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Stephen Alan Brower

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A STUDY ON THE EFFECT OF THE CONSTRUCTION OF THE
ANTI-BALLISTIC MISSILE SYSTEM UPON THE
NORTH CENTRAL MONTANA ECONOMY THROUGH
THE USE OF INPUT-OUTPUT ANALYSIS

By

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B.A., Texas A & M University, 1968

Presented in partial fulfillment of the
requirements for the degree of

Master of Business Administration

UNIVERSITY OF MONTANA

1971

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CHAPTER I

INTRODUCTION

THE SAFEGUARD ABM SYSTEM

Amid considerable political controversy, the United States Congress passed Senate Bill 2546 on November 6, 1969, and the President signed Public Law 121, 91st Congress on November 19, 1969, providing for the initial deployment of two Safeguard Anti-Ballistic Missile System sites. The primary purpose of the Safeguard system is to protect the Boeing Minuteman Intercontinental Ballistic Missile from a first strike attack by the Soviet Union, and thus permit effective retaliation. Consequently the location of these first two sites will be near Minuteman bases. The two bases are Grand Forks AFB in Northeastern North Dakota and Malmstrom AFB in North Central Montana, which is the area of interest for this study.

The safeguard system has four main elements, the perimeter acquisition radar, PAR, the missile site radar, MSR, and two types of missiles, the Spartan and the Sprint. The PAR is designed to detect an incoming enemy ICBM while it is still a considerable distance away and calculate its path. This information is passed on to the MSR which has control of actually launching the missiles. The Spartan is
long ranged and would intercept the enemy at altitudes of 200 to 400 miles. The Sprint is smaller and would act as a back up, seeking out warheads that passed through the Spartan screen and destroying them within forty miles of the target area.

Four Safeguard facilities are to be located in Montana, two in Pondera county and two in Toole county. The Montana program consists of three stages of activities, the construction phase, the equipment installation and test phase, and the operational phase. There will also be the resurfacing of approximately forty-one miles of Federal highway in the area. During the construction phase many of the workers will probably be from outside the local area. After this phase the construction workers will be replaced by technicians who will install and test the specialized equipment. The operational work force, mainly military personnel, will take the sites over from the technicians when they are ready for use.

PURPOSE OF THE STUDY

The decision for the location of the ABM was political and military. The local residents had only a small voice in it, but yet, they will be effected to a greater extent than the country as a whole. Ignoring the nation-wide controversy

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concerning the ABM's need, effectiveness, cold war strategy, and cost, the local residents are left with a very basic and legitimate question, "How will it effect me?" A military build up of this type will have many influences upon all aspects of the life of a community, including economic, social, political, and environmental. It is this economic effect on the North Central Montana area that is of interest in this study.

The Safeguard program will require over $200 million of Federal funds in order to build the four sites in Montana. After the construction and test phases are completed, approximately 1,000 personnel with 1,500 dependents will be required to operate and man the sites. The effect of the income generated from this employment will probably not vary substantially from an increase in income through more normal sources. If the income of the region were to increase due to productivity the effect on the economy could be much the same as this increase from a change in government employment in the area. Likewise, the technicians will add to the income of the region, through consumption, but the activity of their installation and testing will be supported from outside the region by the specialized manufacturing industries. However, the estimated $200 million for the construction phase appears as if it would have a substantial influence upon the economy of the region.

The subject of this paper is the effect that this
construction will have on the economy of the region. It is hypothesized that this construction activity will have little effect on the primary industries of the region, while the secondary industries will be influenced to a measurable degree. This influence will be estimated. The process that will be used is input-output analysis; a model will be built for the region and used to measure the impact.

Input-output analysis is an appropriate method for this type of study for many reasons. First it shows the interdependence of economic activity. Increased activity in one sector of the economy will cause changes in the other sectors as well. In this case all the direct increase in activity will be in one sector, construction, but it is predicted that influences will be present in other sectors too. Since secondary industries and the labor force can be included in the model, it can be used to measure this entire effect. Secondly, input-output analysis is a consistent forecaster. It can be used for the forecast of each sector and the total will be consistent with the total change for the economy. In addition, the method can be used for multiplier or impact analysis, by determining the total requirements, direct and indirect, necessary to sustain a higher level of economic activity. This impact analysis will be the primary use of the model in this study.
CHAPTER II

A REVIEW OF INPUT-OUTPUT ANALYSIS

Input-output analysis is an econometric method that relates the input of each industry in an economy as an output of the other industries. It sets up each industry in terms of its interindustry flows within the framework of the entire economy, at general equilibrium. As such, it is concerned with technology and is empirical in nature.

HISTORY

The beginnings of input-output analysis can be traced back rather far into the history of economic thought, but it has only recently been given much attention or respect, at least in this country. The first work to show the seeds of the technique was published in 1758 by Francois Quesnay entitled Tableau Economique. In it he illustrated the operation of a single firm, a farm, and showed the interdependence of economic activity. Leon Walras introduced the basic ideas for the method with his work on general equilibrium theory. In attempting to analyze the general equilibrium of production, he conceptualized rations between the quantity of factors required in a production process to the quantity of finished goods produced. These were based on the level
of technology and termed the coefficients of production. Walras' model showed the interdependence of industries within an economy and the competing needs of industries, consumers, and government for scarce resources. His work was published under the title Elements d'Economic Politique Pure, in 1874.

Other economists, notably Karl Marx, Gustav Cassel, V.K. Dmitriev and Vilfredo Pareto, also contributed ideas and insights to the body of knowledge that would one day become input-output analysis. However, it was the work of Professor Wassily Leontief of Harvard that put these ideas into a usable form. He first introduced his work in a Moscow journal in 1925. In 1936 Professor Leontief published his basic work in The Review of Economics and Statistics with an article titled "Quantitative Input-Output Relations in the Economic System of the United States." This was followed up by a book in 1941, The Structure of American Economy, 1919-1929. He took the previous ideas and concepts and molded them into a form that could have actual statistical data applied to it and used for analysis. In fact, input-output analysis is often called Leontief analysis in honor of his work.

Even so, input-output analysis did not gain immediate popularity or recognition, due to both political and technical problems. Until the advent of large capacity computers,

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the mathematical computations were too restrictive for it to be used effectively or routinely. An even larger hurdle in this country was political.

The first input-output table for the United States was by Professor Leontief for the 1919 economy. He later made tables using the 1929 and 1939 data. These were all contained in his book published in 1941. The Bureau of Labor Statistics played a leading role in producing a government input-output study for the 1949 economy which was published in 1952. This study was organized around 500 industrial sectors, although only 200 were ever published. However, at this time the method ran into political trouble. Sanctioned research in the area ceased, "apparently because input-output studies were associated in the minds of certain public officials with state planning and hence Socialism."\(^2\) Towards the end of the 1950s this attitude lessened and the Department of Commerce was given the assignment of preparing periodic input-output studies. Their first study was on the 1958 economy and was published in 1964. It contained 86 sectors. Many of the users of these tables desired more detail in the breakdown of the industries, and the Commerce Department responded; its next study contained 370 industries.\(^3\)


This was a study for the 1963 economy which was published in 1969. It is the Department's latest published study for the national economy.

Input-output analysis suffered none of this prejudice in other countries. It was not seen as a tool of Communist take over, but rather a useful tool for economic analysis that could be adjusted and applied to many different types of economic situations. Many countries throughout the world have employed it. France is a notable example of how it can be used in a free market economy. Italy and Japan also have made national input-output tables. Russia does use it for planning and economic policy purposes. Nearly every developing nation has established some type of a development program that incorporates input-output analysis. Burma, India, Pakistan, and the Netherlands are some notable examples.

USES

Input-output analysis has many and diverse uses. It can be used in evaluating the market potential of an individual firm, while on the other end of the spectrum, it can be used to analyze the consequences of national economic programs. The most obvious use is that it structures an economy and thus exhibits the relationship of the various industries and sectors to each other. It will show the market and supply sources of each industry and thus allow

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a firm to understand how forces and changes in demand or output in other industries will effect it. This structural analysis in itself would be enough to prove the merit of input-output analysis, as it would allow economists, policy makers and businessmen to study the basic economic relationships in the country. But, its uses go much farther. It can be used for comparative analysis between countries, such as developed to developing nations, or free market to planned economy. It can be used as a forecasting tool to determine the intermediate levels of activity necessary for a given output or final demand and visa versa. As a forecasting tool it is especially useful and has many advantages over other methods. As mentioned before, it is a consistent forecaster. "When an input-output table is projected, 'the output of each industry is consistent with the demands, both final and from other industries, for its product.'"\footnote{Clopper Almon, Jr., "Progress Towards a Consistent Forecaster of the American Economy in 1970," (mimeographed, 1964), p. 2, quoted by William H. Miernyk, The Elements of Input-Output Analysis, (New York, 1965), p. 32.} Input-output analysis is less aggregated than forecasting by the use of simultaneous equations tends to be, another way to handle the problem of consistency. It is also useful for impact or multiplier analysis. This is a method where the total influence on output, income and employment from a change in final demand can be measured. In reality this is just the next step from forecasting. Most forecasting models
stop with the new direct or first round requirements. Input-output models can carry the process further to include the subsequent rounds of economic activity that is generated or the multiplier effect. In addition, alternative economic policies can be evaluated with this method with so-called feasibility tests or sensitivity analysis. A public policy maker can make himself aware of the potential effect of a program, by using the model as a consistent forecaster, and from this information judge the feasibility of the program. In sensitivity analysis, the sectors that will be the most sensitive or responsive to a particular change can be determined. The U.S. Department of Labor uses this method to predict employment requirements in various industries, and to provide a basis for evaluating long-range government programs for the economy.  

The experience of the French Government's use of input-output analysis will illustrate some of its potential in a free economy. France has a system of "indicative planning" or "non-coercive planning" set up by the French Planning Commission. This is really a misnomer as the French economy is not planned. Instead, the Commission makes use of various economic methods, especially input-output analysis, to make short run economic forecasts. The resulting government forecast enables the individual businessman to see where potential markets or other opportunities lie. He is free to

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6 Miernyk, p.55.
respond to this forecast in any way that he desires. In effect, the government has predicted the individual business outlook for every industry in the country. Rather than coercing businessmen or planning centrally, the French Planning Commission does the forecasting for French firms and they may do whatever they wish to meet their predicted market conditions. It is obvious that this type of forecasting model would be extremely useful to the government too for its domestic policies.

METHODOLOGY

Input-output analysis is primarily concerned with technology and the production process. Every industry is viewed as a user of goods in order to produce other goods. Empirical, statistical evidence is called upon to provide the relationships between industries. The areas investigated are essentially technological. Given the state of technology and the amount of resources available, the analyst may determine through the use of input-output what goods may be produced and how much of each resource will be used in the process.

Input-output analysis starts with dividing an economy into industrial sectors. Conceptually, all industries produce only one good or service and all industries are included. In practice it becomes immediately obvious that such a table would be of an unworkable size and that firms do not limit themselves to a single product. Thus the sectors must be
aggregated into a manageable few, and firms are classified by their primary product.

A table is constructed with each sector along both the top and side, in the same order, top to bottom as left to right. The dollar value of the finished goods transferred from one industry to every other industry (including itself) is placed in the row of the first industry under the column of the remaining industries. Labor or the household sector, government purchases, transfer payments and taxes, imports and exports, and capital accumulation and depreciation are included as industries and handled the same way, although they are termed the final demand and payments sectors as opposed to the processing sectors. The processing sector is the actual manufacturing portion of the economy. It is in this sector that the goods and services are produced. The payments sector and the final demand sector are really the same thing, Gross National Product, viewed as income and expenditure respectively. The payments sectors are listed along the side of the table and represented as rows, while the final demand sectors are the corresponding columns. When the entire table is completed, the rows and columns can be summed to yield the total gross output or expenditure for each sector. This is called the transactions table and is the first of three input-output tables.

The second table is that of the direct requirements or technical coefficients. It is formed by dividing each term in the processing sector by the total of that column.
The result will be fractions whose sum will be less than one. This table will contain quantities which are the number of cents worth of each good from every industry that will be required to produce one dollar of output in each industry.

The table of direct requirements will give just that, the direct requirements for an increase in output that results from an increase in final demand. However there will also be indirect requirements. These indirect requirements result chiefly from the interdependence of industries and the multiplier effect. This third table of total requirements is found by taking the "Leontief inverse" of the matrix of direct requirements.

Let

\[
A = \begin{pmatrix}
  a_{11} & \cdots & a_{1n} \\
  \vdots & \ddots & \vdots \\
  \vdots & \ddots & a_{ij} \\
  a_{n1} & \cdots & a_{nn}
\end{pmatrix}
\]

where \( a_{ij} \) are the technical coefficients between the processing sectors (the payments sector and the final demand sector have been removed). Then the Leontief inverse is defined as:

\[
(I-A)^{-1}
\]

where \( I \) is the identity matrix. The Leontief inverse is then transposed and that can be used to calculate the total requirements for a change in final demand.
Input-output analysis is usually thought of as pertaining to an entire economy. Most input-output studies and work are done on national economies, although conceptually, there is no need for this restriction. An input-output model can be built to represent any aggregation of economic activity. Thus a national model differs from a regional one only in degree.

In practice, however, these differences are vast due to two main problems. The import-export sector is most serious. For a national model all imports and exports can be grouped together and considered as a sector, as net imports or exports are small compared to the entire GNP, and the economy could be self-sufficient without them (at least this is so in a large developed economy such as the United States). For a regional model only a small part of the total goods imported or exported would be for international or foreign trade. The rest would be domestic trade, but for parts of the country outside the region. Thus for a region the volume of trade with the outside would be too large to group together and consider only the net differences and still maintain meaningful relationships between the sectors. The second problem is one of data. Most statistical information is gathered for the nation, or for states in the case of the United States, and does not break down into enough detail to supply interregional transactions.
There have been various methods developed to minimize the consequences of these problems, but each has its drawbacks and benefits. One way to treat the import-export problem is to divide the sources of supply for each industry into the areas from which it could come, national and international. Thus the amount demanded for region A would be shown to come from regions B, C, and D and the proportions in each case. H.B. Chenery used this technique for an inter-regional study of Italy. He divided the country into Northern and Southern portions and set up an input-output table, breaking each sector into Northern and Southern demand, and supply from the North, South, and foreign import. This is certainly a logical and meaningful way to handle the problem, but it is rather difficult to set up this type of system for small regions where the economies are less distinct than those of Northern and Southern Italy. The other end of the spectrum is to consider the imports as a single "all other" sector, as is done for national studies. As mentioned before the problems associated with this method are considerable. Nevertheless, most regional studies treat the problem in a manner closer to the second method than the first.

There are three major methodologies for handling data sources. The primary method employs sample surveys to

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estimate interindustry relationships. If the secondary data approach is used, national coefficients are multiplied by the gross output of the corresponding regional sector. The results are then summed and divided by the total to arrive at new coefficients. Jerald R. Barnard and Harold K. Charlesworth developed a regional input-output model for the state of Kentucky using this approach. In that study, the authors state that any accuracy that may be lost due to the secondary data approach is usually compensated for by the cost savings. The third method may be used when the other two are not possible. It consists of simply taking the national coefficients and using them unadjusted. Not only are many fundamental problems present with this approach, but accuracy is also sacrificed.

There are many examples of competently performed regional input-output studies. These include the input-output table for Utah by Moore and Peterson and the Colorado River Basin Project by Miernyk, Udis and Stewart, and an input-output study for West Virginia by Miernyk in which primary data was used.

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9 Miernyk, p. 58-74.
CHAPTER III

AN INPUT-OUTPUT MODEL FOR NORTH CENTRAL MONTANA

THE REGION

The Safeguard Anti-Ballistic Missile system to be constructed in Montana consists of four sites in two counties. The perimeter acquisition radar (PAR) site will be located in the southern portion of Toole county, and the missile site radar (MSR) will be placed in Pondera county. A remote Sprint launch (RSL) site will be located in each county.

The local economic effect of this construction will not be felt in these two counties alone, but in a surrounding region. The Federal Government and the Army Safeguard Command designated a surrounding area of approximately fifty miles radius from the major sites as an impact area. It includes most of Toole, Pondera, Teton, Cascade, Choteau, and Liberty counties and extends into Glacier and Hill counties. However, the region for this model will follow political boundaries and will consist of the eight counties mentioned in their entirety, (Figure 3-1).

The region contains 19,807 square miles, and had

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137,343 residents in 1970. It includes the city of Great Falls, one of the largest in the state with a population of 70,905.\(^2\) Great Falls is really an exception to the region, being the only urban concentration, and containing 51 percent of the region's population. Of course Great Falls should be included in the model, as it will serve as a primary market place for the new economic activity.

Primary industries in the region are farming and ranching. Oil and gas production is also present in appreciable quantities. The rest of the economy is made up of supply industries for the primary sectors, construction, service and retail trade, and governmental services. Manufacturing activity is extremely limited.

DESIGN AND ASSUMPTIONS OF THE MODEL

In formulating an input-output model for a region, there are three major methods that may be used for data, as mentioned above. They are the primary data source, the secondary data source and the use of national data. Coefficients developed from national data will be used in this study. This immediately imposes some very serious limitations on the accuracy and relevancy of the model. Of course there are some advantages and necessities that prompted its use.

Figure 3-1
ABM IMPACT REGION

LEGEND
1 MSR Site
2 PAR Site
3 RSL Site
4 RSL Site
The use of national data is more readily available and less expensive, in both money and time than the other two methods. To use primary data, a sample survey must be taken, the regional transactions for each sector are then estimated, and the technical coefficients calculated. The secondary data approach adjusts the national coefficients by multiplying them by the total regional transactions for that sector to yield a new transactions table from which the modified coefficients can be calculated. Both of these methods require statistical data that is not always available, especially for the secondary industries, and is usually expensive to obtain. The secondary approach is less expensive than the primary data approach, but it still requires detailed investigation. The use of the unadjusted national coefficients makes data collection easier, but conceptual accuracy is sacrificed. A region might not correlate highly with the national industrial structure, and thus the national data would be of questionable relevance. In practice this may not be so restrictive.

For this study only the national industries that are present in the region will be explicitly included in the model and used to represent the region. The other industries will be grouped into a single sector and may be considered the rest of the world, (this is possible since the input-output coefficients are linear). The single industry sectors are still the national sectors, but are the national sectors present in the region. In order for them to be used to
represent the region the assumption must be made that if a good or service is available from local sources, it will be purchased from that source. The coefficients are related by technology, not by size, so they probably represent the region's interindustry transactions fairly adequately. In effect, the regional model is a national model as it would be viewed from the region. This way a separate foreign sector, as such, is not required. The "all other" sector contains all goods and services that are not available from the local sources or imported. For example, construction will be included in the model explicitly because it is an industry of interest in the study, and it is present in the region. Under the assumptions of the model, all construction will be supplied by the local sources. This, of course, cannot be true, as the two major bidders for the contract are from outside the region. In interpreting the results it must be realized that if a substantial portion of the construction work goes to outsiders, the results will be biased. The same problem will be faced with the rest of the explicit or "regional" sectors but not nearly in the same degree. In effect, the model will show the potential increase in economic activity that would result if all products were purchased from the local industries.

The national data from the 1963 input-output study by

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3 The two major bidders are Peter Kiewit & Sons of Omaha, Nebraska and Mid-Valley Construction of Houston, Texas.
the U.S. Department of Commerce will be used for the model. These coefficients are available in the Department of Commerce publication, *Input-Output Structure of the U.S. Economy: 1963*, Volume 1 - Transactions Data for Detailed Industries; Volume 2 - Direct Requirements for Detailed Industries; and Volume 3 - Total Requirements for Detailed Industries, (Washington, 1969). The use of data that is eight years old is a serious limitation, but as these are the most recent figures available, there is no choice. It will have to be assumed that technology for the industries involved has not changed substantially, and the industries have the same technological relations between themselves as the national averages.

Since the national data will be used the assumptions associated with these data will be of necessity for this model. Both models are static, and thereby require three general assumptions, which are 1) single producing sector for each group of commodities, 2) the inputs of each sector are a unique function of the level of output, and 3) there are no external economies or diseconomies. In addition, the coefficients will have to be considered as stable over time. It must be assumed that the economy was at general equilibrium before the change in final demand, and that it will return to equilibrium. Since the technical relationships are measured in dollar terms, constant prices (or stable relative prices) will be necessary to maintain continuity of data.
It is immediately evident that some of these assumptions are not easily defended. Even though technology changes fairly slowly, the relationships would be expected to change in eight years. The secondary industries are probably not particularly stable in their relationships to each other, and this region has an economy that is made up to a considerable extent of secondary industries. The amount of inflation that has been present over the past few years is not consistent with the assumption of stable prices. Nevertheless these assumptions will have to be made. They will be considered in the analysis of the results, and perhaps then it will become apparent that some of them could have been relaxed.

THE MODEL

The economic sectors must be chosen to match this general framework. The sectors that are of primary interest for the study will be considered first. These are the construction industry and the secondary industries of retail and wholesale trade. With these included, the rest of the model will represent the general economy of the region as nearly as possible. As mentioned above, the economy of the region is not heavily involved in manufacturing. The national model, however, is highly concerned with the manufacturing industries, and divides them up in considerable detail, while substantially aggregating the rest of the economy. As a consequence, adapting the region to the national model limits
It is immediately evident that some of these assumptions are not easily defended. Even though technology changes fairly slowly, the relationships would be expected to change in eight years. The secondary industries are probably not particularly stable in their relationships to each other, and this region has an economy that is made up to a considerable extent of secondary industries. The amount of inflation that has been present over the past few years is not consistent with the assumption of stable prices. Nevertheless these assumptions will have to be made. They will be considered in the analysis of the results, and perhaps then it will become apparent that some of them could have been relaxed.

THE MODEL

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the possible sectors which may be considered. Within this criteria, the selection of the sectors was judgmental and is broken down as follows:

**Processing Sector**
- Agriculture and agriculture services
- Oil and gas production and related services
- Highway construction
- All other construction
- Transportation
- Financial and real estate
- Wholesale and retail trade
- Amusements
- All other industries

**Payments Sector**
- Total employee compensation
- Profits and capital consumption allowances
- Taxes and current surplus of government enterprises

**Final Demand Sector**
- Personal consumption expenditures
- Gross private domestic investment
- Government purchases of goods and services

The basic organization of the model appears in Table 3-1. The model will not be used in this state for analysis, as certain modifications are required. These consist chiefly of taking the household "industry" into the processing
### TABLE 3-1

<table>
<thead>
<tr>
<th>Payments sector</th>
<th>processing sector</th>
<th>final demand sector</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agriculture</td>
<td>Agriculture and agriculture service</td>
<td>Personal consumption</td>
</tr>
<tr>
<td></td>
<td>Oil and gas production and service</td>
<td>Gross investment</td>
</tr>
<tr>
<td></td>
<td>Highway construction</td>
<td>Government purchases</td>
</tr>
<tr>
<td></td>
<td>All other construction</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Transportation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Financial and real estate</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Wholesale and retail trade</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Amusements</td>
<td></td>
</tr>
<tr>
<td></td>
<td>All other industries</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total employee compensation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Profits and capital consumption allowances</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Taxes and current of government enterprises</td>
<td></td>
</tr>
</tbody>
</table>

ORGANIZATION OF THE MODEL
sector and combining the remaining elements of the payments and final demand sectors into single vectors. The elements of the processing sector with the household sector are explained and described below. The complete composition of the sectors for this model including the corresponding national code number, and SIC codes, are listed in Appendix 1.

Agriculture and agriculture supply is included because it is one of the major industries in the region. It is not expected to respond appreciably to the new activity, but it is probably the most representative sector of the region.

Oil and gas production and services is also included because it is a prominent industry of the area. It includes crude petroleum and natural gas and petroleum refining and related industries.

Highway construction is separated from the rest of the construction industry because there will be the resurfacing of approximately 41 miles of highway, in conjunction with the actual building of the sites.

"All other construction" is used to encompass the general construction industry and all functions that will be required in the building of the sites. Any specialized construction that will be required during the equipment installation and testing phase is not included here. It is through this sector that the increase in final demand will enter the system and work itself through the economy.

Transportation will be important in the study for two
reasons. Transportation will be used substantially for the movement of material and equipment in the construction activity and secondly, transportation will relate to the supply of other goods such as wholesale and retail items. It is another area that does not fit very well into the assumption of regional activity.

Financial and real estate are grouped together mainly because of data problems. Both will be important for any economic growth or activity because they are a portion of the basis that supports such activity.

Wholesale and retail trade are included to represent the bulk of the secondary and service industries. In this case the break down was dictated by the national model. Nationally, this sector is broken into these two areas. Since this is an area that is believed to respond greatly to the expected increased activity, it was desired to have it in as much detail as possible. In particular, eating and drinking establishments and other entertainment activities would be of interest if they were separated. None of this was possible with the national data, since these industries were already aggregated so highly. Thus it was felt that little would be sacrificed if these two aggregated sectors were aggregated even more and combined. The national model uses a special convention for the trade industries. The output for trade represents the total margin, operating expenses and profits, rather than actual trade flows. If
this were not done, the majority of final demand would go to a single sector, trade, and could not be traced back to the producers. Of course, this convention is carried through to this model.

Amusements was included as a sector to represent another outlet for consumption. It is not truly representative of the region as it only includes motion pictures and general recreational services.

The "all other industries" sector represents both the goods and services not available from local producers and the rest of the world outside the region. If the majority of the increase in final demand ends up in this sector, then it can be concluded that the construction activity will do little to the economy of the local region.

The household sector is included as it will be the major means by which the increase in the construction industry will be felt in the rest of the economy. Normally this sector represents the total compensation to labor, both direct and indirect. However only the direct amount paid will find its way back into the income stream of the economy. Thus for impact analysis, only direct compensation should be included in this sector. The remainder of employee compensation is included in the payments sector.

\[\text{Input-Output Structure of the U.S. Economy: 1963, p. 25.}\]
CHAPTER IV

THE USE OF THE MODEL FOR IMPACT ANALYSIS

METHODOLOGY

The use of an input-output model for impact analysis involves five steps. The first is to compile a transactions table. Second, this transactions table is used to calculate the technical coefficients. Third, the coefficients of total requirements are computed. Fourth, the new final demand vector is multiplied times the total requirements matrix to yield a new column vector which represents the new level of output required to support this demand. Finally, this new level of output can be multiplied by the individual technical coefficients to find the projected transactions table. However, before this can be done, the processing sector must be closed with respect to labor. This entails moving the household sector into the processing sector. This household sector consists of the direct payments to labor from the final demand sector.\(^1\) To accomplish this, the matrix of direct requirements for the processing sector, \(A\), of dimension \((n \times n)\) will be increased to size \((n+1 \times n+1)\). The

\(^1\)Indirect employee compensation is not included because this is not income that can be immediately spent. To include it would overstate this sector and bias the model.
technical coefficients for the household "industry," are
determined in the same manner as the other industries.

The source of change in final demand is usually known
in impact studies, consequently, the elements of the final
demand and payments are combined into single vectors for
demand and payments. This process is shown in Appendix 2.

CALCULATIONS AND RESULTS

The sectors for the study, being so highly aggregated
compared to the national model, prohibited the direct use
of the national technical coefficients, and forced the origin­
al transactions data to be employed. The original trans­
actions table was not compiled and included here for two
reasons. First, this study is only concerned with the
change in economic activity that results from the increase
in final demand from construction, and, secondly, as the
national data was used, the transactions table would be for
the nation rather than the region. If there were adequate
menas available to collect this information for the region,
then the national data approach would not have had to be used
in the model.

The matrix of technical coefficients is shown in Table
4-1. These coefficients are computed for the elements of
the processing sector only, after augmenting it to include
the household sector. The details of these calculations are
found in Appendix 3. These quantities are the number of
cents of input which are required from each row industry to
<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agriculture and agriculture services</td>
<td>1.3100</td>
<td>0</td>
<td>0.003</td>
<td>0.055</td>
<td>0.022</td>
<td>0.072</td>
<td>0.0014</td>
<td>0.022</td>
<td>0.0283</td>
<td>0.0134</td>
</tr>
<tr>
<td>Oil and gas production and services</td>
<td>2.0200</td>
<td>0.0566</td>
<td>0.0510</td>
<td>0.0131</td>
<td>0.0396</td>
<td>0.0179</td>
<td>0.0113</td>
<td>0.022</td>
<td>0.0206</td>
<td>0.0219</td>
</tr>
<tr>
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<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.0081</td>
<td>0</td>
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<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.0771</td>
<td>0</td>
</tr>
<tr>
<td>Transportation</td>
<td>5</td>
<td>0.0171</td>
<td>0.0365</td>
<td>0.0433</td>
<td>0.0314</td>
<td>0.0863</td>
<td>0.0095</td>
<td>0.0075</td>
<td>0.022</td>
<td>0.0554</td>
</tr>
<tr>
<td>Financial and real estate</td>
<td>6</td>
<td>0.0491</td>
<td>0.0870</td>
<td>0.0123</td>
<td>0.0105</td>
<td>0.0390</td>
<td>0.1122</td>
<td>0.0688</td>
<td>0.1072</td>
<td>0.0152</td>
</tr>
<tr>
<td>Wholesale and retail trade</td>
<td>7</td>
<td>0.0315</td>
<td>0.0159</td>
<td>0.0589</td>
<td>0.0861</td>
<td>0.0264</td>
<td>0.0451</td>
<td>0.0178</td>
<td>0.0171</td>
<td>0.0307</td>
</tr>
<tr>
<td>Amusements</td>
<td>8</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.0035</td>
<td>0.007</td>
<td>0.1924</td>
<td>0.0124</td>
</tr>
<tr>
<td>All other industries</td>
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<td>0.1774</td>
<td>0.2900</td>
<td>0.3327</td>
<td>0.4159</td>
<td>0.5036</td>
<td>0.0611</td>
<td>0.1593</td>
<td>0.4834</td>
<td>0.0737</td>
</tr>
<tr>
<td>Households</td>
<td>10</td>
<td>0.0495</td>
<td>0.0484</td>
<td>0.2418</td>
<td>0.2543</td>
<td>0.0932</td>
<td>0.1102</td>
<td>0.3791</td>
<td>0.0030</td>
<td>0.4489</td>
</tr>
</tbody>
</table>

**TABLE 4-1**

**MATRIX OF TECHNICAL COEFFICIENTS**
produce one dollar of output by each column industry. As the payments sector is not included, the sums of the columns are not equal to one, the difference represents profits, taxes and indirect employee compensation. The majority of terms are fairly small because only a few industries are explicitly listed in the model, the rest are combined into the "All other" sector, which has correspondingly high coefficients.

The matrix of total requirements coefficients was found from this first matrix, with the aid of a computer. The direct requirements matrix was subtracted from the identity matrix and then inverted. This inverse matrix was transposed (a new matrix was formed by writing the rows as columns) to yield the matrix of total requirements. It is illustrated in Table 4-2. This table is interpreted differently than the previous one. The total value of production is shown, both direct and indirect, that is required from the column industries to produce a dollar of output by each row industry, delivered outside the processing sector. Whereas the table of direct requirements had all terms that were less than one, the total requirements table has many that are larger. The diagonal elements are greater than one because the output of each industry is increased by one in the general solution (this is accomplished mathematically by subtracting from the identity matrix). The inclusion of the households in the processing sector causes some of the off diagonal
<table>
<thead>
<tr>
<th>Industry</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agriculture and agricultural services</td>
<td>1.5195</td>
<td>0.0755</td>
<td>0.0063</td>
<td>0.0607</td>
<td>0.1009</td>
<td>0.2508</td>
<td>0.2197</td>
<td>0.0222</td>
<td>0.788</td>
<td>5.700</td>
</tr>
<tr>
<td>Oil and gas production and services</td>
<td>0.0755</td>
<td>1.106</td>
<td>0.0068</td>
<td>0.0648</td>
<td>0.1183</td>
<td>0.2711</td>
<td>0.1929</td>
<td>0.0230</td>
<td>0.8411</td>
<td>5.671</td>
</tr>
<tr>
<td>Highway construction</td>
<td>0.0063</td>
<td>0.0068</td>
<td>1.009</td>
<td>0.0948</td>
<td>0.1653</td>
<td>0.3089</td>
<td>0.3544</td>
<td>0.0362</td>
<td>1.230</td>
<td>1.015</td>
</tr>
<tr>
<td>All other construction</td>
<td>0.0607</td>
<td>0.0648</td>
<td>0.0948</td>
<td>1.108</td>
<td>0.1666</td>
<td>0.3395</td>
<td>0.4172</td>
<td>0.0410</td>
<td>1.406</td>
<td>1.137</td>
</tr>
<tr>
<td>Transportation</td>
<td>0.1009</td>
<td>0.1183</td>
<td>0.1653</td>
<td>0.1666</td>
<td>1.2212</td>
<td>0.3256</td>
<td>0.3117</td>
<td>0.0378</td>
<td>1.4039</td>
<td>0.9408</td>
</tr>
<tr>
<td>Financial and real estate</td>
<td>0.2508</td>
<td>0.2711</td>
<td>0.3089</td>
<td>0.3395</td>
<td>0.3256</td>
<td>1.2640</td>
<td>0.1831</td>
<td>0.0199</td>
<td>0.4794</td>
<td>0.4505</td>
</tr>
<tr>
<td>Wholesale and retail trade</td>
<td>0.2197</td>
<td>0.1929</td>
<td>0.3544</td>
<td>0.4172</td>
<td>0.3111</td>
<td>0.1831</td>
<td>1.3000</td>
<td>0.0332</td>
<td>0.9735</td>
<td>1.008</td>
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<tr>
<td>Amusements</td>
<td>0.0222</td>
<td>0.0230</td>
<td>0.0362</td>
<td>0.0410</td>
<td>0.0378</td>
<td>0.0199</td>
<td>0.0332</td>
<td>1.2730</td>
<td>1.3634</td>
<td>0.8151</td>
</tr>
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<td>All other industries</td>
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<td>0.8411</td>
<td>1.2304</td>
<td>1.4061</td>
<td>1.4039</td>
<td>0.4794</td>
<td>0.9735</td>
<td>1.3634</td>
<td>2.1140</td>
<td>1.2044</td>
</tr>
<tr>
<td>Households</td>
<td>0.5700</td>
<td>0.5671</td>
<td>1.0158</td>
<td>1.1378</td>
<td>0.9408</td>
<td>0.4505</td>
<td>1.0080</td>
<td>0.8151</td>
<td>1.2044</td>
<td>1.9867</td>
</tr>
</tbody>
</table>

**TABLE 4-2**

MATRIX OF TOTAL REQUIREMENTS COEFFICIENTS
elements to be greater than one. The total requirements for an industry to produce a dollar's worth of output for final demand are shown in this table. Since other industries also use the first industry's output, it is obvious that the industry will have to produce more than a dollar's worth of output to fulfill both elements of demand. This explains the diagonal elements. The off diagonal elements sometimes exceed one chiefly due to increased demand caused by the multiplier effect, i.e., the household sector.

This table of total requirements was then multiplied by a column vector representing the estimated change in final demand. Since the object of the study was to determine the influence of the ABM construction program, all elements of this demand vector were zero except for the highway and "All other" construction sectors. The estimate for the highway construction was $11.8 million and the estimate for the construction phase was $200 million. The sources of these figures are found in Appendix 4. The result of this calculation was another column vector of change in total output. The additional output that each sector will be required to produce in order to support the original estimated increase in final demand is shown in this vector. The change

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²Miernyk, The Elements of Input-Output Analysis, p. 46.
in final demand and total output vectors are shown in Table 4-3.

The final step in the analysis was to multiply the elements of the change in total output by the technical coefficients in order to compile a transactions table for the change. Again, these are only changes in the economy's total transactions. These quantities are listed in Table 4-4.

**ANALYSIS**

The total output required to support this estimated $211.8 million of construction is $1.06 billion. The interdependence of economic activity and the multiplier effect are shown. By far the largest single increase in output is for the "All other industries" sector, which represents the economic activity outside the region. This is not surprising since it represents the bulk of the national economy. However, the regional sectors also experienced appreciable increases. It should be recalled that these are only regional sectors to the extent that the assumption of local purchases from local sources is fulfilled. The actual increase for the region will depend on how well each sector meets this assumption. The $1.06 billion is the maximum possible increase for the region, if all sectors met the local assumption completely.

Agriculture and agriculture services will increase in output by $12.2 million. This will probably be spread fairly evenly through the national economy. At least it is highly
<table>
<thead>
<tr>
<th>Sector</th>
<th>Final Demand Estimates ($ million)</th>
<th>Changes in Total Output ($ million)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Agriculture and agriculture supply</td>
<td>0</td>
<td>12.227</td>
</tr>
<tr>
<td>2. Oil and gas production and related services</td>
<td>0</td>
<td>13.051</td>
</tr>
<tr>
<td>3. Highway construction</td>
<td>11.8</td>
<td>30.891</td>
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<tr>
<td>4. All other construction</td>
<td>200</td>
<td>222.801</td>
</tr>
<tr>
<td>5. Transportation</td>
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</tr>
<tr>
<td>6. Financial and real estate</td>
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<td>71.556</td>
</tr>
<tr>
<td>7. Wholesale and retail trade</td>
<td>0</td>
<td>87.640</td>
</tr>
<tr>
<td>8. Amusements</td>
<td>0</td>
<td>8.634</td>
</tr>
<tr>
<td>9. All other industries</td>
<td>0</td>
<td>295.743</td>
</tr>
<tr>
<td>10. Households</td>
<td>0</td>
<td>239.054</td>
</tr>
<tr>
<td>Total</td>
<td>211.8</td>
<td>1,016.884</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>--------------------------------</td>
<td>-----</td>
<td>-----</td>
</tr>
<tr>
<td>Agriculture and agriculture services</td>
<td>3.782</td>
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</tr>
<tr>
<td>Oil and gas production and services</td>
<td>.260</td>
<td>.736</td>
</tr>
<tr>
<td>Highway construction</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>All other construction</td>
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<td>0</td>
</tr>
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<td>Transportation</td>
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<td>Financial and real estate</td>
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<td>Wholesale and retail trade</td>
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</tr>
<tr>
<td>Amusements</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>All other industries</td>
<td>52.457</td>
<td>85753</td>
</tr>
<tr>
<td>Households</td>
<td>11.855</td>
<td>11592</td>
</tr>
</tbody>
</table>

**TABLE 4-4**

**TABLE OF PROJECTED CHANGES IN TRANSACTIONS**

(In Million Dollars)
unlikely that this entire amount will go to the region as some of the components are not even present.

Oil and gas production and related services are forecast to increase by $13.0 million. Probably more of this will stay within the region than for agriculture. A substantial portion of the petroleum products on the market are produced from within the region. As no great economy of scale would result from importing fuel for the construction work, most of it will most likely be obtained from the local sources. This is a sector that will meet the local assumption fairly well.

Highway construction should increase by $30.8 million. The amount that enters the region will depend on who is contracted for the work.

All other construction is estimated to increase $222.8 million. Again, the determining factor is who gets the contract. The national construction industry will increase by this much, but the companies within the region will not be a very large part of it if they are not awarded the major contracts. Whether this should be considered a regional or national sector depends upon who gets the contract. As the two major bidders are from outside the region, it probably should be considered as a sector outside the region and not included in the regional impact for North Central Montana.

An increase of $35.2 million will accrue to transportation. This is a sector that probably does not fit the regional
assumption very well. It is doubted that a substantial amount of the $35 million will benefit the region.

Financial and real estate should increase $71.5 million. The real estate portion will obviously go to the region as land is not portable. (Note that this real estate does not include the procurement of the sites themselves, only the construction monies were included in the model). No doubt, a considerable amount of the financial figure will go outside the region, but the portion for the region will not be insignificant. All in all, this sector should benefit as much as any from the construction activity.

An increase of $87.6 million is indicated for wholesale and retail trade. With the context of the model, this means that gross margin, or operating expenses and profit will increase by this amount. Although this sector will not be completely regional, the local merchants will certainly benefit by the activity. Depending on the procurement system of the primary industries that expand, it is conceivable that this would be felt entirely within the region. However, this is doubtful as most of the construction supplies will come from other areas which are better able to handle the requirements.

Amusements is programmed to increase $8.6 million. This sector is fairly weak in the region, and it is doubtful that the motion picture theaters of the area will increase in revenue that much. If this figure proves to be true, a
a large portion of the increase will leave the region.

All other industries should increase $295.7 million. This is the largest increase for any sector and it belongs to the rest of the world. This is rather expected in view of the coefficients for the sector, and it is in keeping with the hypothesis of this study.

Households are expected to receive $239 million in wages and benefits because of the construction. A substantial amount of this will be felt in the region. Construction is a rather labor intensive industry and will be responsible for putting a large part of this amount into local households. These local households may only be local on temporary basis, but this will still help the permanent local economy.

The actual estimates of the benefit to the region are judgmental, but this technique gives a framework in which to base these judgments. The forecasts of the model are potential increases. The local businessmen will no doubt have a good idea of how much of this increase he will be able to receive, as he knows his relative share of the market.

The hypothesis was that the primary industries of the region would not feel a substantial impact but that the secondary industries would. At first glance the model does not seem to support this, but a little investigation changes the picture. Construction will increase but as no local
firms are bidding on the contract, they will not share in the growth appreciably. Transportation will probably receive most of its increase outside the region, as may the financial industry. Oil and gas production will probably feel the increase slightly, but agriculture most likely will not. However the largest projected change for a sector that does tend to fit the local assumption is wholesale and retail trade. Granted, much of the building supplies will be purchased outside the area and shipped in, but a sizable portion of the retail trade will be local in nature. The largest increase in activity in the region will be felt in this sector. The results of the study do seem to be in line with the hypothesis.
CHAPTER V

CONCLUSIONS

This study attempted to prove the hypothesis that the construction phase of the Anti-Ballistic Missile system installation will have little effect on the primary industries of the North Central Montana region, while the secondary industries will feel its economic influence. The method used to test this was input-output analysis. Even though numerous input-output studies have been performed for regions, they have yet to become common place, nor has a single regional method evolved that has proved itself to be both feasible and completely conceptually accurate. This study made use of the relationships and data from the national model prepared by the U.S. Department of Commerce. This provides a method whereby a model for a region can be fairly easily formulated from an existing framework, and have the basic data and technical relationships readily available.

However, a model to exactly fit the situation and directly prove the hypothesis could not be built and still stay within the guidelines of the national model. Nevertheless, the national type of model was employed for two reasons. To have developed another type of input-output model would have required the collection and use of primary
data, which would not have been feasible within the scope of this paper. As the national type model is a general method that is relatively easy to construct, it was thought that an investigation of the effectiveness of this technique would be a useful addition to the study. The model was built considering both prominent industries of the area and industrial sectors that were actively involved with the construction activity. These sectors were local only to the extent that goods and services are purchased from local sources when the local sources are available. Some industries did not fit this assumption very well while others did; this necessitates a certain amount of judgment in interpreting the results. The model will predict the total increase in output in the national economy that will result from this construction activity, the amount that will be present in the region is dependent upon the particular sectors and how well they meet the local assumption.

The estimated increase in final demand of $211.8 million produced a total output of $1.016 billion. This clearly shows the interdependence of economic activity, and how an increase in one sector will work its way into other segments of the economy. The $222.8 million for the main construction and the $295.7 million for the "rest of the world" sector will not greatly benefit the region. This is particularly true in view of the fact that the major bidders for the construction contract are from outside the region.
A good portion of the $87.6 million increase for the whole-sale and retail trade sector will most likely go into the region's economy, as will the $239.05 million in direct employee compensation. The increases for the other sectors will fall somewhere in between these in their applicability to the region. The results of the model are in line with the hypothesis and tend to bear it out. To be sure there are still judgmental factors involved, but the analysis at least gives a framework on which to base these judgments.

There are numerous places where the analysis can be criticized. The national coefficients are eight years old, and neither technology nor prices have remained stable. The regional assumption is not completely valid in light of the free mobility of goods that is present in the country. The household sector may not be considered adequately represented because of the data problems that were associated with it. True as these may be, the assumptions had to be made for the workings of the model. There does not seem to be any feasible way to relax them; they can only be considered in the evaluation of the results.

Despite these drawbacks, the model does seem to be useful. It is a straightforward process that gives some insight into the general effect of increased economic activity, especially in regard to other industries. It is not an omniscient forecaster, but it does indicate the direction that changes will take.
APPENDIX
APPENDIX 1: Composition of the Industrial Sectors

The sectors for the model are highly aggregated and encompass several of the national industrial sectors. The industry structure for the national model is listed in Input-Output Structure of the U.S. Economy: 1963, Volume 1 - Transactions Data for Detailed Industries, U.S. Department of Commerce, Washington, D.C., 1969, p. ix-xix. The following is a list of the model's sectors, the corresponding national sectors and code numbers and related SIC codes.

<table>
<thead>
<tr>
<th>Sectors</th>
<th>Related SIC codes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Agriculture and Agriculture Services</td>
<td></td>
</tr>
<tr>
<td>1.01 Dairy farm products</td>
<td>0132, pt 014, pt 02</td>
</tr>
<tr>
<td>1.02 Poultry and eggs</td>
<td>0133, pt 014, pt 02</td>
</tr>
<tr>
<td>1.03 Meat, animals and miscellaneous livestock products</td>
<td>0139, pt 014, 0193, pt 0729, pt 02</td>
</tr>
<tr>
<td>2.01 Cotton</td>
<td>0112, pt 014, pt 02</td>
</tr>
<tr>
<td>2.02 Food feed grains and grass seeds</td>
<td>0113, pt 0119, pt 014 pt 02</td>
</tr>
<tr>
<td>2.03 Tobacco</td>
<td>pt 0119, pt 014, pt 02</td>
</tr>
<tr>
<td>2.04 Fruits and tree nuts</td>
<td>0122, pt 014, pt 02</td>
</tr>
<tr>
<td>2.05 Vegetables, sugar and miscellaneous crops</td>
<td>0123, pt 0119, pt 014, pt 02</td>
</tr>
<tr>
<td>2.06 Oil bearing crops</td>
<td>pt 0119, pt 014, pt 02</td>
</tr>
<tr>
<td>2.07 Forest, greenhouse and nursery products</td>
<td>0192, pt 014, pt 02</td>
</tr>
<tr>
<td>Code</td>
<td>Description</td>
</tr>
<tr>
<td>------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>3.00</td>
<td>Forestry and fishery products</td>
</tr>
<tr>
<td>4.00</td>
<td>Agricultural, forestry and fishery services</td>
</tr>
<tr>
<td>2.</td>
<td>Oil and Gas Production and Related Services</td>
</tr>
<tr>
<td>8.00</td>
<td>Crude petroleum and natural gas</td>
</tr>
<tr>
<td>31.01</td>
<td>Petroleum refining and related products</td>
</tr>
<tr>
<td>31.02</td>
<td>Paving mixtures and blocks</td>
</tr>
<tr>
<td>31.03</td>
<td>Asphalt felts and coatings</td>
</tr>
<tr>
<td>3.</td>
<td>Highway Construction</td>
</tr>
<tr>
<td>11.04</td>
<td>New construction, highways</td>
</tr>
<tr>
<td>4.</td>
<td>All Other Construction</td>
</tr>
<tr>
<td>11.01</td>
<td>New construction, residential buildings</td>
</tr>
<tr>
<td>11.02</td>
<td>New construction, non-residential buildings</td>
</tr>
<tr>
<td>11.03</td>
<td>New construction, public utilities</td>
</tr>
<tr>
<td>11.05</td>
<td>New construction, all other</td>
</tr>
<tr>
<td>5.</td>
<td>Transportation</td>
</tr>
<tr>
<td>65.01</td>
<td>Railroads and related services</td>
</tr>
<tr>
<td>65.02</td>
<td>Local, suburban and interurban highway passenger transportation</td>
</tr>
<tr>
<td>65.03</td>
<td>Motor freight transportation and warehousing</td>
</tr>
<tr>
<td>65.04</td>
<td>Water transportation</td>
</tr>
</tbody>
</table>
65.05 Air transportation  45
65.06 Pipeline transportation  46
65.07 Transportation services  47, except
                           473, 474

6. Financial and Real Estate
    70.01 Banking  60
    70.02 Credit agencies  61, 67
    70.03 Security and commodity brokers  62
    70.04 Insurance carriers  63
    70.05 Insurance agents and brokers  64
    71.01 Owner-occupied dwellings  NA
    71.02 Real estate  65 (except pt 6561), 66

7. Wholesale and Retail Trade
    69.01 Wholesale trade  50 (except manufacturers' sales offices)
    69.02 Retail trade  52, 53, 54, 55, 56, 57, 58, 59, 7396

8. Amusements
    76.01 Motion pictures  78
    76.02 Amusements and recreation services  79

9. All Other Industries
    Remaining codes

10. Households
    NA
APPENDIX 2: Methodology of Impact Analysis

Let $T$ be the matrix of transaction data, such that

$$
T = \begin{pmatrix}
  t_{11} & \cdots & t_{1m} \\
  \vdots & \ddots & \vdots \\
  t_{m1} & \cdots & t_{mm}
\end{pmatrix}
$$

and $t_{ij}$, $i = 1,n$ and $j = 1,n$ are the values for the processing sector.

Then the technical coefficients are defined as

$$
a_{ij} = \frac{t_{ij}}{t_{mj}}
$$

Since these terms are only for the processing and household sectors, the matrix $A$ is of size $(n+1 \times n+1)$.

The matrix of total requirements, $R$, is found by the relationship

$$
R = ((I-A)^{-1})^T
$$

Now let $X_f$ be a column vector of size $(n+1 \times 1)$ and represent the new final demand estimate. Then

$$
RX = Y
$$

where $Y$ is the new required output, and is another vector of size $(n+1 \times 1)$.

The new change in the transactions table is found by

$$
t'_{ij} = a_{ij}y_i \quad \text{where } j = 1,n+1 \\
\quad \text{for each } i = 1,n+1
$$
APPENDIX 3
APPENDIX 3: Data Sources for the Technical Coefficients

Because the industrial sector breakdown was different in the model than the national tables, the direct requirements coefficients could not be used. Instead the transactions data for the national study had to be employed. The appropriate sectors were traced through the tables and the required transactions summed to yield the transaction for the new sectors. These figures between a column industry and the applicable row industries were each divided by the total output of the column industry, to find the technical coefficients. The coefficient for the "All other industries" was the residual of the sum of the other coefficients and the column total of one, after allowing for the value added or payments sector amount. The table of these transactions was not collected and included in the study, as it would have no real meaning in regard to the region. With the exception of one industry, all transactions data was utilized from the Input-Output Structure of the U.S. Economy: 1963, Volume I - Transactions Data for Detailed Industries, U.S. Department of Commerce, Washington, D.C., 1969. This exception was the household sector. These transactions were not listed separately but included with profits, business taxes, and government enterprises surpluses, in the value added term. No way could be found to separate the compensation to labor out from the rest of this figure. This was
only true for the row of the household sector, as personal consumption expenditures were listed in the tables. The problem was overcome for the household row by obtaining the total direct compensation to employees by industry from various sources within the Statistical Abstract of the United States: 1970, and using this figure for the calculation in the same manner as the other sectors. The results of these calculations, the technical coefficients, are listed in figure 4-1.

The sources of the household data are listed below, from Statistical Abstract of the United States: 19701.

1. Agriculture and agriculture services: p. 593 (1965)
2. Oil and gas production and services: p. 702 (1963)
4. All other construction: p. 668 (1967)
5. Transportation: pp. 550, 558, 559, 566 (1965)
9. All other industries: p. 311 (1965)
10. Households: -

There was no figure available for the transactions between

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households, but this figure is believed to be small enough to be safely ignored. The data for 1963, to correspond with the national tables, were not available for all sectors. The closest year available was used.
APPENDIX 4
APPENDIX 4: Cost Estimates

The cost estimates for the construction of the Safeguard sites were obtained from the Montana Safeguard Office of Public Information. They are:

- Phase I Construction: $48 million
- Phase II Construction: 152 million
- Total Construction Phase: $200 million
- Installation and Test Phase: 50 million
- Total Building Cost: $250 million

Unless contract disputes delay the Phase II Construction, the two phases will be accomplished sequentially. For this reason the total estimate for the construction phase was used for the study. The installation and test phase was not included even though it is part of the total building cost. It will be mainly concerned with highly technical and specialized equipment and be supported, for the most part, directly by the manufacturers.

The original bids for the Phase II Construction were considerably higher than the government estimates, $178.9 million by Peter Kiewit & Sons of Omaha, Nebraska, and $208.8 million by the Mid-Valley Construction Company of Houston, Texas. These were rejected by the U.S. Army Corps of Engineers and the bidding was opened again. The Army has taken the position that it will modify the construction requirements, if necessary, to keep the cost in line with the original
estimate.
The government estimate was used for this study for two reasons,

1. there is no other firm figure, and
2. the amount of construction may be reduced in order to meet this estimate.

The estimate for the planned 41 miles of highway construction was not available from the Safeguard office. It is under the U.S. Department of Transportation, Bureau of Public Roads, and the Montana Highway Department. To find an estimate the average construction cost for federal highways in Montana was found and applied to this mileage.

\[
\text{In 1968: } \frac{\$79.2 \text{ million}}{275 \text{ miles}} = \$2.286 \text{ million/mile}
\]

\[(\$2.286 \text{ million/mile})(41 \text{ miles}) = \$11.808 \text{ million}\]
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Input-Output Structure of the U.S. Economy: 1963
Volume 1 - Transactions Data for Detailed Industries,
Volume 2 - Direct Requirements for Detailed Industries,
Volume 3 - Total Requirements for Detailed Industries,


