PRODUCTION FUNCTION SHIFTS IN SOVIET POSTWAR INDUSTRY: THE MID 1970's SHIFT

by

Claire E. Mitchell

Thesis submitted to the Faculty of the

Virginia Polytechnic Institute and State University

in partial fulfillment of the requirements for the degree of

MASTER OF ARTS

in

Economics

APPROVED:

D. I. Meiselman, Chairman

B. A. Kemp

A. N. Freiden

March 1985

Blacksburg, Virginia

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(ABSTRACT)

The Soviet economy experienced a marked decline in the rate of growth of output in the mid 1970s. Research was conducted for Soviet postwar Industry in order to try and identify when the shift was strongest, and in which industrial branches. A statistical technique known as the "Chow Test" was used to test for a "break" year -- the year when the production function most dramatically changed.

Regression results showed that two types of industry -- that which was closely associated with military production, and industry responsible for producing consumer goods, showed little or no shift in the mid 1970s. The remaining sectors, which were primarily resource intensive, did show a significant shift in 1974.

A description of the investigation, including input data and regression results, is included.

CONTENTS

I. INTRODUCTION

The average annual rate of growth of the Soviet economy has dramatically declined in the 1970's, as illustrated in the table below. The seriousness of this decline is yet to be determined. However, even the Soviet government, loathe as it is to admit that anything could be wrong in "paradise", introduced in 1979 the first major economic reform package since 1965 in order to reverse this downslide. [1] Clearly, even they recognize the seriousness of this decline, in particular because it jeopardizes the Soviet Union in two particular areas. First, the question has been raised as to the Soviets' ability to maintain their ambitious level of defense spending, which has remained at 11% of GNP (4% - 5% annual growth rate) for nearly twenty years. Second is the issue of whether the Soviets can continue to economically prop up, as needed, Eastern Europe and its' third world allies in a time of worldwide economic crisis.

GROWTH OF SOVET GNP 1951 - 1980

5-Year Period	Average Annual Percentage Growth of GNP
1951 - 1955	5.5
1956 - 1960	5.9
1961 - 1965	5.0
1966 - 1970	5.2
1971 - 1975	3.7
1976 - 1980	2.7

[1] For a complete discussion of these reforms, see Gertrude E. Schoreder's article, "Soviet Economic Reform Decrees: More steps on the Treadmill", in *Soviet Economy in the 1980's: Problems and Prospects, Part 1, Joint Economic Committee Proceedings*, December 31, 1982.

The purpose of this study is to take a fresh approach toward examining some of the sources of this decline in growth. Analytic studies in the past have tried to explain patterns of Soviet growth by focussing on finding the correct functional form of the production function equation, and then using it to produce estimates of the coefficients for total Soviet Industry.[2] Equations of such studies typically are typically composed of components for capital, labor, and technical change. By producing estimates of these parameters, economists have hoped to find out which of these components is the culprit of the decline, and which might hold the answer.

The research outlined in this paper takes an altogether different approach from the traditional work in this field. For each of the major sectors of Soviet Industry [3],

regressions will be run in order to try and identify whether there has been any major structural shift in the aggregate production function for Soviet industry during the 1970's, when that break occurred, and in what magnitude. While this will not provide any absolute answers as to the sources of the slowdown in Soviet economic growth, it will perhaps point us in the right direction by indicating that certain industrial sectors were affected more than others, and that certain sectors were affected earlier than others.

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[2] There is also the world of large-scale econometric models, which are used to model the Soviet economy and predict economic performance. Two of the major ones are SOVMOD and SOVSIM, which were created and are maintained by Wharton Econometrics, and CIA, respectively, and are not accessible by the general public.

[3] The sectors covered are: Electric Power; Fuels; Chemicals & Petrochemicals; Ferrous Metallurgy; Machine Building & Metalworking; Construction Materials; Timber, Paper & Pulp; Light Industry; Food Industry. Total Industry will also be covered.

Several things make this approach unique. First, a new output data series released by CIA last year now provides a consistent, reconstructed output series for the Soviet Union through 1980, which makes it possible to do this analysis for the 1970s. Second, whereas most studies have focussed only on Total Industry, I will be doing the analysis also for the major branches of Soviet Industry, which will provide a added dimension of comparison. Third, the method of finding structural breaks between different time periods has never been applied to the Soviet economy. Fourth, while I have found references to the use of dummy variables to approximate the Chow test, I have not found any studies which actually do so.

Analysis of the Soviet economy at any level is a difficult undertaking. The centrally planned nature of the Soviet economy poses fundamental problems that I will attempt to address in the following chapters. First, there will be a section describing the background literature on production function analysis of the Soviet economy, and the literature on finding structural breaks between two time periods. Second, the model to be used will be specified, with a separate chapter on data issues and problems. It is in these two sections that the implications of a non-free-market system are crucial. Finally, we will take a look at the results of the analysis, and the conclusions that can be drawn from them.

II. LITERATURE

Two fields of literature have been reviewed in support of the work on trying to establish production functions shifts for postwar Soviet industry. First, the literature on production function analysis of the Soviet economy was reviewed. Second, it was necessary to examine some of the literature that has been done on finding structural breaks for the production function of the U.S. economy.

Production Function Analysis of the Soviet Economy

Production function analysis of the Soviet economy has focussed on trying to explain the reasons for, and solutions to the problems of Soviet economic growth. Virtually all of this research has centered on the postwar (WW II) period, which has seen two major downturns in the rate of economic growth. The first occurred around 1960, and the second in the mid 1970's.

This type of econometric research on the Soviet economy has been closely tied to production function resarch in general. (Although I might add that as with anything that has to do with the Soviet Union, there has usually been a considerable lag time between the introduction in the western world, and the application to the Soviet Union.) As new forms of the production function are discovered and used by the field, they are eventually applied to the Soviet economy.

There have essentially been three "waves" of production function analysis of the Soviet economy. To each of these waves I will give a beginning date, but no ending date, since no form of the production function has yet been declared the "right" form for the Soviet economy. There still continue to be proponents for all of the various forms of the production function that have been used to date.

The first "wave" utilized the familiar Cobb-Douglas form of the production function. Francis Seton was the first to produce any major published work on production function analysis of the Soviet economy in 1959, and in his analysis, he used the Cobb-Douglas framework. The second wave began when Martin Weitzman revitalized the work in this area with his article in 1970 suggesting that the more generalized Constant Elasticity of Substitution (CES) production function provided a richer tool for analysis. This form of the production function, and Weitzman's work in particular, has provided the inspiration for the bulk of the research done to date. And finally, it has been suggested that the even more general Variable Elasticity of Substitution (VES) production function might prove to be an even better form to use with the Soviet economy. Although the first work on this appeared in 1968 at the same time as the work on the CES was begun, the VES to date has received less attention, but interest in this form is beginning to pick up.

Analysis Using Cobb-Douglass Production Function

Ground was broken for production function analysis of the Soviet economy with Francis Seton's 1959 article entitled, " Soviet Economic Trends and Prospects: Production Functions in Soviet Industry". In this ground- breaking work, Seton takes the first tentative step toward econometric analysis of the Soviet economy with the followng declaration:

> ... most economists will hardly feel true to their calling until they advance from the mere measurement of phemonena to an analysis of underlying conditions and causes.

Seton's Cobb-Douglas model contained parameters for capital, labor, and technical change. He did not constrain the labor and capital coefficients to sum to one. For data, Seton simply used the Soviet data that was available at that time. Although he was well aware of the questionable nature of the Soviet data, he was setting out to test, "... how far the quantitative material which the Soviets have so far made available may be expected to take us...".

The goal of Seton's work, besides to simply do what had not been done before, was to compare prewar Soviet economic growth with the postwar period. For this, he ran regressions for 1928 - 1934, and then for 1950 - 1955. His major conclusion from his research was that:

> Continuing high growth rates in postwar Soviet industry are no longer in the main the effects of labor influx and capital accumulation, nor of the slightly increasing (or at least nondiminishing) returns associated with these as long as other resources were untapped and close at hand. They seem to be predominantly the reward of rapidly increasing efficiency (technological, administrative, or both) in utilizing these inputs at any given level...

Several major questions were raised in response to Seton's work. First, the question of correct functional form was raised -- in this case, whether the Cobb-Douglas production function was appropriate. Second, the issue of how trustworthy Soviet data is was raised. These questions are, in essence, are the same questions being asked today in work of this type.

Seton had taken on the task of applying production function analysis to the Soviet economy primarily because it had never been done before. Susequent works along this line had a more focussed purpose. In the mid 1960's there was a wave of production function analysis that

was motivated by a marked decline in the rate of growth of the Soviet economy which began in the late 1950's.which began in the late 1950's. Regression analysis using production functions was used because trends in GNP can be analyzed in terms of trends of basic factor inputs.

The decline in the rate of growth of the Soviet economy was clear, declining after 1955 from an average annual rate of growth of about 11% in 1951-55, to 9% in 1956-61, and to 7% in 1962-65. This trend might simply be attributed to a normal deceleration following a postwar economic surge. However in comparing the record of the Soviet Union to the record of six major industrial nations -- France, West Germany, Italy, United Kingdom, Japan and United States, we see that the Soviet Union had lost it's position as a world leader in economic growth. In the early postwar period, 1950 - 1958, the Soviet Union played a close 2nd to West Germany in Annual Average growth rate of the economy, 7.1% to 7.6%. In the next period, 1958 - 1964, it fell behind Italy, France and Japan, as well. [4] This would suggest that there is something else besides a "normal" postwar economic deceleration that was contributing to this declining trend in economic growth.

The form of the production function analysis used to try and uncover reasons for this declining trend differed little from the form that Seton had used in his work. Included in all work were parameters for labor, capital, and "technical change". The only variation that would appear was whether the coefficients of labor and capital were constrained to sum to one. The data used in these efforts, however, did differ significantly. Whereas Seton had relied entirely on Soviet data

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[4] Noren, James H., "Soviet Industry Trends in Outputs, Inputs, and Productivity," *Joint Economic Committee, New Directions in the Soviet Economy*, pp. 271-325, U.S. G.P.O., Washington, D.C.

for his efforts, the new works relied on Western estimates of the Soviet economy. Typically, this would be CIA data, with some modifications by the individual. Everone has his own theory about what the data should be.

The major conclusions of these studies centered around the decline in the growth of Soviet output being largely due to a decline in the rate of growth of the inputs. Capital productivity had suffered more than labor productivity. However, since labor had the larger factor share, it's declining productivity was the main culprit for the decling growth rate of output. The major reason for the decline in labor productivity was pegged to the restructuring of the workweek, which occurred in the late 1950's, early 1960's. Whereas average work week was 48 hours/week in 1957, it had gradually been reduced over the next few years until it reach 41 hours/week in 1961.

Some studies did note that the retardation in economic growth of output was not quite matched by an equal slowdown in the growth of the inputs. This left the technical change parameter to be explored. Work also continued on trying to further refine the data on the soviet economy.

Analysis Using Constant Elasticity of Substitution Production Functions

Nonlinear estimation software packages helped to expand the use of the production function resarch and open the door to the use of more complex forms of the production function. This allowed economists to move away from the restrictive Cobb-Douglas production function, which assumes an elasticity of substitution of one, to more generalized, complex forms. The form most used was, (and perhaps still is) the Constant Elasticity of Substition (CES) production function. This form,

first introduced in 1961 [5] is simply a generalized Cobb-Douglas production function, which requires that the elasticity of substition be constant, but not necessary one, as did the Cobb-Douglas.

The Cobb-Douglass research in the 1960's had basically focussed on the declinining trend in output growth in the late 1950's to early 1960's. The CES research, on the other hand, sought to understand the overall postwar declining trend in output growth. Moreover, it was not believed that the decline in the rate of growth of output was totally due to a comparable decline in the rate of growth of the inputs; other reasons for the decline were sought.

Martin Weitzman was the first to apply the CES production function to the Soviet economy. His 1970 article, "Soviet Postwar Economic Growth and Capital-Labor Substition, which appeared in the American Economic Review, touched off a debate which has provided the bulk of the production function research that has been done to date on the Soviet economy. Weitzman, as well as the majority of the economists who have used the CES production function for their regression analysis, focussed his research on Soviet industry. His data covers the period from 1950 - 1969, relying on Soviet data as his base, but with the modification of value-added weights.

Weitzman's work yielded two major conclusions. First, he found that the elasticity of substitution was not one, as assumed by the Cobb-Douglas form, but significantly less than one : 0.403. While estimates of this parameter by other economists using the CES have varied, all agree that the elasticity of substitution for the Soviet

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[5] Arrow, K. J., Chenery, H. B., Minhas, B. S., and Solow, R. M., "Capital-Labor Substitution and Economic Efficiency," *Review of Economics and Statistics*, Vol. 43:225-250, August 1961.

Union during the postwar period is not one, and that therefore the CES production function is a better form to use than the Cobb-Douglas. The low elasticity of substitution has the following impact, according to Weitzman:

> A low elasticity of substitution makes labor look in the early 1950's as if it were practically surplus, output going up almost proportionally with capital. By the late 1960's, this is no longer the case... By this time a low elasticity of substitution seems to imply that capital accumulation has outstripped labor growth by a wide enough margin that the drag due to diminishing returns is significantly cutting into output growth.

It is important here to note that Weitzman's emphasis on "diminishing returns" is very different from the previous factor productivity approach, which said that the declining trend in output growth was due entirely to a similar trend in the deline in the rate of growth of the inputs.

The second major Weitzman finding is that "technical progress" for the period grew at a rate of 2%, which is certainly reasonable by world standards. This means that technical change is not the source of the problem. It might, however, be an answer. It is unlikely any help to the situation can be found in either the capital or labor inputs. Capital infusions did not create the same result in the 1970's and 1980's as it did in the 1950's. Demographers predict that the labor supply will remain constant, and perhaps even decline in the coming years. Therefore, the residual is the only part of the equation left from which the Soviets can look for hope.

Both of these conclusions sparked a considerable debate in the literature. Major players in this debate have been Padma Desai, Stanislaw Gomulka, Steven Rosefielde, and Mitchell Kellerman. All have

run regressions for Total Soviet Industry, providing their own estimates of both technical change and the elasticity of substitution. Unlike the case of the Cobb-Douglas research, the form of the CES production function has varied somewhat. The data series used also vary. Padma Desai has perhaps experimented the most with both the functional form and the data. In one of her efforts [6] she had experimented with more than 20 variations of the CES production function, finding only three that produced "good" results. She then used three different data series with the production functions - Soviet, CIA, and her own double-deflated version.

Provided on a separate page is a table which show the ranges of different estimates of the coefficients, that have been found by people using the CES production function. The range of estimates is given, as well as the estimates found by Martin Weitzman and Padma Desai. These latter estimates are important for interpreting the range of results, since Weitzman is a major benchmark, having first analyzed the CES production function, and since Padma Desai has perhaps done the most research in this area.

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[6] Desai, Padma, " The Production Function and Technical Change in Postwar Soviet Industry: A Reexamination," *American Economic Review*, #66, 3:372-381, June 1976.

TABLE 1

PRODUCTION FUNCTION ANALYSIS OF THE POSTWAR SOVIET ECONOMY

The ranges of the estimates for the different parameters are as follows:

		WEITZMAN	DESAI
p:	0.866 < p < 5.211 (Kellman) (Rosefielde)	2.650	4.688
s:	0.161 < s < 0.536 (Rosefielde-a) (Kellman-a)	0.274	0.176
l:	-0.0065 < l < 0.0408 (Rosefielde-b) (Desai-b)	0.0134	0.0034
d:	0.021 < d < 0.893 (Desai-a) (Desai-e)	0.587	0.880
g:	0.211 < g < 0.875 (Kellman-b) (Weitzman-b)	0.875	0.318

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(1) p = rho = efficiency parameter; p = (1-s)/s or s = 1/(1+p);
p != 0; -1 < p < infinity;
(2) s = sigma = elasticity of substitution
(3) l = lambda = technical change coefficient; e ** lt = Hicks neutral technical change
(4) d = delta = distribution parameter; 0 < d < 1
(5) g = gamma = efficiency parameter (capital coefficient); g > 0

Methods for Finding Structural Breaks in Time Series Data

The research for this thesis applies a statistical technique popularly known as the "Chow Test" to the Soviet economy. The motivation is to find out if there is a "structural break" in the Soviet economy in the mid 1970's, and how the various branches of industry were affected by the alleged break.

Although he did not originate the statistical technique that bears his name, Gregory Chow did provide the landmark work on this topic in his 1960 article, "Tests of Equality Between Sets of Coefficients in Two Linear Regressions." In this piece, Chow sets out to provide a statistical framework for assessing whether an economic relationship remains stable in two periods of time. Given two samples of observations, the hypothesis that both samples belong to the same regression (in other words, whether subsets of coefficients in the two regressions are identical.) is tested using an F test. A theoretical F statistic is obtained since the inputs of degrees of freedom is know, and the level of significance can be assumed. An actual F statistic from the regression runs using the two different samples (from different time periods) is then calculated as follows:

$$f(p,n+m-2p) = \frac{H - J - K}{J + K} \cdot \frac{n + m - 2p}{p} ,$$

where,

p = number of parameters in equation
n = number of observations used to estimate the 1st regression
m = number of additional observations
H = sum of squares of the residuals from the regression estimated by the n+m observations
J = sum of squares of the residuals from the regression estimated by the first n observations
K = sum of squares of the residuals from the regression estimated by the second m observations

A number of economists have provided further discussions of the "Chow test, primarily to handle special cases, [7]

The primary application of the technique, on the other hand, was done by Murray Brown in his 1966 book, "On The Theory and Measurement of Technological Change". In that work, he devotes a number of chapters to the statistical methodology for isolating tecnological epochs, using the Chow test. He applies these methods to the private domestic non-farm sector of the United States for the period 1890-1960 using a Cobb-Douglas production function. By taking different periods of observations, for instance using the data from 1890 to 1906 as one sample set, and the data from 1907 - 1913 as the second, he uses the F statistics to find if there are any structural breaks.

Brown finds three breaks, or "epochs" in his analysis. They occurred roughly between 1906 and 1907, between 1920 and 1921, and between 1939 and 1940. Using these break points, we then end up with

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[7] see W. A. Jayatissa, "Tests of Equality between Sets of Coefficients in Two Linear Regressions when Disturbance Variances are Unequal", and J. D. Rea, "Indeterminancy of the Chow Test When the Number of Observations is Insufficient"

four different "epochs" for the Cobb-Douglas production function. By examining the coefficient estimates from his regressions, Brown then goes on to characterize the differences for each epoch. Capital-using technological progress occurred beginning in the first epoch (marginal product of labor has fallen relative to the marginal product of capital), whereas the last epoch indicates labor-using technological change. Concerning returns to scale, it must first be noted that due to the scepticism in the community concering the estimates of returns to scale in time-series applications of Cobb-Douglas functions, Brown's conclusions can't be accepted without further testing, perhaps using the CES production function. With this caveat in mind, Brown finds that there were increasing returns to scale during the first epoch, but durng the rest of the period, there was generally decreasing returns to scale.

There are references to other attempts to use the Chow test to find structural breaks, both with the U.S. and Soviet economies, for various time periods. Greg Hildenbrandt, in his article, "The Dynamic Burden of Soviet Defense Spending"[8], indicates in a footnote that while at the CIA, he attempted to test for structural breaks. Henry Cassidy (in discussions) also indicated that he had conducted research to try and use the Chow test on the United States. While Hildenbrandt at least had some reasonable results, Cassidy indicated that his research yielded little. Therefore, the Brown work provides the the best example to date on the application of the Chow test.

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[8] Joint Economic Committee, "*Soviet Economy in the 1980's: Problems and Prospects*, Washington, D.C.: U.S. GPO, December 31, 1982.

III. METHODOLOGY

The primary focus of this paper is to statistically test for "breaks" or "shifts" in the production function for Soviet Industry, 1950 - 1980. Emphasis is placed on looking at the mid 1970's to see if there has been any underlying break in the production function which might provide some clues as to the reasons for the downturn in growth of output during this time period.

Research will be conducted at the branch level of Industry, in order to gain clues as to which branches might have been more affected by the downturn in growth than others. For instance, if branches that are more energy-intensive register a shift more strongly than other branches, this might lend support to the theory that energy has been a major player in the decline of ouput growth, opening the door to studying this further.

The statistical tool used to search for different "epochs" is the "Chow" test, a technique that assesses whether an economic relationship remains stable in two periods of time. My research utilizes a "modified" Chow test, using dummy variables. By using the modified technique, rather than the "full" Chow test, it is possible to test for breaks through the critical period of the mid 1970's. With a full test, due to the degrees of freedom required for the regression runs, it would only be possible to test for breaks through the early 1970's. Therefore, the modified Chow test is not only simpler to use, but necessary in order to test the mid 1970's time period.

Production Function

Before the methodological considerations of this particular statistical technique can be addressed, the more basic issue of the underlying production function must be addressed. The two forms of the production function most commonly used in econometric analysis of the Soviet economy, are the Cobb-Douglas and Constant Elasticity of Substitition (CES) production functions. The specific forms of these production functions used most include a techniucal change parameter as well as parameters for capital and labor.

For Cobb-Douglas

[1] Y = A L**B K**(1-B), where Y = output
L = labor
K = capital
A = technical progress

[2] ln(Y) = ln(A) + B(ln(K/L))

For CES

[3] Y = g{[d(L**-r) + (1-d)(K**-r)] ** -1/r} * e**lt,

where Y, L, K are as before
g = efficienty parameter, g > 0;
p = substition parameter, -1<r<oo, r!=0;
d = distribution parameter,0 < d < 1;
l = technical progress

(Most analyses use logarithmic transformations of both of these forms.) It is these two forms which I considered using for my resarch.

Both of these functions are of the same family of production functions. The CES form is simply more generalized than the Cobb-Douglas, allowing the elasticity of substition to be any constant, rather than requiring it to be unitary, as does the Cobb-Douglas.

Concerning which of these is the "correct" form of the production function there is no right answer. [9] Despite the attention paid to the CES form in the early 1970's, many researchers, including the CIA, still rely on the Cobb-Douglas for resarch in this area. In the absence of any concensus on which form to use, I have decided to use the logarithmic form of the Cobb-Douglas production function. [10]

Methodological Approach - Dummy Variable Chow test

The "Chow" test is a statistical technique which tests for structural stability between two time periods. It has been used in order to find "breaks' or "shifts" in a set of economic time series data, thereby splitting an economy into one or more different "epochs".

The classic Chow test utilizes F-statistics generated from regression runs for two different time periods in order to calculate whether or not there has been a major shift in the production function. This requires making three separate regression runs, one for a base

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[9] See Chapter 2 on Literature, where this is discussed in more detail.

[10] I did run some test cases using the CES production function for Total Industry, 1950 - 1980. Using Martin Weitzman's data -- which is an earlier version of the same data series that I use, I was able to reproduce the same results he got for estimation of the coeeficient, suggesting that my estimation software package was calibrated to his. However, when I attempted to run the Chow tests on both his and my data, I ran into problems with the estimates being out of the economically meaningful bounds. These problems would have to be investigated further before a full set of CES runs could be done.

period A (i.e., 1950 - 1964), one for a supplementary period B (i.e., 1965 - 1971), and one for the total time span (i.e., 1950 - 1977) in order to generate the F statistics required for Chow's equation. The formula would indicate whether the underlying production function in time period A is significantly different from that in period B. This process is then repeated, each time adding the supplementary period onto the base period, and using the next several years in the data series for the supplementary period. In the case cited above, for the second regression run, base period A would cover 1950 - 1971, and the supplementary period would cover years 1972 - 1978.

Several regression runs were made using this method, and the "full" version was found to be inappropriate for the analysis of this paper for the following reasons. First, the technique was somewhat cumbersome, requiring three regression runs and a calculation for each break tested. More important, however, was the severe penalty imposed by the degrees of freedom required for the full version. In the full runs, at least six data points were needed in the supplementary dataset B. This prohibits one from being able to test for a break in the 1970's, which is the critical period in question.

In order to avoid this problem, the "dummy variable" Chow test was used instead in the regression runs.[11] This method involves using only one regression per test for each structural break, rather than three. Data for all years in the data set are used, with dummy variables on all independent variables for data after a given year. That is, if the time

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[11] This method has been alluded to in the literature, but I found no sources that explcitly outlined this technique, or provided an application of it. The question as to what to use in measuring the breaks arose -- the T-statistic, the R2, or both. I consuled Henry Cassidy and Greg Hildebrandt on this and decided to use both the t-statistic and the R2.

series data is for 1950 - 1980, testing for structural "breaks" in this time period, one regression would be run for this data, using a dummy variable on all data after 1959. This regression would be run many times, moving the year which marks the division between when dummy variables are used and when they are not, to a year later each time. For instance, in the second regression run, years 1950 - 1960 would have no dummy variable, and years 1961 - 1980 would.

In order to determine when the structural break occurred, the R2's for each of these runs would be compared, along with the T statistic. The regression run with the highest R2 (and most significant T-statistic), would indicate the year of the break -- the year that divides the data with and without dummy variables. T-statistics.

Note that since there is a specific time period in question - the mid 1970's, it would have been possible to run only a few regressions, with the breaks at the appropriate years. However, it could turn out that all years would show a significant change. Therefore, it is important to run the regressions for all possible break years, checking the relative measure of the R2 and T-statistic. This process will be done for each branch of industry.

Technical Progress Term

The parameter which is traditionally called "technical progress" is in reality just a residual. Rather than providing any real measure of management improvements, new technology, or improvements in the efficient usage of inputs, this parameter is a "catch-all". Measurement of the coefficient for this variable is traditionally done very crudely, usually using a series of integers from 1 to n as input data. The usefulness of such a crude measure is, at best, questionable.

Given such questions, it is not surprising that in running my regressions, there were severe problems with the technical progress term. When this parameter was included in the regression runs, the estimates for technical progress were not only negative, which is contradictory to the results of others who have done production function analysis of the Soviet economy, but the capital coefficient estimates were often greater than 1. Since the coefficients for labor and capital were constrained to equal one, this yields negative labor coefficients, which would be economically meaningless. [12]

The purpose of this research is not to provide precise estimates of the coefficients, but, rather, to look for relative shifts in the production function. Because of the nature of this research, the elimination of the technical progress term should not seriously alter the results. Therefore, the form of the Cobb-Douglas production function used in the regressions of this resarch will not have a technical progress term.

Correction for Autocorrelation

Whenever time series data is used, as in this case, the question of autocorrelation must be addressed. Therefore, I tested the data used in my resarch for 1st and 2nd order autocorrelation. Results are given in the figures below. The Durbin Watson Statistic indeed revealed that there was 1st order autocorrelation, significant to the 1% level, in most of the data. Second order autocorrelation turned out to be insignificant for all data.

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[12] One possible reason for getting negative technical progress is that quality changes in goods could be overcompensated for in the reconstructed output data.

Although not all data showed significant 1st order autocorrelation, I made the decision to use a statistical regression package that would correct for 1st order autocorrelation for/on all data. It was important to be consistent since I was testing for relative shifts in the production function.

TEST FOR AUTOCORRELATION: TOTAL INDUSTRY 1950 - 1980

Intercept	= 1.648 (262.51)	Capital	= 0.559 (71.68)	Adj R2	= 0.9946
Model SS	= 2.700	Error SS	= 0.014	DW Stat	= 0.279

ONE-SIDED TEST: n = 29; k = 2; d(l) = 1.05; d(u) = 1.33

0.279 < 1.05 -- POSITIVE AUTOCORRELATION
0.5% significance level: 2.771 --

TEST FOR 2ND ORDER AUTOCORRELATION:

Lag 1 = -0.8289 (4.490)
Lag 2 = 0.1072 (0.580)

Break in the 1960's

Before running all of the regressions on the different branches of Soviet Industry, test runs were made for Total Industry for the full period 1950-80. These runs revealed a major "break" in 1961, as shown in Table 11. That is, the most pronounced difference in the underlying production functions for the Soviet economy occurred between the two time periods 1950-1961 and 1962-1978, with the 1961-1962 time frame indicating a significant shift.

TABLE 2

TOTAL INDUSTRY: WORK HOURS - 1950-1978

	INTERCEPT	DUM INTERCPT	cap3	dumc	R2
1990	1.418 (69.98)	---	0.612 (44.21)	---	.9869
1955	1.738 (16.98)	-0.350 (3.33)	0.765 (15.84)	-0.197 (3.76)	.9964
1956	1.727 (22.57)	-0.350 (4.36)	0.761 (20.70)	-0.200 (4.36)	.9971
1957	1.693 (28.46)	-0.318 (5.05)	0.746 (25.58)	-0.193 (5.67)	.9972
1958	1.659 (34.13)	-0.294 (5.54)	0.731 (30.11)	-0.193 (6.23)	.9968
1959	1.680 (41.50)	-0.314 (6.95)	0.741 (35.85)	-0.201 (7.14)	.9971
1960	1.642 (53.90)	-0.270 (8.06)	0.722 (45.61)	-0.175 (8.20)	.9983
1961	1.629 (70.17)	-0.247 (9.77)	0.715 (58.25)	-0.154 (9.19)	.9989
1962	1.601 (73.73)	-0.216 (8.71)	0.702 (59.73)	-0.134 (7.39)	.9986
1963	1.558 (61.95)	-0.175 (5.80)	0.680 (48.93)	-0.117 (4.79)	.9976
1964	1.528 (54.96)	-0.150 (4.17)	0.666 (52.50)	-0.112 (3.51)	.9959
1965	1.511 (49.89)	-0.135 (3.25)	0.659 (37.91)	-0.106 (2.72)	.9937
1966	1.485 (47.73)	-0.116 (2.64)	0.646 (35.71)	-0.113 (2.58)	.9925
1967	1.484 (45.47)	-0.114 (2.43)	0.646 (33.85)	-0.112 (2.28)	.9906
1968	1.481 (44.37)	-0.106 (2.18)	0.645 (32.84)	-0.102 (1.88)	.9890
1969	1.464 (46.00)	-0.101 (2.06)	0.637 (33.45)	-0.126 (2.10)	.9888
1970	1.464 (46.50)	-0.102 (2.02)	0.638 (33.54)	-0.127 (1.90)	.9875
1971	1.459 (47.76)	-0.098 (1.90)	0.635 (34.03)	-0.133 (1.76)	.9869
1972	1.451 (50.18)	-0.105 (2.01)	0.631 (35.24)	-0.176 (2.03)	.9869
1973	1.450 (53.30)	-0.122 (2.29)	0.631 (37.01)	-0.228 (2.32)	.9870
1974	1.450 (57.21)	-0.153 (2.73)	0.631 (39.28)	-0.320 (2.71)	.9876

The literature discusses a significant change in the pperformance of the soviet economy in the late 1950's to early 1960's, as has been discussed in my chapter on literature. This shift was the first major postwar slowdown experienced by the Soviets. Judith Thornton write of this period [13]:

> "The growth of national product after 1958 was somewhat slower than in the 1950s, and within this recent period the slowdown became particularly marked in 1962 and 1963."

There are two important things to note about this break in the early 1960s. First, the fact that my dummy variable approach to the Chow Test revealed this major shift suggests that the statistical methodology works. I will not go into further discussion of this earlier "shift", since it is covered by the literature. But this does provide corroboration of the methodology I have decided to employ.

Second, the break in the early 1960's [14] suggests that in testing for the shift in the mid 1970s, data series used should begin after 1962. This is because the Chow test is intended for testing the stability of a production function between two periods. The early 1960s break already splits the data into two periods. Therefore, this early shift will overshadown and perhaps hinder the appearance of the later shift, if there is one. In order to avoid the possible domination of this earlier break, data series in this research will begin in 1963.

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[13] Thornton, Judith, "Factors in the Recent Decline in Soviet Growth", *Slavic Review*, Vol. 25:101-119, March 1966.

[14] Note that the regression results in Table 2 do show a "break" for total Soviet industry at around 1961 - 1962.

IV. DATA

"There are, of course, also Soviet data, but Western scholars have found many reasons to think that the measurement of Russian national income is too important a task to leave to Russian statisticians."[15]

Much of the work on trying to analyze the Soviet Economy has never gotten past the point of data issues. No one is willing to trust or believe the data which comes from the Soviets. [16] The problems with Soviet data are well-known; the solutions to these problems are not so obvious. Several prominent economists have spent the bulk of their careers trying to unravel the inconsistencies, inaccuracies, and inadequacies of Soviet data.[17]

The Soviet Union is a centralized government, with a centrally planned economy; there is little or no official private sector. One would think that all of this centralization would provide for an efficient, consistent system for collection and dissemination of economic data. In practice, however, this type of a system has done more harm than good, for reasons which will be outlined below.

Two of the data series used in my research, those for labor and capital, come almost directly from Soviet sources. The output series, on the other hand, is a Western reconstruction.

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[15] Abram Bergson,*The Real National Income of Soviet Russia since 1928*, Cambridge, Massachusetts, 1961.

[16] At a recent Kennan Institue presentation, Alec Nove cited that during his last trip to the Soviet Union, he asked one of his Soviet colleagues if there was any new statistical data available. The Soviet replied that he always used Western data.

[17] Abe Becker of the RAND Corporation is perhaps the most notable example, with his contributions on estimating the defense portion of the Soviet economy.

Sources of Data

Soviet economic data is found in several well-controlled government sources. The government organization which is responsible for maintaining and publishing economic data is the Central Statistical Administration (TsSU), a ministry-level office which was created only a few months after the October Revolution. One man has virtually dominated this agency, V. N. Starovskii, who was appointed to this ministerial post in 1940, and served for nearly forty years as the head of TsSU.

Of all of the publications put out by TsSU, three serve as the primary sources of economic statistics. First and foremost is their annual abstract, *Narodnoye Khozyaistvo*, (from now on referred to as *Narkhoz*) which provide the basic statistical series on the Soviet economy. Due to the incompleteness of this data, scholars have also relied heavily upon the periodical, *Vestnik Statistiki*, for supplementary data. Finally, there is additional data found in volumes which are published as a result of censuses that are conducted in the Soviet Union. Population censuses in 1959 and 1970, and capital stock censuses in 1960 and 1973 have provided some help in compiling Soviet labor and capital data series, respectively.

In addition to these primary sources, statistical data on the Soviet economy is also found in a variety of other periodicals and handbooks. These secondary sources help to fill in some of the holes left by the above publications in different data series.

Data Reliability

The problems with the data published in Soviet sources fall into three basic categories -- excessive secrecy, utilization of economic information as a propaganda vehicle, and the different accounting methods employed by the Soviet Union, which differ from those of the West. Due to the nature of these problems, and the fact that they are linked closely with the political nature of the Soviet state, it appears unlikely that there will be any dramatic change in the future. The problems and inaccuracies of Soviet data will, more than likely, continue on indefinitely.

First and foremost is the Soviet obsession with secrecy. During Stalin's reign, from the mid 1930's until 1956, there were virtually no economic statistics published by the Soviet government. In September 1956 this silence was finally broken when the head of TsSU, Starovskiy,, declared:

> "A majority of the materials of State and departmental accounting and statistics were unnecessarily made secret of were put aside into materials not subject to press publication. And until recently, statistical data were not published."

This opened the door for the resumption of publication of statistical data, led by the revival of the annual statistical abstract, *Narzhoz*.

Since the mid 1950's the quantity of statsitical data published by the Soviets has obviously increased. The quality of that data, however, is unknown. This is because that data is still enshrouded in secrecy, and it is not clear that shroud of secrecy is lifting at all. For instance, the short methodological section on branches of industry that has appeared in each Narkhoz since 1963 was missing in the 1968 version,

making it even more difficult to understand the methodological underpinnings of the data. Also, a data series might appear for a number of years, then suddenly be discontinued without announcement or explanation. An example of this was the series on wageworker data for the oil industry, which simply ceased to appear beginning in 1964.

Any industry which could be construed as having a defense application is particularly susceptible to the secrecy. The Soviets publish no explicit economic data on the defense sector of the economy. In addition, industries which have military application, such as Machine Building and Metwalworking (MBMW), have incomplete, distorted, and inaccurate data published.

The second major problem with Soviet economic data is that an important funtion of data which is disseminated to the public is to serve as a propaganda vehicle for the Soviet state. The Soviets do not publish anything - data or words, which does not prove the "glory" of the Soviet system. Anyone who has read official Soviet writings of any kind have experienced this tedium first-hand.

Therefore, if the Soviets are doing poorly in a particular area of the economy, it is conceivable that they might downplay the bad by either publishing data in a different format, or not publishing the data at all. One example of this that has been suggested by Murray Feshbach [18], occurred in 1967 when the Soviets shifted to workweek rather than workday data in reporting worktime. Had this not been done, the 1967 change to a five-day work week (from six days) would have resulted in a reported longer workday, which "would not be considered desirable by the Soviet statistical authorities".

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[18] Vladimir G. Treml and John P. Hardt, eds., *Soviet Economic Statistics*, Duke Univeristy Press, Durham, N.C., 1972.

Finally, there are problems with Soviet data that stem from the fact that the Soviet economic system is very different from our free market system in the West. Here the basic problem is the different accounting practices and procedures, dictated by Marxist ideology. Some of the specific differences in their accounting practices for labor, capital, and GNP will be mentioned below. There are two predominent problems which have had the greatest impact on Western researchers. First, prices in the Soviet Union are fixed by the state, rather than by consumer demand. The full impact of this is difficult to assess, but it is well-accepted that these prices understate inflation. [19] Second, the Soviet Union employs very different methods for measuring national economic activity. They utilize the Marxian concept of national income (SNI), as opposed to our Western concept of gross national product (GNP). This, by far, poses the most difficult data problem for Western economists, and thus most Western economists use Western reconstructions of Soviet output, rather than the official Soviet national income series.

In addition to these and other specific examples, there is a general question of whether, or how much the Central government drives the statistics. Factories know what their production, labor, and capital statistics *should* be, based upon the planning figures set by Soviet government officials. It is difficult to imagine that this

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[19] I can cite many examples of this from personal experience, but one simple example is that the same loaf of bread that cost me 22 kopeks in 1967 in Leningrad, also cost me 22 kopeks in 1977. I know for a fact that wages rose during that time frame, and I cannot imagine that the cost of the factors of production that went into making that loaf of bread did anything but go up in price. Yet the price of that loaf of bread remained the same. Constructed indexes on inflation then understate it's growth.

information would not influence the data that these factories eventually turn in to TsSU.

In summary, when faced with the question as to whether Soviet economic statistics published today on industrial data are a vast improvement over the statistics published 20 - 25 years ago, the answer would have to be mixed. There is no doubt that the quantity of data has increased since publication of economic statistics was resumed in 1956. However, since that first breakthrough, there has been no significant improvement in the quality of that data. All of the familiar ambiguities, selectivities, and problems of reporting are still present, with little change.

One final word on why I have chosen to deal with Soviet Industry, rather than any of the other sectors of the economy. First, output measurement problems for industry are far less severe than for such sectors as services or construction, where there are basic difficulties in defining output. In fact, compared to capitalist econommies, Soviet industry is relatively free of fluctuations, which is both good and bad. At any rate, Soviet industry contains perhaps the most consistent and complete data available on the Soviet economy.

Prices

Before turning to the data on labor, capital, and national income, it is essential to cover one underlying issue which has profound implications for these data series. Prices in the Soviet Union are not determined by the consumer demand, but rather are set by government planners. These prices are intended to be set according to a cost-plus system, however, the setting of those prices often has little to do with the cost of producing that good. Many items, such as the basic

food staples of meat and bread, and other goods, such as coal and timber, have their prices set at far below cost.

The revision of prices is a difficult and immense task, and therefore is carried out infrequently. [20] The last major price reform occurred in 1967, with some partial revisions since then. This task is complicated by the fact that the data used by the planners for setting these prices comes from the plant managers, who frequently inflate prices at the planning stage, so that they can fulfill their portion of the plan, and show reduced costs.

In order to change prices without a major reform, often a "new" product will be introduced at a considerably higher price. This "new" product in fact differs little, or not at all, with the product it replaces, but it provides a mechanism for the raising of prices without an official price reform.

These problems with the setting of prices are compounded by the fact that there are different prices for different customers. [21] The specific impact of this is not known, but it has been suggested that this applies to the defense sector, in particular. That is, a factory which produces military goods would pay less for it's inputs than any other industry.[22] Another distortion of prices comes from the

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[20]I made three trips to the Soviet Union over a twelve year time span (1967 - 1979) and was constantly amazed at the fact that prices stayed virtually constant over that time period. I could detect no significant difference in the prices of any of the consumer goods I bought.

[21] For consumer goods, I personally know of at least three pricing systems used in the Soviet Union. First, there are the official prices in regular stores which are open to all people. Second, there are different prices set *for these same goods* for foreigners who can pay with Western currency. Finally, there is yet another pricing system, using special "ruble" coupons which only high-ranking Soviets can obtain, at special stores.

[22] This specific example was raised by Paul Gregory at a recent conference on "Modeling of the Soviet Economy", held at the Rand Corporation in October 1984.

"turnover tax". This is a tax which is levied mostly on consumer goods, payable by the industry. While certain industries pay no tax, others do, such as the sugar industry, which pays a tax of 30 percent of the gross output.[23] This surrogate price increase distorts the prices further.

Because of all of these distortions to prices and price indexes, most Western analysis totally discard the Soviet price data. This also calls into question the reliability of the capital and output series data, as discussed in the following sections.

Labor

The primary Soviet labor series used in this country (and which I use in my research) is compiled and updated by the Foreign Demographic Analysis Division (FDAD) of the Bureau of the Census. The data compiled by FDAD is based totally on Soviet sources. This task is neither straightforward nor simple. Rather, Soviet sources provide a maze of statistics, which is constantly changing. Statistics may be published for a few years, then omitted for several years, then resumed again. One of the most notable examples of this has been the discontinuation of publishing data on annual average and work-hour employment by branch of industry, which was stopped in 1975.

There are three primary sources of Soviet labor statistics. The first two are publications which I've mentioned previously, the annual abstract, *Narkhoz*, and the periodical, *Vestnik Statistiki*. The third source is a statistical handbook, *Trud v SSSR* (*Labor in the U.S.S.R.*), which provides detailed data on labor in the USSR. This handbook,

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[23] *USSR: Measures of Economic Growth and Development, 1950-1980*, Joint Economic Committee, U.S. GPO, Washington, D.C., December 8, 1982.

published in 1968, was the first such book to appear in 32 years. While it much new information not seen since the 1930's, there was much data omitted which TsSU is known to collect Still, this book proved to be a major contribution.

Statistics on industrial labor are derived primarily from monthly, quarterly, and annual labor plan fulfillment reports submitted to TsSU by industrial enterprises.

There are several differences in the accounting practices of the Soviets which are worth noting. First, the calculation of average employment uses the number of calendar days rather than the number of actual work days. For days off/holidays, the number of workers used in the calculation is the same number that was reported on the previous work day.

A second very important accounting difference is that data on the worktime of industrial workers is based upon the scheduled work hours, rather than the actual hours worked. If a worker shows up for work, a day of work is counted, regardless of the number of hours actually worked.

Murray Feshbach did some work to determine the effect of the difference between the actual and scheduled workweek for the year 1967. This work was based solely on data gathered from Soviet sources; therefore other accounting inconsistencies inherent to Soviet data are still present. [24] Nonetheless, Feshbach found that the difference

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[24] One inconsistency inherent to Soviet data is worth noting here. At any given hour of the data, even during work hours, the streets of Soviet cities are filled with people. Many Soviets typically take several hours off in the middle of the day to shop for goods difficult to find. Therefore, the actual number of hours worked each day must be considerably less than reported.

between scheduled work hours and actual work hours for all industry was 0.2 hours per week (40.4 actual and 40.6 scheduled). This adds up to a total number of hours worked in all of industry for 1967 equal to 4.8 million hours less than scheduled. For the troublesome branch of Machine Building and Metalworking (MBMW), the difference was 0.5 hours per week (40.4 actual and 40.9 scheduled), with a total of 4.2 million hours worked less than scheduled.

Capital

Capital series data used in the West to analyze the Soviet economy are constructed directly from official Soviet data. The primary sources for these data are abstracts, *Narkhoz* and the Statisticheskiy Yezhegodnik Stran-Chlenov Soveta Ekonomicheskoy Vzainopomoshchi (CEMA handbook). There have also been two official capital censuses, in 1960 and 1973, which have produced much useful information on capital. As in the case of labor data, the primary responsibility of Western users of this data has been to compile and clean up this Soviet data, patching holes whereever possible, in addition to making conversions to the same price base. Major revisions based on Western speculation as to the accuracy of the data have not occurred.

As with most data, the Soviets do not publish explicit explanations of the derivation or source of the data. Therefore, the capital censuses are important, not only because of the data they provide, but also because the handbooks from these censuses reveal something about the Soviet methodology of constructing capital series data.

The purpose of the 1973 census was to provide complete and accurate data, based on consistent valuations of assets. Assets were to be revalued at "current replacement values", which were, for the most part,

provided by the equipment handbooks provided. No explanation of how the Soviet officials arrived at the deflated prices was given.

Next to the censuses, the principal information on the capital stock published by TsSU has been the time series data published in the *Narkhoz* abstracts. In these series, capital is gross of depreciation, but exclusive of projects in progress, which can represent a significant portion. [25] Revisions to these data are made periodically, though less frequently than one would expect, and with no regularity. In 1975, *Narkhoz* had still not published any revisions to the 1969 data.

There are numerous problems with the capital series data published by the First, the Soviet definition of fixed capital differs in some respects from the definition used in the West. Fixed capital is broken down into "productive" and "nonproductive" capital, where the former is capital used directly in the production process. Therefore, capital infused into a particular industrial branch which is not used directly for production might be classified differently than it would be by Western standards.

Second, there is the fundamental problem of whether the Soviet data adequately takes inflation into account. The involves the problem of prices, recounted earlier. If inflation is not adequately accounted for, then the amount of investments would be exaggerated.

One economist, Alec Nove, contends the problem caused by inadequately capturing inflationary increases in machinery and construciton prices is a major problem, with severe implications for the analysts who try to use this overstated data in studying the Soviet

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[25] Any visitor to the Soviet Union is struck by the amount of construction work being conducted. Much of this is repair work to existing structures, which can last for decades.

economy. Nove also indicates that perhaps this inability to adequately capture the real inflation of investment goods and of construction could be part of the reason for the relative ineffective- ness of investment expenditure. Therefore, if corrected properly for price increases of capital equipment, the official investment index would show a decline rather than the claimed increase.

Cohn and Wiles [26] on the other hand, believe that while this problems exists, Alec Nove has incorrectly assessed the problem, and overstated it.

A number of statistical checks have been made in the past to try and assess the seriousness of the problems with the capital data series. Consistency checks have been made on this data, when possible, in order to try and determine just how serious the problems are, and whether the data is acceptable at any level. Moorsteen and Powell [26] have tested the Soviet capital census data from 1960 and 1973 with data on the Soviet capital stock obtained independently, by a perpetual inventory method, and also with the annual indexes of the capital stock published for intervening years. They found the correspondence to be reasonably close.

Specifically, the equation $C(t) = I(g) + (UC(t-1) - UC(t))$ was used to test the compatibility of the published statistical series. If the data are totally consistent, the expression should hold. It did not hold in any of the years tested (1961 - 1980) but the ratio of the left

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Cohn, Stanley H., "Soviet Growth Retardataion: Trends in Resource Availability and Efficiency," Joint Economic Committee, New Directions in the Soviet Economy, Washington, D.C.: U.S. GPO, 1966.

[26] Moorsteen, Richard, and Powell, Raymond, The Soviet Capital Stock from Census to Census, 1960 - 1973," *Soviet Studies* XXXI, Jnauary 1979, pp. 56 - 75.

side of the equation to the right ranged only from 0.93 to 1.02 and averaged 0.97, which was respectable. These results, in particular, have been a major reason for the "acceptance" of the Soviet capital series in the West, for use in statistical analyses.

Output

The measurement which the Soviet use in order to measure the producitivity of their nation, Net Material Product (NMP) is significantly different from that used by the West (GNP). The problems here are so dramatic that while the official capital and labor series are still used, with some minor modification and clean-up, by Western analysts, the official output series is not. Rather, many economists use the reconstructed output series published by the CIA, or their own deflated or double-deflated series.

While all of the problems previously mentioned concerning the capital and labor data series are also true for the output data series -- inconsistency, sparseness, and noncomparable data, the problems are particularly exaggerated with respect to the output series. One interesting statistic points out the seriousness of this problem particularly well. Using Soviet data, Soviet NMP increased 57% in constant prices, and 51% in current prices from 1970 to 1979, implying *deflation* in the Soviet Union during a time when the rest of the world was facing runaway inflation, and the Soviets themselves claim deflation during this time period. This statistic is difficult to believe.

Another indication of the severity of the problems with the Soviet output series are the items *not* included in their accounting methods. Missing in the Soviet data for output are the value added in the service sector (value added in production of goods and a few services is

included), and all depreciation income. It is estimated that these exclusions amount to omitting roughtly 25% of the resources used to produce goods and services in the U.S.S.R. [27]

It would be impossible within the scope of this paper to give proper discussion to all of the problems with the Soviet output series. Therefore, I provide below a checklist of the most prominent problems. While some of these problems are common to any data series on output, others are not. Even the "common" problems are much more serious in the case of the Soviets, since they publish no explanation of such moves as changes in product coverage or changes in price bases.

- o Price base of some series are periodically changed
- o Product coverage can be altered without notice.
- o Soviet indices of industrial and agricultural production are based on gross output rather than value added (thus double counting of materials used in production is incorporated into the indices)
- o Problems with price and quality changes -- there will be a tremendous jump in price when a "new" product is in fact the same as the old product.
- o Whole pricing system does not have market determined prices, but rather centrally fixed ones which are nowhere near what the market-determined ones would be. (thus CIA put together a series of factor-cost prices, intended to be more true-to-life)

Central Intelligence Agency, "USSR: Toward a Reconciliation of Marxist and Western Measures of National Income, ER 78-10505, October 1978.

- o Exclusion of depreciation affects the growth rate if the total depreciation grows more rapidly than the other elements of value added, or if the base-year distribution of depreciation among sectors of origin differs markedly from the distribution of the remaining components of value added; exclusion of depreciation affects absolute size of NMP

The most widely used Western series on Soviet output is the series reconstructed by CIA. This is a synthetic series made by aggregating with value added weights individual component sub-series, consisting largely of physical units, but with some ruble values

It is important to note that the Soviet and CIA series move together; the Soviet data is simply inflated. Regressions that Martin Weitzman has run [27] indicate that the official Soviet GNP series grows at about 1.6% faster per year than the OER reconstruction, but with no systematic time trend in the difference. Most of the difference between the two indexes show up in two sub-sectors - Machine Building and Metal Working (MBMW) and Chemicals & Petrochemicals. Specific data on what the upward bias of the Soviet data might be was published by the Joint Economic Committee [28]

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[27] Weitzman, Martin L., "Industrial Production", a paper presented for the Conference on the Soviet Economy, Arilie Huse, Virginia, August 1980.

Joint Economic Committee, "*Soviet Economy in the 1980's: Problems and Prospects*, Washington, D.C.: U.S. GPO, December 31, 1982.

AVERAGE GROWTH OF INDUSTRIAL PRODUCTION

	SPIOER	OFFICIAL
1951-1959	9.4	12.0
1960-1975	6.3	8.2
1976-1980	3.4	4.4

A more complete picture of the difference between the official Soviet data and the SPIOER data is published in Appendix 2. Even from this small picture of the bias, it is clear to see that the differences between the two indexes are greatest in the earlier years. Differences in data for recent years is not so pronounced.

Fairly extensive testing has been conducted on the CIA data series. However, the best test will be the use of this data, and until the data is actually used in analyses, it will be difficult to asses it's accuracy.

Three basic types of tests were conducted by the CIA. First, the data was tested with collateral information for consistency. As mentioned earlier, when compared with official data, the CIA data did reflect trends similar to those shown by the Soviet data. The consistency was best in the most recent periods. Second, the representativeness of the sample was tested. While the data was inadequate to test directly for this, a high share of the total production covered by the sample in 1972 suggests that it is representative. Coverage was poorest in non-ferrous metals and chemicals & petrocheicals.

Finally, tests for biases in the basic data were made, and the following results were found (SPIOER refers to the CIA output data series):

- o industrial growth implied by the 1959, 1966, 1972 io tables was compared with the growth registered by SPIOER indexes over the same periods. SPIOER samples grew more slowly, which could suggest downward bias in SPIOER, but also could have resulted from using the spurious official price indexes to deflate io tables to constrant prices to arrive at "comparable" growth rates w SPIOER.
- o SPIOER's reliance on gross output rather than value-added indexes could be am important source of bias, but does not seem to be (in effect assuming that at the sector level, the ratio of value-added to gross output has remained constant.
- o performance of SPIOER is at least satisfactory in controlling the biases in the basic data. Series that measure output in quanitity terms almost certainly understate the true growth rate because they fail to account for improvements in quality and changes in product mix. (this is most serious in the machinery branch

The effect of the biases for the "worst" sector (MBMW) shows that even if all of the differences in growth rates between the value and physical series in the producer durables sector (where problems are the worst) were actually attributable to inflation, the SPIOER index would overstate machinery growth by a maximum of 1.2% per year and overall industrial growth by 0.3%.

In any case, the CIA output series is preferable over the Soviet data series. Confirmation of the CIA series as accurate, or at least adequate, will not come until the series has been used in analyses, and proven to be adequate.

V. RESULTS

The purpose of this paper was to establish whether or not there was a major shift in the production function of Soviet industry in the mid 1970's. The null hypothesis stated that there was no major shift.

Before beginning the discussion of the details of the results, I think it is important to note that a major success of this research was the fact that there were reportable results at all. While I know of no attempts to use this statistical technique on the Soviet economy, I do know of several applications of the Chow test to the U.S. economy. The work of Murray Brown, covered in the chapter on Literature, yielded interesting results for U.S. industry, for the period 1890 - 1960. Application of this process to the U.S. economy in more recent years has not been so fruitful. Work of this nature conducted by Dr. Henry Cassidy produced no meaningful results. Therefore, the fact that this statistical technique "worked" at all is an accomplishment in and of itself

The regressions I ran using the Chow test did show a "break" point in the mid 1970's for most branches of Soviet industry. Four branches showed no significant break - Light Industry, Food, Electricity, and Machine Building and Metalworking. [28] The results of my research are summarized in Table 5. The exact year of the break differs for some branches, but generally occurs around 1974. Total Industry, as previously mentioned, shows a significant break in 1976. This splits Soviet postwar industry into three separate epochs -- the postwar surge

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[28] While Electricity showed a slight trend towards a break, it also shows no significant shift in the production function in the time period covered in this analysis, 1963 - 1980.

until the early 1960's, followed by a period of more moderate economic growth through the 1960's and early 1970's, which has now been followed by a period of more dramatic slowdown, beginning in the mid 1970's.

TABLE 3

	BREAK YEAR	COEFFICIENT INT	COEFFICIENT CAP	DUMMY VARIABLE INT	DUMMY VARIABLE CAP	R2
TOTAL	1976	-2.73	0.63	-1.32	-0.26	.9930
		(26.79)	(33.58)	(1.89)	(1.81)	
MCH BLDG		* * * NO BREAK * * *				
FOOD		* * * NO BREAK * * *				
FUELS	1976	-0.95	0.70	0.52	-0.624	.9992
		(333.44)	(94.64)	(9.33)	(10.30)	
PAPER	1975	-4.03	0.38	-2.22	-0.397	.9973
		(85.70)	(49.35)	(10.29)	(10.02)	
LGHT IND		* * * NO BREAK * * *				
CONSTRUC	1973/4	-1.05	0.50	-0.14	-0.24	.9908
		(40.41)	(20.64)	(3.73)	(4.18)	
ELECTRIC [1]	1973	-1.38	0.78	0.20	-0.10	.9958
		(42.02)	(28.91)	(1.41)	(1.18)	
CHEMICLS	1973/4	-1.14	0.60	0.11	-0.21	.9949
		(103.18)	(22.50)	(5.37)	(3.64)	
FERR MET	1974	-1.06	0.50	0.16	-0.34	.9973
		(380.52)	(41.47)	(7.02)	(8.36)	

[1] It is debatable whether Electricity had any "break" at all; while the R2 of the other branches showed a definite trend -- the R2 is the primary criteria for judging breaks, the R2 for Electricity remained within a very tight range for all break years tested.

There are several general points worth noting about the results of these regression runs. First, the literature identifies this downturn in growth as beginning in 1976. This coincides with the ending of the 9th five-year plan, and the beginning of the 10th, which ran from 1976 - 1980. Due to the significant role that central planning plays in the Soviet economy, economic performance will show trends coinciding with these five-year periods. Therefore, it is reasonable for economists to associate the beginning of a new five-year plan with a dramatic change in economic performance.

My research, however, indicates that while the downturn occurred in 1976 for Total Industry, the turning point for the individual branches was typically 1974. This is one interesting point that would not have been seen had I looked only at Total Industry, as does much of the analysis on this topic. Part of the reason for the difference in break years between Total Industry and the branches might be due to the influence of the Machine Building and Metalworking branch, which will be discussed below.

Second, this research was, in part, a testing of the new output series released by CIA last year. Until that time, there was no Western output series which extended to 1980, thereby allowing analysts to test the mid 1970's. The publication of the CIA represents the culmination of a major effort by CIA, extended over a number of years, to fill that void. The complexity of the task of reconstructing a Soviet output series dictates that problems are bound to be uncovered in the data. However, the data was adequate enough to produce results in the environment of the regressions that I ran. The one serious question I

have concerning the data, as a result of these regressions, is that perhaps quality changes are overcompensated for in the data. This might be the reason for getting negative technical progress in test runs.

Third, results were produced for all branches of Soviet industry. None of the branches were unable to yield results using the Chow test technique, although one branch did seem to have some problems - Machine Building and Metalworking (MBMW). This branch of industry has traditionally been the most difficult to get accurate, consistent, and unbiased data on. The Soviets have restricted and hidden data on this specific branch because of it's strong ties to the defense industry, in keeping with the Soviet policy of acute secrecy for any defense-related activity. [29]

Branches without Shifts

Three out of nine branches of Soviet industry showed no significant break in the mid 1970's -- Machine Building and Metalworking, Electricity, and Light Industry. One other branch, Food, indicates a possible minor shift around 1970, but no major break in the mid 1970's time period. [30] Gertrude Schroeder has recently written an article which pegs part of the problem of declining Soviet economic growth rates on the planning factors dictated by the Soviet government, for each five-year plan. [31] In particular, for the 10th five year plan, 1976 -

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[29] Because there is no private enterprise at the industrial level, and everything is run by the State, the line between industries used for civilian goods and military goods is not always clear. This is particularly true with the branches that produce heavy machinery, such as MBMW.

[30] The regression runs for this industrial branch are somewhat suspect, with the estimates of the capital coefficients varying somewhat wildly, between 0.490 and 0.979.

[31] Schroeder, Gertrude, "The Slowdown in Soviet Industry, 1976 - 1982", *Soviet Economy*, January 1985.

1980, the Soviets instituted moderate reductions in the growth of national income and industrial output, and drastically reduced new fixed investment, as compared with the previous five-year period. Schroeder examines productivity data for each industrial branch to see what affect these factors might have had. Schroeder's productivity statistics are provided in Table 4.

Table 2 - Annual Growth in Output and Productivity in Soviet Industry

	1971	1972	1973	1974	1975	1976	1977	1978	1979	198(
TOT IND										
Output	6.0	5.0	5.8	6.1	6.6	4.0	4.0	3.4	1.9	2.9
Productivity	0.8	0.5	1.9	1.4	1.9	-0.8	-0.2	-0.3	-1.9	-0.5
FERR METALS										
Output	3.8	3.3	4.0	4.2	4.4	2.7	0.7	2.2	-0.8	-0.4
Productivity	-1.4	0.1	0.6	-1.0	0.3	-2.4	-3.2	-1.2	-4.2	-2.4
FUELS										
Output	4.7	4.8	4.9	4.9	5.8	3.7	4.2	3.1	2.9	1.8
Productivity	0.3	2.4	2.5	0.9	1.1	-0.5	1.2	-0.9	-2.6	-2.9
ELECTRIC PWR										
Output	8.1	7.1	6.8	6.7	6.6	6.9	3.6	4.6	2.9	4.5
Productivity	-0.2	0.8	0.3	0.9	0.9	1.3	-1.9	0.2	-2.3	-0.7
MACH BLDG										
Output	8.0	6.7	8.1	7.7	8.3	5.7	5.6	5.0	4.1	4.4
Productivity	1.7	1.9	3.6	2.3	2.8	1.0	0.5	1.6	0.1	1.4
CHEMICALS										
Output	8.1	6.7	9.0	9.5	9.7	4.8	5.2	3.6	-0.2	4.7
Productivity	0.1	1.1	3.5	2.9	3.3	-0.2	0.6	-0.6	-4.7	-1.5
PAPER										
Output	2.8	1.3	2.6	0.9	5.8	-0.2	0.3	-0.4	-3.0	0.6
Productivity	-0.3	-0.3	0.3	-1.7	3.1	-1.8	-1.9	-2.4	-4.9	-0.6
CONSTRUCTION										
Output	6.5	5.2	6.1	4.8	4.7	3.8	2.8	3.1	-4.9	0.9
Productivity	0.8	1.4	1.9	0.5	1.1	0.4	-0.7	0.7	-7.5	-0.7
LIGHT IND										
Output	4.5	0.7	2.8	2.7	2.9	4.1	2.5	2.6	1.8	2.3
Productivity	0.7	-0.8	0.2	-0.6	1.0	1.4	0.0	1.0	-0.2	1.0
FOOD										
Output	3.0	3.8	1.0	8.0	5.7	-0.9	4.3	0.5	2.5	0.4
Productivity	-0.1	0.2	-2.2	2.8	1.9	-4.0	0.3	-1.6	-0.2	-2.0

Schroeder notes that only two branches seemed to have escaped the dramatic decline in productivity experienced by all other branches, in 1976 and 1977 [32] -- Electric Power and Light Industry. The research which I conducted also showed no significant breaking point for these two industrial branches.

The reasons for the lack of any identifiable "break" point for the Food and Light Industry branches might be tied to the recent attempts by the Soviet government to place more emphasis on comsumer goods. In the recent Soviet literature, more and more attention is being focussed on trying to satisfy consumers by improving the quality of consumer goods, and linking the quantity of goods produced more to consumer demand. In the 10th five-year plan, consumer goods were given a higher priority, and the issue of improved quality was specifically addressed by Gosplan Chairman Baibakov [33]:

> "The targets for 1976 are permeated with the idea of improving the efficiency and quality of all work. National economic proportions, the buildup of production potential, and the distribution of resources all are subordinated to this goal." [34]

In particular, the planners incorporated into the 10th five year plan lower growth targets, hoping that this would free the managers up to more efficiently use the resources, and produce a higher quality product.

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[32] Machine Building and Metalworking is excluded from this portion of the discussion, and will be reviewed as a separate issue.

[33] *Pravda*, December 3, 1975.

This attention given to the consumer goods industries might have given them a higher priority in resource allocations. In the past, consumer goods always stood last in line for all inputs - fuels, machinery, and raw materials. Their current increased priority could be bringing them the resources they need to maintain production levels, at the sacrifice of the other industrial branches.

Machine Building and Metalworking (MBMW) is the third branch for which the Chow tests did not reveal a break point. The case of this branch of industry, and the possible reasons for its continued growth differ somewhat from Electric Power and Light Industry because of it's connection with the defense industry.

It is estimated that weapons account for roughly one quarter of the value added in MBMW. While the growth rates for Soviet industry have been declining almost across the board, the estimated [34] defense growth rates have remained fairly constant, at about 4% - 5% annually, with the defense portion of Soviet GNP being approximately 13% - 14%. Therefore, given the connection between MBMW and the military, it stands to reason that MBMW would not be as affected as other branches which suffered a severe decline in growth rates. The military spending would, in part, counteract the other reasons for declines in output growth and productivity.

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[34] All references to Soviet defense spending will be carefully caveated as "estimated" since the Soviets publish no data on their defense spending. The figures quoted here are those generally accepted in the West.

Branches with Shifts

The question arises as to why the individual industrial branches seem to indicate a break point in 1974, while the runs for Total Industry point to a break in 1976. Three out of the five branches with shifts indicate a shift in 1974 or 1973. [35] A fifth, Paper, Pulp and Timber, has a break in 1975, with only one branch, Fuels, indicating a shift in 1976. How does this add up to a break for Total Industry in 1976?

Clearly, even though the remaining four branches do not show a clear break point for the mid 1970's, their growth trends will influence the trend for Total Industry. Most important, one of the branches that does not show a shift -- Machine Building and Metalworking, has historically accounted for 30% - 40% of all industry. Therefore, what happens in this branch will strongly affect the growth patterns for Total Industry, in this case moving the break point out to 1976.

Concerning the five branches which show significant breaks in the mid 1970's, it is difficult to analyze differences between each individual branch. The trends for all are very similar in direction (the sign of the shift for all was negative), and magnitude (all had significant t-statistics at the 1% level, and all had dummy variables that were sizeable). The time of the break was close in all cases. Due to the multitude of possible reasons for declines in growth rates, it is difficult at this level of analysis to make any judgements as to why the Fuels branch experienced a shift later than the other branches.

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[35] If Electricity is to be included, that would make four.

Taking the group as a whole, it is possible to comment on why these industrial branches suffered a noticeable break while others did not. One key issue in the mid to late 1970's has been the shortages of key raw materials. There were shortages of iron ore, coking coal, and scrap metal, which had a severe impact on steel production. These and other shortages also had an impact on the production of important chemicals.

The problems with raw materials stem from two basic reasons. First, the Soviets have been raw material-rich in the past, and have exploited their natural resources as if the supplies were endless. Sources have been drying up in the recent past, with the quality of the materials now extracted, deteriorating. Second, the Soviet Union has recently experienced problems with transportation bottlenecks. Virtually all shipping of both raw materials and finished products is done by railroad in the U.S.S.R. Very little travels by either truck, or waterway. Soviet railroads have recently simply reached their capacity limit, and while planners have allowed for new rail lines (such as the BAM railway), they have not made the necessary changes to the railroad yard facilities. Therefore, materials will often just sit in the railroad yard, waiting to be loaded onto trains.

The resources affected by these problems are ones which would have more of an impact on the branches that experienced breaks (Fuels, Chemicals, Construction, Ferrous Metallurgy, and Paper) than the consumer goods industries that demonstrated no break. Therefore, this could be a significant cause of the declining growth rates for these branches.

Other Reasons for Declining Growth Rates

Several reasons for the declining economic growth rates, accompanied by significant shifts in the production function have been given. Shortages of raw materials, transportation bottlenecks, priority of military products, and the increasing emphasis on consumer goods have all been key players in the declining Soviet growth rates.

There are many other important factors which could be players in this, that can't be tied in directly to the results of my research, but should be mentioned in any case.

Soviet industries do not retire capital stock as frequently as do plants in the West. A major consequence of this is the fact that as capital stock matures, productivity declines. The mid 1970's represents a time when this problem was particularly acute. This issue was directly addressed in the 10th five-year plan, which called for accelerated retirement of machinery. The aging capital stock of the 1970's most certainly accounted for some of the decline in industrial growth rates.

In the past twenty years, technological improvements have provided a means of maintaining output growth rates, even with declining producitivity of capital and labor inputs. The technological revolution caused by computers and microchips, and it's application to industry, is still accelerating. The Soviets typically lag behind in incorporating new technology into industry, largely because they are not willing to pay the hard currency required to obtain such technology. There is still much that the Soviets could do to take up the slack of declining productivity of labor and capital by incorporating new technology. This

is one area which is particularly worthy of study, but which my research did not address, partly due to the fact that I did not include a parameter for technical change in my regression runs.

While the Soviets are not currently dependent upon outside oil or other energy resources, they are beginning to face energy constraints. Total energy supplies to the economy (tons of standard fuel) have experienced decreasing growth rates since 1976. This has been accompanied by irregularities of supply, either due to transportation bottlenecks, power outages, or decreased quality of electricity supply. These energy constraints have affected all branches of industry, and it is difficult, if not impossible, to pinpoint the exact effects this has had on Soviet industry.

VI. CONCLUSIONS AND FUTURE DIRECTIONS

The purpose of this paper was to attempt to apply the statistical technique traditionally known as the "Chow" test to finding structural "breaks", or different "epochs" in Soviet postwar industry. The emphasis was to be on examining the mid 1970's, which experienced a dramatic downturn in the growth of Soviet industry.

This technique did, in fact, "work", when applied to the case of Soviet postwar industry. The results of this research show that there was, indeed, a significant break in the mid 1970's for most branches of Soviet industry. Factors which led to the break in 1974 - 1976 include transportation bottlenecks, energy shortages and irregularities, and the lack of raw materials. Branches which although they showed a decline in the growth of output, did not show a significant break in the mid 1970's were either associated with the defense industry or consumer goods. The former has maintained a constant growth rate throughout this troubled economic period, and the latter is becoming more of a priority in Soviet economic planning

The emphasis of this research was on trying a new technique, rather than on perfecting that technique. In the process of making numerous test regression runs, it became apprarent that there were many improvements to this research worth pursuing.

First, the issue of "technical change" needs to be addressed. While the current measurements of this parameter, using a series of numbers, can be questioned, this is an important issue. Either new measurements must be found, or a way needs to be found to include this in the regressions without getting economically meaningless results.

Second, I would like to redo the research when more data points become available. For these runs, my data series ran through 1980, allowing me to "cheat" and use dummy variables to extend my tests through 1977. However, this does not cover the complete five-year plan period in question. While I found a break in 1974, it is not clear that there iisn't a more significant break later.

Third, it would be interesting to run these regressions with the CES production function. Rather than providing additional insights, this would more serve to callibrate and confirm this econometric technique. In addition, it would provide a different context for evaluating the two "competing" production function forms. In addition to these, the Variable Elasticity of Substitution (VES) production function, which is beginning to receive more attention in the literature, might be a third possibility.

Fourth, in addition to running the regressions with a different functional form, it might be of use to run them with different data series. As mentioned in the chapter on Data, the labor and capital series are fairly standard. However the output series has several alternatives, including the Soviet data itself. Running these tests might help to enlighten as to the differences in data series. In particular, it was suggested that perhaps the output series used in this research might have incorrectly adjusted for quality changes in goods, leading to the results of negative technical progress in test runs. Other series might shed light as to whether or not this is true.

Finally, it would be interested to run these regressions on different sectors of the Soviet economy -- agriculture, etc. While the data series for those sectors are not as "reliable" (consistent, bias, etc.) as for industry, it is worth trying.

In short, I feel as if this research has simply provided an open door for further experimentation with this statistical technique.

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APPENDIX 1 - COMPARISON OF WESTERN AND SOVIET ESTIMATES OF SOVIET GNP

COMPARISON OF OFFICIAL SOVIET OUTPUT INDICES AND CIA ESTIMATED INDICES

	55	56	57	58	59	60	61	62	63	64	65
Electric Power											
Sample Index	58	66	72	81	91	100	112	127	141	156	172
Official Sov	54	61	68	77	89	100	112	127	144	160	178
Fuels											
Sample Index	66	74	82	89	95	100	104	110	117	124	132
Official Sov	67	71	77	86	93	100	105	111	120	129	137
Ferrous metals											
Sample Index	68	73	78	84	92	100	109	119	127	137	147
Official Sov	65	72	77	83	91	100	108	118	127	137	147
Nonferrous mtls											
Sample Index	71	74	80	83	94	100	115	121	142	139	150
Official Sov	76	71	76	84	91	100	113	125	147	150	170
Forest Products											
Sample Index	74	77	82	90	100	100	100	102	105	109	108
Official Sov	69	73	78	86	95	100	104	109	115	121	125
Paper&paperboard											
Sample Index	73	79	86	92	96	100	106	113	120	129	145
Official Sov	70	76	83	89	93	100	106	114	122	132	146
Chemicals											
Sample Index	59	66	72	83	91	100	108	119	127	142	161
Official Sov	56	63	71	80	89	100	113	130	151	173	195
Machinery											
Sample IndexA	61	71	80	84	90	100	112	125	132	139	148
Sample IndexB	56	66	76	83	88	100	114	128	139	147	157
Official Sov	52	59	67	76	87	100	115	132	150	164	179
Light industry											
Sample Index	72	77	82	89	94	100	103	107	110	115	117
Official Sov	71	77	81	87	94	100	104	107	109	113	113
Food Industry											
Sample Index	71	78	84	90	98	100	108	114	115	121	139
Official Sov	68	75	82	87	96	100	107	116	122	126	142
Tot Civ Indstry											
Sample MIndxA	65	72	79	86	93	100	108	115	121	129	138
Sample MIndxB	64	71	78	85	93	100	108	116	123	131	140
Official Sov	61	67	74	82	91	100	109	120	129	139	151

APPENDIX 2 - REGRESSION RESULTS

TOTAL INDUSTRY: NUMBER OF LABORERS / 1959 - 1978

Break Year	--INTERCEPT-- Coeff	Dummy	--CAPITAL-- Coeff	Dummy	1st Ordr Autocorr	R2	SSE
1990	1.639	---	0.517	---	0.705	.9807	.0022
	(176.69)		(29.37)		(4.42)		
1962	1.513	0.129	0.349	0.222	0.404	.9961	.0012
	(30.75)	(2.61)	(5.58)	(3.40)	(1.98)		
1963	1.511	0.132	0.345	0.230	0.340	.9966	.0012
	(44.86)	(3.90)	(7.725)	(4.81)	(1.62)		
1964	1.538	0.105	0.378	0.203	0.317	.9967	.0013
	(58.51)	(3.96)	(10.41)	(5.10)	(1.49)		
1965	1.547	0.095	0.390	0.193	0.305	.9968	.0013
	(72.10)	(4.40)	(12.66)	(5.50)	(1.43)		
1966	1.544	0.098	0.386	0.187	0.362	.9969	.0011
	(89.68)	(5.67)	(15.08)	(5.95)	(1.73)		
1967	1.561	0.082	0.408	0.166	0.273	.9967	.0014
	(98.73)	(5.14)	(16.75)	(5.27)	(1.27)		
1968	1.576	0.067	0.429	0.146	0.255	.9960	.0018
	(105.04)	(4.38)	(17.90)	(4.25)	(1.18)		
1969	1.585	0.059	0.441	0.118	0.394	.9951	.0015
	(116.26)	(4.33)	(19.61)	(3.07)	(1.92)		
1970	1.600	0.044	0.465	0.087	0.369	.9938	.0021
	(120.87)	(3.24)	(20.50)	(1.85)	(1.78)		
1971	1.614	0.030	0.484	0.063	0.418	.9917	.0025
	(124.44)	(2.21)	(21.15)	(1.04)	(2.06)		
1972	1.622	0.026	0.495	0.024	0.498	.9902	.0023
	(133.49)	(1.91)	(22.55)	(0.33)	(2.57)		
1973	1.629	0.027	0.506	-0.036	0.569	.9885	.0022
	(141.47)	(1.73)	(23.90)	(0.40)	(3.09)		
1974	1.660	0.034	0.581	-0.253	0.782	.9865	.0035
	(110.0)	(1.62)	(36.45)	(2.07)	(6.77)		

APPENDIX 2 - REGRESSION RESULTS

TOTAL INDUSTRY: WORK HRS/ 1967 - 1977

Break Year	--INTERCEPT-- Coeff	Dummy	--CAPITAL-- Coeff	Dummy	1st Ordr Autocorr	R2	SSE
1990	-3.028	---	0.576	---	0.307	.9684	.0116
	(23.24)		(21.57)		(1.37)		
1967	-3.573	0.584	0.480	0.104	0.292	.9699	.0114
	(2.89)	(0.46)	(2.21)	(0.46)	(1.29)		
1968	-3.361	0.382	0.517	0.069	0.278	.9705	.0115
	(3.45)	(0.37)	(3.01)	(0.38)	(1.23)		
1969	-3.405	0.370	0.510	0.065	0.256	.9719	.0114
	(4.51)	(0.45)	(3.81)	(0.44)	(1.126		
1970	-3.204	0.146	0.545	0.025	0.218	.9733	.0117
	(5.56)	(0.22)	(5.31)	(0.21)	(0.95)		
1971	-3.126	0.008	0.559	-0.001	0.173	.9752	.0118
	(6.89)	(0.01)	(6.88)	(0.01)	(0.74)		
1972	-3.100	-0.220	0.564	-0.046	0.815	.9788	.0119
	(8.82)	(0.41)	(8.94)	(0.45)	(0.35)		
1973	-3.040	-0.694	0.574	-0.141	0.056	.9834	.0117
	(11.57)	(1.24)	(12.08)	(1.27)	(0.24)		
1974	-3.003	-0.874	0.581	-0.178	0.069	.9800	.0115
	(12.34)	(1.07)	(13.11)	(1.08)	(0.29)		
1975	-2.598	-1.323	0.653	-0.255	0.199	.9898	.0046
	(19.89)	(2.40)	(27.26)	(2.29)	(0.86)		
*1976	-2.727	-1.323	0.630	-0.259	0.148	.9930	.0057
	(26.79)	(1.89)	(33.58)	(1.81)	(0.64)		
1977	-2.795	-1.219	0.618	-0.239	0.028	.9899	.0068
	(25.18)	(1.00)	(30.04)	(0.95)	(0.119		

APPENDIX 2 - REGRESSION RESULTS

PAPER: 1963 - 1980 / BREAKS:1967-1977

Break Year	--INTERCEPT-- Coeff	Dummy	--CAPITAL-- Coeff	Dummy	1st Ordr Autocorr	R2	SSE
1990	-4.486	---	0.307	---	0.646	.8965	.0060
	(28.19)		(11.40)		(3.59)		
1967	-3.725	-0.935	0.428	-0.152	0.532	.9312	.0057
	(4.14)	(0.97)	(3.03)	(0.99)	(2.66)		
1968	-3.924	-0.831	0.397	-0.139	0.500	.9414	.0053
	(6.00)	(1.14)	(3.84)	(1.19)	(2.45)		
1969	-3.955	-0.928	0.393	-0.157	0.442	.9547	.0048
	(8.18)	(1.65)	(5.11)	(1.72)	(2.09)		
1970	-3.937	-1.077	0.395	-0.184	0.389	.9642	.0044
	(11.12)	(2.43)	(6.99)	(2.52)	(1.79)		
1971	-3.909	-1.244	0.400	-0.214	0.237	.9749	.0043
	(14.92)	(3.50)	(9.50)	(3.57)	(1.03)		
1972	-4.017	-1.442	0.383	-0.254	0.121	.9853	.0032
	(23.70)	(5.27)	(13.99)	(5.35)	(0.52)		
1973	-4.041	-1.750	0.379	-0.311	0.225	.9940	.0023
	(42.71)	(8.85)	(24.66)	(8.82)	(0.98)		
1974	-4.049	-2.084	0.378	-0.373	0.400	.9973	.0013
	(74.61)	(12.83)	(42.58)	(12.63)	(1.85)		
*1975	-4.026	-2.215	0.381	-0.397	0.411	.9973	.0013
	(85.70	(10.29)	(49.35)	(10.02)	(1.91)		
1976	-4.050	-2.096	0.378	-0.375	0.463	.9973	.0014
	(98.59)	(6.68)	(55.54)	(6.43)	(2.22)		
1977	-4.113	-1.394	0.367	-0.245	0.310	.9944	.0024
	(78.05)	(1.94)	(41.87)	(1.83)	(1.39)		

APPENDIX 2 - REGRESSION RESULTS

LIGHT INDUSTRY: 1963 - 1980 / BREAKS:1967-1977

(APPENDIX 2)

Break Year	--INTERCEPT-- Coeff	Dummy	--CAPITAL-- Coeff	Dummy	1st Ordr Autocorr	R2	SSE
1990	-0.065	---	0.437	---	0.511	.9400	.0081
	(4.34)		(15.33)		(2.52)		
1967	-0.075	0.048	0.565	-0.190	0.114	.9830	.0055
	(5.75)	(2.56)	(3.46)	(1.14)	(0.49)		
1968	-0.067	0.043	0.668	-0.297	0.247	.9786	.0054
	(6.22)	(2.09)	(5.80)	(2.43)	(1.08)		
1969	-0.069	0.050	0.637	-0.273	0.268	.9777	.0053
	(6.90)	(2.08)	(7.19)	(2.74)	(1.18)		
1970	-0.070	0.050	0.609	-0.243	0.232	.9788	.0055
	(7.41)	(1.75)	(8.88)	(2.90)	(1.01)		
*1971	-0.070	0.033	0.593	-0.202	0.233	*.9796	.0053
	(7.61)	(0.92)	(10.83)	(2.61)	(1.02)		
1972	-0.070	0.031	0.535	-0.143	0.206	.9759	.0066
	(7.02)	(0.64)	(11.18)	(1.68)	(0.89)		
1973	-0.069	0.025	0.502	-0.102	0.349	.9656	.0069
	(5.70)	(0.37)	(10.99)	(0.97)	(1.58)		
1974	-0.068	0.057	0.470	-0.110	0.386	.9584	.0077
	(5.09)	(0.65)	(10.76)	(0.86)	(1.77)		
1975	-0.068	0.036	0.469	-0.083	0.445	.9530	.0075
	(4.74)	(0.33)	(11.35)	(0.55)	(2.11)		
1976	-0.067	0.043	0.458	-0.080	0.454	.9505	.0077
	(4.58)	(0.30)	(11.81)	(0.43)	(2.16)		
1977	-0.066	0.032	0.452	-0.060	0.475	.9472	.0078
	(4.39)	(0.15)	(12.28)	(0.23)	(2.29)		

APPENDIX 2 - REGRESSION RESULTS

CONSTRUCTION: 1963 - 1980 / BREAKS:1967-1977

Break Year	--INTERCEPT-- Coeff	Dummy	--CAPITAL-- Coeff	Dummy	1st Ordr Autocorr	R2	SSE
1990	-1.103	---	0.450	---	0.585	.9684	.0034
	(58.39)		(21.43)		(3.06)		
1967	-0.825	-0.293	0.677	-0.251	0.623	.9751	.0024
	(6.65)	(2.27)	(6.65)	(2.23)	(3.38)		
1968	-0.879	-0.235	0.634	-0.199	0.645	.9733	.0023
	(8.14)	(2.05)	(7.04)	(1.92)	(3.58)		
1969	-1.026	-0.103	0.518	-0.120	0.630	.9710	.0027
	(10.69)	(0.99)	(6.35)	(1.20)	(3.44)		
1970	-1.106	-0.118	0.527	-0.141	0.565	.9766	.0027
	(14.53)	(1.50)	(8.64)	(1.75)	(2.90)		
1971	-1.029	-0.116	0.516	-0.157	0.450	.9837	.0026
	(19.79)	(1.92)	(11.11)	(2.28)	(2.14)		
1972	-1.048	-0.119	0.500	-0.194	0.403	.9888	.0020
	(30.25)	(2.70)	(15.75)	(3.33)	(1.87)		
1973	-1.045	-0.137	0.503	-0.235	0.388	.9908	.0017
	(40.41	(3.73)	(20.64)	(4.18)	(1.78)		
**							
1974	-1.037	-0.154	0.510	-0.265	0.400	.9907	.0017
	(46.52)	(4.21)	(23.67)	(4.08)	(1.85)		
1975	-1.042	-0.166	0.506	-0.311	0.465	.9898	.0016
	(52.30)	(4.28)	(25.60)	(4.00)	(2.23)		
1976	-1.046	-0.166	0.502	-0.322	0.461	.9898	.0016
	(59.55)	(3.75)	(28.14)	(3.09)	(2.20)		
1977	-1.059	-0.155	0.490	-0.321	0.396	.9895	.0019
	(66.80)	(2.67)	(29.57)	(2.05)	(1.83)		

APPENDIX 2 - REGRESSION RESULTS

FOOD: 1963 - 1980 / BREAKS:1967-1977

Break Year	--INTERCEPT-- Coeff	Dummy	--CAPITAL-- Coeff	Dummy	1st Ordr Autocorr	R2	SSE
1990	-3.484	---	0.490	---	0.477	.9070	.0124
	(15.76)		(12.10)		(2.30)		
1967	-0.609	-3.278	0.989	-0.577	0.182	.9683	.0084
	(0.35)	(1.86)	(3.30)	(1.90)	(0.79)		
1968	-1.560	-2.488	0.825	-0.445	0.056	.9796	.0693
	(1.51)	(2.36)	(4.62)	(2.44)	(0.24)		
1969	-1.905	-2.313	0.766	-0.418	0.056	.9836	.0055
	(3.01)	(3.48)	(6.96)	(3.59)	(0.24)		
1970	-1.742	-2.497	0.979	-0.450	0.022	.9844	.0056
	(3.77)	(4.88)	(9.86)	(4.96)	(0.09)		
1971	-2.019	-2.334	0.746	-0.425	0.010	..9844	.0057
	(5.61)	(5.24)	(11.84)	(5.26)	(0.04)		
1972	-2.271	-2.238	0.702	-0.411	0.054	.9821	.0060
	(7.43)	(4.80)	(13.05)	(4.75)	(0.23)		
1973	-2.736	-2.382	0.621	-0.450	0.115	.9791	.0063
	(10.42)	(4.49)	(13.38)	(4.46)	(0.49)		
*1974	-2.790	-2.701	0.612	-0.514	0.157	.9788	.0059
	(12.60)	(4.35)	(15.54)	(4.30)	(0.68)		
1975	-2.763	-2.388	0.616	-0.451	0.195	.9781	.0057
	(14.34)	(3.12)	(17.91)	(3.03)	(0.84)		
1976	-2.974	-2.722	0.579	-0.522	0.130	.9741	.0076
	(16.09)	(2.55)	(17.46)	(2.49)	(0.55)		
1977	-3.039	-2.382	0.568	-0.457	0.300	.9633	.0076
	(15.50)	(1.55)	(16.06)	(1.51)	(1.34)		

APPENDIX 2 - REGRESSION RESULTS

ELECTRICITY: 1963 - 1980 / BREAKS:1967-1977

Break Year	--INTERCEPT-- Coeff	Dummy	--CAPITAL-- Coeff	Dummy	1st Ordr Autocorr	R2	SSE
1990	-1.412	---	0.811	---	0.626	.9852	.0032
	(38.57)		(31.56)		(3.40)		
1967	-1.386	-0.067	0.791	0.047	0.375	.9925	.0034
	(8.31)	(0.36)	(4.81)	(0.27)	(1.72)		
1968	-1.383	-0.098	0.787	0.067	0.428	.9923	.0031
	(12.22)	(0.71)	(7.276)	(0.55)	(2.01)		
1969	-1.328	-0.149	0.733	0.119	0.402	.9924	.0032
	(15.98)	(1.23)	(9.51)	(1.22)	(1.86)		
1970	-1.322	-0.110	0.728	0.098	0.357	.9936	.0031
	(22.11)	(1.01)	(13.56)	(1.23)	(1.62)		
1971	-1.344	-0.057	0.744	0.060	0.207	.9949	.0035
	(27.88)	(0.51)	(17.73)	(0.80)	(0.90)		
1972	-1.351	0.076	0.755	-0.022	0.187	.9959	.0029
	(36.83)	(0.64)	(24.30)	(0.288	(0.81)		
*1973	-1.376	0.202	0.778	-0.104	0.188	.9958	.0029
	(42.02)	(1.41)	(28.91)	(1.18)*	(0.81)		
1974	-1.402	0.292	0.803	-0.164	0.295	.9943	.0032
	(41.27)	(1.49)	(29.56)	(1.40)	(1.31)		
1975	-1.423	0.471	0.820	-0.273	0.547	.9909	.0026
	(36.76)	(1.79)	(27.34	(1.75)	(2.77)		
1976	-1.442	0.381	0.837	-0.230	0.590	.9885	.0028
	(35.34)	(1.13)	(27.09	(1.17)	(3.10)		
1977	-1.437	0.511	0.833	-0.301	0.646	.9860	.0028
	(33.46)	(1.12)	(26.12)	(1.14)	(3.59)		

APPENDIX 2 - REGRESSION RESULTS

FUELS: 1963 - 1980 / BREAKS:1967-1977

Break Year	--INTERCEPT-- Coeff	Dummy	--CAPITAL-- Coeff	Dummy	1st Ordr Autocorr	R2	SSE
1990	-0.941	---	0.643	---	0.545	.9820	.0065
	(71.23)		(28.64)		(2.76)		
1967	-0.926	0.007	0.805	-0.191	0.523	.9852	.0057
	(40.73)	(0.30)	(5.68)	(1.26)	(2.61)		
1968	-0.930	0.016	0.787	-0.180	0.506	.9859	.0058
	(51.51)	(0.70)	(6.666)	(1.38)	(2.49)		
1969	-0.941	0.046	0.727	-0.143	0.503	.9873	.0053
	(67.27)	(1.82)	(8.54)	(1.42)	(2.47)		
1970	-0.942	0.064	0.724	-0.159	0.431	.9899	.0051
	(83.81)	(2.29)	(11.58)	(1.99)	(2.03)		
1971	-0.944	0.098	0.714	-0.187	0.410	.9923	.0042
	(100.59	(3.22)	(15.43)	(2.79)	(1.91)		
1972	-0.944	0.126	0.721	-0.225	0.336	.9940	.0039
	(116.92	(3.57)	(20.56)	(3.73)	(1.51)		
1973	-0.945	0.164	0.718	-0.263	0.292	.9952	.0034
	(132.42	(4.01)	(26.94)	(4.49)	(1.30)		
1974	-0.945	0.222	0.712	-0.320	0.231	.9966	.0028
	(158.27	(4.79)	(36.32)	(5.45)	(1.01)		
1975	-0.945	0.325	0.708	-0.425	0.052	.9985	.0021
	(240.25	(6.15)	(59.74)	(7.10)	(0.22)		
*1976	-0.945	0.521	0.702	-0.624	0.078	.9992	.0009
	(333.44	(9.33)	(94.64	(10.30)	(0.33)		
1977	-0.945	0.486	0.702	-0.588	0.135	.9992	.0008
	(320.76	(6.03)	(102.81	(6.95)	(0.58)		

APPENDIX 2 - REGRESSION RESULTS

CHEMICALS & PETROCHEMICALS: 1963 - 1980 / BREAKS:1967-1977

Break Year	--INTERCEPT-- Coeff	Dummy	--CAPITAL-- Coeff	Dummy	1st Ordr Autocorr	R2	SSE
1990	-1.123	---	0.607	---	0.601	.9622	.0093
	(80.56)		(19.54)		(3.19)		
1967	-1.153	0.029	0.555	0.061	0.587	.9640	.0093
	(12.31)	(0.33)	(3.42)	(0.34)	(3.07)		
1968	-1.131	0.005	0.589	0.037	0.579	.9648	.0093
	(15.71)	(0.07)	(4.506)	(0.24)	(3.02)		
1969	-1.163	0.046	0.540	0.051	0.598	.9657	.0085
	(20.93)	(0.90)	(5.11)	(0.38)	(3.16)		
1970	-1.141	0.030	0.583	-0.003	0.517	.9715	.0092
	(27.70)	(0.80)	(7.02)	(0.03)	(2.57)		
1971	-1.138	0.390	0.593	-0.039	0.410	.9783	.0094
	(36.79)	(1.22)	(8.983)	(0.39)	(1.90)		
1972	-1.142	0.071	0.589	-0.103	0.250	.9877	.0078
	(56.74)	(2.74)	(12.92)	(1.30)	(1.09)		
1973	-1.140	0.108	0.597	-0.208	0.003	.9949	.0052
	(103.18	(5.37)	(22.50)	(3.64)	(0120)		
**							
1974	-1.125	0.121	0.628	-0.308	0.094	.9942	.0050
	(114.53	(5.02)	(25.58)	(4.54)	(0.40)		
1975	-1.109	0.110	0.660	-0.355	0.286	.9887	.0066
	(94.39)	(2.90)	(22.29)	(3.41)	(1.27)		
1976	-1.104	0.125	0.665	-0.407	0.502	.9839	.0054
	(87.50)	(2.79)	(21.52	(3.33)	(2.46)		
1977	-1.101	0.153	0.668	-0.478	0.579	.9809	.0051
	(85.64)	(2.38)	(21.63)	(3.04)	(3.02)		

APPENDIX 2 - REGRESSION RESULTS

FERROUS METALS: 1963 - 1980

Break Year	--INTERCEPT-- Coeff	Dummy	--CAPITAL-- Coeff	Dummy	1st Ordr Autocorr	R2	SSE
1990	-1.062	---	0.442	---	0.523	.9671	.0044
	(122.41)		(21.01)		(2.60)		
1967	-1.020	0.026	0.616	-0.211	0.561	.9716	.0034
	(31.78)	(0.91)	(5.35)	(1.67)	(2.87)		
1968	-1.024	0.024	0.603	-0.193	0.534	.9733	.0034
	(42.81)	(1.10)	(6.58)	(1.83)	(2.68)		
1969	-1.053	0.249	0.507	-0.136	0.527	.9763	.0031
	(60.96)	(1.36)	(7.24)	(1.56)	(2.63)		
1970	-1.052	0.034	0.512	-0.156	0.409	.9828	.0031
	(88.90)	(1.91)	(10.06)	(2.28)	(1.90)		
1971	-1.054	0.053	0.504	-0.176	0.297	.9879	.0029
	(125.72)	(2.78)	(13.28)	(3.11)	(1.32)		
1972	-1.055	0.081	0.498	-0.217	0.183	.9924	.0023
	(185.32)	(4.03)	(18.85)	(4.55)	(0.79)		
1973	-1.055	0.112	0.494	-0.265	0.020	.9960	.0018
	(289.03)	(5.53)	(29.17)	(6.55)	(0.09)		
1974	-1.055	0.156	0.497	-0.341	0.056	.9973	.0011
	(380.52)	(7.02)	(41.47)	(8.36)	(0.24)		
1975	-1.054	0.163	0.503	-0.359	0.118	.9968	.0011
	(368.29)	(5.27)	(44.70)	(6.70)	(0.23)		
1976	-1.054	0.150	0.502	-0.338	0.125	.9968	.0011
	(376.86)	(3.32)	(49.48	(4.57)	(0.54)		
1977	-1.056	0.263	0.487	-0.489	0.089	.9950	.0018
	(307.93)	(2.70)	(42.39)	(3.24)	(0.38)		

APPENDIX 2 - REGRESSION RESULTS

MACHINE BUILDING & METALWORKING: 1963 - 1980 / BREAKS:1967-1977

Break Year	--INTERCEPT-- Coeff	Dummy	--CAPITAL-- Coeff	Dummy	1st Ordr Autocorr	R2	SSE
1990	-2.940	---	0.556	---	0.577	.9726	.0049
	(20.49)		(23.06)		(3.00)		
1967	-6.052	3.368	0.066	0.535	0.446	.9938	.0017
	(10.56)	(5.61)	(0.74)	(5.62)	(2.11)		
1968	-5.100	2.436	0.216	0.389	0.347	.9916	.0029
	(8.74)	(3.95)	(2.34)	(3.96)	(1.57)		
1969	-4.491	1.825	0.311	0.293	0.372	.9892	.0035
	(8.55)	(3.12)	(3.73)	(3.16)	(1.70)		
1970	-3.992	1.252	0.390	0.201	0.414	.9872	.0037
	(9.72)	(2.54)	(5.95)	(2.49)	(1.93)		
1971	-3.628	0.833	0.447	0.134	0.351	.9864	.0046
	(10.06)	(1.78)	(7.74)	(1.72)	(1.59)		
1972	-3.461	0.512	0.474	0.080	0.444	.9848	.0040
	(11.43)	(1.11)	(9.71)	(1.02)	(2.10)		
1973	-3.202	0.174	0.515	0.024	0.456	.9816	.0048
	(11.35)	(0.34)	(11.28)	(0.28)	(2.17)		
1974	-3.061	-0.415	0.537	-0.011	0.539	.9766	.0047
	(11.36)	(0.07)	(12.25)	(0.11)	(2.71)		
1975	-2.923	0.010	0.559	0.002	0.553	.9740	.0050
	(11.60)	(0.01)	(13.56)	(0.02)	(2.81)		
1976	-2.952	-0.088	0.554	-0.017	0.574	.9729	.0049
	(13.08)	(0.11)	(14.93)	(0.11)	(2.97)		
1977	-2.926	-0.014	0.558	-0.002	0.572	.9729	.0049
	(14.35	(0.01)	(16.56)	(0.01)	(2.96)		

APPENDIX 3 - ANNUAL GROWTH RATES OF OUTPUT (GNP)

	(1)	(2)	(3)	(4)	(6)	(7)	(8)	(9)	(10)	(11)
1964	11.2	6.5	13.7	7.3	6.4	1.1	4.5	3.0	5.3	6.4
1965	10.0	5.9	14.9	6.4	5.5	1.2	2.0	1.8	11.2	6.5
1966	7.6	6.4	10.0	6.2	4.5	1.3	0.5	7.4	4.5	5.6
1967	7.7	5.2	10.0	5.7	6.7	1.4	5.0	8.3	7.4	6.9
1968	8.8	3.5	7.2	4.6	9.0	1.5	2.4	7.9	5.6	6.5
1969	7.9	4.4	6.1	3.5	6.9	1.7	1.8	6.4	5.7	5.4
1970	7.6	5.5	11.3	5.5	7.7	1.9	4.9	5.9	6.0	7.0
1971	8.1	4.8	8.1	3.8	8.1	2.0	2.8	4.5	2.6	6.2
1972	7.1	4.7	6.7	3.3	6.9	2.0	2.0	0.7	3.3	5.0
1973	6.8	4.9	9.0	4.0	8.3	2.1	2.7	2.8	0.8	5.8
1974	6.7	4.9	9.5	4.2	8.5	2.1	1.8	2.7	7.9	6.5
1975	6.6	5.9	9.7	4.4	7.7	2.0	3.6	2.9	5.1	6.2
1976	6.9	3.7	4.8	2.7	5.5	2.0	-0.1	4.2	-1.1	3.9
1977	3.6	4.2	5.2	0.7	5.6	2.1	0.5	2.5	4.0	4.0
1978	4.7	3.1	3.6	2.2	5.6	2.1	-0.5	2.6	-1.1	3.5
1979	2.9	3.0	0.2	0.0	5.6	2.1	-2.9	1.8	3.2	3.0
1980	4.5	2.3	5.2	-0.3	4.3	2.1	2.8	2.0	-1.4	2.9

(1) = ELECTRIC POWER
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(3) = CHEMICALS & PETROCHEMICALS
(4) = FERROUS METALLURGY
(6) = MACHINE BLDG & METALWORKING
(7) = CONSTRUCTION MATERIALS
(8) = TIMBER, PAPER & PULP
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(10) = FOOD INDUSTRY
(11) = TOTAL INDUSTRY

APPENDIX 4 - ANNUAL GROWTH RATES OF CAPITAL

	(1)	(2)	(3)	(4)	(6)	(7)	(8)	(9)	(10)	(11)
1964	10.1	9.4	20.0	9.0	11.9	8.8	6.4	7.7	7.0	9.3
1965	9.2	6.3	18.5	9.5	11.7	8.0	7.2	5.7	7.2	9.8
1966	10.6	8.1	11.7	8.7	9.2	8.5	6.7	9.5	7.4	8.9
1967	10.2	5.9	11.1	8.0	9.6	7.8	6.3	8.6	7.5	7.7
1968	10.8	5.9	11.9	8.9	9.3	8.2	7.9	9.1	8.2	8.6
1969	10.5	8.1	11.8	8.6	9.2	8.4	6.4	9.4	7.6	8.9
1970	10.0	8.8	14.1	9.6	12.6	11.6	9.5	10.5	5.0	9.4
1971	8.0	7.2	10.1	6.1	10.0	9.0	7.1	7.8	7.2	9.0
1972	8.2	6.4	8.8	6.5	9.8	11.5	8.8	9.6	7.1	8.3
1973	6.8	7.9	9.9	8.8	9.9	9.1	8.1	8.8	10.0	8.3
1974	6.4	8.3	9.7	4.3	10.5	7.3	8.3	6.7	7.3	8.6
1975	6.7	7.6	8.8	8.4	9.5	8.3	6.4	5.7	6.8	8.8
1976	6.4	8.3	8.9	6.4	11.2	7.2	7.1	7.1	6.4	8.1
1977	5.3	6.3	6.4	6.5	8.9	7.6	6.6	6.1	5.0	7.0
1978	6.3	8.5	9.4	6.8	9.7	6.6	6.7	7.3	5.1	7.9
1979	5.9	8.5	11.9	4.0	8.5	5.1	5.8	5.4	5.4	7.1
1980	6.1	9.2	9.4	7.2	9.1	5.6	6.8	6.5	6.2	5.3

(1) = ELECTRIC POWER
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APPENDIX 5 - ANNUAL GROWTH RATES OF LABOR - WORK HOURS

	(1)	(2)	(3)	(4)	(6)	(7)	(8)	(9)	(10)	(11)
1964	6.8	1.8	10.2	3.9	7.1	2.2	1.4	3.9	5.2	4.0
1965	5.7	0.5	8.7	2.2	5.6	1.0	0.1	2.5	3.7	3.5
1966	8.1	2.7	8.4	3.0	5.5	3.9	0.8	14.6	4.0	4.4
1967	3.4	0.7	5.3	3.0	3.8	3.5	0.9	-5.2	4.7	3.6
1968	3.7	1.0	3.9	2.4	4.8	4.0	0.2	3.4	3.3	3.6
1969	1.9	-1.7	4.0	1.4	3.9	3.1	-0.7	2.6	0.8	2.6
1970	0.0	-1.4	3.1	0.1	2.3	2.3	0.5	2.5	-0.8	1.2
1971	2.3	-0.6	2.3	0.0	3.4	2.6	-0.2	1.0	1.2	2.0
1972	0.2	-3.1	1.0	-0.2	2.3	0.8	-1.2	-1.1	0.4	1.1
1973	0.2	-2.2	2.0	-0.4	2.0	0.3	-1.0	-0.3	-0.2	0.6
1974	2.0	-0.5	2.7	1.1	3.3	1.7	-0.2	0.9	1.7	2.0
1975	2.7	0.2	2.8	0.0	3.1	1.4	-0.3	-0.2	0.4	1.7
1976	1.6	-1.3	1.6	1.4	1.9	1.3	-0.3	2.4	0.5	2.2
1977	2.2	-3.1	1.3	0.3	2.1	0.3	-0.2	0.4	1.5	1.5
1978	2.3	2.8	0.4	-0.1	2.2	1.1	-0.6	-0.2	-0.1	1.7
1979	1.2	3.2	1.0	0.2	1.0	-0.4	-0.6	-0.1	0.3	0.2
1980	2.6	0.5	1.0	-0.3	0.6	-0.2	-0.1	-0.5	-0.3	0.7

(1) = ELECTRIC POWER
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APPENDIX 6 - INPUT DATA

ELECTRIC POWER (1)

YEAR	OUTPUT	CAPITAL	----- LABOR -----	
			PERSONS	WK-HRS
1963	4.6	22.8	477	885
1964	5.2	25.1	507	945
1965	5.7	27.4	540	999
1966	6.1	30.3	581	1080
1967	6.6	33.4	602	1122
1968	7.2	37.0	625	1164
1969	7.7	40.9	635	1186
1970	8.3	45.0	633	1187
1971	9.0	48.6	645	1214
1972	9.6	52.6	655	1217
1973	10.3	56.2	659	1220
1974	11.0	59.8	671	1244
1975	11.7	63.8	686	1277
1976	12.5	67.9	698	1298
1977	12.9	71.5	715	1326
1978	13.5	76.0	731	1356
1979	13.9	80.5	*748	*1372
1980	14.6	85.4	*770	*1407

APPENDIX 6 - INPUT DATA

FUELS (2)

YEAR	OUTPUT	CAPITAL	----- LABOR -----	
			PERSONS	WK-HRS
1963	8.4	20.2	1541	2564
1964	8.9	22.1	1560	2611
1965	9.5	23.5	1579	2623
1966	10.1	25.4	1588	2695
1967	10.6	26.9	1595	2713
1968	11.0	28.5	1606	2740
1969	11.4	30.8	1574	2693
1970	12.1	33.5	1542	2655
1971	12.7	35.9	1513	2640
1972	13.3	38.2	1479	2559
1973	13.9	41.2	1447	2502
1974	14.6	44.6	1425	2489
1975	15.4	48.0	1434	2494
1976	16.0	52.0	1440	2461
1977	16.7	55.3	1453	2384
1978	17.2	60.0	1493	2450
1979	17.7	65.1	*1527	*2529
1980	18.1	71.1	*1540	*2543

APPENDIX 6 - INPUT DATA

CHEMICALS & PETROCHEMICAL (3)

YEAR	OUTPUT	CAPITAL	----- LABOR -----	
			PERSONS	WK-HRS
1963	3.9	9.0	1042	1821
1964	4.4	10.8	1142	2006
1965	5.1	12.8	1251	2180
1966	5.6	14.3	1346	2364
1967	6.1	15.9	1424	2489
1968	6.6	17.8	1468	2585
1969	7.0	19.9	1523	2688
1970	7.8	22.7	1568	2771
1971	8.4	25.0	1598	2834
1972	8.9	27.2	1626	2863
1973	9.7	30.0	1667	2921
1974	10.7	32.9	1706	3000
1975	11.7	35.8	1753	3084
1976	12.3	39.0	1783	3133
1977	12.9	41.5	1811	3175
1978	13.4	45.4	1818	3187
1979	13.4	50.8	*1856	*3218
1980	14.1	55.6	*1881	*3250

APPENDIX 6 - INPUT DATA

FERROUS METALLURGY (4)

YEAR	OUTPUT	CAPITAL	----- LABOR -----	
			PERSONS	WK-HRS
1963	6.0	14.5	1161	2100
1964	6.5	15.8	1200	2182
1965	6.9	17.3	1236	2230
1966	7.3	18.8	1267	2296
1967	7.7	20.3	1298	2365
1968	8.1	22.1	1333	2422
1969	8.3	24.0	1348	2455
1970	8.8	26.3	1359	2457
1971	9.1	27.9	1352	2457
1972	9.4	29.7	1354	2451
1973	9.8	32.3	1356	2442
1974	10.2	34.7	1366	2469
1975	10.7	37.6	1369	2468
1976	11.0	40.0	1380	2502
1977	11.0	42.6	1380	2509
1978	11.3	45.5	1377	2503
1979	11.3	47.3	*1395	*2508
1980	11.3	50.7	*1395	*2500

APPENDIX 6 - INPUT DATA

MACHINE BUILDING & METALWORKING (6)

YEAR	OUTPUT	CAPITAL	----- LABOR -----	
			PERSONS	WK-HRS
1963	24.5	25.3	8729	15861
1964	26.1	28.3	9305	16991
1965	27.5	31.6	9905	17948
1966	28.8	34.5	10400	18938
1967	30.7	37.8	10846	19664
1968	33.5	41.3	11282	20601
1969	35.8	45.1	11698	21407
1970	38.5	50.8	12017	21891
1971	41.7	25.0	12369	22641
1972	44.5	27.2	12718	23168
1973	48.3	30.0	13049	23626
1974	52.4	32.9	13424	24397
1975	56.4	35.8	13816	25147
1976	59.5	39.0	14065	25626
1977	62.9	41.5	14355	26155
1978	66.4	45.4	14673	26734
1979	70.1	50.8	*14990	*27012
1980	73.2	55.6	*15142	*27180

APPENDIX 6 - INPUT DATA

CONSTRUCTION MATERIALS (7)

YEAR	OUTPUT	CAPITAL	----- LABOR -----	
			PERSONS	WK-HRS
1963	5.4	8.0	1657	3027
1964	5.7	8.7	1685	3095
1965	6.1	9.4	1716	3127
1966	6.5	10.2	1774	3250
1967	6.9	11.0	1831	3364
1968	7.2	11.9	1901	3500
1969	7.4	12.9	1955	3607
1970	8.0	14.4	1996	3689
1971	8.5	15.7	2039	3785
1972	9.0	17.5	2070	3817
1973	9.5	19.1	2093	3829
1974	10.0	20.5	2115	3893
1975	10.4	22.2	2151	3949
1976	10.8	23.8	2177	3999
1977	11.0	25.6	2188	4011
1978	11.2	27.3	2213	4056
1979	11.3	28.7	*2233	*4040
1980	11.4	30.3	*2233	*4033

APPENDIX 6 - INPUT DATA

TIMBER, PAPER & PULP (8)

YEAR	OUTPUT	CAPITAL	----- LABOR -----	
			PERSONS	WK-HRS
1963	7.6	7.8	2771	5049
1964	8.0	8.3	2796	5119
1965	8.1	8.9	2819	5122
1966	8.2	9.5	2827	5162
1967	8.6	10.1	2830	5207
1968	8.8	10.9	2858	5219
1969	9.0	11.6	2833	5184
1970	9.4	12.7	2848	5211
1971	9.7	13.6	2829	5203
1972	9.8	14.8	2821	5142
1973	10.1	16.0	2807	5092
1974	10.3	17.3	2799	5082
1975	10.7	18.4	2795	5069
1976	10.7	19.7	2773	5052
1977	10.7	21.0	2773	5041
1978	10.7	22.4	2756	5010
1979	10.3	23.7	*2770	*4980
1980	10.6	25.3	*2745	*4919

APPENDIX 6 - INPUT DATA

LIGHT INDUSTRY (9)

YEAR	OUTPUT	CAPITAL	----- LABOR -----	
			PERSONS	WK-HRS
1963	6.6	6.5	4034	7233
1964	6.8	7.0	4171	7516
1965	6.9	7.4	4308	7702
1966	7.4	8.1	4471	8826
1967	8.0	8.8	4651	8367
1968	8.7	9.6	4800	8654
1969	9.2	10.5	4914	8875
1970	9.8	11.6	5019	9096
1971	10.2	12.5	5036	9184
1972	10.3	13.7	5034	9084
1973	10.6	14.9	5045	9055
1974	10.8	15.9	5074	9138
1975	11.2	16.8	5109	9124
1976	11.6	18.0	5191	9339
1977	11.9	19.1	5221	9372
1978	12.2	20.5	5211	9354
1979	12.4	21.6	*5201	*9232
1980	12.7	23.0	*5196	*9187

APPENDIX 6 - INPUT DATA

FOOD INDUSTRY (10)

YEAR	OUTPUT	CAPITAL	----- LABOR -----	
			PERSONS	WK-HRS
1963	7.5	13.0	2370	4475
1964	7.9	13.1	2481	4706
1965	8.8	14.9	2592	4878
1966	9.2	16.0	2680	5071
1967	9.8	15.7	2786	5310
1968	10.4	16.4	2893	5485
1969	11.0	17.4	2911	5531
1970	11.6	17.1	2901	5484
1971	11.9	20.5	2903	5548
1972	12.3	21.8	2920	5571
1973	12.4	22.6	2936	5561
1974	13.4	25.6	2986	5658
1975	14.1	30.7	3015	5683
1976	13.9	32.8	3018	5710
1977	14.5	35.9	3060	5793
1978	14.3	39.1	3057	5787
1979	14.8	41.4	*3102	*5807
1980	14.6	41.7	*3102	*5788

APPENDIX 6 - INPUT DATA

TOTAL INDUSTRY (11)

YEAR	OUTPUT	CAPITAL	----- LABOR -----	
			PERSONS	WK-HRS
1963	79.8	140	25442	45897
1964	85.0	153	26317	47713
1965	90.4	168	27447	49377
1966	95.5	183	28514	51553
1967	102.1	197	29448	53389
1968	108.8	214	30428	55288
1969	114.6	233	31159	56741
1970	122.6	255	31593	57405
1971	130.0	278	32030	58554
1972	136.6	301	32461	59217
1973	144.5	326	32875	59557
1974	153.9	354	33433	60725
1975	163.4	385	34054	61737
1976	169.8	416	34815	63120
1977	176.5	445	35417	64069
1978	182.6	480	36014	65149
1979	188.0	514	-	65291
1980	193.4	551	-	65777

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