WITH    1 DEGREES OF FREEDOM
LOG OF DETERMINANT OF SIGMA=   24.331

ITERATION     1 SIGMA INVERSE
  0.37147E-05
 -0.18503E-05  0.82193E-05

ITERATION     1 COEFFICIENTS
   4.6401       1.9103       -40.084      -0.55532      -0.47634
-0.71077E-01
  0.26717E-03   1.3340      0.14860

ITERATION    1 SIGMA
  0.30384E+06
   68460.      0.13534E+06
LOG OF DETERMINANT OF SIGMA=   24.319

SYSTEM R-SQUARE =  0.9686 ... CHI-SQUARE =   69.206     WITH   9 D.F.
```

VARIABLE	COEFFICIENT	ST.ERROR	T-RATIO
PAREA	4.6401	0.55159	8.4121
PFERT	1.9103	1.5021	1.2717
PAPOP	-40.084	18.692	-2.1444
PSTKS	-0.55532	0.56491	-0.98302
PPROD	-0.47634	0.10686	-4.4577
PRATE	-0.71077E-01	0.27751E-01	-2.5613
PGDPD	0.26717E-03	0.51829E-04	5.1549
WPRIC	1.3340	4.7976	0.27805
PSTKS	0.14860	0.42979	0.34576

```
 EQUATION  1 OF  2 EQUATIONS
DEPENDENT VARIABLE = PPROD                     20 OBSERVATIONS

 R-SQUARE =   0.8820
VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.30384E+06
STANDARD ERROR OF THE ESTIMATE-SIGMA =   551.21
SUM OF SQUARED ERRORS-SSE=  0.60767E+07
MEAN OF DEPENDENT VARIABLE =   6340.5
```

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	ASYMPTOTIC T-RATIO ***** DF	P-VALUE	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
PAREA	4.6401	0.5516	8.412	0.000	0.908	0.8582	1.3962
PFERT	1.9103	1.502	1.272	0.203	0.312	0.0983	0.1234
PAPOP	-40.084	18.69	-2.144	0.032	-0.484	-0.1886	-0.1671
PSTKS	-0.55532	0.5649	-0.9830	0.326	-0.246	-0.0918	-0.0358
CONSTANT	-2008.0	1325.	-1.516	0.130	-0.364	0.0000	-0.3167

EQUATION 2 OF 2 EQUATIONS
DEPENDENT VARIABLE = PIMP 20 OBSERVATIONS

R-SQUARE = 0.8607
VARIANCE OF THE ESTIMATE-SIGMA**2 = 0.13534E+06
STANDARD ERROR OF THE ESTIMATE-SIGMA = 367.88
SUM OF SQUARED ERRORS-SSE= 0.27067E+07
MEAN OF DEPENDENT VARIABLE = 2062.8

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	ASYMPTOTIC T-RATIO ***** DF	P-VALUE	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
PPROD	-0.47634	0.1069	-4.458	0.000	-0.766	-0.7756	-1.4641
PRATE	-0.71077E-01	0.2775E-01	-2.561	0.010	-0.565	-0.3238	-0.0765
PGDPD	0.26717E-03	0.5183E-04	5.155	0.000	0.809	0.5008	1.2291
WPRIC	1.3340	4.798	0.2781	0.781	0.074	0.0300	0.0967
PSTKS	0.14860	0.4298	0.3458	0.730	0.092	0.0400	0.0294
CONSTANT	2445.2	1072.	2.281	0.023	0.521	0.0000	1.1854

```
|_SYSTEM 2 PRATE PGDPD PAREA PFERT PAPOP PSTKS WPRIC/DN
|_OLS PPROD PAREA PFERT PAPOP PSTKS
|_OLS PIMP PPROD PRATE PGDPD WPRIC
```

THREE STAGE LEAST SQUARES-- 2 EQUATIONS
7 EXOGENOUS VARIABLES
2 POSSIBLE ENDOGENOUS VARIABLES
8 RIGHT-HAND SIDE VARIABLES IN SYSTEM
MAX ITERATIONS = 1 CONVERGENCE TOLERANCE = 0.10000E-02
20 OBSERVATIONS
DN OPTION IN EFFECT - DIVISOR IS N

```
ITERATION     0 COEFFICIENTS
   4.5994        2.2127      -39.723     -0.52261     -0.49091
-0.59902E-01
  0.28484E-03   1.5038

ITERATION    0 SIGMA
  0.30319E+06
   64210.       0.13615E+06

BREUSCH-PAGAN LM TEST FOR DIAGONAL COVARIANCE MATRIX
   CHI-SQUARE =     1.9975     WITH    1 DEGREES OF FREEDOM
LOG OF DETERMINANT OF SIGMA=   24.338

ITERATION    1 SIGMA INVERSE
  0.36642E-05
 -0.17280E-05  0.81595E-05

ITERATION     1 COEFFICIENTS
   4.6615        1.9006      -40.104     -0.60562     -0.46300
-0.68872E-01
  0.26637E-03   2.1072

ITERATION    1 SIGMA
  0.30406E+06
   64822.       0.13461E+06
LOG OF DETERMINANT OF SIGMA=   24.327

SYSTEM R-SQUARE =  0.9683 ... CHI-SQUARE =   69.046     WITH   8 D.F.

VARIABLE       COEFFICIENT    ST.ERROR       T-RATIO
PAREA          4.6615        0.54723         8.5184
PFERT          1.9006         1.5031         1.2645
PAPOP        -40.104          18.756        -2.1382
PSTKS        -0.60562        0.54489        -1.1115
PPROD        -0.46300        0.97574E-01    -4.7451
PRATE        -0.68872E-01    0.27311E-01    -2.5218
PGDPD         0.26637E-03    0.51487E-04     5.1734
WPRIC          2.1072         4.2051         0.50111
 EQUATION  1 OF  2 EQUATIONS
DEPENDENT VARIABLE = PPROD                  20 OBSERVATIONS

 R-SQUARE =    0.8819
VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.30406E+06
STANDARD ERROR OF THE ESTIMATE-SIGMA =   551.42
SUM OF SQUARED ERRORS-SSE=  0.60812E+07
MEAN OF DEPENDENT VARIABLE =   6340.5


                                ASYMPTOTIC
VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED
ELASTICITY
  NAME    COEFFICIENT   ERROR    ***** DF   P-VALUE CORR. COEFFICIENT  AT
MEANS
PAREA      4.6615      0.5472       8.518     0.000 0.910      0.8622
1.4027
```

```
PFERT       1.9006      1.503        1.264      0.206 0.310      0.0978
0.1227
PAPOP      -40.104      18.76       -2.138      0.032-0.483     -0.1887
-0.1672
PSTKS     -0.60562      0.5449      -1.111      0.266-0.276     -0.1001
-0.0390
CONSTANT   -2023.9      1327.       -1.525      0.127-0.366      0.0000
-0.3192
 EQUATION  2 OF  2 EQUATIONS
DEPENDENT VARIABLE = PIMP                    20 OBSERVATIONS

 R-SQUARE =   0.8614
VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.13461E+06
STANDARD ERROR OF THE ESTIMATE-SIGMA =   366.89
SUM OF SQUARED ERRORS-SSE=  0.26921E+07
MEAN OF DEPENDENT VARIABLE =   2062.8


                                   ASYMPTOTIC
VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED
ELASTICITY
  NAME    COEFFICIENT   ERROR    ***** DF   P-VALUE CORR. COEFFICIENT  AT
MEANS
PPROD    -0.46300     0.9757E-01  -4.745     0.000-0.775    -0.7539
-1.4232
PRATE    -0.68872E-01 0.2731E-01  -2.522     0.012-0.546    -0.3137
-0.0741
PGDPD     0.26637E-03 0.5149E-04   5.173     0.000 0.801     0.4992
1.2254
WPRIC      2.1072       4.205      0.5011    0.616 0.128     0.0473
0.1528
CONSTANT   2308.5       994.4      2.322     0.020 0.514     0.0000
1.1191


|_SYSTEM 2 PRATE PGDPD PAREA PFERT PAPOP PSTKS/DN
|_OLS PPROD PAREA PFERT PAPOP PSTKS
|_OLS PIMP PPROD PRATE PGDPD

THREE STAGE LEAST SQUARES--    2 EQUATIONS
  6 EXOGENOUS VARIABLES
  2 POSSIBLE ENDOGENOUS VARIABLES
  7 RIGHT-HAND SIDE VARIABLES IN SYSTEM
MAX ITERATIONS =       1         CONVERGENCE TOLERANCE =   0.10000E-02
       20 OBSERVATIONS
DN OPTION IN EFFECT - DIVISOR IS N

ITERATION     0 COEFFICIENTS
   4.5994       2.2127      -39.723     -0.52261     -0.50855
-0.56642E-01
  0.28691E-03

ITERATION    0 SIGMA
  0.30319E+06
   66777.      0.13890E+06
```

BREUSCH-PAGAN LM TEST FOR DIAGONAL COVARIANCE MATRIX
CHI-SQUARE = 2.1176 WITH 1 DEGREES OF FREEDOM
LOG OF DETERMINANT OF SIGMA= 24.352

ITERATION 1 SIGMA INVERSE
0.36888E-05
-0.17734E-05 0.80517E-05

ITERATION 1 COEFFICIENTS
4.6802 1.8437 -40.228 -0.65060 -0.48556
-0.64903E-01
0.26797E-03

ITERATION 1 SIGMA
0.30466E+06
69439. 0.13757E+06
LOG OF DETERMINANT OF SIGMA= 24.337

SYSTEM R-SQUARE = 0.9680 ... CHI-SQUARE = 68.848 WITH 7 D.F.

VARIABLE	COEFFICIENT	ST.ERROR	T-RATIO
PAREA	4.6802	0.54585	8.5742
PFERT	1.8437	1.4982	1.2307
PAPOP	-40.228	18.721	-2.1488
PSTKS	-0.65060	0.53665	-1.2123
PPROD	-0.48556	0.86577E-01	-5.6084
PRATE	-0.64903E-01	0.26192E-01	-2.4780
PGDPD	0.26797E-03	0.51730E-04	5.1802

EQUATION 1 OF 2 EQUATIONS
DEPENDENT VARIABLE = PPROD 20 OBSERVATIONS

R-SQUARE = 0.8817
VARIANCE OF THE ESTIMATE-SIGMA**2 = 0.30466E+06
STANDARD ERROR OF THE ESTIMATE-SIGMA = 551.96
SUM OF SQUARED ERRORS-SSE= 0.60932E+07
MEAN OF DEPENDENT VARIABLE = 6340.5

VARIABLE NAME	ESTIMATED COEFFICIENT	ASYMPTOTIC STANDARD ERROR	T-RATIO ***** DF	P-VALUE	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
PAREA	4.6802	0.5458	8.574	0.000	0.911	0.8657	1.4083
PFERT	1.8437	1.498	1.231	0.218	0.303	0.0949	0.1191
PAPOP	-40.228	18.72	-2.149	0.032	-0.485	-0.1893	-0.1677
PSTKS	-0.65060	0.5366	-1.212	0.225	-0.299	-0.1075	-0.0419
CONSTANT	-2014.6	1326.	-1.520	0.129	-0.365	0.0000	-0.3177

EQUATION 2 OF 2 EQUATIONS
DEPENDENT VARIABLE = PIMP 20 OBSERVATIONS

```
 R-SQUARE =    0.8584
VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.13757E+06
STANDARD ERROR OF THE ESTIMATE-SIGMA =    370.91
SUM OF SQUARED ERRORS-SSE=  0.27515E+07
MEAN OF DEPENDENT VARIABLE =    2062.8


                                   ASYMPTOTIC
VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED
ELASTICITY
  NAME    COEFFICIENT   ERROR    ***** DF    P-VALUE CORR. COEFFICIENT   AT
MEANS
PPROD    -0.48556      0.8658E-01  -5.608     0.000-0.814    -0.7906
-1.4925
PRATE    -0.64903E-01 0.2619E-01  -2.478     0.013-0.527    -0.2956
-0.0698
PGDPD     0.26797E-03 0.5173E-04   5.180     0.000 0.791     0.5022
1.2327
CONSTANT   2742.6      501.5       5.468     0.000 0.807     0.0000
1.3296


|_SYSTEM 2 HRATE HGDPD HAREA HFERT HAPOP DHCAPF HLIB/DN
|_OLS HPROD HAREA HFERT HAPOP
|_OLS NHEXP HPROD HRATE HGDPD DHCAPF HLIB

THREE STAGE LEAST SQUARES--     2 EQUATIONS
  7 EXOGENOUS VARIABLES
  2 POSSIBLE ENDOGENOUS VARIABLES
  8 RIGHT-HAND SIDE VARIABLES IN SYSTEM
MAX ITERATIONS =         1          CONVERGENCE TOLERANCE =    0.10000E-02
       20 OBSERVATIONS
DN OPTION IN EFFECT - DIVISOR IS N

ITERATION      0 COEFFICIENTS
   10.066       -3.1378       -251.01       47.734       -4545.8
2038.8
  -10329.      -0.12410E+07

ITERATION     0 SIGMA
  0.14976E+06
 -0.19729E+08  0.53750E+11

BREUSCH-PAGAN LM TEST FOR DIAGONAL COVARIANCE MATRIX
   CHI-SQUARE =   0.96711      WITH     1 DEGREES OF FREEDOM
LOG OF DETERMINANT OF SIGMA=    36.575

ITERATION     1 SIGMA INVERSE
  0.70168E-05
  0.25755E-08  0.19550E-10

ITERATION      1 COEFFICIENTS
   9.9660       -2.9155       -251.81       35.602       -2230.7
2530.1
  -11373.      -0.15325E+07
```

```
ITERATION    1 SIGMA
  0.14995E+06
 -0.23591E+08  0.53961E+11
LOG OF DETERMINANT OF SIGMA=   36.558

SYSTEM R-SQUARE =  0.9280 ... CHI-SQUARE =   52.621     WITH   8 D.F.

VARIABLE       COEFFICIENT    ST.ERROR       T-RATIO
HAREA          9.9660          1.3067          7.6269
HFERT         -2.9155          1.5236         -1.9136
HAPOP         -251.81          31.522         -7.9884
HPROD          35.602          82.429         0.43192
HRATE         -2230.7          8971.4        -0.24864
HGDPD          2530.1          1216.3          2.0802
DHCAPF        -11373.          3741.8         -3.0393
HLIB         -0.15325E+07   0.72819E+06       -2.1045
 EQUATION  1 OF  2 EQUATIONS
DEPENDENT VARIABLE = HPROD                    20 OBSERVATIONS

 R-SQUARE =    0.8574
VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.14995E+06
STANDARD ERROR OF THE ESTIMATE-SIGMA =   387.23
SUM OF SQUARED ERRORS-SSE=  0.29990E+07
MEAN OF DEPENDENT VARIABLE =    5492.7


                                     ASYMPTOTIC
VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED
ELASTICITY
  NAME     COEFFICIENT   ERROR    ***** DF   P-VALUE CORR. COEFFICIENT  AT
MEANS
HAREA       9.9660      1.307       7.627     0.000 0.886     1.1513
2.2715
HFERT      -2.9155      1.524      -1.914     0.056-0.432    -0.2936
-0.1604
HAPOP      -251.81      31.52      -7.988     0.000-0.894    -0.7756
-0.7017
CONSTANT   -2248.4      1297.      -1.733     0.083-0.398     0.0000
-0.4093
 EQUATION  2 OF  2 EQUATIONS
DEPENDENT VARIABLE = NHEXP                    20 OBSERVATIONS

 R-SQUARE =    0.6047
VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.53961E+11
STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.23229E+06
SUM OF SQUARED ERRORS-SSE=  0.10792E+13
MEAN OF DEPENDENT VARIABLE =  0.11293E+07


                                     ASYMPTOTIC
VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED
ELASTICITY
  NAME     COEFFICIENT   ERROR    ***** DF   P-VALUE CORR. COEFFICIENT  AT
MEANS
HPROD       35.602      82.43      0.4319     0.666 0.115     0.0988
```

```
0.1732
HRATE     -2230.7        8971.      -0.2486     0.804-0.066    -0.0739
-0.0947
HGDPD      2530.1        1216.       2.080      0.038 0.486     0.5672
2.2260
DHCAPF    -11373.        3742.      -3.039      0.002-0.630    -1.6322
-2.6467
HLIB     -0.15325E+07 0.7282E+06  -2.105      0.035-0.490    -0.9899
-0.7026
CONSTANT  0.23093E+07 0.1531E+07   1.509      0.131 0.374     0.0000
2.0449


|_SYSTEM 2  HGDPD WPRIC HAREA HFERT HAPOP HLIB DHCAPF/DN
|_OLS HPROD HAREA HFERT HAPOP WPRIC
|_OLS NHEXP HPROD HGDPD DHCAPF HLIB

THREE STAGE LEAST SQUARES--     2 EQUATIONS
   7 EXOGENOUS VARIABLES
   2 POSSIBLE ENDOGENOUS VARIABLES
   8 RIGHT-HAND SIDE VARIABLES IN SYSTEM
MAX ITERATIONS =        1         CONVERGENCE TOLERANCE =   0.10000E-02
       20 OBSERVATIONS
DN OPTION IN EFFECT - DIVISOR IS N

ITERATION     0 COEFFICIENTS
   10.654      -3.6377      -261.70       4.7748       31.086
2452.1
  -10058.     -0.13389E+07

ITERATION    0 SIGMA
  0.14084E+06
 -0.19197E+08  0.53992E+11

BREUSCH-PAGAN LM TEST FOR DIAGONAL COVARIANCE MATRIX
   CHI-SQUARE =   0.96929     WITH    1 DEGREES OF FREEDOM
LOG OF DETERMINANT OF SIGMA=   36.518

ITERATION    1 SIGMA INVERSE
  0.74621E-05
  0.26532E-08  0.19465E-10

ITERATION     1 COEFFICIENTS
   10.568      -3.4153      -262.00       4.3928       17.349
2830.5
  -11406.     -0.16064E+07

ITERATION    1 SIGMA
  0.14109E+06
 -0.21642E+08  0.54205E+11
LOG OF DETERMINANT OF SIGMA=   36.510

SYSTEM R-SQUARE =  0.9314 ... CHI-SQUARE =   53.588     WITH   8 D.F.

VARIABLE       COEFFICIENT    ST.ERROR       T-RATIO
```

HAREA	10.568	1.3685	7.7225
HFERT	-3.4153	1.5409	-2.2165
HAPOP	-262.00	31.964	-8.1969
WPRIC	4.3928	4.1409	1.0608
HPROD	17.349	82.175	0.21112
HGDPD	2830.5	1121.3	2.5242
DHCAPF	-11406.	3512.6	-3.2472
HLIB	-0.16064E+07	0.72532E+06	-2.2148

EQUATION 1 OF 2 EQUATIONS
DEPENDENT VARIABLE = HPROD 20 OBSERVATIONS

R-SQUARE = 0.8658
VARIANCE OF THE ESTIMATE-SIGMA**2 = 0.14109E+06
STANDARD ERROR OF THE ESTIMATE-SIGMA = 375.62
SUM OF SQUARED ERRORS-SSE= 0.28217E+07
MEAN OF DEPENDENT VARIABLE = 5492.7

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	ASYMPTOTIC T-RATIO ***** DF	P-VALUE	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
HAREA	10.568	1.369	7.723	0.000	0.894	1.2209	2.4088
HFERT	-3.4153	1.541	-2.216	0.027	-0.497	-0.3440	-0.1879
HAPOP	-262.00	31.96	-8.197	0.000	-0.904	-0.8070	-0.7301
WPRIC	4.3928	4.141	1.061	0.289	0.264	0.0949	0.1196
CONSTANT	-3352.5	1601.	-2.094	0.036	-0.476	0.0000	-0.6104

EQUATION 2 OF 2 EQUATIONS
DEPENDENT VARIABLE = NHEXP 20 OBSERVATIONS

R-SQUARE = 0.6029
VARIANCE OF THE ESTIMATE-SIGMA**2 = 0.54205E+11
STANDARD ERROR OF THE ESTIMATE-SIGMA = 0.23282E+06
SUM OF SQUARED ERRORS-SSE= 0.10841E+13
MEAN OF DEPENDENT VARIABLE = 0.11293E+07

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	ASYMPTOTIC T-RATIO ***** DF	P-VALUE	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
HPROD	17.349	82.18	0.2111	0.833	0.054	0.0481	0.0844
HGDPD	2830.5	1121.	2.524	0.012	0.546	0.6345	2.4903
DHCAPF	-11406.	3513.	-3.247	0.001	-0.642	-1.6370	-2.6545
HLIB	-0.16064E+07	0.7253E+06	-2.215	0.027	-0.496	-1.0376	

```
-0.7365
CONSTANT  0.20512E+07 0.9414E+06   2.179     0.029 0.490     0.0000
1.8163
!_END
READ ERROR IN LINE  36
```

VITA

Gary Lee Taylor

Candidate for the Degree of

Doctor of Philosophy

Thesis: INSTITUTIONAL CHANGE IN POLAND AND HUNGARY: AN ANALYSIS OF WHEAT MARKET IMPACTS

Major Field: Agricultural Economics

Biographical:

Personal Data: Born in Rensselaer, Indiana, on March 15, 1957, the son of Robert and Arlene Taylor.

Education: Graduated from Rensselaer Central High School, Rensselaer, Indiana in May 1975; received Bachelor of Science degree in Quantitative Agricultural Economics from Purdue University, May 1990; received Master of Science Degree in Agricultural Economics from Michigan State University, May 1994. Completed the requirements for the Doctor of Philosophy degree with a major in Agricultural Economics at Oklahoma State University in December 1995.

Experience: Raised on a farm near Rensselaer, Indiana; employed as a farm laborer and farmed independently for ten years; employed by Purdue University, Agricultural Economics Department as an undergraduate teaching assistant, 1988-1990; employed by Michigan State University, Department of Agricultural Economics as a graduate research assistant, 1990-1992; employed by Oklahoma State University, Department of Agricultural Economics as a graduate research assistant, 1992-1995.

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