ECONOMIC IMPACTS AND BENEFITS OF SITE REMEDIATION: METHODOLOGY AND CASE STUDY OF THE DOMTAR SITE, TRANSCONA

by

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ECONOMIC IMPACTS AND BENEFITS OF SITE REMEDIATION: METHODOLOGY AND CASE STUDY OF THE DOMTAR SITE, TRANSCONA

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A Thesis/Practicum submitted to the Faculty of Graduate Studies of the University of Manitoba in partial fulfillment of the requirements for the degree of

MASTER OF ARTS

ABSTRACT

The objective of this thesis is to identify, quantify and evaluate the economic impacts from remediation of a contaminated site. A case study based on a contaminated former wood preserving treatment plant site in Winnipeg, Manitoba is presented. An overview of applicable economic impact analysis methodologies is discussed. The methodology of input-output analysis is selected. Based on the Statistics Canada input-output model and its input-output tables, operational input-output models are developed for three regional levels: national (Canada), provincial (Manitoba), and city (Winnipeg). The Winnipeg city model is created using a nonsurvey regionalization technique. Using these models, measured economic impacts resulting from the remediation expenditures include employment, income, tax revenue and GDP generation. Apart from the economic impacts, site remediation can also generate additional or non-market economic *benefits* resulting from the improvement in environmental quality. The evaluation of these benefits is reviewed and the methodology for measuring them are outlined in an appendix.

ACKNOWLEDGMENTS

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Finally, deep gratitude and love to Anna, who helped make it all possible.

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1.0 Introduction

The objective of this study is to identify, quantify, and evaluate the economic impacts that accrue from remediation of the site of the former Domtar wood preservation plant in Transcona, Winnipeg, Manitoba. The cleanup of the site creates economic activity which involves expenditures on goods and services, and this results in employment, income, tax revenue and GDP generation.

Manitoba Environment has tasked the owner of the site, Domtar Inc., with developing and implementing a remediation program for the site. In 1993 Domtar contracted TriWaste Reduction Services Inc. (TriWaste) to treat a portion of the contaminated soil, concentrated in one area of the site. The area is Area A, shown in Figure 1, p.6. The economic impact analysis of this study focuses on the activity involved in remediating this selected area. Research funding for the study has been obtained from the Canadian Environment Industry Association (CEIA) and Environment Canada.

In late 1995, Domtar cancelled the remediation project contract with TriWaste. Fortunately, sufficient expenditure data was obtained to complete an economic impact analysis of remediation based on activity that had occurred up to the time of cancellation and by using estimates of projected expenditures for completion of remediation. The study presents results based on these actual and projected expenditures.

The evaluation of the economic impacts involves the selection of a methodology that will best capture the impacts arising from the site remediation activity. The methodology must produce results that are understandable and useful. The methodology chosen to determine the market benefits of the site remediation is input-output analysis. Input-output analysis is a branch of economics that has developed as a practical tool for defining and empirically testing an accounting structure of an economy. It allows the creation of models which can capture the framework of an economy through the collection, organization, and manipulation of the fundamental components of economic activity: industries and goods and services (commodities). The input and output of industry production and the directly related movement of commodities caused by their supply and demand are used by input-output analysis to represent a "picture" of the economy at a given point in time. This revealed industry interdependency can then be applied as the tool to determine the impact on the economy of any economic activity that has occurred, or that may occur dependent on the resultant forecasted impact.

The methodology and data used in the economic impact analysis of the remediation is based on Statistics Canada's input-output model of the national and provincial economies. The Input-Output Division of Statistics Canada uses the System of National Accounts (SNA) data along with its own accounting systems to create input-output accounts that comprehensively capture the activity of an economy. These economic accounts are created from data collected through surveys, and the resultant input-output tables reflect the most accurate representation of the national and provincial economies. These survey methods are expensive and time-consuming, and are therefore limited to these levels. To capture the input-output relationships of a sub-provincial region where there is not the required survey data to create input-output tables, a nonsurvey method is used. The selection of the nonsurvey technique is based on what survey data is available on the specific region in question. The survey data that was used to reduce, or regionalize, the provincial input-output model to the sub-provincial region of Winnipeg were employment statistics on the Winnipeg metropolitan region. The models developed allow estimation of the economic impacts in detail.

A summary of the findings is as follows:

(i) The actual and projected expenditures for remediation of Site A (Figure 1) on goods and services totalled approximately $2,370,000. The total impacts on industry output resulting from these expenditures were $6,280,000 at the national level, $3,010,000 at the provincial level, and $2,890,000 at the Winnipeg metropolitan region level.

(ii) The government revenue generated from indirect taxes was $297,000 at the national level and $189,000 at the provincial level.

(iii) The government revenue generated from direct (income) taxes is estimated at between $379,000 and $606,500.

(iv) The national level employment created by the remediation project was approximately 51 person-years. The provincial level employment was 28 person-years, and the Winnipeg level was 18 person-years.

(v) The industry receiving the largest share of the direct impacts was non-residential construction. The industry receiving the largest share of the total impacts was the household industry (i.e. labour income).

The thesis is organized as follows. Chapter 1 states the goals of the study and briefly introduces the site to be remediated and the parties involved. An overview of the chosen methodology occurs and a summary of the findings is presented, followed by an outline of the study. Chapter 2 discusses the case study site, including a site description and background, a map of the site indicating the area to be treated, the selected area remediation activity, and the remediation technology to be employed. Chapter 3 presents the development of the research methodology. The economic impact methodologies applicable to a contaminated site remediation are reviewed, followed by the rationale for selecting: 1.) the input-output analysis methodology and 2.) the Statistics Canada input-output model. Extensions of the input-output model are then discussed, including an explanation of economic multipliers and data sources used. A detailed derivation of the operational models is carried out in Chapter 4. This includes the derivation of key matrices required for the creation of the impact matrix. The determination of the economic impacts from these models is also revealed. The results of the economic analysis are presented in Chapter 5, and Chapter 6 discusses conclusions, an alternative form of economic analysis, and possible implications of this study. Each chapter is backed up by detailed appendices.

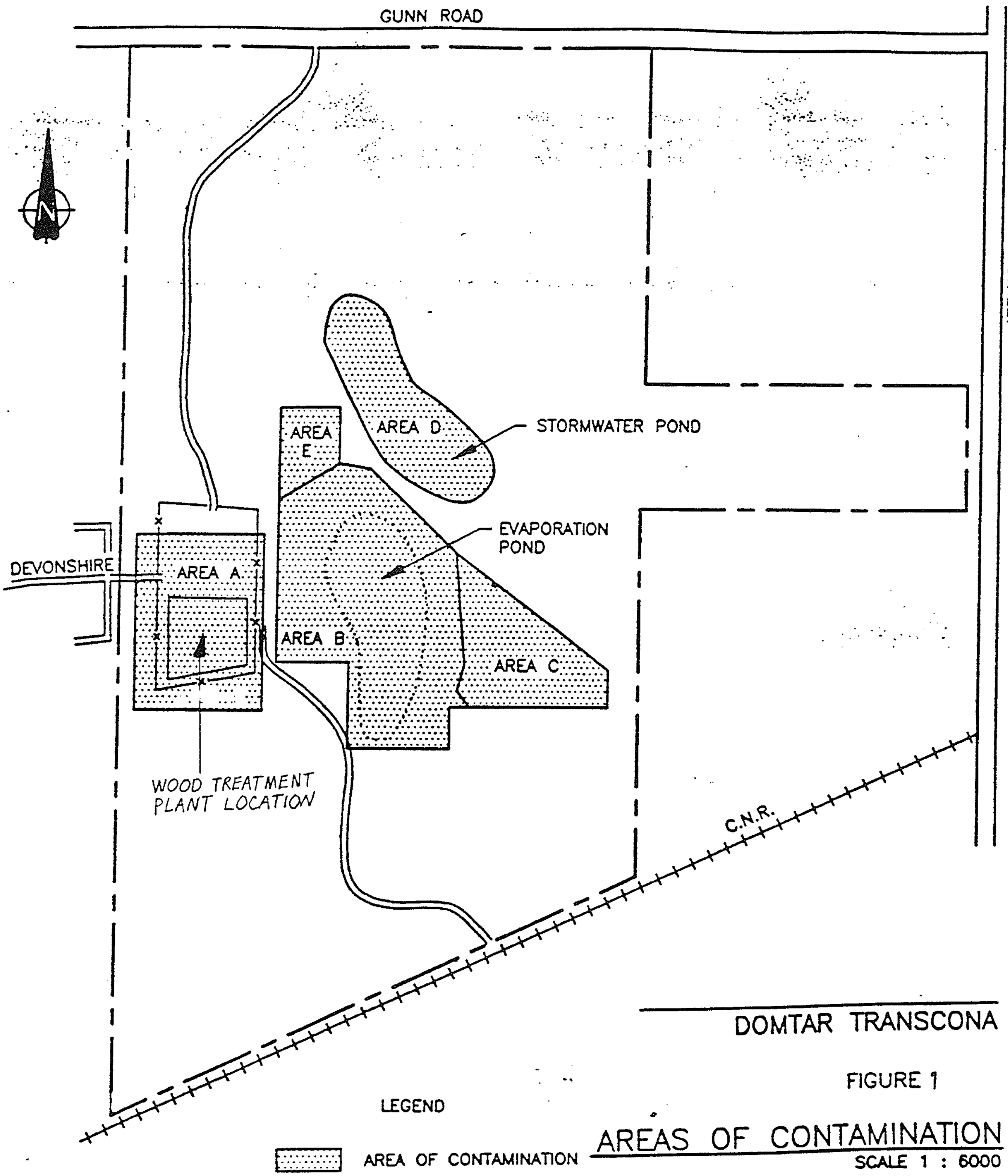
2. Case Study Site Background

A discussion of the case study site is presented as a background for the economic impact analysis. A site description and history will identify the Transcona site and its contaminants. The remediation process is examined to help understand the types of expenditures that can result from the cleanup.

2.1 Site Description and History

The contaminated site targeted for remediation is located in Transcona, an eastern district of the city of Winnipeg, Manitoba. The 62 hectare site is bordered by residential development on the west and south sides. Figure 1 shows the site location and areas of contamination. The site was the location of a former wood preserving plant owned and operated by Dominion Tar and Chemical Company (now Domtar Inc.). The plant supplied preserved railway ties and timbers to the Canadian National Railway and the Canadian Pacific Railway from 1911 to 1976. The plant was shutdown in 1976 due to lack of sufficient demand to justify continued operation.

In October of 1976 Domtar sold the site to Sunny Hill Investments. During the same year another company, Nelson Square Developments, applied to the Province of Manitoba for residential development of the site. The Province determined that site remediation was required before development could proceed. The Environmental Control Board Branch of the Province of Manitoba issued a request to Domtar for a site cleanup and restoration proposal intended to remedy the site to a level adequate for residential development. The completion of this proposal and the subsequent



DOMTAR TRANSCONA

FIGURE 1

AREAS OF CONTAMINATION

SCALE 1 : 6000

remediation was to be carried out by Domtar and this was understood in the sales agreement between Domtar and Sunny Hill Investments. In November 1976, Sunny Hill then sold the site to Imperial Developments (Canada) Inc. The original application filed by Nelson Square Developments for residential development was a condition of the sale, but the remediation proposal and implementation was not. This required the assurance by Sunny Hill Investments to Imperial Developments that Domtar would proceed as planned with site remediation. Following the insolvency of Imperial Developments, Domtar regained ownership of the property in 1995.

This study focuses on the economic impacts resulting from the remediation of the most heavily contaminated part of the site, Area A. Area A is the location of the former wood treatment plant (see Figure 1), approximately 2.2 hectares in size. The environmental assessment of the Transcona site found very high concentrations of contaminated soil in this area. The main contaminants detected were creosote, pentachlorophenols (PCPs), and tetrachlorophenols (TCPs). The objective of remediating Area A was to reduce the presence of the identified contaminants to "acceptable levels" for residential development, based on the Canadian Council of Ministers of the Environment (CCME) soil contaminant level criteria. Appendix A details the site environmental assessment, the contamination characteristics, and the CCME criteria specifications.

Domtar contracted TriWaste Reduction Services Inc. (TriWaste) to remediate Area A. TriWaste proceeded with the remediation of this selected area, reaching the point of setting up and testing their soil remediation system onsite. However, Domtar cancelled the contract in late 1995, and TriWaste proceeded with disassembling and removing their operations from the site. The economic impact analysis of this study is therefore based on those expenditures obtained before the contract was cancelled (the expenditures incurred from the setting up and testing of TriWaste's soil remediation system) plus the projected expenditures had the remediation of the selected area proceeded as planned.

2.2 Selected Area Remediation Activity

The economic impact analysis included the activity expenditures involved in preparing Area A for soil remediation, and the soil remediation itself. The setup and operation of the soil treatment system for soil remediation made up the majority of the actual and projected expenditures. It will therefore be detailed below.

To prepare for excavation of the soil and its treatment, onsite debris had to be removed from the soil. Both contaminated and uncontaminated debris were removed as part of the remediation. Debris included railway spikes, railway ties, concrete, wood chips, brush, and old storage tanks containing creosote used during plant operation. Once the debris had been removed there was a final soil preparation which included fine screening of the soil before treatment.

2.2.1 Soil Treatment System

The soil treatment system employed thermal phase separator (TPS) technology. This treatment process involves indirectly heating the contaminated soil to a temperature which vaporizes the contaminants, allowing separation. The gaseous contaminants are then collected through condensation.

The soil treatment system consists of five separate steps: 1.) soil pre-treatment, 2.) extraction chamber/thermal processing, 3.) treated soil handling, 4.) extracted contaminant gas treatment, and 5.) water/condensate treatment. These steps will be described by how they utilize the subsystems of the soil treatment system shown in Figure 2.

Soil Pre-treatment The soil is pre-treated by first screening to remove rock cobbles and then fragmenting by passing it through a clay lumpbreaker. The screened soil is moved to the lumpbreaker by conveyor belt. Another conveyor belt moves the soil from the lumpbreaker to the extraction chamber/thermal processing subsystem (TPS) for treatment.

Extraction Chamber/Thermal Processing Two parallel screw augers move the soil through the extraction chamber (TPS). A steel plate separates the extraction chamber from the source of heat, acting as a heat exchanger between the propane burners and the soil. The soil is heated to within the range of 650°C to 660°C which converts the water and the contaminants into a gaseous state.

Treated Soil Handling The treated soil exits the extraction chamber via an airlock valve, is wetted and removed from the treatment system area for storage, sampling, and eventual replacement to the site. The soil is wetted to cool it and prevent dust emissions. Any vapour still remaining is moved to the water/condensate treatment subsystem (described below) for further treatment.

Extracted Contaminant Gas Treatment The water and contaminant gases extracted in the extraction chamber are moved to the extracted contaminant gas treatment subsystem (Quench and Condenser). Here they are condensed by quenching with a water spray, and then further cooled by a fan cooler. The non-condensible gases remaining are passed through a mist eliminator and carbon absorption bed (Carbon Bed) for final treatment.

Water/Condensate Treatment The condensed output of the gas treatment subsystem is moved to the water/condensate treatment subsystem. Here it is passed through a sludge settling chamber and a three phase oil/water/solids separator. The contaminants, in the form of liquids and sludge, are then removed and stored. The remaining treated water is recirculated back into the system for use in the treated soil spraying and gas treatment quenching steps.

The TPS technology was chosen by TriWaste for its ability to remediate soil onsite to CCME standards criteria. It is a technology capable of obtaining the treatment levels required. The TPS is a non-destruction system operating at relatively low temperatures. There are no stacks from incineration-type units involved which makes the system very appealing for use in and near residential areas. As well, the treatment costs of the TPS technology ($/tonne) are reasonable.

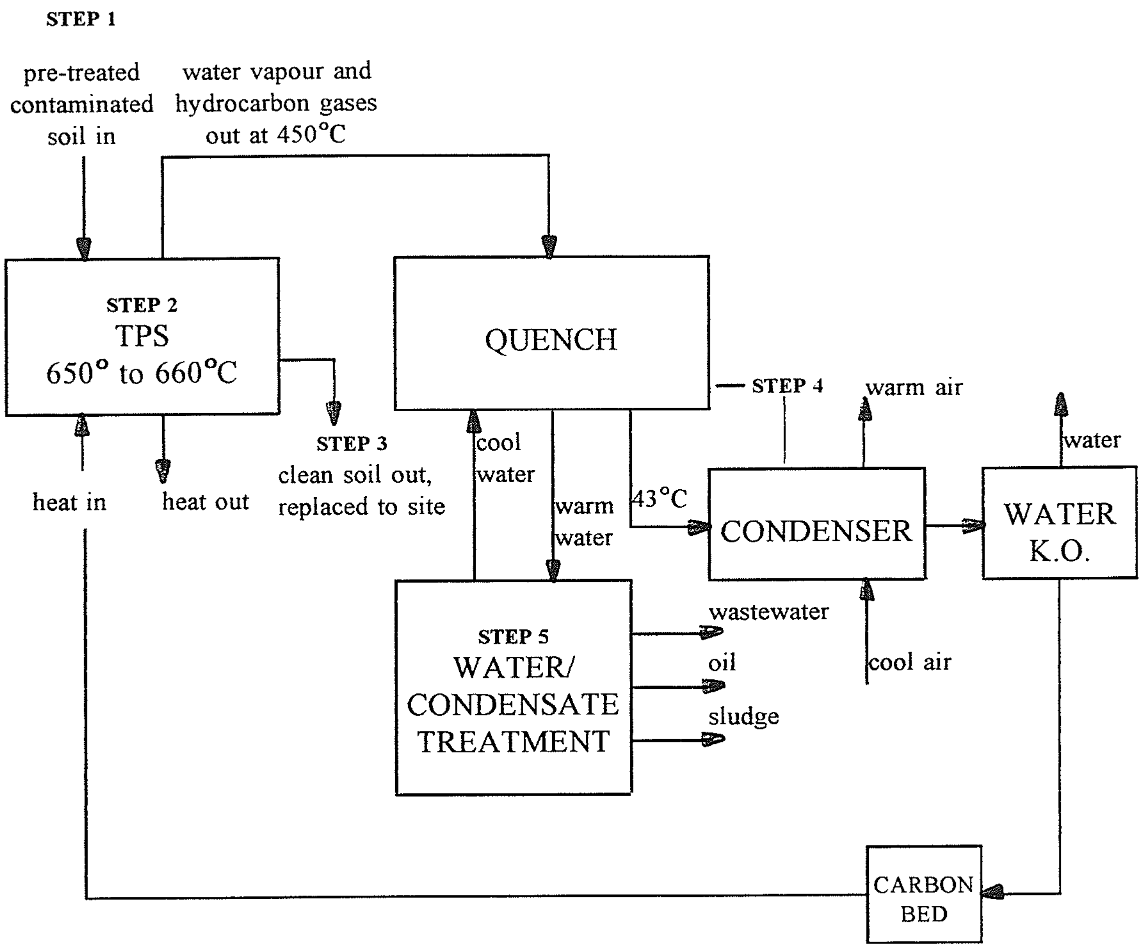


Figure 2. Soil Treatment System

3. Development of Research Methodology

This chapter presents the development of the research methodology. A review of economic impact analysis methodologies, focussing on those methods applicable to a site remediation impact analysis, is presented. The rationale for selecting 1.) the input-output analysis methodology, and then 2.) the Statistics Canada input-output model, are discussed next. This is followed by further developments of the input-output model for the site remediation analysis: the closing of the model, an examination of the model modification for the City of Winnipeg level impact analysis, and the economic multipliers for measuring the impacts. An explanation of the model's data sources occurs in the final section.

3.1 Economic Impact Analysis Methodologies

The cleanup of the site will generate economic activity that will be measured in the form of goods, services, taxes, employment, etc. that will "ripple" through the economy and thus multiply in value. To capture these various economic impacts and describe their multiplier effects, a methodology is needed that will: a.) reveal the framework of the economy and its industry interdependency, b.) allow for the development of models that can isolate the impacts to a specific region or regions, c.) process the provided expenditure data effectively, and d.) determine the magnitudes of the defined economic multipliers. A methodology with these capabilities will allow the capturing of the economic impacts and linkages as well as trace labour, materials, equipment and service expenditures to the supplying sectors at the local (Winnipeg), provincial (Manitoba), and national (Canadian) economies.

The three basic methodologies that can be applied to a contaminated site remediation project are discussed here: the economic base model, the income expenditure model, and the input-output model.

3.1.1 Economic Base Model

An economic base model divides a regional economy into two separate categories of industries: "base" and local. The base industries supply the exports and the local industries supply the local, or internal demands of the regional economy. National accounting categories are used to represent the regional economic product value, referred to as the Gross Regional Product (***GRP***):

$$GRP = C + I + G + E - M \tag{3.1}$$

where C = regional consumption, I = regional investment, G = local government spending, E = exports sales and M = import purchases. This mathematical representation is of the model in its simplest form; each component can be expanded on to introduce more complex economic behavioral relationships. Examples would include introducing marginal propensity to consume to C, marginal propensity to invest to I, and marginal propensity to import to M. But this is not necessary for explaining in general how the model functions.

The dominant characteristic of the economic base model is its recognition of only one of these five components as a source of economic stimulus. The model only recognizes an increase in export demand (***E***) as having an impact on the economy. The magnitude of the other components are considered relatively small compared to exports and are therefore eliminated as economic stimuli (Pleeter, 1980). With ***E*** representing the activity from this change in demand (export sales), ***L*** can represent the rest of the economy or the local industries and their activity. Total increase in economic activity in the region, measured as change in ***GRP***, can then be stated as:

$$\Delta GRP = \Delta E + \Delta L \qquad \textbf{(3.2)}$$

If the proportion of local activity (***L***) to base activity (***E***) is assumed to remain constant over the period of time in which the impact analysis is being performed, a constant

$$k = \frac{L}{E} \qquad \textbf{(3.3)}$$

is determined. When substituted in the last equation, the dependence of the regional economic activity on export activity is revealed:

$$\Delta GRP = (1 + k)\ \Delta E \qquad \textbf{(3.4)}$$

This shows that the local economic activity is a multiple **(1 + *k*)** of the export activity (Davis, 1990). The exogenous change in export demand impacts the base industries which in turn effect regional employment, income, investment, etc. directly and also indirectly as the effects multiply or ripple through the economy.

Assumptions of Economic Base Model

The most prominent assumption is the role of export demand in the regional economy. It is assumed to be the only source of economic growth, i.e. change in ***GRP***. All the other components of ***GRP*** (***C, I, G, M***) are not considered. This is a very strong assumption and tends to limit the model to those economies that are export-based; i.e., highly dependent on export activity. Examples would include mining towns and tourist resort areas.

Another strong assumption of the model is homogeneity of the export industries. All exported goods and services (commodities) are said to effect the regional economy equally, regardless of the type of activity that occurs in their production (changes in employment, amount of income, increase in investment). A change in the demand for one export commodity will have the same impact as the change in the demand for a different commodity, provided the changes are equal in terms of monetary valuation.

The proportion of local activity to base activity (constant ***k***) remaining constant over the period of time in which the impact analysis is being performed is a major assumption of the economic base model. This is realistic if the period is in the short run. Over the long run, if export demand continues to increase, the region may begin to have import replacement, population growth, and other activity that will increase the local side of the economy. This would result in ***k*** increasing and therefore the multiplier increasing. Most economic impact studies are done in the context of a short run time dimension.

Ignoring feedback effects is another assumption of the model. Export demand will increase regional income and therefore regional imports. These imports are a second region's exports and this will result in an increase in the second region's imports, which are the first region's exports, in the same manner. The model does not capture the economic activity resulting from this feedback.

A final assumption is that the local economy has a perfectly elastic supply of resources to meet the increase in export demand. Abundant factors of production insure that no price increase of the export commodity occurs.

3.1.2 Income Expenditure and Regional Multiplier Model

The income expenditure and regional multiplier model is also known as the Keynesian multiplier model. It is based on the principal that the income of a region is directly linked to the expenditures in that region. A simple mathematical representation of the model equates total income (***Y***) to consumption (***C***) and investment (***I***):

$$Y = C + I \tag{3.5}$$

Focussing on the consumption component, autonomous consumption c_0 (consumption that occurs regardless of the level of income) and marginal propensity to consume c_1 (spend) are related to income, giving an expanded consumption component:

$$C = c_0 + c_1 Y \tag{3.6}$$

An increase in regional income will be divided between consumption and savings. Assuming investment remains constant, the expanded consumption component can be substituted into the model equation:

$$Y = \frac{1}{1 - c_1} (c_0 + I) \tag{3.7}$$

This reveals the impact measurement of the income expenditure model. Regional income is affected by regional expenditures. If either regional investment expenditures (*I*) or regional autonomous consumption (c_0) increase, the amount of increase in income is determined by the multiplier **1/(1 -** c_1**)**.

The model is made more realistic by introducing the other components of the economy: government spending (*G*), exports out of the region (*E*), and imports into the region (*M*). Incorporating these into the model, the total income for the regional economy becomes:

$$Y = C + I + G + E - M \tag{3.8}$$

The government obtains its revenue through a tax rate (*t*) on income *Y*, which reduces income to disposable income Y_d:

$$Y_d = Y - tY \tag{3.9}$$

Consumption is now based on this disposable income, and the import component ***M*** (with autonomous imports m_0 and marginal propensity to import m_1) is also a function of Y_d:

$$C = c_0 + c_1 Y_d$$
$$M = m_0 + m_1 Y_d \tag{3.10}$$

The more realistic multiplier is calculated in a similar fashion to the simple multiplier above. The regional economy's total income is now:

$$Y = \frac{(c_0 + I + G + E - m_0)}{1 - (1 - t)\ (c_1 - m_1)} \tag{3.11}$$

This produces a multiplier which determines the amount of regional income increase given these components of the economy:

$$\frac{1}{[1 - (1 - t)\ (c_1 - m_1)]} \tag{3.12}$$

Assumptions of Income Expenditure Model

The main assumption of the income expenditure model focusses on the multiplier. All of the coefficients of the multiplier, regardless of its complexity, are assumed constant over the period in which the analysis is said to occur. The tax rate, the marginal propensity to consume, the marginal propensity to import, etc. are constant regardless of the level of income as well.

Related to this is the assumption that marginal propensities are equal to average propensities. This is because of the difficulty in estimating marginal propensities. Average propensities can be calculated using data representing a single time period, which is often the only type available.

As with the economic base model, there is an assumption of product homogeneity. All the producers of a particular commodity generate the same amount of regional income per dollar of regional consumption of that commodity. Further to this is that monetarily equal expenditures on different commodities, regardless of where they are made (locally or imported) also have the same income effect.

Feedback effects are assumed to be zero. Deciding which expenditures result from interregional effects and then incorporating this economic behaviour into the multiplier would be difficult and highly subjective.

The increased demand for commodities within the region from the increase in income is assumed to be met by increased production of the commodities and not their prices. This is the assumption of no supply constraints (Davis, 1990).

3.1.3 Input-Output Model

Input-output analysis represents the activities of an economy by the recorded economic transactions that occur. The interrelationships of the various economic agents (producers and consumers) in the economy are defined by these transactions. While it may not be possible or desirable to account for every transaction that occurs, the aggregation of similar transactions into classified groups allows for the creation of the input-output accounts. The structure or framework created from these accounts allows for the empirical analysis of the economy.

The basic structure of an input-output model is the input-output transactions table, shown in Table 1. This table represents the transactions between producers and consumers of commodities within a defined geographical or political area. Industry production involves the consumption of inputs which are the outputs of other industries, and the production of outputs which are the inputs of these other industries. The rows of an input-output table contain the allocation of the outputs of producers and the columns contain the allocation of the inputs of producers; i.e., what they consume in order to produce. This is referred to as intermediate use or demand.

To complete the representation of the economy, an input-output table must also contain the final demand sector and the primary input sector. The final demand sector represents transactions between producers and consumers towards an end use. The consumption of a commodity within the final demand categories signifies that it is being purchased for final use. Each final demand categories' column in the table describes the commodities it consumes from each of the industry output rows. Appendix B presents the mathematical development of the input-output model.

The primary input sector represents the transactions of primary inputs. These are inputs which are consumed by producers as part of their production but are not outputs of other producers. Examples of these inputs include labour (represented by payment to labour - labour income) and government services (represented by payment to government - indirect taxes). The primary input sector is described by rows of production (nonindustrial) of primary inputs. Each of these rows describes the distribution (output) of the primary inputs into each of the industry input columns.

The transactions that occur between producers and consumers represent the flow of commodities. The entries are meant to represent physical inputs and outputs but are measured in monetary values. While the quantifying of these transactions in actual physical units is possible, the occurrence of classifying commodities in the same category which in reality have different attributes and prices would create enormous valuation inaccuracies. For example, a luxury import sedan and a domestically produced economy car are both classified as automobiles but are quite different in attributes and price. The actual entries in an input-output table are therefore aggregated in monetary values, as this is the only form of measurement which can translate the vast amount of different characteristics between commodities into one common unit.

Table 1. The Basic Input-Output Transactions Table

		Inputs		
		Commodities	Industries	Final Demand
Outputs	Commodities		Consumption of Commodities for Intermediate Use	Consumption of Commodities for Final Use
	Industries	Production of Commodities by Industries		
	Primary Inputs		Consumption of Primary Inputs Used by Industries	

Assumptions of Input-Output Model

Each industry is assumed to produce only one homogeneous commodity; an industry is identified by this output commodity. In the model above there are ***n*** different industries and therefore ***n*** different commodities produced. In reality a business firm producing more than one type of commodity (secondary production) will be classified into more than one industry group.

All of the producers of an industry have identical production techniques. The production functions display constant returns to scale: there is no input substitution or economies of scale. If production input amounts change they must all change according to fixed input ratios. The output would also change proportionately. In other words, increasing all the inputs of a production function by some multiple will increase the output of that production function by the same multiple; similarly, a decrease of all inputs by some multiple will decrease the output by the same multiple. This fixed input-output relationship is represented by the input coefficients which, along with the technology matrix (see Appendix B), complete the assumption of no change in production technology.

The model does not specify a time dimension. Input-output analysis involves determining the impacts of a change in final demand by comparing the values of the model variables before and after the exogenous change has occurred. The model does not measure the time it takes for this change to move through the economy. The measured amount of input into a particular industry's production is assumed to occur during the same time period as the measured output of that industry. Supply of an input is assumed to meet its demand (and vice versa) during the specified time period; i.e., market equilibrium exits. All valuations are in terms of flows during a given time period, the most common being a year. The values reflect inputs actually absorbed into production as opposed to just shipped to producers.

If production output amounts increase due to increased demand (intermediate and final), the market share assumption states that the original proportional share of the demand before the increase occurred is still maintained for each output industry. This assumption also applies in the case of an output decrease. Variations in output have no effect on productivity or efficiency. The available production capital can respond to demand changes, and there is no re-allocation of production resources in response to relative price changes between capital and labour.

The closed model with respect to households (discussed below) has two assumptions related to consumer behaviour. The first is the assumption that the marginal propensity to consume is equal to the average propensity to consume. This is because the coefficients reflecting household consumption and production (represented by household income) are calculated as averages using the statistical input-output data on households during the time period represented by this data. This average consumption behaviour is then assumed to hold for any marginal changes in household income that occur. The second assumption is that the consumption behaviour in the form of spending patterns remains constant for all income types.

3.2 Selection of Economic Impact Analysis Methodology and Model

Of the three methodologies, input-output analysis has been selected for this study. The Statistics Canada input-output model and its accompanying input-output tables are used as the basis for the model development for the site remediation impact analysis. The rationale for both of these choices will be presented in turn.

3.2.1 Rationale for Selecting Input-Output Analysis Methodology

The dominant reason for selecting input-output analysis is the detail it gives to the economy being examined. Unlike the economic base model, it recognizes more than just exports as a source of economic stimulus. Consumption, investment, government spending, and imports are incorporated into the input-output model. These additional components of the economy are also captured by the income expenditure model, but the input-output model goes much further in its disaggregation of the economy. It breaks down the producers and consumers into individual industries, which results in a more detailed account of where the economic impacts occur. In the case of a contaminated site remediation impact analysis, it allows for the determination of which industries are affected by the economic activity. The purpose of this research is to reveal how a remediation project, with the Transcona site as the case study, impacts specific economic components such as individual industry output, government revenue and income. An input-output model has this capability.

The economic base model produces a single multiplier representing the magnitude of the economic impact given an increase in export activity, usually in terms of employment or income. The income expenditure model similarly produces a single multiplier, in terms of the income impact from expenditures. In contrast to this, the input-output model produces as many multipliers as there are output (producing) industry categories. The result is a more detailed picture of where the impacts occur and how they are apportioned between industries. In the case of the Transcona site remediation, the input-output models of the sub-provincial (city), provincial, and national economies are capable of producing different multiplier values for the same industry.

The multipliers of the economic base model and the income expenditure model produce the total impact resulting from the exogenous stimulus to the economy (the total impact is the summation of the direct, indirect, and induced impacts - these will be discussed in detail below). But the multiplicand consisting of direct and indirect impact components of the total must be provided before the total can be determined. Inherent in the input-output model is the provision of the indirect impact component. This is because the input-output model includes the producer-to-producer transactions, which make up the indirect effects. Only the direct impact is required; the input-output multipliers themselves produce the combined direct and indirect impacts if the model is open and the total effect if the model is closed (Davis, 1990).

The application of the economic base model is limited to economies that are export-based. The combination of a dichotomized economy and export dependence further confines its usage to those economies that are isolated and export a single commodity. The income expenditure approach can be applied more broadly, as its model recognizes other sources of economic stimuli, such as increases in government and/or consumer spending. It also allows for more than one producing industry. But both of these models are not suited for complex economies such as metropolitan areas because the interdependence between producers is considered insignificant. The input-output model explicitly accounts for the interdependence between producers and between producers and consumers.

There is a cost to pay for the superiority of the input-output model - that of data needs. The time involved and the cost of obtaining the necessary information from producers and consumers is considered relatively high compared to the other two models. And there is also the additional costs of constructing the input-output tables, and of insuring their reliability and accuracy. There are data sources available, though, that can respond to these potential data problems. They are discussed next.

3.2.2 Rationale for Selecting Statistics Canada Input-Output Model

The methodology selected for the economic impact analysis of the remediation is also used by the federal government in its model development of the national and provincial economies. The Input-Output Division of Statistics Canada uses the System of National Accounts (SNA) data along with its own accounting systems to create input-output accounts that capture the activity of an economy. The research model developed in this study will use these accounts. The rationale for this choice is explained.

The sources and methods used by Statistics Canada Input-Output Division to compile the input-output tables, both at the national and provincial levels, are the most comprehensive and accurate of their kind. The input-output tables are derived from the larger SNA. The Input-Output Division must account for all economic activity by industry and commodity, and it does so by means of commodity balancing. Because this procedure is unique to the compilation of input-output tables, the Input-Output Division faces a complex challenge in deriving their economic accounts from the SNA data. Economic data is sourced from business accounting records, and these are not in the format required to compile input-output tables. There are also many different sources used, each with a different purpose in mind for collection. But the Input-Output Division must draw on these, as "a data base designed to serve the needs of the Input-Output Tables would be much more expensive, both in statistical resources and response burden" (Statistics Canada, 1987).

To further support the use of the Statistics Canada input-output tables as a data source for an input-output model, even a regionalized one through reduction techniques, the more prominent problems identified and remedied by the Input-Output Division will be outlined.

With commodity balancing it was found that the classification of commodities varied. Emphasis was placed on those commodities which dominated the type of activity (exports, imports, industry output, final demand, etc.) being measured. For example, export commodity classification would focus on those commodities exported. In general, the commodity grouping reflected "special interests and historical development" (Statistics Canada, 1987). But the Input-Output Division created a common commodity classification called the Principal Commodity Group (PCG) system. The comprehensiveness of the PCG system is shown by the list of Statistics Canada divisions that contribute to its large database source: the Structural Analysis Division, the Standards Division, the Industry Division, the International Trade Division, and the Prices Division. Along with this, the PCG system consolidates the

Standard Commodity Classification, Industry Commodity Classification, Export Commodity Classification and Import Commodity Classification.

Yet in compiling accurate and reliable input-output tables, there are numerous problems associated with these sources and classifications. Industries are surveyed at different intervals, taxation statistics often provide details at the multi-establishment level only (input-output uses the concept of individual establishments), industry output (production), exports, imports, and final demand categories may be unrecorded or classified incorrectly. This potential for errors is magnified by the diversity of commodities, especially with the decisions that must decide whether a commodity is a good or a service. But the Input-Output Division found that with "laborious investigation" of basic records, the commodity balance approach, "with detailed counting of output by industries along with detailed counting of use by industries or final demand transactors" was able to overcome these survey problems and provide input-output tables with the highest degree of accuracy and reliability (Statistics Canada, 1987).

3.3 Extensions to the Input-Output Model

The input-output model described measures economic impacts by capturing the effects of a change in final demand on the economy. The objective of this study is to capture as many of the effects (impacts) resulting from the Transcona site remediation as possible. To operationalize the input-output model to measure the economic impacts of site remediation, three topics must be discussed: 1.) closing of the model, 2.) the economic multipliers derived from the model, and 3.) modification of the model for the city level impact analysis.

3.3.1 Closing the Model

Closing the model is an important modification which aids in capturing more of the impacts. Before describing how this is done, the types of effects that occur from a change in final demand will be discussed.

The total effect that the initial change in final demand causes can be broken down into direct and indirect effects, and also induced effects if the model is closed. Direct effects are the impacts that occur to the industries directly responding to the change in final demand. These industries directly supply the commodities which are now demanded in greater quantities. Direct effects are the direct and equal response to the increased demand. The increase in production by the industries to meet the direct effect will require those industries to input more from their supplying industries, and these supplying industries will then have to input more from their supplying industries, and so on. This ripple of activity through the economy is known as the indirect effect. If the input-output model is open, the total effects are the direct and indirect effects combined. If the model is closed with respect to household income, then the induced effects resulting from household spending of the income created can also be captured. The induced effects are the increase in economic activity (consumer expenditures) resulting from the household income earned by the additional labour inputs hired to meet the demand of the directly and indirectly effected industries.

The goal of "closing the model" is to capture the induced effects of the site remediation. In the closed model the exogenous household (consumer expenditures) sector of final demand is endogenized into the interindustry system. The full description of this model is partially closed with respect to households, since there are still other exogenous sectors remaining (Note: This is the most common sector to be endogenized because it is relatively large compared to the other final demand categories, and because household consumption propensities are traditionally stable). It is treated as another industry, with inputs consisting of commodities consumed and outputs being labour services. The labour is measured in the form of wages and salaries received. In the simple model developed so far, an extra row is added in which each coefficient represents the amount of labour services input by each industry per dollars' worth of that industry's output. An extra column is also added, and its coefficients represent the amount of consumption of each (row) industry's output by the household industry. Where the new row and column intersect is simply the consumption of labour services by the household sector.

The household industry's position in the tables will be revealed in the next chapter when the actual operational model is developed. Appendix B details the closing of the mathematical input-output model.

3.3.2 Economic Multipliers

Once an input-output model is created, the effects of an exogenous change in final demand can be determined as they "ripple" through the economy. Economic multipliers resulting from the model are used to measure these effects. In the case of the Transcona site cleanup, economic multipliers would reflect the magnitude of the effects resulting from the remediation expenditures.

There are two basic types of multipliers derived from these effects, identified as Type I and Type II. Type I multipliers are the simple multipliers calculated using the open model. They are calculated as the ratio of direct and indirect effects to the initial change in final demand. This multiplier is the partial effect of an exogenous change in demand. Type II multipliers are calculated using the closed model. They are calculated as the ratio of the direct, indirect, and induced effects to the direct effects. In the context of the closed input-output model, they reflect the total effect. These multiplier ratios are used as tools to determine what quantity of expenditures result from an initial expenditure. With the basic multiplier types defined, their application depends on how the effects are measured.

An *output multiplier* is the ratio of all the measurable expenditures (demand) occurring throughout the economy to the initial expenditures that occurred for the output of an industry. As a ratio, the multiplier value reflects the total value of economic production necessary to supply the final demand for one dollar's worth of that industry. The closed input-output model developed for the Transcona site remediation allows the determination of the Type II industry output multiplier for all industry output combined, or alternatively, for each separate industry directly affected by the remediation.

An *income multiplier* defines the amount of a specified type of income (e.g., labour income, net income of unincorporated business) resulting from a change in final demand. With the contaminated site, it attempts to determine the change in labour income resulting from a change in final demand (remediation expenditures). Each output industry will have its own Type II income multiplier which is derived from the closed input-output model's income information.

An *employment multiplier* is similar except it attempts to measure the impact in employment (physical labour units) terms. Employment multipliers can be determined if there is statistical information relating industry output to the number of employment units created by that output. These employment units are not monetary values, otherwise income multipliers would suffice. The closed input-output model is used to determine the Type II employment multipliers.

These multipliers are derived from the impact matrix of the closed input-output model. Appendix B presents the mathematical derivation of the multipliers.

3.3.3 Modification for Development of the Winnipeg City Model

The input-output model developed so far is applied at the national and provincial levels based on an extensive and reliable system of economic accounts which are collected and processed by Statistics Canada, particularly by the System of National Accounts (SNA) and the Input-Output Division. These economic accounts are created from data collected through surveys, and the resultant input-output tables reflect the most accurate representation of the national and provincial economies. But these survey methods are expensive and time-consuming, and are therefore limited to these levels.

To capture the input-output relationships at a sub-provincial level in which there is not the required survey data available for creating sub-provincial input-output tables, a nonsurvey technique is selected based on what survey data are available on the specific region in question. Nonsurvey techniques estimate input-output coefficients by adjusting the coefficients of available survey coefficients, usually of the larger (base) economy in which the region is part of. The sub-provincial region in this study is metropolitan Winnipeg, and the base economy is the Province of Manitoba.

The rationale for selecting a nonsurvey approach to the city model will be shown, followed by the explanation for the type of technique chosen. A discussion of the prominent nonsurvey techniques reviewed are outlined in Appendix C.

Rationale for Nonsurvey Approach to City Model

The legitimacy of using a nonsurvey approach to building an economic model of the city of Winnipeg is based on two main premises: 1.) the ability of the Winnipeg - Manitoba economic relationship to fulfil the strong assumptions of the nonsurvey methodologies, and 2.) the availability of an accurate and comprehensive Manitoba model in which to regionalize or reduce to the city level. In addition, employment figures are well known as a dominant indicator of economic activity and hence the economic structure of an economy. Population and number of households in a region can also contribute to an accurate representation of the household industry (consumer expenditures) when a model is closed in this respect to capture the induced effects of economic activity. All three of these types of data (employment, population, number of households) on the city of Winnipeg are available through Statistics Canada.

The two main assumptions of a nonsurvey methodology are similar consumption patterns and identical industry production functions between the base economy (Manitoba) and the region for which the reduction occurs (Winnipeg). The portrayal of Winnipeg as the dominant consumption centre in Manitoba will be shown to give support for the first assumption. The presentation of Winnipeg as a microcosm of Manitoba will support the second assumption. These will be discussed in order.

Provincial consumption pattern data is collected by Statistics Canada. Metropolitan Winnipeg is included in the surveys conducted to collect this information for the Province of Manitoba. To show how the consumption patterns of the City are compared to those of the Province, population, number of households, employment and employment income are compared in Table 2.

Table 2 - Comparison of Population, Number of Households (1991), Total Employment (1990) and Income (1990)

	Manitoba	Winnipeg	Ratio of City/ Province (%)
Total Population	1,091,942	652,354	59.7
Number of Households	407,089	252,934	62.1
Total Employment	505,000	312,000	61.8
Total Employment Income	$17,746,035,810	$11,657,148,880	65.7

Source: Census of Canada, 1991

As seen from the figures in Table 2, Winnipeg dominates the population, number of households, and income measurements of Manitoba. These are key indicators for portraying how the provincial input-output data on consumption behaviour reflects those of the City.

Another indicator of the similar economic activity patterns between Manitoba and Winnipeg is the data available on retail trade. A prominent indicator of retail trade is the sales activity of retail chain outlets. The percentage of the value of these purchases made in Winnipeg at retail chain outlets relative to the rest of Manitoba in 1990 was 78.3% (Statistics Canada, 1993). This further supports the dominant role Winnipeg has in making up the composition of the provincial input-output consumption data. The cause of this, in addition to the statistics just presented, is the fact that the City "casts a large economic shadow" into bordering municipalities and also attracts "travel by non-Winnipeg residents to Winnipeg for major purchases" (Mason, 1985).

The rational for choosing input-output analysis was discussed earlier in this chapter. The point to be stressed again is that the framework of the economy of a region is captured best when the fundamental components of economic activity, the input and output of industry production and the directly related movement of commodities (goods and services), can be collected. This condition is satisfied by Statistics Canada at the provincial level. It is not collected at the metropolitan level. But employment is a dominant economic indicator, and can be considered "as a second best alternative" (Mason, 1985). Statistics Canada does provide employment figures at the metropolitan level corresponding to the industry classifications of its input-output tables. These are presented and compared to the Manitoba values in Table 3.

Table 3 - Comparison of Employment By Industry, thousands of persons (1990)
(... indicates estimates subject to variability of >33.3% and/or <4,000 persons)

	Employment '000 Persons		
	Manitoba	Winnipeg	Ratio of City/Province (%)
All Industries	505	312	61.8
Other Primary and Agric.	47	...	-
Manufacturing	54	40	74.1
Construction	23	13	56.5
Trans., Comm., Other Util.	46	32	69.6
Trade	89	58	65.2
Finance, Insur., Real Estate	29	22	75.9
Services	181	120	66.3
Public Admin.	36	24	66.7

Source: Labour Force Annual Averages, 1990

In addition to the raw employment numbers, other studies done on Winnipeg's economy have conclusions that support the City as a microcosm of the provincial economy. The Price Waterhouse study of Winnipeg states that while the available trucking industry figures are for the Province of Manitoba, "they largely reflect the situation in Winnipeg, as most of the large interprovincial carriers and the major suppliers of goods and services for the trucking industries are located in the City" (Price Waterhouse, 1990). Similarly for air transportation, as the Winnipeg International Airport is located within Winnipeg. Another major industry pointed out in the report is financial services. The economic activity of this industry in the Province is captured by the provincial input-output model; Winnipeg is the provincial headquarters for all the major financial institutions in this industry. Similar arguments can be made for the other industries. Almost all the major provincial research and development centres, recreational and cultural resources, and retail shopping centres reside in the City (Price Waterhouse, 1990).

The assumption of identical industry production functions is supported by the dominance of Winnipeg in all the input-output industry categories according to employment share. As well, it can be assumed that similar technologies are being employed by industries within the City and outside of it.

The ability of a nonsurvey methodology to represent the Winnipeg economy is strongly supported by the arguments presented. The main assumptions of consumption patterns and industry production functions for reduction techniques have been revealed to hold for Manitoba and Winnipeg. Employment indicators and the proportion of industries' activities in Winnipeg have highlighted the City's dominance of the provincial economy. And the availability of highly reliable and comprehensive data, both of the site remediation expenditures and the Input-Output Division's input-output tables used for the Manitoba model, has been outlined. This quality of data contributes to assuring the accuracy of a nonsurvey approach.

Selection of Nonsurvey Technique for City Model

The chosen technique for the City of Winnipeg model is the Simple Location Quotient (SLQ) technique. The empirical studies found that support the selection of the SLQ technique are discussed in Appendix C. The main arguments of these studies are mentioned here.

The studies present nonsurvey approaches as an alternative to survey methods for regional studies. They conclude that survey methods are prohibitively expensive and time-consuming for constructing regional input-output tables, and that the data necessary for constructing regional tables is often out-of-date or unavailable. When the various nonsurvey techniques were examined, the studies concluded that the SLQ technique produced the best results given the minimum amount of data available to construct the regional input-output tables. In constructing input-output tables for the regional, or sub-provincial economy of Winnipeg, the SLQ technique was found to be the best choice given the financial, time, and economic data resources available for the study.

Using the SLQ technique, the Province of Manitoba is the base economy and the Statistics Canada input-output table data along with the necessary derived matrices from the provincial model development are used to determine the location quotient (LQ) values. The most comparable economic measurement available to determine the relative size of the city (regional) to the provincial (base economy) is the employment statistics for the City of Winnipeg. In the section *Rationale for Nonsurvey Approach to City Model*, employment was found to be a reliable measure in approximating the local (city) model.

The ***LQ*** values for each industry_i are determined using the city and provincial employment data:

$$LQ^{W}_{i} = \left[\frac{\frac{emp^{W}_{i}}{EMP^{W}}}{\frac{emp^{M}_{i}}{EMP^{M}}} \right] \tag{3.13}$$

The "emp_i" denotes the industry$_i$ employment and "***EMP***" is the total employment in the economy Winnipeg (***W***) or Manitoba (***M***).

The industry row coefficients of the provincial impact matrix are manipulated by the corresponding ***LQ*** industry values according to the SLQ condition: if $LQ_i < 1$, then proceed with multiplication of the ***LQ*** value and the row coefficients; if $LQ_i \geq 1$, the impact row coefficients remain unchanged. The explanation for this is as follows: (refer to Appendix C *Location Quotient Techniques: Simple Location Technique*) an LQ_i value that is less than one would indicate that the city is not self-sufficient in the production of output x_i and therefore its input coefficient is calculated from multiplying the corresponding provincial economy coefficient by the LQ_i value. If the LQ_i value is greater than or equal to one, it is assumed that the local (city) production can supply the demands of the city and export any excess supply to the provincial economy. In this case, the provincial economy coefficient can be used for the corresponding city coefficient value.

The assumptions of the provincial model are applied to the city model as well, and the "regionalized" impact matrix is employed in the same manner to determine the impacts on the City of Winnipeg.

3.4 Data Sources

The input-output tables of the Input-Output Division of Statistics Canada are used in this study to build the input-output model. The Input-Output Division classifies industries, commodities, and final demand in three levels of aggregation - "small" (S), "medium" (M) and "worksheet" (W) level. Level S is the most aggregated and therefore has the "smallest" number of classifications. Level W is the least aggregated and therefore has the largest number of classifications (i.e. most detailed). There are economic accounts and constructed input-output tables at all three of these levels. The aggregation dimensions are shown below in Table 4.

Table 4. Aggregation Level Dimensions

Aggregation Level	Number of Industries	Number of Commodities and Primary Inputs	Number of Final Demand Categories
S	16	49	14
M	50	100	28
W	161	485	136

Source: The Input-Output Structure of the Canadian Economy, 1990.

The development of the input-output model for this study requires the complete matrices of the input-output tables. The "medium" and "worksheet" levels have some of their input-output table entries suppressed because they are confidential to meet secrecy requirements of the Statistics Act. They could not be used. The research methodology of this study required the complete data (all cell entries) of the input-output tables. The matrices development and manipulation cannot be accomplished with incomplete table data. However, the "small" level of aggregation input-output tables have no data entries suppressed and can therefore be used without problems for the development of the model.

At the "small" level of aggregation there are 16 industry categories, 49 commodity categories (which include 4 primary inputs), and 14 final demand categories. These are listed in table 5.

For the regionalization of the model to the city level, employment statistics are used to calculate the location quotients discussed above. Statistics Canada Household Surveys Division publishes annual employment by industry for the larger metropolitan areas of Canada, including Winnipeg. The main attraction of this data is that the industry classification used in the surveys is almost identical to that of the Input-Output Division (Some aggregation of the employment by industry was performed to match the input-output classifications listed in Table 5). Therefore, the employment statistics are used as a comparable industry output indicator for the city.

Table 5. Commodity, Industry, and Final Demand Categories - Aggregation "S"

Commodity

1.	Grains
2.	Other Agricultural Products
3.	Forestry Products
4.	Fishing and Trapping Products
5.	Metal Ores and Concentrates
6.	Minerals Fuels
7.	Non-metallic Minerals
8.	Services Incidental to Mining
9.	Meat, Fish and Dairy Products
10.	Fruits, Veg., Feed, Misc Food Prod.
11.	Beverages
12.	Tobacco and Tobacco Products
13.	Rubber, Leather, Plastic Fab. Prods.
14.	Textile Products
15.	Knitted Products and Clothing
16.	Lumber, Sawmill, Other Wood Prod.
17.	Furniture and Fixtures
18.	Paper and Paper Products
19.	Printing and Publishing
20.	Primary Metal Products
21.	Metal Fabricated Products
22.	Machinery and Equipment
23.	Autos, Trucks, Other Transp. Eqp.
24.	Elec. and Communications Prod.
25.	Non-metallic Mineral Products
26.	Petroleum and Coal Products
27.	Chemicals, Chemical Products
28.	Misc. Manufactured Products
29.	Residential Construction
30.	Non-residential Construction
31.	Repair Construction
32.	Transportation and Storage
33.	Communication Services
34.	Other Utilities
35.	Wholesale Margins
36.	Retail Margins
37.	Imputed Rent Owner Ocpd. Dwel.
38.	Other Finance, Ins., Real Estate
39.	Business Services
40.	Personal and Other Misc. Services
41.	Transportation Margins
42.	Operating, Office, Lab and Food
43.	Travel, Advertising, and Promotion
44.	Non-competing Imports
45.	Unallocated Imports and Exports
46.	Net Indirect Taxes
47.	Labour Income
48.	Net Income Unincorporated Business
49.	Other Operating Surplus or GDPFC

Industry

1.	Agricultural and Related Services Ind.
2.	Fishing and Trapping Industries
3.	Logging and Forestry Industries
4.	Mining, Quarrying and Oil Well Ind.
5.	Manufacturing Industries
6.	Construction Industries
7.	Transportation and Storage Industries
8.	Communication Industries
9.	Other Utility Industries
10.	Wholesale Trade Industries
11.	Retail Trade Industries
12.	Finance, Insurance, and Real Estate Ind.
13.	Community, Business, Personal Serv.
14.	Operating, Off., Cafet. and Lab Supplies
15.	Travel, Advertising and Promotion
16.	Transportation Margins

Final Demand

1.	Personal Expenditures, Durable
2.	Personal Expenditures, Semi-durable
3.	Personal Expenditures, Non-durable
4.	Personal Expenditures, Services
5.	Construction, Business
6.	Construction, Government
7.	Machinery and Equipment, Business
8.	Machinery and Equipment, Government
9.	Inventories
10.	Domestic Exports
11.	Re-exports
12.	Imports
13.	Government Gross Current Expenditures
14.	Government Sales of Goods and Services

4. Development of Input-Output Models

The operational input-output models are developed in this chapter. The determination of the economic impacts from these models is revealed in the final section.

The components and assumptions of the models are defined as they are developed. Table 6 displays the accounting framework of both Statistics Canada's national and provincial input-output tables. The table reveals the specific final demand and primary input categories discussed in the development of the input-output models.

The Input-Output Division employs the same accounting framework and input-output table construction at the national and provincial levels. Therefore, one operational input-output model will be developed in this study for both the national economy and the provincial economy. The main difference will be in the definition of imports and exports. These two categories at the national level refer to foreign transactions. At the provincial level, imports include foreign and other provincial/ territorial imports into Manitoba; exports are the combination of Manitoba exports to the other provinces/territories and to foreigners. The modification of the provincial model for determining the city impacts follows the SLQ technique discussed in the previous chapter.

The Statistics Canada model is open with respect to households; this means the personal (household) expenditures are considered a sector within final demand. The objective of this study was to endogenize households in order to capture the induced effects of the site remediation. Appendix D describes the input-output table matrix manipulations to close the model.

4.1 Input-Output Matrices Derivations

The development of the operational models consists of three main steps: the derivation of the market share and industry technology matrices, the derivation of the domestic production leakage matrices, and the derivation of the impact matrix from model equilibrium. Once the impact matrix is derived, the economic impacts can be determined. These derivations will refer to the matrices of the accounting framework of the Statistics Canada's input-output tables (Table 6). The data tables corresponding to these matrices used in the computer development of the operational models are in Appendix E.

4.1.1 Derivation of Market Share and Industry Technology Matrices

The vector of the values of total commodity outputs is $\boldsymbol{q}$ while the vector of the values of total industrial outputs is $\boldsymbol{g}$. The number of commodity categories can be greater than the number of industry categories. The relationship between commodity production and industrial output is based on the assumption of constant domestic market shares. This states that each industry has a constant share of a commodity market, regardless of fluctuations in total commodity production due to changes in

Table 6. The Accounting Framework of Statistics Canada Input-Output Tables: Final Demand and Primary Input Categories Expanded (Aggregation S)

			Inputs										
					Final Demand								
			Commodities	Industries	PE	FCF	VPC	E	R	M	GGCE	GR	Total
Outputs	Commodities			***U***				***F***					***q***
	Industries		***V***										***g***
	Primary Inputs	NetIndTax		***YI***				***YF***					
		LabInc											
		NetInUnB											
		OthOpSur											
	Total		***q'***	***g'***									

Glossary

Notation	Matrix Name	Description	Dimensions
U	Use	values of intermediate industry inputs by commodity	49 x 16
V	Make	values of industry outputs by commodity	16 x 49
F	Final Demand	values of final demand categories by commodity	49 x 14
YI	Primary Input	values of primary inputs by industry	4 x 16
YF	Primary Input Final Demand	values of primary inputs by final demand categories	4 x 16
q	Commodity Output	values of total commodity outputs	49 x 1
g	Industry Output	values of total industry outputs	16 x 1

Table 6 continued

Glossary (continued)

Notation	Matrix Name/Description	Dimensions
	Final Demand Categories	
PE	Personal Expenditures - durable, semi-durable, non-durable, and services	49 x 4
FCF	Fixed Capital Formation - business construction, government construction, business machinery and equipment, government machinery and equipment	49 x 4
VPC	Inventory - value of physical change in inventories	49 x 1
E	Exports - domestic exports of goods and services	49 x 1
R	Re-exports - re-exports of goods and services	49 x 1
M	Imports - imports of goods and services	49 x 1
GGCE	Gross Government Current Expenditures - on goods and services	49 x 1
GR	Government Revenue - from sale of goods and services	49 x 1
	Primary Inputs (Industry) Categories	
NetIndTax	Net Indirect Taxes	1 x 16
LabInc	Labour Income	1 x 16
NetInUnB	Net Income Unincorporated Business	1 x 16
OthOpSur	Other Operating Surplus	1 x 16

Source: The Input-Output Structure of the Canadian Economy, 1987.

intermediate and final demand. A domestic market share matrix $\boldsymbol{D}$ is introduced:

$$\boldsymbol{g} = \boldsymbol{Dq} \qquad (d_{ij} = v_{ij} / \sum v_j), \qquad \textbf{(4.1)}$$

where each coefficient of $\boldsymbol{D}$ represents the share of a commodity market that each industry has of the total domestic commodity production. $\boldsymbol{D}$ is obtained by dividing each element in each column of the Make matrix $\boldsymbol{V}$ (the columns reveal the share each industry has of the total production of a commodity) by the summation of the respective column (the total commodity output). This equation states that the value of each industry output is determined by the value of each commodity output multiplied by the domestic market share matrix.

The Use matrix, $\boldsymbol{U}$, reveals the commodity mix of inputs that each producing industry requires. The column coefficients of this matrix represent the value of each intermediate input into the industry output as a proportion of total output. Multiplying this matrix by a unit column vector $\boldsymbol{c}$ (with dimension equal to the number of industries) collapses the Use matrix into a column vector $\boldsymbol{Uc}$ in which each element represents the total amount of the intermediate inputs of all industries, categorized by commodity. The assumption that fixes the input coefficients regardless of changes in the output mix of an industry (its share of the commodity market) is the industrial technology assumption. An industry technology matrix $\boldsymbol{B}$ is created by dividing each column (industry) coefficient of the Use matrix by the total industry output for that industry. The following equation:

$$\boldsymbol{Uc} = \boldsymbol{Bg} \qquad (b_{ij} = u_{ij} / g_j), \qquad \textbf{(4.2)}$$

shows that the values of total intermediate inputs, categorized by commodity, is equal to the values of total industry outputs multiplied by the industry technology matrix.

The assumption of constant domestic market shares distributes the production of commodities between industries. Recalling from the derivation of the market share matrix, this means each industry has a constant share of the commodity market, regardless of fluctuations in total commodity production due to changes in intermediate or final demand. The industrial technology assumption defines the production functions of the industries and therefore establishes the intermediate input amounts required by each industry. Before the assumption of total domestic production of commodities can be equated to total demand (model equilibrium), the components of final demand and their corresponding proportionality assumptions must also be introduced.

4.1.2 Derivation of Domestic Production Leakage Matrices

The import share assumption states that the demand for imports is proportional to total domestic demand. This means that imports have a constant share of the commodity market, regardless of fluctuations in intermediate or final demand. Demand for imports, vector ***m***, originates from intermediate use, ***Bg***, and final demand use ***FCF*** + ***GGCE*** + ***R***. (See Table 6 for the descriptions and dimensions of the matrices discussed here and below). Re-exports, ***R***, allows for the isolation of those exports, ***E***, resulting solely from domestic production. These export commodities, by definition, do not use imports in their production. ***FCF*** represents fixed capital formation (private and government) and ***GGCE*** is gross government current expenditure on goods and services. The proportionality is defined by determining the ratios of imports to their intermediate, final demand, and re-export uses. A diagonal matrix, ***P***, is created with these ratios as the non-zero coefficients, and this is used to calculate the import leakage:

$$m = P\ (Bg + FCF + GGCE + R). \qquad \textbf{(4.3)}$$

The model has two other leakages with similar proportionately assumptions: government production of goods and services, and withdrawals from inventories. The ratios of government production to use is captured by a diagonal matrix as well (*A*), and the use components include exports ***E***:

$$a = A\ (Bg + FCF + GGCE + E), \qquad \textbf{(4.4)}$$

where vector ***a*** is the government production leakage (government production of goods and services are treated as leakages to avoid double counting - they have already been accounted for by ***GGCE***). The vector of net withdrawals from inventories, ***v***, is calculated using a diagonal matrix, ***V***, with ratios of withdrawals to use as the coefficients:

$$v = V\ (Bg + FCF + GGCE + E). \qquad \textbf{(4.5)}$$

The import, government production, and inventory withdrawal to use matrix coefficients are presented in Appendix E.

4.1.3 Model Equilibrium and Derivation of Impact Matrix

Model equilibrium can now be stated, equating the sum of total commodity outputs, imports, government production, and inventory withdrawals (total supply) to the sum of intermediate use, final demand use, exports and re-exports (total demand):

$$q + m + a + v = Bg + FCF + GGCE + R + E. \tag{4.6}$$

Total commodity outputs and total industry outputs can be determined from this equilibrium relationship:

$$q = Bg + FCF + GGCE + R + E - m - a - v. \tag{4.7}$$

Using the equation $g = Dq$, industry output g can be defined as:

$$g = D\,(\,Bg\,) + D\,(\,FCF + GGCE + R + E - m - a - v\,) \tag{4.8}$$

$$g = (\,I - DB\,)^{-1} + D\,(\,FCF + GGCE + R + E - m - a - v\,). \tag{4.9}$$

The leakages of imports, government production, and inventory withdrawals are now substituted into these equations:

$$q = Bg + FCF + GGCE + R + E - P\,(\,Bg + FCF + GGCE + R\,) - A\,(\,Bg + FCF + GGCE + E\,) - V\,(Bg + FCF + GGCE + E\,). \tag{4.10}$$

This allows for the model commodity outputs to be determined:

$$q = (\,I - P - A - V)\,Bg + (\,I - P - A - V\,)\,(\,FCF + GGCE\,) + (\,I - A - V)\,E + (\,I - P\,)\,R \tag{4.11}$$

and, using $\boldsymbol{g = Dq}$:

$$g = [\, I - D\,(\, I - P - A - V\,)\, B\,]^{-1}\, D\,[\,(\, I - P - A - V\,)\,(\, FCF + GGCE\,) + (\, I - A - V)\, E + \;(\, I - P\,)\, R\,]. \tag{4.12}$$

This last equation expresses the effect, or impact, on industry outputs as a result of changes in demand, allowing for import, government production, and inventory withdrawal leakages.

4.2 Determination of Economic Impacts

Since the site remediation expenditures will not involve exports or re-exports, they are assumed to have no change in demand and their terms can be set to zero. Therefore, the matrix equation for determining the impact of a change in final demand (resulting from site remediation) on industry output is:

$$\Delta g = [\, I - D\,(\, I - P - A - V\,)\, B\,]^{-1}\, D\,(\, I - P - A - V)\, \Delta(\, FCF + GGCE\,). \tag{4.13}$$

To utilize this matrix, the site remediation expenditure data is first formulated into a final demand column vector according to commodity classification. Matrix multiplication of this vector and the impact matrix produces a vector whose coefficients reflect the amount of industry output (*g*) that is required, and therefore generated, to supply the remediation demands.

Output Impacts

With the determination of the change in total industry output (***g***), the models can now measure the impact on total commodity output (***q***), income, value added (GDP), employment, and indirect taxes. Total commodity output is determined by using the equation representing the fixed market shares relationship $\boldsymbol{g} = \boldsymbol{Dq}$ previously developed. A variation of the ***D*** matrix is derived to solve for the change in ***q*** resulting from the now known change in ***g***.

Income and Value Added Impacts

The impact on income and value added is determined by deriving ratios of income to industry outputs and ratios of value added to industry outputs, organized in an income coefficient matrix (***INC_COEF***) and a value added coefficient matrix (***VA_COEF***), respectively. These matrices are used to calculate changes in income and value added from industry outputs. The income values (INC) are represented by the summation of the Labour Income and Net Income Unincorporated Business rows of the Use matrix, and the value added values (VA) are the summation of these two rows and the Other Operating Surplus row in the Primary Input matrix. This form of value added measurement refers to GDP at factor cost (GDPFC). If GDP at market prices (GDPMP) is sought, the Indirect Taxes row of the Primary Input matrix must also be added in the calculation of VA. The ***VA_COEF*** matrix is for GDPFC.

Employment Impacts

Employment impacts require the creation of a labour coefficient matrix, ***EMP_COEF*** for each model. The total employment per industry (EMP) at the national, provincial and city levels are derived from Statistics Canada data, aggregating where necessary to match the industry classification of the input-output model. The matrix contains labour to industry input-output ratios as coefficients. The effect on employment at each model level from an increase in industry output at each model level is then determined.

Indirect Taxes Impacts

An indirect taxes coefficient matrix, ***TXI_COEF***, is derived in which the coefficients are indirect taxes to industry output ratios. The indirect taxes (TXI) are represented by the Net Indirect Taxes row of the Primary Input matrix. Recall that indirect taxes include commodity indirect taxes such as national, provincial, and municipal sales taxes, excise taxes and duties, provincial motor fuel taxes, licenses, fees and permits, and property taxes. Net indirect taxes result from subtracting government subsidies.

The derived coefficient matrices are used to determine the economic impacts of the change in final demand:

$$\Delta INC = (INC\_COEF)\ \Delta g \tag{4.14}$$

$$\Delta VA = (VA\_COEF)\ \Delta g \tag{4.15}$$

$$\Delta EMP = (EMP\_COEF)\ \Delta g \tag{4.16}$$

$$\Delta TXI = (TXI\_COEF)\ \Delta g \tag{4.17}$$

These coefficients are also presented in Appendix E.

The modification of the provincial model to develop the local or city level model utilizes metropolitan Winnipeg industry employment data. It was explained in the previous chapter how the industry coefficients of the provincial impact matrix are manipulated with this data using the SLQ nonsurvey technique. As a result, only the impacts to industry output (Δg), commodity output (Δq), and employment (ΔEMP) from the change in final demand are determinable for the city.

5. Results of Economic Impact Analysis

5.1 Economic Impacts of Site Remediation Expenditures

The input-output models developed in this study are based on the 1990 input-output tables of the Input-Output Division of Statistics Canada. The 1990 tables are the most recent published. The Transcona site remediation expenditures are deflated to 1990 values to correspond with these tables. All dollar amounts quoted are therefore in 1990 dollars unless otherwise indicated.

The total amount of the remediation expenditures (project costs) obtained from TriWaste before their contract was cancelled plus projected expenditures to completion of remediation of Site A was $2,370,000 ($1,356,000 actually spent and $1,014,000 projected). These commodity expenditures by industry were entered into the models to yield the economic impacts in the form of increased commodity and industry output, government indirect tax revenue, income and Gross Domestic Product (GDP), and employment.

Before the impact results are presented, an important disclaimer must be stated. In this case study of a contaminated site remediation, the owner, Domtar, is funding the remediation. A key assumption of the input-output model in regards to source of funds is that financing the remediation does not create adverse effects. This disclaimer is included because it could reduce the aggregate benefits.

5.1.1 Commodity and Industry Output

The direct effects of the site remediation are summarized in tables of national, provincial, and metropolitan Winnipeg. Table 8 gives national, Table 9 provincial, and Table 10 Winnipeg city output impacts. The direct commodity impacts represent the initial or direct change in final demand (the actual expenditures) grouped by commodity. The industries experiencing the largest *direct impacts* (direct effect) are those supplying the following commodities: non-residential construction, machinery and equipment, petroleum and coal products, and metal fabricated products.

The resulting total effects of the remediation on commodity and industry output are also presented in the tables, both by commodity and industry classification. These values indicate the total commodity and industry output required to meet this new demand. At the national level, the industries experiencing the largest *total impacts* (total effect) are those supplying the following commodities: labour income (i.e. households), non-residential construction, personal and other miscellaneous services (examples include: accommodation services, meals, rental of automobiles and trucks), other finance, insurance and real estate services, and residential construction. The national level total impact is \$6,285,000, with an output multiplier value of 2.7. At the provincial and city level, the supplying industries impacted the most reflect the local nature of the remediation economic activity: labour income, non-residential construction, personal and other miscellaneous services, and residential construction. The provincial level total impact is \$3,010,000 with an output multiplier of 1.3, and the city level is \$2,890,000 with a 1.2 output multiplier.

5.1.2 Government Revenue

The determination of the type and amount of government indirect tax revenue generated by the remediation activity is derived from the input-output model, which uses tax rates and tax bases from the federal, provincial and local tax legislation. This provides the indirect taxes. There is also, in addition, direct (income) tax revenue generated. It could be estimated from labour income by assuming alternative marginal tax rates.

Indirect Tax Revenue

Net indirect taxes include commodity indirect taxes, other indirect taxes, and subsidies. Commodity indirect taxes are those taxes that are paid by industry on commodities purchased for intermediate use. Examples include excise taxes and duties, provincial motor sales taxes, provincial sales taxes (PST) and municipal sales taxes. The 1990 input-output tables still capture federal sales tax revenue in the form of the manufacturers' sales tax at the intermediate level of commodity input use (the Goods and Services Tax (GST) had not yet been enacted). These are summed together and represent what is paid beyond the producers' prices. Other indirect taxes contain property taxes and certain fees and licensing taxes. Government subsidies received by industries have negative values in the input-output accounts, and are treated as company revenues.

The government indirect tax revenues resulting from the site remediation are presented in Table 11 (national) and Table 12 (provincial), classified by industry. At the national level the total is $297,000 with a indirect tax multiplier of 0.13 and at the provincial level it is $189,000 with a 0.08 indirect tax multiplier.

Direct Tax Revenue

The direct taxes resulting from the remediation activity would consist of income taxes. Accurate estimates of individual income tax also depend on tax legislation and salary information. Expenditure details on job classifications and salaries of those being employed by the remediation project had been requested, but could not be acquired. If the salary information was obtained, the tax revenue could be calculated by multiplying the salaries by an actual marginal tax rate. For a more accurate calculation, the tax rate could be varied with the average salary level by industry to reflect the progressive structure of income tax.

Table 7. Estimated Government Direct (Income) Tax Revenue

Total Labour Income (1994$)	Approximate Marginal Tax Rates* (%)	Income Tax Revenue (1994$)
1,516,000	25	379,000
	30	455,000
	35	531,000
	40	606,000

*Approximated from *The National Finances, 1994*, Table 7.14.

The direct (income) taxes are therefore estimated. For the majority of the population, the combined federal and provincial personal income marginal tax rates are between 25% and 45% (salary range of between $10,000 and $50,000). Based on these rates, the direct tax revenues on total labour income of $1,516,000 (1994) are estimated at between $379,000 and $606,500 (1994). Details are in Table 7.

5.1.3 Income and Gross Domestic Product (GDP)

There are three categories of income in the input-output accounts: Labour Income, Net Income of Unincorporated Business, and Other Operating Surplus. Labour Income consists of wages and salaries and supplementary income. All payments to wage earners and salaried employees, including payments-in-kind (example: board and lodging), commissions, bonuses, tips, directors' fees and taxable allowances are accounted for under wages and salaries. These are gross valuations at the time of payment; i.e. before tax deductions for unemployment insurance, pensions, and other social service insurance. These sources of income are captured by the supplementary labour income account, as they are considered payment for employees' labour services, an industry input.

The Net Income of Unincorporated Business includes the following: net earnings of working proprietors, earnings from independent professional practice, accrued net income of farm operators from farm production, net rental income of persons renting residential and non-residential property, and the imputed net rental income from owner-occupants of housing.

Other Operating Surplus includes profits from private sector corporations and government enterprises, before taxes and dividends. Also included in surplus are capital consumption allowances for corporate and unincorporated sectors (i.e.

depreciation), the non-farm inventory valuation adjustment (valuation of inventory withdrawals and additions), and miscellaneous investment income. Capital consumption allowances are included in this category because they are not counted as part of actual production. Other Operating Surplus is significant because it accounts for the residual (surplus) between gross production (GDP) and all of the intermediate and primary inputs used by industry to produce GDP.

The income values reported in the results below are calculated by the summation of Labour Income and Net Income Unincorporated Business. The Value Added (VA) values are the summation of these two and Other Operating Surplus. This form of Value Added measurement refers to GDP at factor cost (GDPFC). If GDP at market prices (GDPMP) is sought, the Indirect Taxes must also be added in the calculation of Value Added. The Value Added presented here is GDPFC.

For the national level impacts income is $1,590,000 (income multiplier = 0.70) and value added is $2,190,000. At the provincial level, income is $740,000 (income multiplier = 0.31) and value added is $1,090,000.

5.1.4 Employment

Employment relates industry output to the number of employment units created by that output. These employment units are not monetary values, otherwise income measures would suffice. They are measured in units of person-years, one person-year representing the equivalent of the full-time employment of one person for one year.

The employment multipliers of this economic impact analysis are in units of person-years per one million dollars of direct expenditures.

The national level employment created by the site remediation is approximately 51 person-years. This results in an employment multiplier of 21.7 person-years per one million dollars. When the Manitoba economy by itself is examined, the provincial level employment created by the site remediation is approximately 28 person-years with a multiplier of 12.0 person-years per one million dollars. The Winnipeg economy by itself produces a city level employment impact of approximately 18 person-years with a multiplier of 7.6 person-years per one million dollars.

Table 8. National Impacts of the Transcona Site Remediation by Industry and Commodity Output (1990 Values ($))

Commodity	Final Demand Impact Direct	Total	Industry	Total
1 Grains	0.00	19,942.19	1 Agricultur	83,382.06
2 Other Agricultural Products	0.00	62,556.60	2 FishgTrap	6,165.78
3 Forestry Products	0.00	37,061.80	3 LogForest	40,443.83
4 Fishing & Trapping Products	0.00	6,082.44	4 Mining	135,543.12
5 Metallic Ores & Concentrates	0.00	38,206.69	5 Manufact	1,529,860.82
6 Minerals Fuels	0.00	71,516.42	6 Construct	708,004.42
7 Non-metallic Minerals	0.00	8,750.09	7 Transport	224,001.07
8 Services Incidental to Mining	0.00	13,742.14	8 Communic	89,672.84
9 Meat, Fish & Dairy Products	0.00	106,201.90	9 OthrUtil	104,083.78
10 Fruit,Veg.,Feed,Misc.Food Prod.	0.00	86,218.29	10 WholeTra	167,195.38
11 Beverages	0.00	27,269.94	11 RtailTra	223,831.52
12 Tobacco & Tobacco Products	0.00	8,896.30	12 FinRealEs	556,400.18
13 Rubber,Leather,Plastic Fab.Prod.	0.00	38,237.79	13 ComBusSer	491,320.03
14 Textile Products	0.00	29,018.63	14 OpOfCaLab	97,803.95
15 Knitted Products & Clothing	0.00	33,523.81	15 TraAdvPro	100,159.48
16 Lumber,Sawmill,Other Wood Prod.	0.00	72,483.49	16 TransMarg	53,597.22
17 Furniture & Fixtures	0.00	24,176.09	17 Household	1,673,519.48
18 Paper & Paper Products	0.00	124,967.26		
19 Printing & Publishing	0.00	63,907.65		
20 Primary Metal Products	0.00	106,103.99		
21 Metal Fabricated Products	**205,948.45**	80,866.49		
22 Machinery and Equipment	**633,123.29**	66,915.10		
23 Autos,Trucks,Other Transp.Eqp	5,010.31	255,405.97		
24 Elec. & Communications Prod.	25,639.56	86,559.46		
25 Non-metallic Mineral Products	0.00	35,170.15		
26 Petroleum & Coal Products	**338,105.10**	103,963.22		
27 Chemicals, Chemical Prod.	36,649.53	115,132.14		
28 Misc. Manufactured Products	21,878.82	35,474.48		
29 Residential Construction	0.00	**252,930.69**		
30 Non-residential Construction	**598,034.07**	**350,232.09**		
31 Repair Construction	64,437.45	101,284.51		
32 Transportation & Storage	71,532.55	219,368.22		
33 Communication Services	4,647.97	86,168.54		
34 Other Utilities	13,819.62	101,207.79		
35 Wholesale Margins	0.00	184,386.75		
36 Retail Margins	0.00	187,202.96		
37 Imputed Rent Owner Ocpd. Dwel.	0.00	202,076.59		
38 Other Finance,Ins.,Real Estate	0.00	**356,815.69**		
39 Business Services	39,070.42	171,207.99		
40 Personal & Other Misc.Service	76,290.99	**388,672.51**		
41 Transportation Margins	0.00	53,597.22		
42 Operating,Office,Lab & Food	10,449.12	97,803.95		
43 Travel, Advertising, Promotion	12,374.30	100,159.48		
44 Labour Income	209,082.82	**1,516,339.19**		
45 Net Income Uninc. Business	0.00	157,180.30		
46 Total	2,366,094.38	6,284,984.97		6,284,984.97

Table 9. Provincial Impacts of the Transcona Site Remediation by Industry and Commodity Output (1990 Values ($))

	Final Demand Impact			
Commodity	Direct	Total	Industry	Total
1 Grains	0.00	11,910.79	1 Agricultur	30,553.43
2 Other Agricultural Products	0.00	17,591.72	2 FishgTrap	584.27
3 Forestry Products	0.00	3,397.92	3 LogForest	3,221.41
4 Fishing & Trapping Products	0.00	582.55	4 Mining	41,397.12
5 Metallic Ores & Concentrates	0.00	8,937.63	5 Manufact	281,973.11
6 Minerals Fuels	0.00	28,391.36	6 Construct	684,862.58
7 Non-metallic Minerals	0.00	4,033.31	7 Transport	108,906.79
8 Services Incidental to Mining	0.00	3,225.88	8 Communic	39,205.62
9 Meat, Fish & Dairy Products	0.00	29,365.66	9 OthrUtil	53,022.52
10 Fruit,Veg.,Feed,Misc.Food Prod.	0.00	26,869.82	10 WholeTra	68,896.49
11 Beverages	0.00	5,747.34	11 RtailTra	118,508.92
12 Tobacco & Tobacco Products	0.00	0.00	12 FinRealEs	289,119.55
13 Rubber,Leather,Plastic Fab.Prod.	0.00	7,974.86	13 ComBusSer	235,804.78
14 Textile Products	0.00	2,252.43	14 OpOfCaLab	48,454.09
15 Knitted Products & Clothing	0.00	12,291.84	15 TraAdvPro	48,029.08
16 Lumber,Sawmill,Other Wood Prod.	0.00	7,917.89	16 TransMarg	10,030.42
17 Furniture & Fixtures	0.00	5,882.87	17 Household	948,733.20
18 Paper & Paper Products	0.00	14,274.85		
19 Printing & Publishing	0.00	15,381.33		
20 Primary Metal Products	0.00	38,004.40		
21 Metal Fabricated Products	**205,948.45**	13,933.91		
22 Machinery and Equipment	**633,123.29**	28,895.84		
23 Autos,Trucks,Other Transp.Eqp	5,010.31	30,248.74		
24 Elec. & Communications Prod.	25,639.56	15,588.67		
25 Non-metallic Mineral Products	0.00	5,855.72		
26 Petroleum & Coal Products	**338,105.10**	414.20		
27 Chemicals, Chemical Prod.	36,649.53	11,535.39		
28 Misc. Manufactured Products	21,878.82	6,313.68		
29 Residential Construction	0.00	**172,409.82**		
30 Non-residential Construction	**598,034.07**	**375,136.92**		
31 Repair Construction	64,437.45	132,284.45		
32 Transportation & Storage	71,532.55	104,893.32		
33 Communication Services	4,647.97	36,649.62		
34 Other Utilities	13,819.62	52,660.36		
35 Wholesale Margins	0.00	66,328.18		
36 Retail Margins	0.00	99,633.93		
37 Imputed Rent Owner Ocpd. Dwel.	0.00	115,660.69		
38 Other Finance,Ins.,Real Estate	0.00	174,685.17		
39 Business Services	39,070.42	53,203.94		
40 Personal & Other Misc.Service	76,290.99	**215,689.61**		
41 Transportation Margins	0.00	10,030.42		
42 Operating,Office,Lab & Food	10,449.12	48,454.09		
43 Travel, Advertising, Promotion	12,374.30	48,029.08		
44 Labour Income	209,082.82	**842,572.63**		
45 Net Income Uninc. Business	0.00	106,160.57		
46 Total	2,366,094.38	3,011,303.39		3,011,303.39

Table 10. City Impacts of the Transcona Site Remediation by Industry and Commodity Output (1990 Values ($)), Employment Impacts

	Commodity	Final Demand Impact Direct ($)	Final Demand Impact Total ($)		Industry	Total ($)	Employment (person-years)
1	Grains	0.00	0.00	1	Agricultur	0.00	0.00
2	Other Agricultural Products	0.00	0.00	2	FishgTrap	0.00	0.00
3	Forestry Products	0.00	158.05	3	LogForest	0.00	0.00
4	Fishing & Trapping Products	0.00	0.00	4	Mining	0.00	0.00
5	Metallic Ores & Concentrates	0.00	906.51	5	Manufact	281,973.11	1.52
6	Minerals Fuels	0.00	0.00	6	Construct	635,652.78	2.66
7	Non-metallic Minerals	0.00	2,398.64	7	Transport	108,906.79	0.87
8	Services Incidental to Mining	0.00	0.00	8	Communic	39,205.62	0.41
9	Meat, Fish & Dairy Products	0.00	29,118.68	9	OthrUtil	53,022.52	0.22
10	Fruit,Veg.,Feed,Misc.Food Prod.	0.00	26,861.22	10	WholeTra	68,896.49	0.61
11	Beverages	0.00	5,747.34	11	RtailTra	118,508.92	2.56
12	Tobacco & Tobacco Products	0.00	0.00	12	FinRealEs	289,119.55	1.27
13	Rubber,Leather,Plastic Fab.Prod.	0.00	7,974.86	13	ComBusSer	235,804.78	5.22
14	Textile Products	0.00	2,252.43	14	OpOfCaLab	48,454.09	1.15
15	Knitted Products & Clothing	0.00	12,291.84	15	TraAdvPro	48,029.08	1.47
16	Lumber,Sawmill,Other Wood Prod.	0.00	7,915.41	16	TransMarg	10,030.42	0.00
17	Furniture & Fixtures	0.00	5,882.87	17	Household	948,733.20	0.00
18	Paper & Paper Products	0.00	14,274.85				
19	Printing & Publishing	0.00	15,381.33				
20	Primary Metal Products	0.00	38,004.40				
21	Metal Fabricated Products	**205,948.45**	13,933.91				
22	Machinery and Equipment	**633,123.29**	28,806.12				
23	Autos,Trucks,Other Transp.Eqp	5,010.31	30,248.74				
24	Elec. & Communications Prod.	25,639.56	15,588.67				
25	Non-metallic Mineral Products	0.00	5,855.72				
26	Petroleum & Coal Products	338,105.10	392.04				
27	Chemicals, Chemical Prod.	36,649.53	10,941.45				
28	Misc. Manufactured Products	21,878.82	6,313.68				
29	Residential Construction	0.00	**160,021.56**				
30	Non-residential Construction	**598,034.07**	**348,182.00**				
31	Repair Construction	64,437.45	122,779.34				
32	Transportation & Storage	71,532.55	104,893.32				
33	Communication Services	4,647.97	36,649.62				
34	Other Utilities	13,819.62	52,660.36				
35	Wholesale Margins	0.00	66,326.65				
36	Retail Margins	0.00	99,633.93				
37	Imputed Rent Owner Ocpd. Dwel.	0.00	115,660.69				
38	Other Finance,Ins.,Real Estate	0.00	174,391.87				
39	Business Services	39,070.42	53,203.45				
40	Personal & Other Misc.Service	76,290.99	**215,439.00**				
41	Transportation Margins	0.00	10,030.42				
42	Operating,Office,Lab & Food	10,449.12	48,454.09				
43	Travel, Advertising, Promotion	12,374.30	48,029.08				
44	Labour Income	209,082.82	**842,572.63**				
45	Net Income Uninc. Business	0.00	106,160.57				
46	Total	2,366,094.38	2,886,337.35			2,886,337.35	17.97

Table 11. National Total Income, Value Added (GDPFC), Net Indirect Taxes and Employment Impacts

Industry	Income ($)	Value Added ($)	Net Indirect Taxes ($)	Employment (person-years)
1 Agricultur	20,319.34	38,661.31	-3,938.25	1.44
2 FishgTrap	2,771.17	3,657.26	85.87	0.14
3 LogForest	12,807.66	16,504.40	1,248.26	0.29
4 Mining	24,696.62	71,535.69	4,919.80	0.60
5 Manufact	336,972.23	514,612.63	18,341.96	9.69
6 Construct	243,639.35	289,403.23	50,571.49	5.48
7 Transport	79,658.43	111,977.51	4,678.40	2.46
8 Communic	35,749.97	65,399.00	-90.38	1.19
9 OthrUtil	21,007.16	74,705.53	4,329.29	0.57
10 WholeTra	85,199.93	112,007.94	5,325.74	2.06
11 RtailTra	118,975.04	144,619.77	8,317.35	6.62
12 FinRealEs	153,402.03	354,492.61	63,428.32	2.83
13 ComBusSer	267,976.93	329,081.55	9,873.12	11.44
14 OpOfCaLab	0.00	0.00	0.00	2.92
15 TraAdvPro	0.00	0.00	0.00	3.65
16 TransMarg	0.00	0.00	0.00	0.00
17 Household	191,353.03	65,858.98	130,092.23	0.00
18 Total	1,594,528.89	2,192,517.42	297,183.20	51.36

Table 12. Provincial Total Income, Value Added (GDPFC), Net Indirect Taxes and Employment Impacts

Industry	Income ($)	Value Added ($)	Net Indirect Taxes ($)	Employment (person-years)
1 Agricultur	5,781.27	12,657.69	-1,178.09	0.53
2 FishgTrap	322.10	375.95	22.67	0.03
3 LogForest	701.74	1,314.20	116.65	0.04
4 Mining	9,074.23	28,668.51	1,207.82	0.22
5 Manufact	63,091.75	103,547.66	3,182.75	2.05
6 Construct	247,622.99	305,201.26	45,292.94	5.07
7 Transport	39,441.72	58,106.42	2,096.89	1.23
8 Communic	16,091.53	28,332.96	-192.54	0.58
9 OthrUtil	11,769.34	39,612.62	3,186.02	0.31
10 WholeTra	32,944.84	43,183.64	2,244.88	0.93
11 RtailTra	59,334.58	73,625.46	5,453.93	3.93
12 FinRealEs	74,818.23	189,948.43	34,219.93	1.67
13 ComBusSer	130,431.12	156,129.98	8,392.36	7.88
14 OpOfCaLab	0.00	0.00	3,585.66	1.74
15 TraAdvPro	0.00	0.00	3,562.18	2.22
16 TransMarg	0.00	0.00	0.00	0.00
17 Household	48,224.94	51,376.55	77,499.80	0.00
18 Total	739,650.37	1,092,081.31	188,693.85	28.44

6.0 Conclusions

This study has identified and quantified the economic impacts of the Transcona contaminated site remediation project. Although the remediation project was cancelled before its completion, sufficient expenditure information was obtained to determine the economic impacts of the remediation based on actual expenditures of the activity that did occur and estimates of projected expenditures. The input-output models created for the analysis were able to determine the impacts resulting from the projected expenditures provided and the actual expenditures of the remediation system setup and test activity.

The activities of the site remediation impacted the economy in several ways: demand for commodities and industry output increased, government indirect tax revenue was generated, labour income resulted from employment creation, and GDP was increased.

The remediation project expenditures (actual and projected expenditures) at the Transcona site totalled $2,370,000 (1990$). These were the initial direct costs of the cleanup. As these direct impacts worked through the economy, the multiplier effect produced indirect and induced impacts. The resultant total impacts are greater than the initial direct impacts. For example, at the national level the total industry output was $6,280,000 (1990$) and at the provincial level it was $3,010,000 (1990$). The results of this study show that the economic activity of the Transcona site remediation would have substantial impacts on the national, provincial and local economies. The cleanup would have economic implications for all those involved: the suppliers of commodities, the providers of industrial services, the employees, and the governments at the three levels. The models and results of the economic impact analysis develop an understanding of the economic interdependencies, and this helps to more fully comprehend the impacts.

6.1 Alternative Economic Analysis: Economic Benefits

The economic impact analysis focusses on the economic activity resulting from the site remediation. The activity has been specified in terms of increased industry production (industry and commodity output), transferred spending power (tax revenue), and increased consumption (more household income). These impacts lend themselves to measurement through input-output analysis because of their easily determined market values (i.e., dollar amounts). The impacts are measured in the form of increased industry output, government indirect tax revenue, income/GDP, and employment. This has answered the questions of what are the economic impacts.

There is an additional set of questions that needs to be answered - what are the benefits arising from the remediation and how can they be measured? Economic impacts are not necessarily benefits in the welfare economic sense. Welfare economic benefits measure the overall gains (market and non-market) that result or could result from the site remediation. "Benefits are the gain associated with the environmental improvement" (Freeman III, 1993, p.8). They include a range of non-monetary non-market benefits and are not so easily quantifiable as the economic impacts. Nonetheless, they are still relevant and substantial, and cannot be overlooked. These benefits can be the reduced risk of negative health effects, improved property values, and/or just "peace of mind" knowing the contamination has been reduced or removed. Although the quantification of these benefits is beyond the scope of this study, this section presents a brief introduction to the methodologies for determining the market and non-market benefits of environmental improvement. The measurement of these benefits is discussed in greater detail in Appendix F. The focus is limited to those methods that are applicable to contaminated site remediation.

Site Remediation Economic Benefits: Valuation Methodologies Overview

The goal of attempting to measure the market and non-market benefits of the site remediation is to determine the monetary valuation of the environmental improvement. There is always debate on the whole concept of placing a "value" on the environment. However, because money is a common measuring rod for people's preferences, it serves as the best way to represent the value of any benefits accrued. It is assumed that what people prefer is considered a benefit, and that the willingness to pay (WTP) for the benefit or the willingness to accept (WTA) compensation in order to *forego* the benefit allows a monetary valuation. Appendix F elaborates on WTP and WTA measures.

One approach to measurement is to develop a model which directly reveals the individuals' WTP/WTA for the environmental change by making the environmental attribute (or commodity) one of the determining variables. One valuation methodology is based on a surrogate market; i.e., a commodity market which is influenced by the non-marketed environmental commodity. The value of the environmental commodity is inferred from how it affects values in the surrogate market. In the case of site remediation, this approach would employ the *hedonic property value method*. This method makes a direct link between the environmental change (commodity) and its value.

The hedonic property value approach is based on the principle that the value of a property is determined by the attributes that make up that property: size, location, agricultural output, shelter, etc. This list can also contain environmental quality, or the proximity of the property to an area of environmental degradation. All of these characteristics help make up the value of a property, and the hedonic approach is used to identify how much of a property value differential is due to a difference in environmental quality between properties. An increase in the property value would reflect the reservoir of accumulated benefits, or the present value, of expected future uses of the improved (remediated) land and the resultant reduced negative health effects. It also attempts to determine how much individuals are willing to pay for an improvement in environmental quality and what the value of this is in terms of social benefit.

Another valuation methodology is based on a contingent (hypothetical) market created by asking individuals directly what their WTP and/or WTA values are for the change in human health. A value would be elicited for a reduction in the risk of morbidity, or even a reduction in the mortality risk. This employs the *contingent valuation method*. The values revealed would be contingent upon the created market.

The contingent valuation method (CVM) seeks to determine what individuals are willing to pay for a benefit and/or willing to accept through compensation to put up with a cost. In the case of a contaminated site being remediated, the benefits would be the improved environment and the resulting reduction in associated environmental and health risks. If the contaminated site was not remediated, the costs would be the lack of environmental improvement and the associated environmental and health risks that remain.

The CVM directly asks individuals what they are willing to pay or accept for an increase or decrease in the quantity of a commodity (environmental improvement or lack of), *contingent* upon a hypothetical market. The reason for this direct approach is to simulate as closely as possible one of the key attributes of an actual market - the ability to determine exactly what an individual's WTP and/or WTA values are. In this context, the "contingent market" of the commodity is presented with its institutional framework as well as the type of financing vehicle (method of payment) to be used.

One important issue raised with these alternative valuation methods is the requirement of perfect markets in which to function. For example, an empirical test comparing market values of residential properties adjacent to the contaminated site with the market values of similar properties several blocks away would reveal any discounts "enjoyed" by those who are closest to the site. This example emphasizes the basic assumption of perfect markets underlying these methods discussed. Both methods are explained in greater detail in Appendix F and their potential for application to remediation of contaminated sites evaluated.

6.2 Implications

Site remediation has become a multi-billion dollar environmental problem throughout the industrialized world. Contaminated sites can be both a financial problem for corporations and a difficult challenge for government. The determination of the economic impacts arising from a site remediation can help to convert contaminated site cleanup from a problem into an opportunity and stimulus for economic and environmental improvement, and provide economic benefits beyond the economic impacts of site remediation. Site remediation could also encourage the development of new or improved environmental technologies and contribute to strengthening the international competitiveness of Canadian companies in the relatively new environmental industry.

Site remediation is traditionally viewed almost entirely as a cost. Expenditures on site remediation, however, do generate employment, economic activity and income in other sectors. The economic activity and resulting additional tax revenues can, at least partially, offset the costs of site remediation. This may encourage government and the private sector to invest in site cleanups as the cost could be viewed not as a unproductive corporate expenditure but as a positive expenditure of resources that generates a positive return.

The ability of the models to provide economic impacts, especially estimates of tax revenues and employment for separate political jurisdictions, can have important implications if negotiating of financial support for the site remediation occurs. For example, the results can help determine cost sharing between government levels and the corporation owning the site and undertaking remediation.

Site remediation also results in improved environmental quality, reduced environmental risk, and increased land values. Benefits can accrue from the environmental improvement resulting from site remediation. Remediating the site to the point where it can safely be subject to development can increase the property value levels to that of the surrounding property. Adjacent and surrounding property values can also increase due to the reduction in human health risks. These are just two examples. The implications of revealing these benefits can be very strong because of the increasingly active involvement of concerned local residents and environmental groups in dealing with contaminated sites.

The economic impact analysis of the Transcona site is transferable. The methodologies and models developed are not site specific; they can be applied elsewhere to other contaminated sites in the same or other jurisdictions. The Statistics Canada input-output tables of another province can be used for a site in that other province, and new multipliers can be derived for the province. The impact analysis application to other sites can aid in the development of a standardized model or strategy in dealing with contaminated sites. This could be useful for those corporations responsible for such sites and for governments mandating site remediation.

A final implication deals with the cancellation of the remediation. While the remediation methodology and activity on which this study is based has been cancelled, Manitoba Environment still has an outstanding order for Domtar to remediate the site.

The site will be cleaned up by other methods that will likely involve very similar economic impacts. What is now brought into the analysis is a temporal dimension through the delay of the cleanup. The immediate avoidance of remediation could result in the contaminant levels being reduced through natural processes (example natural reclamation), which could reduce the cost of the cleanup in the future. This would financially cost Domtar less, in present discounted terms. Alternatively, the delay could cause local residents to more highly value the removal or reduction of the contamination because of their *perceived* longer exposure, regardless of whether or not the contaminant levels were dropping. In this case, Domtar's costs could end up being greater because there may be a stronger demand for a more thorough remediation. This has already been suggested by Manitoba Environment in its response to the cancellation. A temporal model could be developed that estimates the costs and impacts of a selected remediation methodology at different points in time, but it would be difficult to forecast the costs and impacts of the remediation if the remediation methodology is subject to change. Domtar's selection of remediation methodology cannot be speculated on.

Appendix A - Case Study Site Background

A.1 Site Environmental Assessment History

The site environmental monitoring, analysis and risk assessment was performed by MacPlan Environmental Services Limited (MacPlan) in association with MacLaren Plansearch (MacLaren). Much of the information on the site background was obtained from their environmental report on the Transcona site, titled *Transcona Site Environmental Risk Assessment*, June 1993. The report by MacPlan and MacLaren details how the site was tested for contamination, their findings, and the remediation methods suggested.

The initial examination by MacLaren included soil samples from test holes drilled onsite. Samples of surface water were also taken from an old evaporation pond found onsite. The soil and water samples were analyzed for creosote, PCPs, dioxins, and other related chemicals to determine remediation requirements. The "hot-spots" that were identified (refer to Figure 1 in Chapter 2) include the original wood treatment plant location (in Area A), the old evaporation pond (in Area B), and the stormwater pond (in Area C).

MacLaren then submitted a remediation plan based on these findings. The plan recommended the immediate removal of all buildings and tanks (and their contents), the closure of the four water wells discovered onsite, and the capping and sealing of the most contaminated areas with clean clay. To keep the contaminants undisturbed, the plan suggested rezoning these capped areas to park/recreational use. The Province of Manitoba accepted the remediation plan in January, 1978.

Imperial Developments did not proceed with their development plans. Instead, in 1981 concern was raised by Domtar regarding the extent of the original site environmental study, the possible presence of other contaminants, including methane gas (from onsite wood chips) and PCP (pentachlorophenol) leachate generation, and future potential costs of the contaminated site such as restoration, maintenance, and security. As a result, Domtar had another site assessment completed by MacLaren. This assessment confirmed that the areas of contamination described in the initial assessment were still accurate. More extensive tests for dioxins were also performed, as well as a test to determine if the generation of methane gas was a concern. Results of these tests declared that dioxin levels present were acceptable and that the probability of methane gas generation was minimal because the required oxygen contact was not present with the contaminated wood. Laboratory studies indicated that PCP leaching through soil was dependent on the clay content of the soil. As soil samples at the Transcona site had a high clay content, it was concluded that PCP leachate generation would be low.

A revised remediation plan was submitted by Domtar to the Province in December, 1983 which called for blending the uncontaminated wood chips into uncontaminated soils. An advanced containment system was designed for the contaminated soil and contaminated chips with a venting system and leachate control facilities.

A separate reclamation study done by Domtar in 1983 also found that natural reclamation of the site was occurring. Aerial photographs indicated a vegetation regrowth and surface pond water shrinkage of approximately 40% and 50% respectively in area, over an eleven year period. The pond was originally constructed to utilize natural evaporation in eliminating the contaminated water resulting from the treatment process; its shrinkage represented the reduction of contaminated water onsite.

The Province of Manitoba Clean Environment Commission approved the revised remediation plan in 1984, but only general cleanup procedures were started. The clay capping of the most contaminated areas did not occur because there were no immediate development plans. As new remediation technologies became available, the capping proposal was dropped as the solution for dealing with the contaminated soil (the remediation technology employed is discussed in Chapter 2). Remediation activity was increased in 1988 (other than the capping) including the first groundwater testing in 1989.

A surface water treatment plant was constructed onsite and began operation in November of 1992. Its initial purpose was to treat the existing contaminated water and then treat any further water that collects onsite until the remediation of the site has been completed.

A.2 Contamination Characteristics

The environmental assessments performed by MacPlan and MacLaren (up to June 1993) include an extensive characterization of the contamination present at the Transcona site. First, the types of media contamination and their possible effects are identified. This includes soil, surface water, groundwater, subsurface water, and air contamination. Second, the types of contaminants found onsite are discussed. The results are based on monitoring data collected throughout the site.

The Transcona site contamination accrues through the following five site physical conditions: 1.) soil contamination, which could have adverse effects on humans, animals, and plants coming into contact with it, and which could lead to the further occurrence of the remaining four physical media conditions discussed next; 2.) surface water contamination, which may also have adverse effects on humans, animals, and plants, and possibly lead to the contaminating of clean soil through runoff; 3.) subsurface water contamination, which could effect humans, animals, and plants by eventually flowing into the groundwater; 4.) ground-water contamination, which may adversely affect humans, animals, and plants if it ends up being a source of drinking water and/or irrigation water; and 5.) air contamination, which through contact with humans, animals, and plants could cause adverse effects, as well as contaminate clean soil and surface water through airborne migration of the contaminants.

The contaminants found onsite resulted from the wood treatment process. The first wood preserving chemical used was creosote. Creosote-treated wood is black, oily, and difficult to handle in terms of cleanliness. Creosote was used as the primary preservative for railway ties and heavy timbers until the plant was closed, but in 1952 the preserving chemical pentachlorophenol (PCP) was introduced for the treatment of utility poles. This occurred because of an increase in market demand for a "cleaner" treated wood in terms of handling.

Creosote is derived through a distillation process from bituminous coal. The main components of creosote are polyaromatic hydrocarbons (PAHs), tar acids and tar bases. The PAHS include fluorene, phenanthrene, flouranthene, pyrene and acenaphthene. The tar acids include phenols, cresols, xylenols and naphthols and the tar bases include pyridines, quinolines and acridines.

Pentachlorophenol (PCP) is synthesized from phenol and chlorine. The predominant chemicals added to PCP used for wood preservation are tetrachlorophenol (TCP), and groups of dioxins (eg. heptachlorodibenzo-p-dioxin, octachlordibenzo-p-dioxin) and furans (eg. heptachlorodibenzofuran, octachlorodibenzofuran).

These lists of chemicals demonstrate the range and complexities of the contaminants found at the Transcona site.

Soil sampling since 1976 has found the highest concentrations of contaminated soil to be in the area where the plant operations occurred (area A). This area is approximately 2.2 hectares in size. The next substantial area of high soil contamination is the old evaporation pond location, approximately 3.6 hectares in size (Area B). Analysis has found oils, phenols, PCPs, TCPs and PAHs in these areas. The main ingredient of creosote is PAHs.

The combination of poor site drainage and an underlying layer of relatively impermeable clay facilitates the collection of surface water on the site and its subsequent contamination by contact with the contaminated soil. The surface water was found to be contaminated with oils, phenols, PCPs, TCPs and PAHs. The combination also hinders the surface water from soaking into the ground, which has helped to minimize the groundwater and subsurface water contamination. A water treatment system began operating in November, 1992 and is used to treat any surface water that collects onsite.

Groundwater samples have been taken since 1986 at eight wells onsite and six wells outside of the Transcona site. The water levels in the aquifer are approximately 12 to 15 meters below the ground surface of the site location. Testing for the same contaminants found in the soil indicated insignificant concentration levels in the groundwater. As of the final draft of the MacPlan and MacLaren report, groundwater remediation was said to be unnecessary. Similar results were found with the subsurface water as well. Contaminants in this water were tested for using piezometer nests.

Air contamination monitoring was carried out from May to October of 1992 by MacPlan and MacLaren. This procedure required the setup and use of an onsite meteorological station to monitor weather conditions during air sampling. This remediation analysis is used to check for atmospheric migration of contaminants. The contaminants detected were PCPs and PAHs. Insignificant amounts were measured except when the preliminary excavation of contaminated soil occurred. At this time an increase in airborne PAHs was measured. Part of this increase was attributed to the presence of diesel exhaust (from the machinery onsite) and smoke from nearby farm stubble being burned during the air sampling period.

A.3 CCME Criteria Specifications

The objective of the site remediation is to reduce the presence of the identified contaminants to acceptable levels. These levels are based on the Canadian Council of Ministers of the Environment (CCME) criteria. This criteria lists the minimum acceptable amounts of contaminants allowable for agricultural, residential/parkland, and commercial/ industrial land utilization. The measurement is in micrograms of contaminant per dry gram of soil (μg/g). The minimum levels for residential/parkland use is 0.5 μg/g for PCPs and TCPs and 1 μg/g for PAHs. For commercial/industrial use they are 5 μg/g for PCPs and TCPs and 10 μg/g for PAHs. PCPs, tetrachlorophenols (TCPs), and polycyclic aromatic hydrocarbons (PAHs) are the main contaminants of concern at the Transcona site. They have been found in the soil at levels higher than those specified by the CCME criteria.

Appendix B - Mathematical Foundations of the Model

B.1 Mathematical Structure of Input-Output Model

The input-output model is represented by a set of linear equations in which each equation equates total supply of an output to its summation of demands, both for intermediate input use and final demand. Let x_i be the total supply of the output of industry$_i$ and $a_{ij}x_i$ be the input demand from industry$_j$ to produce its output: x_j. The coefficient a_{ij} is the amount of output of industry$_i$ used as inputs by industry$_j$ to produce one dollar's worth of x_j. Each column of $a_{ij}x_i$ terms would therefore represent the input requirements of each x_i needed by industry$_j$ to produce one dollar's worth of x_j. Then the equations

$$\begin{aligned}
x_1 &= a_{11}x_1 + a_{12}x_2 + a_{13}x_3 + \ldots + a_{1i}x_i + \ldots + a_{1n}x_n + d_1 \\
x_2 &= a_{21}x_1 + a_{22}x_2 + a_{23}x_3 + \ldots + a_{2i}x_i + \ldots + a_{2n}x_n + d_2 \\
&\vdots \\
x_i &= a_{i1}x_1 + a_{i2}x_2 + a_{i3}x_3 + \ldots + a_{ii}x_i + \ldots + a_{in}x_n + d_i \\
&\vdots \\
x_n &= a_{n1}x_1 + a_{n2}x_2 + a_{n3}x_3 + \ldots + a_{ni}x_i + \ldots + a_{nn}x_n + d_n
\end{aligned} \tag{B.1}$$

represent the input and output requirements throughout the economy, with d_i being the final demand for commodity x_i. The a_{ij} coefficients are referred to as input coefficients because they define the amount of industry$_i$ input by industry$_j$ for its production.

The procedure for solving this system of equations depends on what variables are known and which are unknown. The goal of input-output analysis in the context of the site remediation case study is to determine what effect the expenditures have on the economy. In the context of the terminology developed so far, the expenditures, which are known, will fall under the final demand categories. The unknown will be the impact of this new final demand (remediation expenditures) on the output of the industries, x_i (those industries which are directly and indirectly affected by the expenditures). To solve for these, like terms are grouped together to one side of the equation system:

$$
\begin{array}{l}
(1 - a_{11})\, x_1 - a_{12}\, x_2 - a_{13} x_3 - \ldots - a_{1i}\, x_i - \ldots - a_{1n}\, x_n = d_1 \\
- a_{21}\, x_1 + (1 - a_{22})\, x_2 - a_{23} x_3 - \ldots - a_{2i}\, x_i - \ldots - a_{2n}\, x_n = d_2 \\
\vdots \\
- a_{i1}\, x_1 - a_{i2}\, x_2 - a_{i3}\, x_3 - \ldots + (1 - a_{ii})\, x_i - \ldots - a_{in}\, x_n = d_i \\
\vdots \\
- a_{n1}\, x_1 - a_{n2}\, x_2 - a_{n3}\, x_3 - \ldots - a_{ni}\, x_i - \ldots + (1 - a_{nn})\, x_n = d_n
\end{array}
\qquad \textbf{(B.2)}
$$

Using matrix notation, an input coefficient matrix is created from the input coefficients. Let A be the n x n input coefficients matrix of the a_{ij} input coefficients. To represent the negativity of the a_{ij} coefficients and the uniqueness of the principal diagonal coefficients, A is subtracted from an n x n identity matrix I (1s down the principal diagonal, zeros in every other place) and $(I - A)$ becomes the technology matrix. If X is the x_i column vector and D is the d_i column vector, then the complete system of linear equations above is:

$$(\boldsymbol{I} - A)\, \boldsymbol{X} = \boldsymbol{D}. \qquad \textbf{(B.3)}$$

To solve for X, the $(\boldsymbol{I} - A)$ technology matrix is inverted (it is assumed to be nonsingular) and the unique solution is found:

$$\boldsymbol{X} = (\boldsymbol{I} - A)^{-1}\, \boldsymbol{D}. \qquad \textbf{(B.4)}$$

The $(\boldsymbol{I} - A)^{-1}$ matrix is called the inverse or impact matrix. Its coefficients e_{ij} show the impact of the final demand values on the industry output values.

B.2 Closing of the Input-Output Model

The mathematical model and its notation will be modified to incorporate the new household industry. Since the household sector was removed from the final demand categories, $\boldsymbol{D}^*$ will now represent final demand. The $\boldsymbol{n}$ x $\boldsymbol{n}$ input coefficient matrix A is expanded to the dimensions $(\boldsymbol{n} + 1)$ x $(\boldsymbol{n} + 1)$ becoming A^*, and the modified industry output column vector $\boldsymbol{X}$ (with the new industry x_{n+1} added) is X^*. The original linear equation system is now:

$$x_1 = a_{11}x_1 + a_{12}x_2 + a_{13}x_3 + \ldots + a_{1i}x_i + \ldots + a_{1n}x_n + a_{1,n+1}x_{n+1} + d^*_1$$
$$x_2 = a_{21}x_1 + a_{22}x_2 + a_{23}x_3 + \ldots + a_{2i}x_i + \ldots + a_{2n}x_n + a_{2,n+1}x_{n+1} + d^*_2$$

•

•

•

$$x_i = a_{i1}x_1 + a_{i2}x_2 + a_{i3}\,x_3 + \ldots + a_{ii}x_i + \ldots + a_{in}x_n + a_{i,n+1}x_{n+1} + d^*_i$$

•

•

•

$$\vdots$$

$$\begin{aligned} x_n &= a_{n1}x_1 + a_{n2}x_2 + a_{n3}x_3 + \ldots + a_{ni}x_i + \ldots + a_{nn}x_n + a_{n,n+1}x_{n+1} + d^*_n \\ x_{n+1} &= a_{n+1,1}x_1 + a_{n+1,2}x_2 + a_{n+1,3}x_3 + \ldots + a_{n+1,i}x_i + \ldots + a_{nn}x_n + a_{n+1,n+1}x_{n+1} \\ &\quad + d^*_{n+1} \end{aligned} \tag{B.5}$$

and after manipulating to group like terms and expressing in matrix form the system is:

$$(\boldsymbol{I} - \boldsymbol{A^*})\,\boldsymbol{X^*} = \boldsymbol{D^*} \tag{B.6}$$

with the solution being:

$$\boldsymbol{X^*} = (\boldsymbol{I} - \boldsymbol{A^*})^{-1}\,\boldsymbol{D^*}. \tag{B.7}$$

The $(\boldsymbol{I} - \boldsymbol{A^*})^{-1}$ matrix is the closed model impact matrix and its coefficients are denoted e^*_{ij}.

B.3 Mathematical Derivation of the Multipliers

Output Multipliers

An industry's output multiplier is the total value of production necessary to produce one dollar of it's output. In terms of the defined effects, the simple version of this multiplier is the ratio of the direct and indirect output values to the direct output value. If households are endogenized, the induced output values would be added to the numerator of this ratio, creating a total multiplier version (Type II). To make it clear that the industry outputs are being examined and that there is a different value for each industry, this multiplier can also be called an industry output multiplier.

An industry output multiplier is derived from the impact matrix. The coefficients of this matrix represent the impact of the final demand values on the industry output values. To convert this into a multiplier measurement, the impact of the final demand on each supplying industry involved needs to be captured. This includes the direct effects on the output industry that produces the final demand commodity, and the indirect effects on the output industries that supply the initial industry. A summation of the impact matrix column coefficients (e_{ij}) for the output industry$_j$ fulfilling the initial demand will produce a scalar representing this simple (Type I) multiplier value:

$$O_j = \sum_{i=1}^{n} e_{ij} \qquad \textbf{(B.8)}$$

The same procedure with the closed model impact matrix will produce the total industry output multiplier (Type II) for each industry$_j$.

Income Multipliers

There are two basic types of income multipliers, based on whether the model is open or closed. They both attempt to determine the change in labour income resulting from a change in final demand. Each output industry will have its own set of income multipliers which are derived from the input-output model's income information.

A Type I income multiplier is the ratio of the direct and indirect income effects (changes) to the direct change in income resulting from a change in final demand. It is the income change per dollars' worth of any particular industry's output in an open model. The calculation builds on the industry output multiplier by multiplying each impact matrix column coefficient e_{ij} by the corresponding output industry's (including the output industry that produces the final demand commodity) household row coefficient from the input coefficients matrix (A), and then dividing by the household row coefficient of the output industry directly affected. Summing this for all the output industries produces the Type I income multiplier for each industry$_j$:

$$I_j = \sum_{i=1}^{n} \frac{a_{n+1,i}\, e_{ij}}{a_{n+1,j}} \qquad \textbf{(B.9)}$$

If the input-output model is closed, the coefficients of the closed model impact matrix are substituted for the e_{ij} values; the rest of the equation remains the same. This is used to calculate Type II income multipliers for each industry$_j$.

Employment Multipliers

In the context of the input-output methodology, employment per dollars' worth of an industry's output can be represented by a coefficient; this employment coefficient can be substituted for the household row coefficient in the Type I and Type II income multipliers. The following equation shows the equation for the industry$_j$ Type II employment multiplier:

$$L_j = \sum_{i=1}^{n} \frac{l_{n+1,i}\, e^*_{ij}}{l_{n+1,j}} \qquad \textbf{(B.10)}$$

To calculate the Type I employment multipliers, the open model impact matrix coefficients are used.

Appendix C - Nonsurvey Methodology Background

C.1 Outline of Prominent Nonsurvey Techniques

C.1.1 Location Quotient Techniques

Simple Location Technique

The Simple Location Quotient (SLQ) technique creates a simple quotient (ratio) which measures an industry's ability to supply the intermediate and final demand for its commodity output. The industry and the demand are within the same specific location (region). The SLQ approach involves creating a location quotient (LQ) for each category of output in the region comparing the regional industry production quantities to the larger base economy. If x_i^R is the regional output of x_i, x_i^B is the base economy output of x_i, and the total regional and base economy outputs are X^R and X^B respectively, then the location quotient is

$$LQ_i^R = \left[\frac{\frac{x_i^R}{X^R}}{\frac{x_i^B}{X^B}} \right] \tag{C.1}$$

for output x_i. The regional values in the numerator are the ratio of x_i^R to its total X^R, and similarly with the base economy values in the denominator. The advantage of this "relative size" comparison is that even though input-output table data at the regional level is not available, other economic indicators or measurements of the region by output category can be used in the SLQ approach to estimate the LQ values.

The LQ values for each x_i output are used to calculate the regional input coefficients from the base economy input coefficients. Recalling that the input coefficients matrix A consists of input coefficients a_{ij}, a regional input coefficients matrix A^R can be derived from the LQ values and the base economy matrix A^B. An LQ_i^R value that is less than one would indicate that the region is not self-sufficient in the production of output x_i and therefore its input coefficient is calculated from multiplying the corresponding base economy coefficient by the LQ_i^R value. If the LQ_i^R value is greater than or equal to one, it is assumed that the regional production can supply the demands of the region and export any excess supply to the base economy. In this case, the base economy coefficient can be used for the corresponding regional coefficient value. The A^R coefficient calculations are:

$$\begin{aligned} &\text{If } LQ_i^R < 1 \qquad a_{ij}^R = LQ_i^R \cdot a_{ij}^B \\ &\text{If } LQ_i^R \geq 1 \qquad a_{ij}^R = a_{ij}^B \end{aligned} \qquad \text{(C.2)}$$

Once A^R is determined, a regional technology matrix $(I - A^R)$ and its inverse $(I - A^R)^{-1}$, or impact matrix, is derived.

Purchases-Only Location Technique

The Purchases-Only Location Quotient (PLQ) technique compares the ability of a region to supply its industry inputs with that of the base economy, but only with certain industries. The PLQ for industry$_i$ represents a ratio of only those industries that use industry_i as an input; i.e., only those industries that purchase industry_i output. The rationale for only being concerned with the purchases-only industries is that if an industry_j does not use industry_i as an input, then the value of its output is not critical in determining the ability of the region to supply all of the demand for industry_i's output. In this case, only those industries' outputs which use industry_i as an input are totalled in calculating the location quotients. The calculation of the PLQ values are identical to the SLQ calculations, except for these different totals, indicated by an asterisk (*):

$$PLQ_i^R = \left[\frac{\dfrac{x_i^R}{X^{*R}}}{\dfrac{x_i^B}{X^{*B}}} \right] \tag{C.3}$$

The PLQ values are then used to adjust the base economy coefficients in the same manner described with the SLQ technique.

Cross-Industry Quotient

A third location quotient technique is the Cross-Industry Quotient (CIQ). This method is unique in that it allows individual cell modifications of the base economy input coefficients matrix A^B, as opposed to the whole row modifications of the previous location quotient techniques. The focus of the CIQ technique is on both the output of industry_i and the input of industry_j. By examining both the selling and purchasing industries at the regional and base economy level and comparing them, a conclusion can be made on whether or not the regional selling industry can fully supply the regional purchasing industry. If the regional selling industry$_i$ output relative to the base economy selling industry$_i$ output is greater than that of the regional purchasing industry$_j$ output relative to the base economy purchasing industry$_j$ output, it is assumed that the regional industry$_i$ can supply all of industry$_j$'s demand for industry$_i$'s output. If this comparison produces the opposite result in which the regional industry$_i$ output is relatively less than that of regional industry$_j$, then it is assumed that some of industry$_j$'s demand will have to be supplied from outside the region. These CIQ values are calculated and then compared to determine the regional coefficients as shown:

$$CIQ_{ij}^{R} = \left[\frac{\dfrac{x_i^R}{x_i^B}}{\dfrac{x_j^R}{x_j^B}} \right] \qquad \textbf{(C.4)}$$

$$\begin{array}{ll} If\ CIQ_i^R < 1 & a_{ij}^R = CIQ_i^R \cdot a_{ij}^B \\ If\ CIQ_i^R \geq 1 & a_{ij}^R = a_{ij}^B \end{array} \qquad \textbf{(C.5)}$$

C.1.2 Supply-Demand Pool Technique

The Supply-Demand Pool (SDP) technique estimates regional coefficients using known values of regional industry output and the base economy coefficients. The base economy coefficients, a_{ij}^B, are considered the first estimation of the regional coefficients. They are then multiplied by the regional industry output values (x_i^R) to determine the total inputs required from other industries to support each regional industry's output. This must also include the final demand sector; the base economy final demand coefficients, c_{if}^{B} , are multiplied by the regional final demand values (y_i^R) to determine the regional share of final demand. These total input and final demand values are summed to estimate the total regional output requirements for industry$_i$:

$$\bar{x}^R_i = \sum_j a^B_{ij}\, x^R_j + \sum_f c^B_{if}\, y_f \tag{C.6}$$

A commodity balance for each industry$_i$ is then calculated by subtracting these estimated regional industry outputs from the known regional industry outputs:

$$b_i = x^R_i - \bar{x}^R_i \tag{C.7}$$

If the balance is greater than or equal to zero, the base economy coefficients are used to represent the regional industry output and final demand sectors because using the base economy coefficients does not overestimate these regional values. If $\boldsymbol{b_i}$ is less than zero, the base economy coefficients overestimate the regional output values and therefore must be adjusted accordingly:

$$\textit{If } b_i \geq 0 \qquad \begin{aligned} a^R_{ij} &= a^B_{ij} \\ c^R_{if} &= c^B_{if} \end{aligned} \tag{C.8}$$

$$\textit{If } b_i < 0 \qquad a_{ij}^R = a_{ij}^B \cdot \left(\frac{x_i^R}{\overline{x}_i^R} \right)$$

$$c_{if}^R = c_{if}^B \cdot \left(\frac{x_i^R}{\overline{x}_i^R} \right) \qquad \textbf{(C.9)}$$

The adjustment effectively reduces the base economy coefficients by the exact amount to make the regional balance for that particular industry equal to zero.

C.2 Empirical Studies Supporting the Selection of the SLQ Technique

Schaffer and Chu (1969) examine the nonsurvey approaches as an alternative to what they observe as expensive and time-consuming direct-survey methods for constructing regional input-output models: "frequently out of date when published" and data analysts not able to "pay for the cost of continuous updating". They use a survey-based national input-output table and estimate a regional input-output table using nonsurvey techniques which include those discussed above: the simple location quotient, the purchases-only location quotient, the cross-industry quotient, and the supply-demand pool technique. More complex nonsurvey techniques were ignored "which would involve exercised judgment, detailed examination of cell values, and extensive data collection". The estimation results are then compared with a survey-based input-output table of the region in question. The national table is of the United States and the region is Washington State. The estimated nonsurvey regional coefficients were compared with the survey-based regional coefficients using chi-square tests. Chi-square values were calculated for each column in the estimated tables. The survey-based income multipliers were also compared with the nonsurvey income multipliers. The results of the chi-square tests and the multiplier comparisons indicated that the simple location quotient (SLQ) technique was the most successful overall (Schaffer and Chu, 1969).

Morrison and Smith (1974) recognize that "data are rarely published in a form directly available for urban or regional input-output studies", resulting in attempts to produce an input-output table "from the available published statistics" which is "often the most attractive from the point of view of cost". In response to this, they evaluate the nonsurvey methods, including the location quotient and supply-demand pool techniques. The national input-output tables are used to estimate a regional table, in this case an urban area. The nation is England and the urban area is the City of Peterborough, England. A survey-based input-output table of Peterborough was constructed; this provided the comparison for the nonsurvey techniques applied to the city. Morrison and Smith utilized five different comparative methods: the mean similarity index, information content, the mean absolute difference, chi-square and regression. They were applied by rows, columns and at the entire matrix level to compare the survey input-output coefficients with the nonsurvey coefficients. The income multipliers were also compared. The results of the tests indicated that the Simple Location Quotient technique was the best approach (Morrison and Smith, 1974).

Eskelinen and Suorsa (1980) state that "a shortage of necessary data is a most serious impediment to the application of input-output analysis at the regional level".

Of the two choices (survey and nonsurvey) in constructing a regional input-output table, the survey approach "because of its heavy data requirements it is often regarded as too expensive and time-consuming to be applied on a full scale". Their study compares the results of a regional input-output table constructed by survey with the results of three nonsurvey constructed input-output tables (derived from national tables). The region in this study is North Karekia, situated in Eastern Finland; the national tables represent the Finnish economy. Comparisons are done with relatively simple methods: row totals and column totals are compared between the various tables constructed. The deviations of these totals from the survey table revealed that "the location quotient [SLQ] table does not deviate quite as much from the survey table" as the other nonsurvey methods did (Eskelinen and Suorsa, 1980).

Sawyer and Miller (1983) experiment in regionalizing a national input-output table, the nation being the United States and the region is the State of Washington. The nonsurvey methods include the Simple Location Quotient and the Supply-Demand Pool. Survey and nonsurvey regional coefficients were compared with two types of measurement: the mean absolute deviation, and the mean absolute deviation as a percentage of the mean coefficient. The study found its comparison approach "substantiates the results of previous research on alternative nonsurvey techniques" (including Schaffer and Chu, 1969, Morrison and Smith, 1974, and Eskelinen and Suorsa, 1980) and concluded that "moreover, the SDP approaches provide less accurate estimates of regional coefficients than do equivalent SLQ approaches" (Sawyer and Miller, 1983).

Miller and Blair (1985) found, in the composition of their comprehensive volume on input-output analysis (with its examination of nonsurvey methods), that even the best survey-based table is not completely accurate because "errors and compromises of many sorts enter into [its] production". They concluded that the SLQ approach is "the best of the various location quotient techniques" and is also "generally better than the supply-demand pool approaches" (Miller and Blair, 1985).

Appendix D - Closing the Statistics Canada Model

D.1 Input-Output Table Matrix Manipulations to Close the Model

In closing the model, the Statistics Canada input-output tables are manipulated to endogenize households. This involves augmenting both the Make and Use matrices to capture the new household "industry", and adjusting the Final Demand matrix to reflect the loss of personal (household) expenditures as an exogenous demand category. The Primary Input matrix is also affected by the closing of the model.

The first step in closing the model with respect to households is the aggregating of the consumer expenditure columns in the Final Demand matrix: categories Personal Expenditures - Durable, Semi-durable, Non-durable, and Services (see Table 6). This is accomplished by summing these four columns $\boldsymbol{p}_j$ ($\boldsymbol{j}$ = 1 to 4) across the commodity rows $\boldsymbol{i}$ ($\boldsymbol{i}$ = 1 to 49):

$$h = \sum_{j=1}^{4} p_{ij} \text{ for all } i \qquad \textbf{(D.1)}$$

where $\boldsymbol{h}$ is the household industry vector. This vector is then moved to the Use matrix and Primary Input matrix. The intermediate input commodities portion of the household vector $\boldsymbol{h}$ (i = 1 to 43) is augmented to the Use matrix and the primary input commodities portion (i = 44 to 49) is augmented to the Primary Input matrix.

The Use matrix and the Primary Input matrix are thus augmented by one column representing the household industry. The household column rows of the Use matrix represent the "input" of the household industry in the form of expenditures on intermediate commodities. The next step is the moving of the primary inputs representing household "output" to the Use matrix. These are the Labour Income (LabInc) and Net Income Unincorporated Business Income (NetInUnB) category rows. Being moved to the Use matrix, they now become intermediate commodity inputs to all the industries. The Use matrix is now closed. To complete the closing of the Primary Input matrix, a Net Savings row is added which has null entries except under the household industry column. This non-zero value represents the difference between household income (LabInc and NetInUnB) and household expenditures (on commodities).

The Make matrix is closed with respect to households by adding a household industry row and two columns representing the labour services. Since only the household industry "produces" labour services in the form of the two income categories, these two columns have null entries for each industry except the household industry. Correspondingly, since the household industry only produces labour services, the household industry row has null entries for each commodity except under the income columns.

The calculation of these new entries is based on the basic accounting identities of the accounting framework of Statistics Canada's input-output tables (refer to Table 6). The industry accounts basic identity states that industry_j's total output is equal to its total intermediate and primary inputs. In matrix notation terms:

$$\sum_{j=1}^{m} v_{ij} = \sum_{i=1}^{m} u_{ij} + \sum_{i=1}^{p} yi_{ij} \qquad \textbf{(D.2)}$$

(referring to Table 6, $\boldsymbol{g} = \boldsymbol{g}'$), where $\boldsymbol{m}$ = number of commodities and $\boldsymbol{p}$ = number of primary inputs. Therefore, for the household industry (industry 17) row of the Make matrix, the following values must be equal:

$$\sum_{j=1}^{45} v_{17\,j} = \sum_{i=1}^{45} u_{i\,17} + \sum_{i=1}^{5} yi_{i\,17} \qquad \textbf{(D.3)}$$

The commodity accounts basic identity states that the total output of commodity$_i$ is equal to its total intermediate use plus its final demand use:

$$\sum_{i=1}^{n} v_{ij} = \sum_{j=1}^{n} u_{ij} + \sum_{j=1}^{r} f_{ij} \qquad \textbf{(D.4)}$$

(from Table 6, $\boldsymbol{q} = \boldsymbol{q}'$); $\boldsymbol{n}$ = number of industries and $\boldsymbol{r}$ = number of final demand categories. For the LabInc (commodity 44) entry in the Make matrix:

$$\sum_{i=1}^{17} v_{i\,44} = \sum_{j=1}^{17} u_{44\,j} + \sum_{j=1}^{10} f_{44\,j} \qquad \textbf{(D.5)}$$

For the NetInUnB (commodity 45) entry:

$$\sum_{i=1}^{17} v_{i\,45} = \sum_{j=1}^{17} u_{45\,j} + \sum_{j=1}^{10} f_{45\,j} \qquad \textbf{(D.6)}$$

These identities were tested with the current input-output table values and the results proved them to hold.

The above closed matrices are used in the development of the national and provincial models in this research study. Mathematically, they can be substituted for the open versions in the derivation of the market share and industry technology matrices, and in the derivation of the domestic production leakage matrices.

Appendix E - Input-Output and Model Coefficient Tables

This appendix contains the Statistics Canada national and provincial input-output tables. It also contains the derived import, government production and inventory to use matrix coefficients (national and provincial), and the national, provincial and city impact matrices. Following these are the derived income, value added, net indirect taxes and employment coefficients (national and provincial).

The abbreviated industries and commodities listed in the tables, by row and/or column, are spelled out in full by number in *Table 5. Commodity, Industry, and Final Demand Categories - Aggregation "S"*, page 42.

Table E.1. National Make Matrix (TRANSPOSED) 1990 Aggregation - S (millions $)

						O	U	T	P	U	T	S						
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
		Agricultur	FishgTrap	LogForest	Mining	Manufact	Construct	Transport	Communi	OthrUtil	WholeTra	RtailTra	FinRealEs	ComBusS	OpOfCaLa	TraAdvPr	TransMar	Household	Total
	1 Grains	5932.3	0	0	0	1.3	0	0	0	0	0	0	0	0	0	0	0	0	5933.6
	2 OthAgrPr	18024.1	0	365.8	0	26.4	0	35.1	0	0	0	0	0	0	0	0	0	0	18451.4
	3 ForestPr	185.8	0	7774.5	0	88.4	0	0	0	12.2	15.8	0	0	0	0	0	0	0	8076.7
	4 FishTrap	0	1685.9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1685.9
	5 MetalCon	0	0	0	9841.3	1121	0	0	0	0	0	0	0	0	0	0	0	0	10962.3
	6 MinFuels	0	0	0	21465.1	1.2	0	0	0	0	3.3	0	0	0	0	0	0	0	21469.6
	7 NonMetMn	0	0	0	2397.2	149.4	0	0	0	0	12	0	0	0	0	0	0	0	2558.6
	8 MinServ	0	0	0	4125.6	0	0	0	0	0	0	0	0	0	0	0	0	0	4125.6
	9 MeFiDaPr	256	18.1	0	0	21442.3	0	0	0	0	13.8	361.6	0	0	0	0	0	0	22091.8
	10 FrVeFeMF	76.9	0	0	0	17192	0	0	0	0	296.3	428.4	0	0	0	0	0	0	17993.6
	11 Beverage	0	0	0	0	5633.9	0	0	0	0	0.2	0	0	0	0	0	0	0	5634.1
	12 TobaToPr	0	0	0	0	1838	0	0	0	0	0	0	0	0	0	0	0	0	1838
	13 RuLePlFP	0	0	0	0	7839.4	0	0	0	0	83.8	0	0	0	0	0	0	0	7923.2
	14 TextileP	0	0	0	0	5981.2	0	0	0	0	10.3	8.1	0	0	0	0	0	0	5999.6
I	15 KnitPrCl	0	0	0	0	6902.3	0	0	0	0	31.2	1.5	0	0	0	0	0	0	6935
	16 LuSawOWP	0	0	96.8	0	14641	0	0	0	0	107.3	199.3	0	0	0	0	0	0	15044.4
	17 FurnFix	0	0	0	0	4990	0	0	0	0	6.7	0	0	0	0	0	0	0	4996.7
N	18 PapPapPr	0	0	0	0	25764.1	0	0	0	0	75.3	0	0	0	0	0	0	0	25839.4
	19 PrintPub	0	0	0	0	13195.9	0	0	0	0	10.5	0	0	0	0	0	0	0	13206.4
	20 PrimMePr	0	0	0	14.6	21878.7	0	0	0	0	45.1	0	0	0	0	0	0	0	21938.4
P	21 MetFabPr	0	0	0	0	16655	0	0	0	0	72.2	0	0	0	0	0	0	0	16727.2
	22 MachEqui	0	0	0.2	178.2	13573.3	0	0	0	0	177.9	0	0	0	0	0	0	0	13929.6
	23 AuTruOte	0	0	0	0	51967.1	0	746.1	0	0	84.6	0	0	0	0	0	0	0	52797.8
U	24 EleComPr	0	0	0	0	17407.4	0	0	414.9	0	194.4	0	0	0	0	0	0	0	18016.7
	25 NoMetMiP	0	0	0	5.2	7250.3	0	0	0	0	17.1	0	0	0	0	0	0	0	7272.6
	26 PetCoalP	0	0	0	1275.5	20595.8	0	0	0	1.6	5.7	0	0	0	0	0	0	0	21878.6
T	27 ChemChPr	272.8	0	0	949.8	22819.2	0	0	0	0	171.9	0	0	0	0	0	0	0	24213.7
	28 MiManuPr	0	0	0	0	7249.1	0	0	0	0	102.1	0	0	7	0	0	0	0	7358.2
	29 ResConst	0	0	0	0	0	35922.4	0	0	0	0	0	0	0	0	0	0	0	35922.4
S	30 NonResCo	0	0	0	0	0	49741.6	0	0	0	0	0	0	0	0	0	0	0	49741.6
	31 RepConst	0	0	0	0	0	14384.9		0	0	0	0	0	0	0	0	0	0	14384.9
	32 TransSto	0	0	222.1	0	0	0	45155.5	0	193.7	0	33.9	0	195.6	0	0	0	0	45800.8
	33 CommunSe	0	0	0	0	0	0	0	22024.7	0	0	0	0	0	0	0	0	0	22024.7
	34 OthUtil	0	0	0	5.3	43.3	0	0	0	24024.7	0	0	0	0	0	0	0	0	24073.3
	35 WhlslMrg	0	0	17.9	32.3	7497.1	0	15.7	0	0	41461.2	0	0	618.3	0	0	0	0	49642.5
	36 RtlMarg	0	0	0	0	0	0	65	0.3	195.6	0	45876.8	0	708.9	0	0	0	0	46846.6
	37 ImpRent	0	0	0	0	0	0	0	0	0	0	0	53920.8	0	0	0	0	0	53920.8
	38 OthFinan	64	0	22.8	280	203.9	273.2	154.2	47.8	49.9	198.9	167.6	92876.8	489.1	0	0	0	0	94828.2
	39 BusServ	0	0	0	2.5	247.9	0	78.5	286.3	16.9	672.2	4.2	125.5	38932.6	0	0	0	0	40366.6
	40 PersOMiS	0	5	257.7	119.5	1877.6	232	456.7	146.4	268.4	3870.8	9015.4	1543.1	74564.3	0	0	0	0	92356.9
	41 TransMar	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	18817.6	0	18817.6
	42 OpOfCaLa	0	0	0	0	0	0	0	0	0	0	0	0	0	25728.1	0	0	0	25728.1
	43 TraAdvPr	0	0	0	0	0	0	0	0	0	0	0	0	0	0	23100	0	0	23100
	44 LabInc	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	372243.3	372243.3
	45 NetInUnB	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	38585.9	38585.9
	46 Total	24811.9	1709	8757.8	40692.1	316073.5	100554.1	46706.8	22920.4	24763	47740.6	56096.8	148466.2	115515.8	25728.1	23100	18817.6	410829.2	1433283

Table E.2. Provincial Make Matrix (TRANSPOSED) 1990 Aggregation - S (thousands $)

		OUTPUTS 1 Agricultur	2 FishgTrap	3 LogForest	4 Mining	5 Manufact	6 Construct	7 Transport	8 Communi	9 OthrUtil	10 WholeTra	11 RtailTra	12 FinRealEs	13 ComBusS	14 OpOfCaLa	15 TraAdvPrc	16 TransMarg	17 Household	18 Total
	1 Grains	878180	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	878180
	2 OthAgrPr	1297034	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1297034
	3 ForestPr	7252	0	72067	0	3876	0	0	0	0	276	0	0	0	0	0	0	0	83471
	4 FishTrap	0	17214	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	17214
	5 MetalCon	0	0	0	214578	23842	0	0	0	0	0	0	0	0	0	0	0	0	238420
	6 MinFuels	0	0	0	758569	0	0	0	0	0	0	0	0	0	0	0	0	0	758569
	7 NonMetMn	0	0	0	38938	2435	11200	0	0	0	403	0	0	0	0	0	0	0	52976
	8 MinServ	0	0	0	86190	0	0	0	0	0	0	0	0	0	0	0	0	0	86190
	9 MeFiDaPr	18210	0	0	0	764507	0	0	0	0	381	598	0	0	0	0	0	0	783696
	10 FrVeFeMF	634	0	0	0	675777	0	0	0	0	7269	14644	0	0	0	0	0	0	698324
	11 Beverage	0	0	0	0	151155	0	0	0	0	5	0	0	0	0	0	0	0	151160
	12 TobaToPr	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	13 RuLePlFP	0	0	0	0	208058	0	0	0	0	1658	0	0	0	0	0	0	0	209716
	14 TextileP	0	0	0	0	58843	0	0	0	0	0	250	0	0	0	0	0	0	59093
I	15 KnitPrCl	0	0	0	0	319836	0	0	0	0	3316	47	0	0	0	0	0	0	323199
	16 LuSawOWP	0	0	57	0	192963	0	0	0	0	3414	7382	0	0	0	0	0	0	203816
	17 FurnFix	0	0	0	0	154580	0	0	0	0	142	0	0	0	0	0	0	0	154722
N	18 PapPapPr	0	0	0	0	373850	0	0	0	0	1563	0	0	0	0	0	0	0	375413
	19 PrintPub	0	0	0	0	404484	0	0	0	0	57	0	0	0	0	0	0	0	404541
	20 PrimMePr	0	0	0	0	999478	0	0	0	0	69	0	0	0	0	0	0	0	999547
P	21 MetFabPr	0	0	0	0	365457	0	0	0	0	999	0	0	0	0	0	0	0	366456
	22 MachEqui	0	0	1	2396	754167	0	0	0	0	3398	0	0	0	0	0	0	0	759962
	23 AuTruOte	0	0	0	0	753703	0	34488	0	0	679	0	0	0	0	0	0	0	788870
U	24 EleComPr	0	0	0	0	377640	0	0	26638	0	1308	0	0	0	0	0	0	0	405586
	25 NoMetMiP	0	0	0	0	153650	0	0	0	0	354	0	0	0	0	0	0	0	154004
	26 PetCoalP	0	0	0	592	10311	0	0	0	0	0	0	0	0	0	0	0	0	10903
T	27 ChemChPr	43791	0	0	0	285116	0	0	0	0	2607	0	0	0	0	0	0	0	331514
	28 MiManuPr	0	0	0	0	163803	0	0	0	0	1967	0	0	134	0	0	0	0	165904
	29 ResConst	0	0	0	0	0	782482	0	0	0	0	0	0	0	0	0	0	0	782482
S	30 NonResCo	0	0	0	0	0	1702559	0	0	0	0	0	0	0	0	0	0	0	1702559
	31 RepConst	0	0	0	0	0	600373	0	0	0	0	0	0	0	0	0	0	0	600373
	32 TransSto	0	0	0	0	0	0	2309280	0	0	0	1111	0	42	0	0	0	0	2310433
	33 CommunSe	0	0	0	0	0	0	0	827640	0	0	0	0	0	0	0	0	0	827640
	34 OthUtil	0	0	0	0	0	0	0	0	838264	0	0	0	0	0	0	0	0	838264
	35 WhlslMrg	0	0	35	0	131420	0	514	0	0	1576399	0	0	4220	0	0	0	0	1712588
	36 RtlMarg	0	0	0	0	0	0	8537	9	4988	0	1607714	0	23721	0	0	0	0	1644969
	37 ImpRent	0	0	0	0	0	0	0	0	0	0	0	2010851	0	0	0	0	0	2010851
	38 OthFinan	7597	0	0	2422	0	6292	11616	437	777	7734	5921	2953037	28157	0	0	0	0	3023990
	39 BusServ	0	0	0	13	10103	0	0	26703	0	36073	0	3952	704605	0	0	0	0	781449
	40 PersOMiS	0	51	1740	2363	77080	5343	34809	3934	0	130190	321516	58728	2561208	0	0	0	0	3196962
	41 TransMar	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1154846	0	1154846
	42 OpOfCaLa	0	0	0	0	0	0	0	0	0	0	0	0	0	973565	0	0	0	973565
	43 TraAdvPr	0	0	0	0	0	0	0	0	0	0	0	0	0	0	756454	0	0	756454
	44 LabInc	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.2E+07	1.2E+07
	45 NetInUnB	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1572627	1572627
	46 Total	2252698	17265	73900	1106061	7416134	3108249	2399244	885361	844029	1780261	1959183	5026568	3322087	973565	756454	1154846	1.4E+07	4.7E+07

Table E.3. National Market Share Matrix D (TRANSPOSED)

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
							O	U	T	P	U	T	S						
		Agricultur	FishgTrap	LogForest	Mining	Manufact	Construct	Transport	Communi	OthrUtil	WholeTra	RtailTra	FinRealEs	ComBusS	OpOfCaLa	TraAdvPrc	TransMarg	Household	Total
	1 Grains	0.999781	0	0	0	0.000219	0	0	0	0	0	0	0	0	0	0	0	0	1
	2 OthAgrPr	0.976842	0	0.019825	0	0.001431	0	0.001902	0	0	0	0	0	0	0	0	0	0	1
	3 ForestPr	0.023004	0	0.962584	0	0.010945	0	0	0	0.001511	0.001956	0	0	0	0	0	0	0	1
	4 FishTrap	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	5 MetalCon	0	0	0	0.89774	0.10226	0	0	0	0	0	0	0	0	0	0	0	0	1
	6 MinFuels	0	0	0	0.99979	5.6E-05	0	0	0	0	0.000154	0	0	0	0	0	0	0	1
	7 NonMetMn	0	0	0	0.936919	0.058391	0	0	0	0	0.00469	0	0	0	0	0	0	0	1
	8 MinServ	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	9 MeFiDaPr	0.011588	0.000819	0	0	0.9706	0	0	0	0	0.000625	0.016368	0	0	0	0	0	0	1
	10 FrVeFeMF	0.004274	0	0	0	0.955451	0	0	0	0	0.016467	0.023808	0	0	0	0	0	0	1
	11 Beverage	0	0	0	0	0.999965	0	0	0	0	3.5E-05	0	0	0	0	0	0	0	1
	12 TobaToPr	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1
	13 RuLePlFP	0	0	0	0	0.989423	0	0	0	0	0.010577	0	0	0	0	0	0	0	1
	14 TextileP	0	0	0	0	0.996933	0	0	0	0	0.001717	0.00135	0	0	0	0	0	0	1
I	15 KnitPrCl	0	0	0	0	0.995285	0	0	0	0	0.004499	0.000216	0	0	0	0	0	0	1
	16 LuSawOWP	0	0	0.006434	0	0.973186	0	0	0	0	0.007132	0.013247	0	0	0	0	0	0	1
	17 FurnFix	0	0	0	0	0.998659	0	0	0	0	0.001341	0	0	0	0	0	0	0	1
N	18 PapPapPr	0	0	0	0	0.997086	0	0	0	0	0.002914	0	0	0	0	0	0	0	1
	19 PrintPub	0	0	0	0	0.999205	0	0	0	0	0.000795	0	0	0	0	0	0	0	1
	20 PrimMePr	0	0	0	0.000665	0.997279	0	0	0	0	0.002056	0	0	0	0	0	0	0	1
P	21 MetFabPr	0	0	0	0	0.995684	0	0	0	0	0.004316	0	0	0	0	0	0	0	1
	22 MachEqui	0	0	1.4E-05	0.012793	0.974421	0	0	0	0	0.012771	0	0	0	0	0	0	0	1
	23 AuTruOte	0	0	0	0	0.984266	0	0.014131	0	0	0.001602	0	0	0	0	0	0	0	1
U	24 EleComPr	0	0	0	0	0.966181	0	0	0.023029	0	0.01079	0	0	0	0	0	0	0	1
	25 NoMetMiP	0	0	0	0.000715	0.996934	0	0	0	0	0.002351	0	0	0	0	0	0	0	1
	26 PetCoalP	0	0	0	0.058299	0.941367	0	0	0	7.3E-05	0.000261	0	0	0	0	0	0	0	1
T	27 ChemChPr	0.011266	0	0	0.039226	0.942409	0	0	0	0	0.007099	0	0	0	0	0	0	0	1
	28 MiManuPr	0	0	0	0	0.985173	0	0	0	0	0.013876	0	0	0.000951	0	0	0	0	1
	29 ResConst	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1
S	30 NonResCo	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1
	31 RepConst	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1
	32 TransSto	0	0	0.004849	0	0	0	0.985911	0	0.004229	0	0.00074	0	0.004271	0	0	0	0	1
	33 CommunSe	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1
	34 OthUtil	0	0	0	0.00022	0.001799	0	0	0	0.997981	0	0	0	0	0	0	0	0	1
	35 WhlslMrg	0	0	0.000361	0.000651	0.151022	0	0.000316	0	0	0.835196	0	0	0.012455	0	0	0	0	1
	36 RtlMarg	0	0	0	0	0	0	0.001388	6.4E-06	0.004175	0	0.979298	0	0.015132	0	0	0	0	1
	37 ImpRent	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1
	38 OthFinan	0.000675	0	0.00024	0.002953	0.00215	0.002881	0.001626	0.000504	0.000526	0.002097	0.001767	0.979422	0.005158	0	0	0	0	1
	39 BusServ	0	0	0	6.2E-05	0.006141	0	0.001945	0.007092	0.000419	0.016652	0.000104	0.003109	0.964476	0	0	0	0	1
	40 PersOMiS	0	5.4E-05	0.00279	0.001294	0.02033	0.002512	0.004945	0.001585	0.002906	0.041911	0.097615	0.016708	0.80735	0	0	0	0	1
	41 TransMar	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1
	42 OpOfCaLa	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1
	43 TraAdvPr	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1
	44 LabInc	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
	45 NetInUnB	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1

Table E.4. Provincial Market Share Matrix D (TRANSPOSED)

							O	U	T	P	U	T	S						
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
		Agricultur	FishgTrap	LogForest	Mining	Manufact	Construct	Transport	Communi(	OthrUtil	WholeTra	RtailTra	FinRealEs	ComBusS	OpOfCaLa	TraAdvPrc	TransMarg	Household	Total
	1 Grains	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	2 OthAgrPr	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	3 ForestPr	0.08688	0	0.863378	0	0.046435	0	0	0	0	0.003307	0	0	0	0	0	0	0	1
	4 FishTrap	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	5 MetalCon	0	0	0	0.887845	0.112155	0	0	0	0	0	0	0	0	0	0	0	0	1
	6 MinFuels	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	7 NonMetMn	0	0	0	0.286678	0.674673	0.037307	0	0	0	0.001342	0	0	0	0	0	0	0	1
	8 MinServ	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	9 MeFiDaPr	0.023236	0	0	0	0.975515	0	0	0	0	0.000486	0.000763	0	0	0	0	0	0	1
	10 FrVeFeMF	0.000908	0	0	0	0.967713	0	0	0	0	0.010409	0.02097	0	0	0	0	0	0	1
	11 Beverage	0	0	0	0	0.999967	0	0	0	0	3.3E-05	0	0	0	0	0	0	0	1
	12 TobaToPr	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	13 RuLePIFP	0	0	0	0	0.992094	0	0	0	0	0.007906	0	0	0	0	0	0	0	1
	14 TextileP	0	0	0	0	0.995769	0	0	0	0	0	0.004231	0	0	0	0	0	0	1
I	15 KnitPrCl	0	0	0	0	0.989595	0	0	0	0	0.01026	0.000145	0	0	0	0	0	0	1
	16 LuSawOWP	0	0	0.00028	0	0.946751	0	0	0	0	0.01675	0.036219	0	0	0	0	0	0	1
	17 FurnFix	0	0	0	0	0.999082	0	0	0	0	0.000918	0	0	0	0	0	0	0	1
N	18 PapPapPr	0	0	0	0	0.995837	0	0	0	0	0.004163	0	0	0	0	0	0	0	1
	19 PrintPub	0	0	0	0	0.999859	0	0	0	0	0.000141	0	0	0	0	0	0	0	1
	20 PrimMePr	0	0	0	0	0.999931	0	0	0	0	6.9E-05	0	0	0	0	0	0	0	1
P	21 MetFabPr	0	0	0	0	0.997274	0	0	0	0	0.002726	0	0	0	0	0	0	0	1
	22 MachEqui	0	0	1.3E-06	0.003153	0.992375	0	0	0	0	0.004471	0	0	0	0	0	0	0	1
	23 AuTruOte	0	0	0	0	0.955421	0	0.043718	0	0	0.000861	0	0	0	0	0	0	0	1
U	24 EleComPr	0	0	0	0	0.931097	0	0	0.065678	0	0.003225	0	0	0	0	0	0	0	1
	25 NoMetMiP	0	0	0	0	0.997701	0	0	0	0	0.002299	0	0	0	0	0	0	0	1
	26 PetCoalP	0	0	0	0.054297	0.945703	0	0	0	0	0	0	0	0	0	0	0	0	1
T	27 ChemChPr	0.132094	0	0	0	0.860042	0	0	0	0	0.007864	0	0	0	0	0	0	0	1
	28 MiManuPr	0	0	0	0	0.987336	0	0	0	0	0.011856	0	0	0.000808	0	0	0	0	1
	29 ResConst	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1
S	30 NonResCo	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1
	31 RepConst	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1
	32 TransSto	0	0	0	0	0	0	0.999501	0	0	0	0.000481	0	1.8E-05	0	0	0	0	1
	33 CommunSe	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1
	34 OthUtil	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
	35 WhlslMrg	0	0	2E-05	0	0.076738	0	0.0003	0	0	0.920478	0	0	0.002464	0	0	0	0	1
	36 RtlMarg	0	0	0	0	0	0	0.00519	5.5E-06	0.003032	0	0.977352	0	0.01442	0	0	0	0	1
	37 ImpRent	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1
	38 OthFinan	0.002512	0	0	0.000801	0	0.002081	0.003841	0.000145	0.000257	0.002558	0.001958	0.976537	0.009311	0	0	0	0	1
	39 BusServ	0	0	0	1.7E-05	0.012929	0	0	0.034171	0	0.046162	0	0.005057	0.901665	0	0	0	0	1
	40 PersOMiS	0	1.6E-05	0.000544	0.000739	0.02411	0.001671	0.010888	0.001231	0	0.040723	0.100569	0.01837	0.801138	0	0	0	0	1
	41 TransMar	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1
	42 OpOfCaLa	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1
	43 TraAdvPr	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1
	44 LabInc	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
	45 NetInUnB	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1

Table E.6. National Use Matrix 1990 Aggregation - S (millions $)

						O	U	T	P	U	T	S						
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
		Agricultur	FishgTrap	LogForest	Mining	Manufact	Construct	Transport	Communi(	OthrUtil	WholeTra	RtailTra	FinRealEs	ComBusS	OpOfCaLa	TraAdvPrc	TransMarg	Household	Total
	1 Grains	1269.9	0	0	0	1179.7	0	0	0	0	49.4	0	0	0	0	0	0	0	2499
	2 OthAgrPr	3305.9	0	0	0	10176.8	189.9	7.5	0	0	10.4	350.4	0	379.8	122.8	0	0	3692.2	18235.7
	3 ForestPr	1.9	0	1673.2	0	6056.9	26.9	0	0	0	27.3	0	0	0	0	0	0	467.1	8253.3
	4 FishTrap	0	30.9	0	0	1157.3	0	0	0	0	0	0	0	25.3	6.3	0	0	111.3	1331.1
	5 MetalCon	0	0	0	13	6459.9	0	0	0	360.8	2.5	0	0	9.5	0	0	0	0	6845.7
	6 MinFuels	26.5	0.5	0.8	67.1	15768.5	7.6	98.8	4.8	1141.3	22.3	83.6	156.9	90.6	0	0.7	0	877.6	18347.6
	7 NonMetMn	28	2.3	0	101.2	1074.2	645	13.5	0	0	1.3	0.3	0	5.4	1.2	0	0	49.5	1921.9
	8 MinServ	0	0	0	1709.5	0	2416.1	0	0	0	0	0	0	0	0	0	0	0	4125.6
	9 MeFiDaPr	14.2	0	0	0	3852	0	0	0	0	6.5	25.5	0	3312.9	941.5	0	0	12320	20472.6
	10 FrVeFeMF	2175.2	62.8	0	0	3418.6	0	7.4	0	0	70.8	109.9	0	1506.1	418.8	0	0	11753.4	19523
	11 Beverage	0	0	0	0	276.2	0	0	0	0	0.1	0	0	167	55.3	138.9	0	5011	5648.5
	12 TobaToPr	0	0	0	0	258.9	0	0	0	0	0	0	0	0	0	0	0	1558	1816.9
	13 RuLePlFP	37.8	0	0	6.7	4129.6	1609.9	264.2	0.4	0	184.3	164.8	0	108.7	1552.3	3.1	0	2833.7	10895.5
	14 TextileP	49.9	44.5	9.5	5.7	5163	775.9	34.6	3.1	0	24.9	42.6	0	226.3	153	0	0	1657.1	8190.1
I	15 KnitPrCl	0	0	0	0	575.2	0	0	0	0	0	107.2	0	23.7	229.4	0	0	9070.6	10006.1
	16 LuSawOWP	13.1	15.6	0	2.7	4113.2	5253.8	0	0	0	76.5	20.3	0	79.9	27.7	0	0	264.1	9866.9
	17 FurnFix	0	0	0	0	376.4	58.8	0	1.2	0	0	3.6	8.9	10.9	0	0	0	3089.5	3549.3
N	18 PapPapPr	16	0	0	37.9	9744.7	663.3	38.5	0	0	367.1	706.8	0	405.9	1313.6	8.9	0	1977.2	15279.9
	19 PrintPub	0	0	0	1.1	1234	0	42.3	490.4	12	57.6	55.4	246.8	171.1	4102.5	4727	0	3360.3	14500.5
	20 PrimMePr	0	0	0	375.8	15167.7	2076.6	42	0	0	67.9	0	0	24.1	171.7	0	0	0	17925.8
P	21 MetFabPr	105.6	5.7	48.6	37.1	7599.4	7794.1	32.3	0.3	0	175.4	168.4	0	28.7	1438.5	0	0	784.7	18218.8
	22 MachEqui	200.3	18.9	34.4	916.6	4129.6	821.9	12.8	0.6	0	37.8	0	32	1.5	2418.4	0	0	1128.1	9752.9
	23 AuTruOte	4.9	95.3	17.7	150.4	23131.5	61.1	1993.2	0.1	0	7.7	0	0	0	765.6	50.8	0	14660.4	40938.7
U	24 EleComPr	0	42.7	0	45.4	7852.5	2945.5	90.3	542.2	73	54.4	0	0	2	1935.2	7.4	0	5431.9	19022.5
	25 NoMetMiP	14.9	1.6	0.4	84.7	2486	4949	36	0	0	14.3	4.8	0	53.1	127.5	0	0	689.4	8461.7
	26 PetCoalP	938.8	96.6	176.5	480.3	4032.9	1141.2	2732.3	81.1	587.9	570	413.3	494.7	668	28.3	336.2	0	5999.7	18777.8
T	27 ChemChPr	1838.6	2.8	8.3	526.1	14009.5	1025.1	52.4	3.9	0	98.8	32.7	0	395.9	1573	1.5	0	4945.1	24513.7
	28 MiManuPr	0	17.5	0	0	2248.3	677.8	23.5	27.6	0	25.6	35	0	595.4	1000.1	457.6	0	5741.2	10849.6
	29 ResConst	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S	30 NonResCo	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	31 RepConst	404.4	41.7	84.6	516.8	1314.3	72.2	1338.5	474.3	691.7	99.4	213	4971.3	293.6	0	0	0	207	10722.8
	32 TransSto	89.5	24	804.2	334.8	1811.6	319	5710.2	291.2	40.8	767.3	424.4	139.4	376.4	0	4030.2	18817.6	9142.9	43123.5
	33 CommunSe	123.4	1.5	9.6	98.9	1454.4	178.4	756.9	908.9	98.4	1175.8	1131.5	2480.2	1982.5	0	2273.8	0	7873.1	20547.3
	34 OthUtil	424.2	2.8	8.5	1074.7	5461.7	91.5	520.8	122.2	679	445.7	1380.7	2421.8	1159.4	0	0.4	0	10851	24644.4
	35 WhlslMrg	791.2	65.2	89.3	807.9	7698.1	4983.8	1303	98.9	159.9	713.1	285.7	162	1040.9	4010.6	306.8	0	14505.7	37022.1
	36 RtlMarg	112.9	7.9	2.7	15.3	43.3	571	58.2	46.4	12.9	51.6	36.5	18.8	497.8	1310.5	236.3	0	42218.8	45240.9
	37 ImpRent	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	53920.8	53920.8
	38 OthFinan	1147.9	23.2	630.8	5325.9	5104.3	1649.6	1709.9	513.2	760.8	3559.9	5439.3	12524	6849.2	0	0	0	43419.1	88657.1
	39 BusServ	103	8.4	98.1	1500.9	4579.4	6621.2	847.6	862.3	304.6	1755.8	2430.9	7281	4883.7	0	3520.8	0	2160	36957.7
	40 PersOMiS	278.6	30.3	414.9	985.4	4203.3	1904.8	2633.8	1114.7	406.4	453.7	551.5	1042.6	4045.8	1002.8	4882.7	0	60676	84627.3
	41 TransMar	309.2	11.8	9.4	176.3	5188.4	1477.9	141.9	17.2	113.5	68.9	56.9	21.7	241.8	530.4	55.8	0	2775.2	11196.3
	42 OpOfCaLa	651.6	17.2	773.1	2040.9	7100.5	803.1	935.6	265.1	365.6	600.7	652.5	1485.3	2782.7	0	0	0	1360.5	19834.4
	43 TraAdvPr	2.1	0	18.8	300	5586.8	457.3	904.7	357.5	150.8	2593	2826.9	3463.6	3310.4	0	0	0	647.7	20619.6
	44 LabInc	2334.9	319.9	2497.6	7289.8	69365.6	30945.5	15792.6	9098.1	4983.4	23888.3	27729.9	28647	48619.3	0	0	0	15038.8	286594.7
	45 NetInUnB	3711.5	448.2	275.8	124.5	253.8	3657.3	817.1	39.6	14.5	439.5	2087.7	12285.8	14385.6	0	0	0	0	38585.9

Table E.6. Provincial Use Matrix 1990 Aggregation - S (thousands $)

						O	U	T	P	U	T	S						
		1 Agricultur	2 FishgTrap	3 LogForest	4 Mining	5 Manufact	6 Construct	7 Transport	8 Communi	9 OthrUtil	10 WholeTra	11 RtailTra	12 FinRealEs	13 ComBusS	14 OpOfCaLa	15 TraAdvPrc	16 TransMarg	17 Household	18 Total
	1 Grains	96025	0	0	0	61806	0	0	0	0	833	0	0	0	0	0	0	0	158664
	2 OthAgrPr	235112	0	0	0	513354	5959	486	0	0	296	597	0	11976	5535	0	0	129072	902387
	3 ForestPr	0	0	13737	0	58098	1085	0	0	0	0	0	0	0	0	0	0	11292	84212
	4 FishTrap	0	184	0	0	23113	0	0	0	0	0	0	0	2338	252	0	0	10781	36668
	5 MetalCon	0	0	0	0	548695	0	0	0	0	46	0	0	254	0	0	0	0	548995
	6 MinFuels	1372	5	57	114	100270	202	3364	0	6381	0	4852	8891	3645	0	21	0	58981	188155
	7 NonMetMn	3467	27	0	8608	25989	21179	831	0	0	29	13	0	296	51	0	0	2768	63258
	8 MinServ	0	0	0	27910	0	41612	0	0	0	0	0	0	0	0	0	0	0	69522
	9 MeFiDaPr	805	0	0	0	135317	0	0	0	0	176	865	0	97917	60833	0	0	413441	709354
	10 FrVeFeMF	137087	40	0	0	94492	0	679	0	0	1781	3689	0	61775	17175	0	0	533099	849817
	11 Beverage	0	0	0	0	9898	0	0	0	0	2	0	0	5601	1776	3081	0	164996	185354
	12 TobaToPr	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	68625	68625
	13 RuLePlFP	2506	0	0	0	91904	43075	13013	22	0	5221	5655	0	3743	51439	93	0	90689	307360
	14 TextileP	2392	365	73	26	148872	18867	1428	161	0	869	1550	0	9775	5473	0	0	46379	236230
I	15 KnitPrCl	0	0	0	0	10031	0	0	0	0	0	3781	0	873	7958	0	0	319017	341660
	16 LuSawOWP	583	100	0	5	73251	118328	0	0	0	2644	709	0	3755	976	0	0	7917	208268
	17 FurnFix	0	0	0	0	8740	1658	0	63	0	0	183	323	566	0	0	0	94842	106375
N	18 PapPapPr	0	0	0	0	237738	16744	2288	0	0	12699	24095	0	17691	49016	253	0	74826	435350
	19 PrintPub	0	0	0	0	14568	0	1243	43470	464	0	1873	5009	3607	149979	135471	0	106822	462506
	20 PrimMePr	0	0	0	8138	288934	62804	5176	0	0	610	0	0	811	5593	0	0	0	372066
P	21 MetFabPr	7025	57	0	427	151964	224112	3963	0	0	5251	5915	0	1075	47551	0	0	24615	471955
	22 MachEqui	23995	167	188	17798	144819	21800	184	28	0	546	0	1224	63	74295	0	0	24313	309420
	23 AuTruOte	570	1003	0	0	225824	1984	77981	11	0	115	0	0	0	25540	1653	0	427985	762666
U	24 EleComPr	0	411	0	894	107834	103843	1808	17542	2640	567	0	0	83	57447	223	0	169312	462604
	25 NoMetMiP	52	16	5	3780	76744	137912	2901	0	0	437	169	0	2386	4256	0	0	25296	253954
	26 PetCoalP	95959	704	1013	9809	28647	33920	108729	2919	5732	21731	15518	6789	19615	1226	12086	0	192607	557004
T	27 ChemChPr	268134	23	63	15285	189647	33368	2417	106	0	2322	1073	0	13216	49564	49	0	181015	756282
	28 MiManuPr	0	165	0	0	37477	19168	862	710	0	903	1292	0	15994	27851	13080	0	219175	336677
	29 ResConst	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S	30 NonResCo	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	31 RepConst	36884	700	600	0	20300	2001	90800	25500	36600	0	7550	177168	6419	0	0	0	9257	413779
	32 TransSto	7661	228	6680	10810	36535	12343	239817	14405	1006	29846	15887	4930	10784	0	150695	1154846	443869	2140342
	33 CommunSe	11960	14	70	1881	43582	5363	40964	34100	3578	52760	42798	57055	63584	0	60961	0	336274	754944
	34 OthUtil	40438	13	96	23651	117791	2589	26412	3705	16324	17694	48552	67791	38796	0	12	0	411280	815144
	35 WhlslMrg	88264	571	650	18671	256185	145350	62034	3939	1769	25631	8890	2606	34353	142616	9875	0	538955	1340359
	36 RtlMarg	11209	66	26	361	1268	20939	2171	2321	367	1795	1475	365	18654	48388	9487	0	1498343	1617235
	37 ImpRent	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2010851	2010851
	38 OthFinan	136614	238	764	44918	129928	56000	97759	16022	45401	157454	199483	470284	164305	0	0	0	1573460	3092630
	39 BusServ	12055	82	907	27253	89852	209647	40384	31063	10823	78392	89309	163757	109511	0	99750	0	96245	1059030
	40 PersOMiS	32746	150	5309	18203	70677	58944	149506	29613	18596	18814	19028	28758	85050	27495	201061	0	2261015	3024965
	41 TransMar	41847	87	84	6701	130487	53006	9743	1040	3083	3503	2595	601	10141	20529	2497	0	118510	404454
	42 OpOfCaLa	110498	70	11826	44775	-163399	28284	46661	10537	13426	34059	36471	52638	97257	0	0	0	73840	723741
	43 TraAdvPr	100	0	199	7068	133231	15500	43286	12382	5317	121115	107404	81044	88384	0	0	0	28637	643667
	44 LabInc	144181	4845	5291	237626	1651790	970440	831970	349296	186486	832583	910016	838474	1332110	0	0	0	714388	9009540
	45 NetInUnB	282071	4673	10807	4822	7577	153397	36941	14091	862	18700	70900	462299	505442	0	0	0	0	1572627

Table E.7. National Industry Technology Matrix B

			O U T P U T S															
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
			Agricultur	FishgTrap	LogForest	Mining	Manufact	Construct	Transport	Communic	OthrUtil	WholeTra	RtailTra	FinRealEs	ComBusS	OpOfCaLa	TraAdvPrc	TransMarc	Household
	1	Grains	0.051181	0	0	0	0.003732	0	0	0	0	0.001035	0	0	0	0	0	0	0
	2	OthAgrPr	0.133238	0	0	0	0.032198	0.001889	0.000161	0	0	0.000218	0.006246	0	0.003288	0.004773	0	0	0.008987
	3	ForestPr	7.7E-05	0	0.191053	0	0.019163	0.000268	0	0	0	0.000572	0	0	0	0	0	0	0.001137
	4	FishTrap	0	0.018081	0	0	0.003661	0	0	0	0	0	0	0	0.000219	0.000245	0	0	0.000271
	5	MetalCon	0	0	0	0.000319	0.020438	0	0	0	0.01457	5.2E-05	0	0	8.2E-05	0	0	0	0
	6	MinFuels	0.001068	0.000293	9.1E-05	0.001649	0.049889	7.6E-05	0.002115	0.000209	0.046089	0.000467	0.00149	0.001057	0.000784	0	3E-05	0	0.002136
	7	NonMetMn	0.001128	0.001346	0	0.002487	0.003399	0.006414	0.000289	0	0	2.7E-05	5.3E-06	0	4.7E-05	4.7E-05	0	0	0.00012
	8	MinServ	0	0	0	0.042011	0	0.024028	0	0	0	0	0	0	0	0	0	0	0
	9	MeFiDaPr	0.000572	0	0	0	0.012187	0	0	0	0	0.000136	0.000455	0	0.028679	0.036594	0	0	0.029988
	10	FrVeFeMF	0.087668	0.036747	0	0	0.010816	0	0.000158	0	0	0.001483	0.001959	0	0.013038	0.016278	0	0	0.028609
	11	Beverage	0	0	0	0	0.000874	0	0	0	0	2.1E-06	0	0	0.001446	0.002149	0.006013	0	0.012197
	12	TobaToPr	0	0	0	0	0.000819	0	0	0	0	0	0	0	0	0	0	0	0.003792
	13	RuLePlFP	0.001523	0	0	0.000165	0.013065	0.01601	0.005657	1.7E-05	0	0.00386	0.002938	0	0.000941	0.060335	0.000134	0	0.006898
	14	TextileP	0.002011	0.026039	0.001085	0.00014	0.016335	0.007716	0.000741	0.000135	0	0.000522	0.000759	0	0.001959	0.005947	0	0	0.004034
I	15	KnitPrCl	0	0	0	0	0.00182	0	0	0	0	0	0.001911	0	0.000205	0.008916	0	0	0.022079
	16	LuSawOWP	0.000528	0.009128	0	6.6E-05	0.013013	0.052248	0	0	0	0.001602	0.000362	0	0.000692	0.001077	0	0	0.000643
	17	FurnFix	0	0	0	0	0.001191	0.000585	0	5.2E-05	0	0	6.4E-05	6E-05	9.4E-05	0	0	0	0.00752
N	18	PapPapPr	0.000645	0	0	0.000931	0.03083	0.006596	0.000824	0	0	0.007689	0.0126	0	0.003514	0.051057	0.000385	0	0.004813
	19	PrintPub	0	0	0	2.7E-05	0.003904	0	0.000906	0.021396	0.000485	0.001207	0.000988	0.001662	0.001481	0.159456	0.204632	0	0.008179
	20	PrimMePr	0	0	0	0.009235	0.047988	0.020652	0.000899	0	0	0.001422	0	0	0.000209	0.006674	0	0	0
P	21	MetFabPr	0.004256	0.003335	0.005549	0.000912	0.024043	0.077512	0.000692	1.3E-05	0	0.003674	0.003002	0	0.000248	0.055912	0	0	0.00191
	22	MachEqui	0.008073	0.011059	0.003928	0.022525	0.013065	0.008174	0.000274	2.6E-05	0	0.000792	0	0.000216	1.3E-05	0.093998	0	0	0.002746
	23	AuTruOte	0.000197	0.055764	0.002021	0.003696	0.073184	0.000608	0.042675	4.4E-06	0	0.000161	0	0	0	0.029757	0.002199	0	0.035685
U	24	EleComPr	0	0.024985	0	0.001116	0.024844	0.029293	0.001933	0.023656	0.002948	0.001139	0	0	1.7E-05	0.075217	0.00032	0	0.013222
	25	NoMetMiP	0.000601	0.000936	4.6E-05	0.002081	0.007865	0.049217	0.000771	0	0	0.0003	8.6E-05	0	0.00046	0.004956	0	0	0.001678
	26	PetCoalP	0.037837	0.056524	0.020153	0.011803	0.012759	0.011349	0.058499	0.003538	0.023741	0.01194	0.007368	0.003332	0.005783	0.0011	0.014554	0	0.014604
T	27	ChemChPr	0.074102	0.001638	0.000948	0.012929	0.044324	0.010195	0.001122	0.00017	0	0.00207	0.000583	0	0.003427	0.061139	6.5E-05	0	0.012037
	28	MiManuPr	0	0.01024	0	0	0.007113	0.006741	0.000503	0.001204	0	0.000536	0.000624	0	0.005154	0.038872	0.01981	0	0.013975
	29	ResConst	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S	30	NonResCo	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	31	RepConst	0.016299	0.0244	0.00966	0.0127	0.004158	0.000718	0.028657	0.020693	0.027933	0.002082	0.003797	0.033484	0.002542	0	0	0	0.000504
	32	TransSto	0.003607	0.014043	0.091827	0.008228	0.005732	0.003172	0.122256	0.012705	0.001648	0.016072	0.007565	0.000939	0.003258	0	0.174468	1	0.022255
	33	CommunSe	0.004973	0.000878	0.001096	0.00243	0.004601	0.001774	0.016205	0.039655	0.003974	0.024629	0.02017	0.016705	0.017162	0	0.098433	0	0.019164
	34	OthUtil	0.017097	0.001638	0.000971	0.026411	0.01728	0.00091	0.01115	0.005331	0.02742	0.009336	0.024613	0.016312	0.010037	0	1.7E-05	0	0.026412
	35	WhlslMrg	0.031888	0.038151	0.010197	0.019854	0.024355	0.049563	0.027897	0.004315	0.006457	0.014937	0.005093	0.001091	0.009011	0.155884	0.013281	0	0.035308
	36	RtlMarg	0.00455	0.004623	0.000308	0.000376	0.000137	0.005679	0.001246	0.002024	0.000521	0.001081	0.000651	0.000127	0.004309	0.050937	0.010229	0	0.102765
	37	ImpRent	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.131249
	38	OthFinan	0.046264	0.013575	0.072027	0.130883	0.016149	0.016405	0.036609	0.022391	0.030723	0.074568	0.096963	0.084356	0.059292	0	0	0	0.105686
	39	BusServ	0.004151	0.004915	0.011201	0.036884	0.014488	0.065847	0.018147	0.037622	0.012301	0.036778	0.043334	0.049041	0.042277	0	0.152416	0	0.005258
	40	PersOMiS	0.011228	0.01773	0.047375	0.024216	0.013298	0.018943	0.05639	0.048634	0.016412	0.009503	0.009831	0.007022	0.035024	0.038977	0.211372	0	0.147692
	41	TransMar	0.012462	0.006905	0.001073	0.004333	0.016415	0.014698	0.003038	0.00075	0.004583	0.001443	0.001014	0.000146	0.002093	0.020616	0.002416	0	0.006755
	42	OpOfCaLa	0.026262	0.010064	0.088276	0.050155	0.022465	0.007987	0.020031	0.011566	0.014764	0.012583	0.011632	0.010004	0.024089	0	0	0	0.003312
	43	TraAdvPr	8.5E-05	0	0.002147	0.007372	0.017676	0.004548	0.01937	0.015597	0.00609	0.054314	0.050393	0.023329	0.028658	0	0	0	0.001577
	44	LabInc	0.094104	0.187185	0.285186	0.179145	0.21946	0.30775	0.338122	0.396943	0.201244	0.500377	0.494322	0.192953	0.420889	0	0	0	0.036606
	45	NetInUnB	0.149585	0.262259	0.031492	0.00306	0.000803	0.036371	0.017494	0.001728	0.000586	0.009206	0.037216	0.082751	0.124534	0	0	0	0

Table E.8. Provincial Industry Technology Matrix B

							O	U	T	P	U	T	S					
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
		Agricultur	FishgTrap	LogForest	Mining	Manufact	Construct	Transport	Communic	OthrUtil	WholeTra	RtailTra	FinRealEs	ComBusS	OpOfCaLa	TraAdvPrc	TransMarg	Household
	1 Grains	0.042627	0	0	0	0.008334	0	0	0	0	0.000468	0	0	0	0	0	0	0
	2 OthAgrPr	0.104369	0	0	0	0.069221	0.001917	0.000203	0	0	0.000166	0.000305	0	0.003605	0.005685	0	0	0.009184
	3 ForestPr	0	0	0.185886	0	0.007834	0.000349	0	0	0	0	0	0	0	0	0	0	0.000803
	4 FishTrap	0	0.010657	0	0	0.003117	0	0	0	0	0	0	0	0.000704	0.000259	0	0	0.000767
	5 MetalCon	0	0	0	0	0.073987	0	0	0	0	2.6E-05	0	0	7.6E-05	0	0	0	0
	6 MinFuels	0.000609	0.00029	0.000771	0.000103	0.013521	6.5E-05	0.001402	0	0.00756	0	0.002477	0.001769	0.001097	0	2.8E-05	0	0.004197
	7 NonMetMn	0.001539	0.001564	0	0.007783	0.003504	0.006814	0.000346	0	0	1.6E-05	6.6E-06	0	8.9E-05	5.2E-05	0	0	0.000197
	8 MinServ	0	0	0	0.025234	0	0.013388	0	0	0	0	0	0	0	0	0	0	0
	9 MeFiDaPr	0.000357	0	0	0	0.018246	0	0	0	0	9.9E-05	0.000442	0	0.029475	0.062485	0	0	0.029418
	10 FrVeFeMF	0.060855	0.002317	0	0	0.012741	0	0.000283	0	0	0.001	0.001883	0	0.018595	0.017641	0	0	0.037932
	11 Beverage	0	0	0	0	0.001335	0	0	0	0	1.1E-06	0	0	0.001686	0.001824	0.004073	0	0.01174
	12 TobaToPr	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.004883
	13 RuLePlFP	0.001112	0	0	0	0.012392	0.013858	0.005424	2.5E-05	0	0.002933	0.002886	0	0.001127	0.052836	0.000123	0	0.006453
	14 TextileP	0.001062	0.021141	0.000988	2.4E-05	0.020074	0.00607	0.000595	0.000182	0	0.000488	0.000791	0	0.002942	0.005622	0	0	0.0033
I	15 KnitPrCl	0	0	0	0	0.001353	0	0	0	0	0	0.00193	0	0.000263	0.008174	0	0	0.022699
	16 LuSawOWP	0.000259	0.005792	0	4.5E-06	0.009877	0.038069	0	0	0	0.001485	0.000362	0	0.00113	0.001003	0	0	0.000563
	17 FurnFix	0	0	0	0	0.001179	0.000533	0	7.1E-05	0	0	9.3E-05	6.4E-05	0.00017	0	0	0	0.006748
N	18 PapPapPr	0	0	0	0	0.032057	0.005387	0.000954	0	0	0.007133	0.012298	0	0.005325	0.050347	0.000334	0	0.005324
	19 PrintPub	0	0	0	0	0.001964	0	0.000518	0.049099	0.00055	0	0.000956	0.000997	0.001086	0.154051	0.179087	0	0.007601
	20 PrimMePr	0	0	0	0.007358	0.03896	0.020206	0.002157	0	0	0.000343	0	0	0.000244	0.005745	0	0	0
P	21 MetFabPr	0.003118	0.003301	0	0.000386	0.020491	0.072102	0.001652	0	0	0.00295	0.003019	0	0.000324	0.048842	0	0	0.001751
	22 MachEqui	0.010652	0.009673	0.002544	0.016091	0.019528	0.007014	7.7E-05	3.2E-05	0	0.000307	0	0.000244	1.9E-05	0.076312	0	0	0.00173
	23 AuTruOte	0.000253	0.058094	0	0	0.03045	0.000638	0.032502	1.2E-05	0	6.5E-05	0	0	0	0.026233	0.002185	0	0.030452
U	24 EleComPr	0	0.023805	0	0.000808	0.01454	0.033409	0.000754	0.019813	0.003128	0.000318	0	0	2.5E-05	0.059007	0.000295	0	0.012047
	25 NoMetMiP	2.3E-05	0.000927	6.8E-05	0.003418	0.010348	0.04437	0.001209	0	0	0.000245	8.6E-05	0	0.000718	0.004372	0	0	0.0018
	26 PetCoalP	0.042597	0.040776	0.013708	0.008868	0.003863	0.010913	0.045318	0.003297	0.006791	0.012207	0.007921	0.001351	0.005904	0.001259	0.015977	0	0.013705
T	27 ChemChPr	0.119028	0.001332	0.000853	0.013819	0.025572	0.010735	0.001007	0.00012	0	0.001304	0.000548	0	0.003978	0.05091	6.5E-05	0	0.01288
	28 MiManuPr	0	0.009557	0	0	0.005053	0.006167	0.000359	0.000802	0	0.000507	0.000659	0	0.004814	0.028607	0.017291	0	0.015595
	29 ResConst	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S	30 NonResCo	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	31 RepConst	0.016373	0.040544	0.008119	0	0.002737	0.000644	0.037845	0.028802	0.043363	0	0.003854	0.035246	0.001932	0	0	0	0.000659
	32 TransSto	0.003401	0.013206	0.090392	0.009773	0.004926	0.003971	0.099955	0.01627	0.001192	0.016765	0.008109	0.000981	0.003246	0	0.199212	1	0.031583
	33 CommunSe	0.005309	0.000811	0.000947	0.001701	0.005877	0.001725	0.017074	0.038515	0.004239	0.029636	0.021845	0.011351	0.01914	0	0.080588	0	0.023927
	34 OthUtil	0.017951	0.000753	0.001299	0.021383	0.015883	0.000833	0.011008	0.004185	0.019341	0.009939	0.024782	0.013487	0.011678	0	1.6E-05	0	0.029264
	35 WhlslMrg	0.039181	0.033073	0.008796	0.016881	0.034544	0.046763	0.025856	0.004449	0.002096	0.014397	0.004538	0.000518	0.010341	0.146488	0.013054	0	0.038348
	36 RtlMarg	0.004976	0.003823	0.000352	0.000326	0.000171	0.006737	0.000905	0.002622	0.000435	0.001008	0.000753	7.3E-05	0.005615	0.049702	0.012541	0	0.106612
	37 ImpRent	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.143078
	38 OthFinan	0.060645	0.013785	0.010338	0.040611	0.01752	0.018017	0.040746	0.018097	0.053791	0.088444	0.101819	0.09356	0.049458	0	0	0	0.111956
	39 BusServ	0.005351	0.004749	0.012273	0.02464	0.012116	0.067449	0.016832	0.035085	0.012823	0.044034	0.045585	0.032578	0.032965	0	0.131865	0	0.006848
	40 PersOMiS	0.014536	0.008688	0.07184	0.016458	0.00953	0.018964	0.062314	0.033447	0.022032	0.010568	0.009712	0.005721	0.025601	0.028242	0.265794	0	0.160878
	41 TransMar	0.018576	0.005039	0.001137	0.006058	0.017595	0.017053	0.004061	0.001175	0.003653	0.001968	0.001325	0.00012	0.003053	0.021086	0.003301	0	0.008432
	42 OpOfCaLa	0.049051	0.004054	0.160027	0.040481	0.022033	0.0091	0.019448	0.011901	0.015907	0.019131	0.018615	0.010472	0.029276	0	0	0	0.005254
	43 TraAdvPr	4.4E-05	0	0.002693	0.00639	0.017965	0.004987	0.018042	0.013985	0.0063	0.068032	0.054821	0.016123	0.026605	0	0	0	0.002038
	44 LabInc	0.064004	0.280626	0.071597	0.21484	0.222729	0.312214	0.346763	0.394524	0.220947	0.467675	0.464487	0.166808	0.400986	0	0	0	0.050831
	45 NetInUnB	0.125215	0.270663	0.146238	0.00436	0.001022	0.049352	0.015397	0.015916	0.001021	0.010504	0.036189	0.091971	0.152146	0	0	0	0

Table E.9. National Final Demand Matrix (CLOSED MODEL) 1990 Aggregation - S (millions $)

	1	2	3	4	5	6	7	8	9	10	11
	BusConst	GovConst	BusM&E	GovM&E	Inventory	Exports	ReExports	Imports	GrossCurr	Sales	Total
	1FCF	2FCF	3FCF	4FCF	VPC	E	R	M	GGCE	GR	
1 Grains	0	0	0	0	740	2794.7	2	-102.1	0	0	3434.6
2 OthAgrPr	0	0	0	0	7.7	2038.7	45.4	-2264.2	429.1	-41.1	215.6
3 ForestPr	0	0	0	0	-75.6	117.6	6.2	-207	0	-17.7	-176.5
4 FishTrap	0	0	0	0	-7.9	384.8	18.6	-39	0	-1.6	354.9
5 MetalCon	0	0	0	0	53.1	6532	4	-2472.4	0	0	4116.7
6 MinFuels	0	0	0	0	42.5	9596.5	1.4	-6479	181	-220.5	3121.9
7 NonMetMn	0	0	0	0	59.4	927.3	142.6	-642.4	155.4	-5.7	636.6
8 MinServ	0	0	0	0	0	0	0	0	0	0	0
9 MeFiDaPr	0	0	0	0	-19.8	3662.2	49.4	-2077	4.5	0	1619.3
10 FrVeFeMF	0	0	0	0	148.1	1581.3	64.4	-3323.4	0	0	-1529.6
11 Beverage	0	0	0	0	323.6	631.8	5.4	-975.1	0	0	-14.3
12 TobaToPr	0	0	0	0	14.6	104	1.3	-98.7	0	0	21.2
13 RuLePlFP	0	0	33.6	17	-137.2	2042.7	141.1	-5069.7	0.2	0	-2972.3
14 TextileP	0	0	16.5	16.1	-167.8	929.3	67.3	-3241.7	189.9	0	-2190.4
15 KnitPrCl	0	0	0	0	-40.3	366.8	39.8	-3611.1	179.1	-5.5	-3071.2
16 LuSawOWP	0	0	2.8	0.8	169	5934.5	111.7	-1034.1	0	-7.1	5177.6
17 FurnFix	0	0	1827.5	306.9	-72	777.6	107.2	-1535.7	35.8	0	1447.3
18 PapPapPr	0	0	0	0	-252.9	13457.4	45.4	-2713.6	23.3	0	10559.6
19 PrintPub	0	0	0	0	33.2	480.4	51.8	-2446.4	717.9	-130.8	-1293.9
20 PrimMePr	0	0	-530	0	-729.1	10457.1	85.6	-5267.5	0	-3.6	4012.5
21 MetFabPr	0	0	1375.9	69.6	-451.8	2178.3	284.7	-5155.9	208.2	-0.7	-1491.7
22 MachEqui	0	0	15363.2	838.2	-861.6	7129.3	1555.5	-20078.6	239.3	-8.6	4176.7
23 AuTruOte	107.1	0	7798.3	477	-1839.9	38895.8	1572.5	-36749.2	1601.7	-4.2	11859.1
24 EleComPr	0	0	5624.5	431.7	-39.9	6367.5	1105.1	-15009.6	515.7	-0.7	-1005.7
25 NoMetMiP	0	0	33.7	0.3	-48.2	902.6	37.5	-2115	0	0	-1189.1
26 PetCoalP	0	0	0	0	1860.6	3480.3	9.4	-2858.4	634.1	-25.1	3100.9
27 ChemChPr	0	0	280.3	0	130.2	5905.2	341.6	-8946.2	2103.5	-114.7	-300.1
28 MiManuPr	0	0	835.3	403.2	-186.8	2761	525.6	-8642.9	868.1	-54.7	-3491.2
29 ResConst	35908.4	14	0	0	0	0	0	0	0	0	35922.4
30 NonResCo	36228.4	13170	0	0	0	0	0	0	343.2	0	49741.6
31 RepConst	0	0	0	0	0	0	0	0	3662.1	0	3662.1
32 TransSto	0	0	0	0	0	2349.9	0	-1021	1941.4	-593.3	2677
33 CommunSe	0	0	0	0	0	618.7	0	-759	1647.8	-30.1	1477.4
34 OthUtil	0	0	0	0	0	545.6	0	-588.1	2668.2	-3196.8	-571.1
35 WhlslMrg	8.9	0	6277.1	382.3	0	5613.7	0	-637.9	997.1	-20.4	12620.8
36 RtlMarg	7.9	0	600.2	28.7	0	0	0	0	989.9	-20.9	1605.8
37 ImpRent	0	0	0	0	0	0	0	0	0	0	0
38 OthFinan	8270	0	0	0	0	1812.6	0	-4552.3	2969.2	-2328.3	6171.2
39 BusServ	0	0	0	33	0	3252.8	0	-5533.6	6770.2	-1113.6	3408.8
40 PersOMiS	0	0	0	0	0	1263.9	19.3	-1523.1	17560.9	-9591.3	7729.7
41 TransMar	3.2	0	573.6	51	0	6734.7	63	0	195.9	0	7621.4
42 OpOfCaLa	0	0	0	0	0	0	0	0	5893.6	0	5893.6
43 TraAdvPr	0	0	0	0	0	0	0	0	2480.1	0	2480.1
44 LabInc	0	0	0	0	0	218.8	0	0	85429.8	0	85648.6
45 NetInUnB	0	0	0	0	0	0	0	0	0	0	0
46 Total	80533.9	13184	40112.5	3055.8	-1348.8	152847.4	6504.8	-157771	141636.2	-17537	261217.9

Table E.10. Provincial Final Demand Matrix (CLOSED MODEL) 1990 Aggregation - S (thousands $)

	1	2	3	4	5	6	7	8	9	10	11
	BusConst	GovConst	BusM&E	GovM&E	Inventory	Exports	ReExports	Imports	GrossCurr	Sales	Total
	1FCF	2FCF	3FCF	4FCF	VPC	E	R	M	GGCE	GR	
1 Grains	0	0	0	0	170066	600110	136	-50795	0	0	719517
2 OthAgrPr	0	0	0	0	46899	625199	746	-271147	864	-1642	400919
3 ForestPr	0	0	0	0	865	3950	24	-5544	0	0	-705
4 FishTrap	0	0	0	0	-251	2055	4097	-27279	0	0	-21378
5 MetalCon	0	0	0	0	-573730	280366	0	-16851	0	0	-310215
6 MinFuels	0	0	0	0	670626	115282	0	-135732	8279	-156	658299
7 NonMetMn	0	0	0	0	2364	19008	54	-32675	1108	-184	-10325
8 MinServ	0	0	0	0	0	20357	0	-3693	0	0	16664
9 MeFiDaPr	0	0	0	0	-833	412969	2521	-340229	151	0	74579
10 FrVeFeMF	0	0	0	0	8968	428833	839	-590144	0	0	-151504
11 Beverage	0	0	0	0	15434	22392	101	-72116	0	0	-34189
12 TobaToPr	0	0	0	0	-38	0	0	-68587	0	0	-68625
13 RuLePlFP	0	0	1186	1416	-818	158603	1789	-259816	3	0	-97637
14 TextileP	0	0	401	1341	-3598	37603	242	-220931	7819	0	-177123
15 KnitPrCl	0	0	0	0	-1174	267576	940	-292562	6915	-153	-18458
16 LuSawOWP	0	0	873	26	7786	116173	3754	-129552	0	0	-940
17 FurnFix	0	0	57629	10809	-177	78937	2610	-103278	1821	0	48351
18 PapPapPr	0	0	0	0	-7437	265012	735	-318890	702	0	-59878
19 PrintPub	0	0	0	0	548	149277	253	-223076	15655	-2696	-60039
20 PrimMePr	0	0	-18000	0	10942	937728	186	-303356	0	-10	627490
21 MetFabPr	0	0	20060	2814	220	222062	2967	-359374	5274	-1	-105978
22 MachEqui	0	0	356176	42081	-7097	705200	54742	-706416	6020	-158	450548
23 AuTruOte	3170	0	235422	17542	2597	639281	68257	-974109	23841	0	16001
24 EleComPr	0	0	150240	2808	-4581	340938	6683	-579431	7466	0	-75877
25 NoMetMiP	0	0	688	13	-3209	28360	301	-126074	0	0	-99921
26 PetCoalP	0	0	0	0	8504	6919	1	-579948	19554	-1110	-546080
27 ChemChPr	0	0	0	0	-20893	224229	17071	-725390	88359	-8293	-424917
28 MiManuPr	0	0	17893	11031	-3145	106531	5100	-335612	28047	-598	-170753
29 ResConst	782482	0	0	0	0	0	0	0	0	0	782482
30 NonResCo	1255059	444000	0	0	0	0	0	0	3500	0	1702559
31 RepConst	0	0	0	0	0	0	0	0	177394	0	177394
32 TransSto	0	0	0	0	0	674956	0	-536426	54970	-20998	172502
33 CommunSe	0	0	0	0	0	245291	0	-233393	61255	-458	72695
34 OthUtil	0	0	0	0	0	72809	0	-16884	77948	-109780	24093
35 WhlslMrg	333	0	160702	13349	0	732852	0	-565141	30748	-628	372215
36 RtlMarg	304	0	22759	1406	0	145506	0	-178549	36854	-588	27692
37 ImpRent	0	0	0	0	0	0	0	0	0	0	0
38 OthFinan	183000	0	0	0	0	337404	0	-627751	112613	-69549	-64283
39 BusServ	0	0	0	1197	0	96840	0	-436820	162807	-98205	-274181
40 PersOMiS	0	0	0	0	0	418559	133	-688288	783248	-341578	172074
41 TransMar	62	0	14835	1861	0	1002678	2341	-278293	6907	0	750391
42 OpOfCaLa	0	0	0	0	0	0	0	0	249824	0	249824
43 TraAdvPr	0	0	0	0	0	0	0	0	112787	0	112787
44 LabInc	0	0	0	0	0	3931	0	0	3468117	0	3472048
45 NetInUnB	0	0	0	0	0	0	0	0	0	0	0
46 Total	2224410	444000	1020864	107694	318838	1.1E+07	176623	-1.1E+07	5560850	-656785	8328118

Table E.11. National Import, Government Sales, and Inventory Withdrawal to Use (Leakage) Coefficients
($ impact (leakage) per $1 commodity output, positive value indicates injection)

Commodity	Import (M)	Govt. Sales (A)	Inventory (V)
1 Grains	-0.04082	0	0.139788806
2 Other Agricultural Products	-0.12101	-0.00199	0.000371918
3 Forestry Products	-0.02506	-0.00211	-0.00903129
4 Fishing & Trapping Products	-0.0289	-0.00093	-0.004604
5 Metallic Ores & Concentrates	-0.36095	0	0.003969292
6 Minerals Fuels	-0.34965	-0.00784	0.001511106
7 Non-metallic Minerals	-0.28938	-0.0019	0.019769686
8 Services Incidental to Mining	0	0	0
9 Meat, Fish & Dairy Products	-0.10119	0	-0.00082024
10 Fruit,Veg.,Feed,Misc.Food Prod.	-0.16967	0	0.007017527
11 Beverages	-0.17247	0	0.051526201
12 Tobacco & Tobacco Products	-0.05428	0	0.007600604
13 Rubber,Leather,Plastic Fab.Prod.	-0.45725	0	-0.01056278
14 Textile Products	-0.38228	0	-0.01796208
15 Knitted Products & Clothing	-0.35316	-0.00052	-0.00381918
16 Lumber,Sawmill,Other Wood Prod.	-0.10359	-0.00045	0.010692819
17 Furniture & Fixtures	-0.26356	0	-0.01108187
18 Paper & Paper Products	-0.1768	0	-0.00879328
19 Printing & Publishing	-0.16021	-0.00833	0.002114811
20 Primary Metal Products	-0.30132	-0.00013	-0.02617681
21 Metal Fabricated Products	-0.25578	-3.2E-05	-0.02048905
22 Machinery and Equipment	-0.72358	-0.00026	-0.02585609
23 Autos,Trucks,Other Transp.Eqp	-0.70005	-4.7E-05	-0.02048462
24 Elec. & Communications Prod.	-0.56217	-2.2E-05	-0.00124836
25 Non-metallic Mineral Products	-0.24786	0	-0.00512859
26 Petroleum & Coal Products	-0.14718	-0.0011	0.081276592
27 Chemicals, Chemical Prod.	-0.32843	-0.0035	0.003969185
28 Misc. Manufactured Products	-0.64108	-0.00348	-0.01188507
29 Residential Construction	0	0	0
30 Non-residential Construction	0	0	0
31 Repair Construction	0	0	0
32 Transportation & Storage	-0.02266	-0.01251	0
33 Communication Services	-0.0342	-0.00132	0
34 Other Utilities	-0.02153	-0.11475	0
35 Wholesale Margins	-0.01427	-0.00041	0
36 Retail Margins	0	-0.00045	0
37 Imputed Rent Owner Ocpd. Dwel.	0	0	0
38 Other Finance,Ins.,Real Estate	-0.04557	-0.02289	0
39 Business Services	-0.12645	-0.02369	0
40 Personal & Other Misc.Service	-0.0149	-0.09271	0
41 Transportation Margins	0	0	0
42 Operating,Office,Lab & Food	0	0	0
43 Travel, Advertising, Promotion	0	0	0
44 Labour Income	0	0	0
45 Net Income Uninc. Business	0	0	0

Table E.12. Provincial Import, Government Sales, and Inventory Withdrawal to Use (Leakage) Coefficients
($ impact (leakage) per $1 commodity output, positive value indicates injection)

Commodity	Import (M)	Govt. Sales (A)	Inventory (V)
1 Grains	-0.31987	0	0.224132614
2 Other Agricultural Products	-0.29994	-0.00107	0.030684026
3 Forestry Products	-0.06582	0	0.009811483
4 Fishing & Trapping Products	-0.66918	0	-0.00648194
5 Metallic Ores & Concentrates	-0.00354	0	-0.11392148
6 Minerals Fuels	-0.07831	-8.4E-05	0.362766046
7 Non-metallic Minerals	-0.50722	-0.00221	0.028354163
8 Services Incidental to Mining	-0.05312	0	0
9 Meat, Fish & Dairy Products	-0.47783	0	-0.00074211
10 Fruit,Veg.,Feed,Misc.Food Prod.	-0.69375	0	0.007013647
11 Beverages	-0.38886	0	0.074292646
12 Tobacco & Tobacco Products	-0.99945	0	-0.00055373
13 Rubber,Leather,Plastic Fab.Prod.	-0.8334	0	-0.00174574
14 Textile Products	-0.89797	0	-0.01269611
15 Knitted Products & Clothing	-0.83705	-0.00025	-0.00190538
16 Lumber,Sawmill,Other Wood Prod.	-0.60845	0	0.023931887
17 Furniture & Fixtures	-0.57619	0	-0.00069257
18 Paper & Paper Products	-0.49289	0	-0.00816128
19 Printing & Publishing	-0.46628	-0.0043	0.000873393
20 Primary Metal Products	-0.85633	-7.7E-06	0.008470391
21 Metal Fabricated Products	-0.71436	-1.4E-06	0.00030464
22 Machinery and Equipment	-0.91929	-0.00011	-0.00500177
23 Autos,Trucks,Other Transp.Eqp	-0.87687	0	0.001544067
24 Elec. & Communications Prod.	-0.89325	0	-0.00466055
25 Non-metallic Mineral Products	-0.49449	0	-0.01133862
26 Petroleum & Coal Products	-1.00588	-0.0019	0.014574696
27 Chemicals, Chemical Prod.	-0.8418	-0.00776	-0.01954681
28 Misc. Manufactured Products	-0.84166	-0.0012	-0.00628775
29 Residential Construction	0	0	0
30 Non-residential Construction	0	0	0
31 Repair Construction	0	0	0
32 Transportation & Storage	-0.24435	-0.00732	0
33 Communication Services	-0.28595	-0.00043	0
34 Other Utilities	-0.01891	-0.11366	0
35 Wholesale Margins	-0.36567	-0.00028	0
36 Retail Margins	-0.10637	-0.00032	0
37 Imputed Rent Owner Ocpd. Dwel.	0	0	0
38 Other Finance,Ins.,Real Estate	-0.18527	-0.01867	0
39 Business Services	-0.35716	-0.0744	0
40 Personal & Other Misc.Service	-0.18073	-0.08081	0
41 Transportation Margins	-0.6465	0	0
42 Operating,Office,Lab & Food	0	0	0
43 Travel, Advertising, Promotion	0	0	0
44 Labour Income	0	0	0
45 Net Income Uninc. Business	0	0	0

Table E.13. National Impact Matrix [I - D (I - P - A - V) B]-1 D (I - P - A -V) (TRANSPOSED)

							O	U	T	P	U	T	S						
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
		Agricultur	FishgTrap	LogForest	Mining	Manufact	Construct	Transport	Communi(	OthrUtil	WholeTra	RtailTra	FinRealEs	ComBusS	OpOfCaLa	TraAdvPrc	TransMarg	Household	Total
	1 Grains	1.35959	0.002372	0.019252	0.045296	0.564537	0.04479	0.086341	0.04796	0.064076	0.103861	0.123296	0.342232	0.19712	0.069873	0.040394	0.036066	0.902623	4.04968
	2 OthAgrPr	1.06128	0.001892	0.036442	0.036031	0.44973	0.03573	0.072689	0.038397	0.050973	0.082852	0.09886	0.27471	0.158849	0.05712	0.032447	0.028564	0.724029	3.240596
	3 ForestPr	0.061141	0.001843	1.140273	0.031213	0.404443	0.037275	0.175953	0.046174	0.048317	0.090084	0.130023	0.379193	0.244597	0.133525	0.043244	0.020306	0.963394	3.950997
	4 FishTrap	0.030396	0.984742	0.013248	0.03599	0.461864	0.044567	0.082899	0.042214	0.044911	0.094447	0.127165	0.309232	0.199339	0.041031	0.037208	0.024349	0.978717	3.552318
	5 MetalCon	0.01526	0.001068	0.006905	0.622419	0.252264	0.02002	0.037705	0.021724	0.034421	0.042667	0.052594	0.20273	0.114853	0.046828	0.024043	0.011695	0.393919	1.901116
	6 MinFuels	0.011924	0.000768	0.005019	0.68806	0.169554	0.020526	0.035885	0.021218	0.034446	0.041824	0.051638	0.207304	0.114938	0.047965	0.023022	0.01054	0.385507	1.870137
	7 NonMetMn	0.015693	0.001065	0.006916	0.733046	0.245773	0.022895	0.041927	0.024494	0.038987	0.051313	0.059274	0.232006	0.130331	0.053466	0.026921	0.012686	0.443556	2.140349
	8 MinServ	0.01851	0.001192	0.007791	1.068594	0.263188	0.031873	0.055714	0.032939	0.053485	0.064785	0.080171	0.321881	0.178457	0.074483	0.035738	0.016365	0.598509	2.903675
	9 MeFiDaPr	0.07407	0.00584	0.032285	0.074576	1.341212	0.0224	0.07564	0.037517	0.048697	0.072571	0.101824	0.234338	0.162963	0.052152	0.047044	0.030435	0.668361	3.081925
	10 FrVeFeMF	0.061189	0.004693	0.029752	0.068749	1.234849	0.020836	0.070659	0.035622	0.045501	0.080772	0.101889	0.221116	0.153473	0.048331	0.04477	0.028083	0.629682	2.879966
	11 Beverage	0.061161	0.005084	0.03219	0.074296	1.341321	0.021669	0.074113	0.036229	0.047398	0.070471	0.084417	0.2262	0.158234	0.051221	0.045632	0.03005	0.647333	3.007022
	12 TobaToPr	0.066329	0.005513	0.03491	0.080574	1.454663	0.0235	0.080373	0.039289	0.051402	0.07639	0.091547	0.245303	0.171597	0.055548	0.049486	0.032589	0.702002	3.261015
	13 RuLePlFP	0.036801	0.003055	0.019349	0.044663	0.805503	0.013131	0.04491	0.022128	0.028701	0.048266	0.051339	0.13774	0.096215	0.03093	0.027862	0.018103	0.39389	1.822586
	14 TextileP	0.04166	0.003461	0.021917	0.050589	0.913028	0.014791	0.050572	0.024779	0.032353	0.049081	0.058484	0.154615	0.108104	0.034921	0.031208	0.020474	0.442334	2.052369
I	15 KnitPrCl	0.044581	0.003703	0.023453	0.054133	0.976852	0.015845	0.054189	0.026583	0.034648	0.054369	0.061964	0.165759	0.115878	0.037394	0.033478	0.021915	0.474201	2.198947
	16 LuSawOWP	0.062204	0.005146	0.039691	0.075298	1.355426	0.022511	0.077072	0.038007	0.049054	0.079087	0.100128	0.237139	0.165165	0.053053	0.047763	0.030621	0.676261	3.113624
	17 FurnFix	0.050429	0.004191	0.026538	0.061252	1.105685	0.017882	0.061161	0.029927	0.039112	0.059095	0.069696	0.186783	0.130637	0.042252	0.037693	0.024781	0.534482	2.481596
N	18 PapPapPr	0.056568	0.0047	0.029765	0.0687	1.239938	0.020081	0.068679	0.033646	0.043915	0.067629	0.078306	0.209897	0.146771	0.047421	0.042375	0.027803	0.600556	2.78675
	19 PrintPub	0.057971	0.004818	0.030509	0.070416	1.271179	0.020549	0.070283	0.034377	0.044946	0.067457	0.080075	0.214586	0.150094	0.048562	0.043298	0.028485	0.614063	2.851667
	20 PrimMePr	0.046703	0.003881	0.024575	0.057191	1.023797	0.016581	0.056684	0.027754	0.036255	0.055251	0.064618	0.173237	0.12113	0.039166	0.034953	0.022955	0.495551	2.300284
P	21 MetFabPr	0.050226	0.004173	0.026424	0.06099	1.100642	0.017846	0.061037	0.029934	0.039024	0.06111	0.069626	0.186662	0.130499	0.042124	0.037697	0.02469	0.534022	2.476727
	22 MachEqui	0.017123	0.00142	0.008999	0.024127	0.374172	0.0062	0.021036	0.0104	0.013498	0.023201	0.024119	0.06507	0.04529	0.014592	0.013076	0.008449	0.185016	0.855788
	23 AuTruOte	0.019262	0.001599	0.010128	0.023398	0.421446	0.007007	0.027969	0.011618	0.015073	0.022888	0.026983	0.072293	0.050639	0.01626	0.014559	0.009492	0.206873	0.957487
U	24 EleComPr	0.029719	0.002462	0.015597	0.036019	0.648386	0.010927	0.036697	0.02859	0.023434	0.03949	0.04233	0.113355	0.079524	0.025168	0.022825	0.014655	0.324742	1.493918
	25 NoMetMiP	0.051877	0.004311	0.027297	0.063564	1.137148	0.018422	0.062978	0.030843	0.04028	0.061605	0.0718	0.192503	0.134594	0.043511	0.038842	0.025499	0.550637	2.55571
	26 PetCoalP	0.062124	0.005145	0.03259	0.132368	1.354608	0.023393	0.077103	0.038009	0.050351	0.074167	0.088741	0.243617	0.167871	0.055241	0.04756	0.03092	0.679614	3.163424
T	27 ChemChPr	0.054062	0.003719	0.023587	0.082145	0.97895	0.016889	0.055897	0.027662	0.036262	0.05832	0.064438	0.175716	0.121279	0.039558	0.034544	0.022417	0.493578	2.289026
	28 MiManuPr	0.0237	0.001966	0.012455	0.028751	0.518308	0.00848	0.028999	0.014333	0.018531	0.032291	0.033207	0.089128	0.062557	0.01995	0.01804	0.011664	0.254817	1.177176
	29 ResConst	0.035467	0.00233	0.015794	0.066195	0.548435	1.022471	0.083195	0.045301	0.045964	0.106976	0.124272	0.311136	0.254164	0.04415	0.045557	0.033488	0.935553	3.720448
S	30 NonResCo	0.035467	0.00233	0.015794	0.066195	0.548435	1.022471	0.083195	0.045301	0.045964	0.106976	0.124272	0.311136	0.254164	0.04415	0.045557	0.033488	0.935553	3.720448
	31 RepConst	0.035467	0.00233	0.015794	0.066195	0.548435	1.022471	0.083195	0.045301	0.045964	0.106976	0.124272	0.311136	0.254164	0.04415	0.045557	0.033488	0.935553	3.720448
	32 TransSto	0.027785	0.001787	0.018141	0.034483	0.396086	0.052363	1.143629	0.06081	0.057562	0.089306	0.125342	0.328835	0.253065	0.052946	0.058563	0.020018	0.94275	3.663472
	33 CommunSe	0.022382	0.001386	0.009139	0.022622	0.294437	0.038627	0.06745	1.040794	0.041521	0.058416	0.112914	0.281914	0.230299	0.036743	0.046762	0.014398	0.863262	3.183068
	34 OthUtil	0.012073	0.000766	0.005026	0.049355	0.167467	0.034989	0.033864	0.022807	0.902724	0.034794	0.055833	0.161975	0.105762	0.02824	0.022198	0.0118	0.431681	2.081354
	35 WhlslMrg	0.034892	0.002285	0.015799	0.036898	0.528795	0.026133	0.089552	0.069463	0.054001	0.900875	0.129442	0.372403	0.252448	0.045702	0.08591	0.020337	1.022841	3.687777
	36 RtlMarg	0.034647	0.001729	0.011454	0.029868	0.364106	0.030079	0.084599	0.072342	0.073924	0.072696	1.120458	0.431152	0.280993	0.044247	0.09034	0.018302	1.128746	3.889682
	37 ImpRent	0.016586	0.001004	0.006549	0.018472	0.209678	0.049957	0.044464	0.047962	0.043167	0.043185	0.083019	1.281746	0.179776	0.029986	0.048579	0.010741	0.658635	2.773506
	38 OthFinan	0.016545	0.000959	0.006528	0.020519	0.201094	0.04885	0.043769	0.045305	0.040932	0.042909	0.079752	1.176134	0.173386	0.028423	0.04548	0.010237	0.619011	2.599831
	39 BusServ	0.029169	0.001823	0.01069	0.026594	0.350838	0.023643	0.068678	0.064169	0.049939	0.082161	0.128162	0.345595	1.0579	0.048698	0.060011	0.017376	0.979797	3.345242
	40 PersOMiS	0.030764	0.001948	0.014386	0.029604	0.37541	0.027554	0.075703	0.062097	0.055308	0.107783	0.218595	0.373396	0.965639	0.049531	0.064632	0.018098	1.011089	3.481539
	41 TransMar	0.027785	0.001787	0.018141	0.034483	0.396086	0.052363	1.143629	0.06081	0.057562	0.089306	0.125342	0.328835	0.253065	0.052946	0.058563	1.020018	0.94275	4.663472
	42 OpOfCaLa	0.045042	0.003316	0.019887	0.047722	0.780293	0.018696	0.081835	0.037148	0.039198	0.187529	0.131561	0.215118	0.17577	1.037955	0.044496	0.040715	0.600227	3.506507
	43 TraAdvPr	0.032571	0.002327	0.016306	0.036907	0.542579	0.028021	0.254087	0.145916	0.045707	0.085608	0.131164	0.277769	0.474576	0.043449	1.050082	0.021036	0.785297	3.973404
	44 LabInc	0.036922	0.002131	0.01387	0.033064	0.429402	0.028886	0.086657	0.062186	0.06545	0.088062	0.203932	0.48722	0.28306	0.037968	0.04826	0.022082	1.697853	3.627007
	45 NetInUnB	0.036922	0.002131	0.01387	0.033064	0.429402	0.028886	0.086657	0.062186	0.06545	0.088062	0.203932	0.48722	0.28306	0.037968	0.04826	0.022082	1.697853	3.627007

Table E.14. Provincial Impact Matrix [I - D (I - P - A - V) B]-1 D (I - P - A - V) (TRANSPOSED)

						O	U	T	P	U	T	S							
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
		Agricultur	FishgTrap	LogForest	Mining	Manufact	Construct	Transport	Communi	OthrUtil	WholeTra	RtailTra	FinRealEs	ComBusS	OpOfCaLa	TraAdvPrc	TransMarc	Household	Total
	1 Grains	1.034502	0.000218	0.001061	0.012737	0.09169	0.027486	0.027195	0.018017	0.033359	0.046956	0.053986	0.171446	0.072165	0.062932	0.014538	0.009494	0.408524	2.086303
	2 OthAgrPr	0.834758	0.000176	0.000856	0.010278	0.073986	0.022179	0.021944	0.014538	0.026918	0.037889	0.043562	0.138343	0.058231	0.050781	0.011731	0.007661	0.329645	1.683475
	3 ForestPr	0.126212	0.000336	0.962207	0.018182	0.152127	0.023394	0.098049	0.020795	0.026261	0.053105	0.074161	0.174933	0.131997	0.177965	0.022895	0.005704	0.538187	2.60651
	4 FishTrap	0.005135	0.325585	0.000517	0.005582	0.03412	0.018416	0.015866	0.008864	0.011105	0.018064	0.033702	0.085806	0.041387	0.008016	0.007381	0.00201	0.293467	0.915024
	5 MetalCon	0.014044	0.000264	0.001435	0.831312	0.145864	0.00994	0.026242	0.01438	0.031784	0.029727	0.045059	0.137887	0.07416	0.046065	0.018318	0.004541	0.376653	1.807671
	6 MinFuels	0.011003	0.00024	0.00103	1.330642	0.073011	0.013821	0.037199	0.020016	0.046061	0.041093	0.064349	0.199148	0.107008	0.068026	0.024604	0.005901	0.537261	2.580412
	7 NonMetMn	0.007324	0.000143	0.000753	0.401133	0.065511	0.115866	0.016385	0.009432	0.017845	0.024059	0.030136	0.087537	0.050066	0.024646	0.011401	0.003093	0.249495	1.114823
	8 MinServ	0.008112	0.000177	0.000759	0.980989	0.053826	0.010189	0.027424	0.014756	0.033958	0.030295	0.04744	0.146818	0.078889	0.050151	0.018139	0.004351	0.396085	1.902356
	9 MeFiDaPr	0.055595	0.000669	0.004612	0.048703	0.58176	0.008411	0.019058	0.01181	0.019492	0.025775	0.031527	0.087411	0.047093	0.023905	0.018129	0.005266	0.261949	1.251167
	10 FrVeFeMF	0.025349	0.0004	0.002755	0.029096	0.346967	0.005015	0.01167	0.007365	0.011845	0.018518	0.025659	0.053878	0.029042	0.014151	0.011477	0.003112	0.161225	0.757525
	11 Beverage	0.056222	0.000897	0.006195	0.065382	0.782171	0.010819	0.025142	0.015546	0.025619	0.033528	0.040886	0.11441	0.062015	0.031041	0.024095	0.006921	0.344852	1.645741
	12 TobaToPr	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	13 RuLePlFP	0.013436	0.000215	0.00148	0.015621	0.186767	0.002607	0.006078	0.003778	0.006168	0.009359	0.009885	0.02771	0.015008	0.00746	0.005869	0.001658	0.083395	0.396492
	14 TextileP	0.007303	0.000117	0.000805	0.008492	0.101549	0.001413	0.003283	0.002035	0.003346	0.004364	0.005722	0.014974	0.008109	0.004044	0.003157	0.0009	0.045086	0.214698
I	15 KnitPrCl	0.013079	0.000209	0.001441	0.015204	0.18175	0.002544	0.005938	0.003698	0.006018	0.009506	0.009681	0.027088	0.014667	0.007274	0.005747	0.001615	0.081483	0.38694
	16 LuSawOWP	0.032623	0.000523	0.003726	0.037917	0.451129	0.006708	0.015652	0.010006	0.015839	0.027141	0.04074	0.072904	0.039172	0.018739	0.015654	0.00408	0.217191	1.009743
	17 FurnFix	0.034682	0.000554	0.003821	0.04033	0.482448	0.00668	0.01553	0.009608	0.015817	0.02107	0.025254	0.070682	0.038309	0.01916	0.014895	0.00427	0.21301	1.016118
N	18 PapPapPr	0.04079	0.000651	0.004494	0.047428	0.567217	0.007883	0.018351	0.011379	0.018658	0.026462	0.029843	0.083589	0.045289	0.022586	0.017656	0.005027	0.25175	1.199053
	19 PrintPub	0.043493	0.000694	0.004792	0.050579	0.605078	0.00837	0.019453	0.012029	0.019821	0.025996	0.031634	0.088524	0.047983	0.024015	0.018644	0.005354	0.266819	1.273279
	20 PrimMePr	0.012478	0.000199	0.001375	0.014511	0.1736	0.002401	0.005581	0.003451	0.005686	0.007447	0.009075	0.025395	0.013765	0.00689	0.005348	0.001536	0.076543	0.365281
P	21 MetFabPr	0.023403	0.000374	0.002578	0.027213	0.325495	0.004516	0.010507	0.006509	0.010691	0.014755	0.017087	0.047843	0.025926	0.012946	0.010095	0.002883	0.144131	0.686953
	22 MachEqui	0.006161	9.8E-05	0.000679	0.007409	0.085661	0.001193	0.002779	0.001723	0.002827	0.004029	0.00452	0.012666	0.006862	0.003424	0.002673	0.00076	0.038133	0.181598
	23 AuTruOte	0.009848	0.000158	0.001084	0.011453	0.136436	0.002188	0.010464	0.002915	0.004669	0.006214	0.0076	0.021261	0.011644	0.005619	0.00442	0.001233	0.064011	0.301217
U	24 EleComPr	0.007899	0.000127	0.000869	0.009172	0.109215	0.001799	0.00382	0.009229	0.003781	0.005231	0.006289	0.017473	0.009606	0.004525	0.0036	0.00099	0.053045	0.246672
	25 NoMetMiP	0.04046	0.000646	0.004458	0.047048	0.562746	0.007804	0.018154	0.011242	0.018476	0.025289	0.029521	0.082651	0.04479	0.022374	0.017435	0.004984	0.249016	1.187092
	26 PetCoalP	0.00053	8.5E-06	5.8E-05	0.000995	0.007353	0.000105	0.000246	0.000151	0.000253	0.000326	0.000402	0.00113	0.000612	0.000311	0.000233	6.7E-05	0.003387	0.016169
T	27 ChemChPr	0.029031	0.000152	0.001039	0.010998	0.130321	0.002322	0.004712	0.002952	0.004889	0.007478	0.007849	0.022393	0.011731	0.006343	0.00433	0.001323	0.065326	0.313189
	28 MiManuPr	0.012248	0.000196	0.001349	0.014237	0.17016	0.002388	0.005577	0.003478	0.005647	0.009158	0.009075	0.025462	0.013906	0.006825	0.005406	0.001513	0.076574	0.363201
	29 ResConst	0.018569	0.000356	0.002055	0.033173	0.147841	1.014571	0.038495	0.024949	0.02834	0.05978	0.083963	0.211191	0.14121	0.029194	0.026373	0.009849	0.679751	2.549659
S	30 NonResCo	0.018569	0.000356	0.002055	0.033173	0.147841	1.014571	0.038495	0.024949	0.02834	0.05978	0.083963	0.211191	0.14121	0.029194	0.026373	0.009849	0.679751	2.549659
	31 RepConst	0.018569	0.000356	0.002055	0.033173	0.147841	1.014571	0.038495	0.024949	0.02834	0.05978	0.083963	0.211191	0.14121	0.029194	0.026373	0.009849	0.679751	2.549659
	32 TransSto	0.01028	0.000236	0.001018	0.012084	0.067179	0.041983	0.835459	0.028549	0.029125	0.038269	0.066892	0.184629	0.11666	0.030275	0.03062	0.0041	0.547855	2.045213
	33 CommunSe	0.01032	0.000235	0.001046	0.010661	0.075624	0.031127	0.033339	0.750982	0.022852	0.025603	0.062457	0.159995	0.101452	0.022067	0.02435	0.003063	0.52597	1.861142
	34 OthUtil	0.006682	0.000154	0.000659	0.015858	0.041834	0.046306	0.018484	0.014841	0.896752	0.018947	0.043775	0.144656	0.070938	0.023929	0.015937	0.003223	0.369331	1.732307
	35 WhlslMrg	0.013312	0.000273	0.001333	0.013518	0.113391	0.012088	0.0375	0.032236	0.026318	0.613226	0.060998	0.192765	0.100524	0.026138	0.055395	0.003391	0.524223	1.826627
	36 RtlMarg	0.014392	0.000331	0.001385	0.017061	0.091589	0.02167	0.051516	0.042115	0.052444	0.037121	0.963809	0.297442	0.157626	0.03669	0.069672	0.004353	0.787348	2.646565
	37 ImpRent	0.008687	0.000201	0.000843	0.011457	0.05308	0.047458	0.024164	0.025329	0.031168	0.022834	0.05606	1.216996	0.093206	0.023422	0.029979	0.002648	0.48993	2.137461
	38 OthFinan	0.009338	0.000164	0.000685	0.009909	0.043338	0.039058	0.022903	0.020535	0.025222	0.020687	0.046919	0.951146	0.082626	0.019098	0.024218	0.002178	0.395654	1.713676
	39 BusServ	0.012251	0.000352	0.001049	0.011367	0.077752	0.012184	0.026705	0.044917	0.025796	0.052945	0.062762	0.174398	0.604757	0.028983	0.029818	0.003292	0.523878	1.693206
	40 PersOMiS	0.016026	0.000456	0.001875	0.015953	0.107215	0.01726	0.043372	0.033537	0.034281	0.064409	0.154363	0.237671	0.710342	0.036958	0.04053	0.004249	0.671117	2.189614
	41 TransMar	0.003634	8.3E-05	0.00036	0.004272	0.023748	0.014841	0.295334	0.010092	0.010296	0.013528	0.023646	0.065266	0.041239	0.010702	0.010824	0.354948	0.193666	1.076479
	42 OpOfCaLa	0.026025	0.000415	0.002117	0.022334	0.250598	0.006988	0.023139	0.013024	0.015288	0.104257	0.074093	0.085502	0.062006	1.01631	0.020058	0.010377	0.241897	1.974428
	43 TraAdvPr	0.017401	0.000374	0.001872	0.01908	0.176096	0.01914	0.189999	0.084321	0.024982	0.047286	0.086653	0.159175	0.312538	0.026866	1.027952	0.004917	0.467185	2.665839
	44 LabInc	0.022497	0.000549	0.002239	0.02161	0.126956	0.023588	0.056604	0.040791	0.052962	0.053469	0.16227	0.407811	0.18746	0.029396	0.031595	0.006317	1.487356	2.713471
	45 NetInUnB	0.022497	0.000549	0.002239	0.02161	0.126956	0.023588	0.056604	0.040791	0.052962	0.053469	0.16227	0.407811	0.18746	0.029396	0.031595	0.006317	1.487356	2.713471

Table E.15. City Impact Matrix [I - D (I - P - A - V) B]-1 D (I - P - A - V) (TRANSPOSED)

							O	U	T	P	U	T	S					
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
		Agricultur	FishgTrap	LogForest	Mining	Manufact	Construct	Transport	Communic	OthrUtil	WholeTra	RtailTra	FinRealEs	ComBusS	OpOfCaLa	TraAdvPrc	TransMarg	Household	Total
	1 Grains	0	0	0	0	0.09169	0.025511	0.027195	0.018017	0.033359	0.046956	0.053986	0.171446	0.072165	0.062932	0.014538	0.009494	0.408524	1.035811
	2 OthAgrPr	0	0	0	0	0.073986	0.020585	0.021944	0.014538	0.026918	0.037889	0.043562	0.138343	0.058231	0.050781	0.011731	0.007661	0.329645	0.835814
	3 ForestPr	0	0	0	0	0.152127	0.021713	0.098049	0.020795	0.026261	0.053105	0.074161	0.174933	0.131997	0.177965	0.022895	0.005704	0.538187	1.497892
	4 FishTrap	0	0	0	0	0.03412	0.017093	0.015866	0.008864	0.011105	0.018064	0.033702	0.085806	0.041387	0.008016	0.007381	0.00201	0.293467	0.576881
	5 MetalCon	0	0	0	0	0.145864	0.009226	0.026242	0.01438	0.031784	0.029727	0.045059	0.137887	0.07416	0.046065	0.018318	0.004541	0.376653	0.959903
	6 MinFuels	0	0	0	0	0.073011	0.012828	0.037199	0.020016	0.046061	0.041093	0.064349	0.199148	0.107008	0.068026	0.024604	0.005901	0.537261	1.236504
	7 NonMetMn	0	0	0	0	0.065511	0.10754	0.016385	0.009432	0.017845	0.024059	0.030136	0.087537	0.050066	0.024646	0.011401	0.003093	0.249495	0.697144
	8 MinServ	0	0	0	0	0.053826	0.009457	0.027424	0.014756	0.033958	0.030295	0.04744	0.146818	0.078889	0.050151	0.018139	0.004351	0.396085	0.911587
	9 MeFiDaPr	0	0	0	0	0.58176	0.007807	0.019058	0.01181	0.019492	0.025775	0.031527	0.087411	0.047093	0.023905	0.018129	0.005266	0.261949	1.140983
	10 FrVeFeMF	0	0	0	0	0.346967	0.004654	0.01167	0.007365	0.011845	0.018518	0.025659	0.053878	0.029042	0.014151	0.011477	0.003112	0.161225	0.699563
	11 Beverage	0	0	0	0	0.782171	0.010042	0.025142	0.015546	0.025619	0.033528	0.040886	0.11441	0.062015	0.031041	0.024095	0.006921	0.344852	1.516268
	12 TobaToPr	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	13 RuLePlFP	0	0	0	0	0.186767	0.002419	0.006078	0.003778	0.006168	0.009359	0.009885	0.02771	0.015008	0.00746	0.005869	0.001658	0.083395	0.365553
	14 TextileP	0	0	0	0	0.101549	0.001312	0.003283	0.002035	0.003346	0.004364	0.005722	0.014974	0.008109	0.004044	0.003157	0.0009	0.045086	0.19788
I	15 KnitPrCl	0	0	0	0	0.18175	0.002361	0.005938	0.003698	0.006018	0.009506	0.009681	0.027088	0.014667	0.007274	0.005747	0.001615	0.081483	0.356825
	16 LuSawOWP	0	0	0	0	0.451129	0.006226	0.015652	0.010006	0.015839	0.027141	0.04074	0.072904	0.039172	0.018739	0.015654	0.00408	0.217191	0.934472
	17 FurnFix	0	0	0	0	0.482448	0.0062	0.01553	0.009608	0.015817	0.02107	0.025254	0.070682	0.038309	0.01916	0.014895	0.00427	0.21301	0.936251
N	18 PapPapPr	0	0	0	0	0.567217	0.007316	0.018351	0.011379	0.018658	0.026462	0.029843	0.083589	0.045289	0.022586	0.017656	0.005027	0.25175	1.105125
	19 PrintPub	0	0	0	0	0.605078	0.007769	0.019453	0.012029	0.019821	0.025996	0.031634	0.088524	0.047983	0.024015	0.018644	0.005354	0.266819	1.173119
	20 PrimMePr	0	0	0	0	0.1736	0.002229	0.005581	0.003451	0.005686	0.007447	0.009075	0.025395	0.013765	0.00689	0.005348	0.001536	0.076543	0.336545
P	21 MetFabPr	0	0	0	0	0.325495	0.004192	0.010507	0.006509	0.010691	0.014755	0.017087	0.047843	0.025926	0.012946	0.010095	0.002883	0.144131	0.633059
	22 MachEqui	0	0	0	0	0.085661	0.001108	0.002779	0.001723	0.002827	0.004029	0.00452	0.012666	0.006862	0.003424	0.002673	0.00076	0.038133	0.167165
	23 AuTruOte	0	0	0	0	0.136436	0.002031	0.010464	0.002915	0.004669	0.006214	0.0076	0.021261	0.011644	0.005619	0.00442	0.001233	0.064011	0.278518
U	24 EleComPr	0	0	0	0	0.109215	0.00167	0.00382	0.009229	0.003781	0.005231	0.006289	0.017473	0.009606	0.004525	0.0036	0.00099	0.053045	0.228476
	25 NoMetMiP	0	0	0	0	0.562746	0.007243	0.018154	0.011242	0.018476	0.025289	0.029521	0.082651	0.04479	0.022374	0.017435	0.004984	0.249016	1.09392
	26 PetCoalP	0	0	0	0	0.007353	9.8E-05	0.000246	0.000151	0.000253	0.000326	0.000402	0.00113	0.000612	0.000311	0.000233	6.7E-05	0.003387	0.014569
T	27 ChemChPr	0	0	0	0	0.130321	0.002155	0.004712	0.002952	0.004889	0.007478	0.007849	0.022393	0.011731	0.006343	0.00433	0.001323	0.065326	0.271802
	28 MiManuPr	0	0	0	0	0.17016	0.002216	0.005577	0.003478	0.005647	0.009158	0.009075	0.025462	0.013906	0.006825	0.005406	0.001513	0.076574	0.334999
	29 ResConst	0	0	0	0	0.147841	0.941671	0.038495	0.024949	0.02834	0.05978	0.083963	0.211191	0.14121	0.029194	0.026373	0.009849	0.679751	2.422605
S	30 NonResCo	0	0	0	0	0.147841	0.941671	0.038495	0.024949	0.02834	0.05978	0.083963	0.211191	0.14121	0.029194	0.026373	0.009849	0.679751	2.422605
	31 RepConst	0	0	0	0	0.147841	0.941671	0.038495	0.024949	0.02834	0.05978	0.083963	0.211191	0.14121	0.029194	0.026373	0.009849	0.679751	2.422605
	32 TransSto	0	0	0	0	0.067179	0.038966	0.835459	0.028549	0.029125	0.038269	0.066892	0.184629	0.11666	0.030275	0.03062	0.0041	0.547855	2.018578
	33 CommunSe	0	0	0	0	0.075624	0.028891	0.033339	0.750982	0.022852	0.025603	0.062457	0.159995	0.101452	0.022067	0.02435	0.003063	0.52597	1.836644
	34 OthUtil	0	0	0	0	0.041834	0.042979	0.018484	0.014841	0.896752	0.018947	0.043775	0.144656	0.070938	0.023929	0.015937	0.003223	0.369331	1.705626
	35 WhlslMrg	0	0	0	0	0.113391	0.011219	0.0375	0.032236	0.026318	0.613226	0.060998	0.192765	0.100524	0.026138	0.055395	0.003391	0.524223	1.797323
	36 RtlMarg	0	0	0	0	0.091589	0.020113	0.051516	0.042115	0.052444	0.037121	0.963809	0.297442	0.157626	0.03669	0.069672	0.004353	0.787348	2.611839
	37 ImpRent	0	0	0	0	0.05308	0.044048	0.024164	0.025329	0.031168	0.022834	0.05606	1.216996	0.093206	0.023422	0.029979	0.002648	0.48993	2.112864
	38 OthFinan	0	0	0	0	0.043338	0.036252	0.022903	0.020535	0.025222	0.020687	0.046919	0.951146	0.082626	0.019098	0.024218	0.002178	0.395654	1.690774
	39 BusServ	0	0	0	0	0.077752	0.011308	0.026705	0.044917	0.025796	0.052945	0.062762	0.174398	0.604757	0.028983	0.029818	0.003292	0.523878	1.667311
	40 PersOMiS	0	0	0	0	0.107215	0.01602	0.043372	0.033537	0.034281	0.064409	0.154363	0.237671	0.710342	0.036958	0.04053	0.004249	0.671117	2.154063
	41 TransMar	0	0	0	0	0.023748	0.013774	0.295334	0.010092	0.010296	0.013528	0.023646	0.065266	0.041239	0.010702	0.010824	0.354948	0.193666	1.067063
	42 OpOfCaLa	0	0	0	0	0.250598	0.006486	0.023139	0.013024	0.015288	0.104257	0.074093	0.085502	0.062006	1.01631	0.020058	0.010377	0.241897	1.923034
	43 TraAdvPr	0	0	0	0	0.176096	0.017765	0.189999	0.084321	0.024982	0.047286	0.086653	0.159175	0.312538	0.026866	1.027952	0.004917	0.467185	2.625737
	44 LabInc	0	0	0	0	0.126956	0.021893	0.056604	0.040791	0.052962	0.053469	0.16227	0.407811	0.18746	0.029396	0.031595	0.006317	1.487356	2.664882
	45 NetInUnB	0	0	0	0	0.126956	0.021893	0.056604	0.040791	0.052962	0.053469	0.16227	0.407811	0.18746	0.029396	0.031595	0.006317	1.487356	2.664882

Table E.16. National Income, Value Added (GDPFC), Net Indirect Taxes and Employment Coefficients
($ impact per $1 industry output, employment is in person-years per $million output)

Industry	Income	Value Added	Net Indirect Taxes	Employment
1 Agricultural and Related Services	0.243690	0.463665	-0.047231	17.249787
2 Fishing and Trapping	0.449444	0.593154	0.013926	23.405500
3 Logging and Forestry	0.316678	0.408082	0.030864	7.193587
4 Mining, Quarrying and Oil Well	0.182205	0.527771	0.036297	4.423463
5 Manufacturing	0.220263	0.336379	0.011989	6.330806
6 Construction	0.344121	0.408759	0.071428	7.737129
7 Transportation and Storage	0.355616	0.499897	0.020886	10.962001
8 Communication	0.398671	0.729307	-0.001008	13.219665
9 Other Utility	0.201829	0.717744	0.041594	5.492065
10 Wholesale Trade	0.509583	0.669922	0.031853	12.295614
11 Retail Trade	0.531538	0.646110	0.037159	29.573879
12 Finance, Insurance, Real Estate	0.275705	0.637118	0.113998	5.085333
13 Commmunity, Business, Personal S	0.545422	0.669791	0.020095	23.286858
14 Operating, Office, Cafet., Lab Suppli	0.000000	0.000000	0.000000	29.811762
15 Travel, Advertising, Promotion	0.000000	0.000000	0.000000	36.450216
16 Transportation Margins	0.000000	0.000000	0.000000	0.000000
17 Household	0.114342	0.039354	0.077736	0.000000

Table E.17. Provincial Income, Value Added (GDPFC), Net Indirect Taxes and Employment Coefficients
($ impact per $1 industry output, employment is in person years per $thousand output)

Industry	Income	Value Added	Net Indirect Taxes	Employment
1 Agricultural and Related Services	0.189218	0.414281	-0.038558	0.017313
2 Fishing and Trapping	0.551289	0.643440	0.038807	0.057921
3 Logging and Forestry	0.217835	0.407957	0.036211	0.013532
4 Mining, Quarrying and Oil Well	0.219199	0.692524	0.029177	0.005425
5 Manufacturing	0.223751	0.367225	0.011287	0.007281
6 Construction	0.361566	0.445639	0.066134	0.007400
7 Transportation and Storage	0.362160	0.533543	0.019254	0.011254
8 Communication	0.410439	0.722676	-0.004911	0.014683
9 Other Utility	0.221969	0.747090	0.060088	0.005924
10 Wholesale Trade	0.478179	0.626790	0.032583	0.013481
11 Retail Trade	0.500676	0.621265	0.046021	0.033177
12 Finance, Insurance, Real Estate	0.258780	0.656989	0.118359	0.005769
13 Commmunity, Business, Personal S	0.553132	0.662115	0.035590	0.033413
14 Operating, Office, Cafet., Lab Suppli	0.000000	0.000000	0.074001	0.035950
15 Travel, Advertising, Promotion	0.000000	0.000000	0.074167	0.046269
16 Transportation Margins	0.000000	0.000000	0.000000	0.000000
17 Household	0.050831	0.054153	0.081688	0.000000

Appendix F - Outline of Revealing and Measuring the Economic Benefits

F.1 Revealing the Benefits: Theory and Methodologies

F.1.1 Valuing Benefits: Willingness to Pay and Willingness to Accept

Recall from Chapter 6 that it is assumed what people prefer is considered a benefit, and that the willingness to pay (WTP) for the benefit or the willingness to accept (WTA) compensation in order to *forego* the benefit leads to a monetary valuation. What cannot be assumed is that the WTP or WTA as measured by market prices is indicative of the whole benefit to either individuals or all of society. This is because some individuals may be willing to pay more (or accept less), which results in receiving a larger benefit than what the market price indicates. The "excess" that these individuals receive is known as consumer surplus, and it is included in WTP/WTA.

The relationship between WTP, market price and consumer surplus is:

WTP = market price + consumer surplus

A graphical representation of this is shown in Figure F.1. The price P_1 is reached through the dynamics of supply and demand; at that price quantity Q_1 is demanded. The total expenditure to obtain that amount is represented by the area $P_1E_1Q_1O$; the total benefit though is area ME_1Q_1O. Therefore, the excess of benefits, or consumer surplus, is area P_1ME_1. This area is an accumulation of those individuals who would

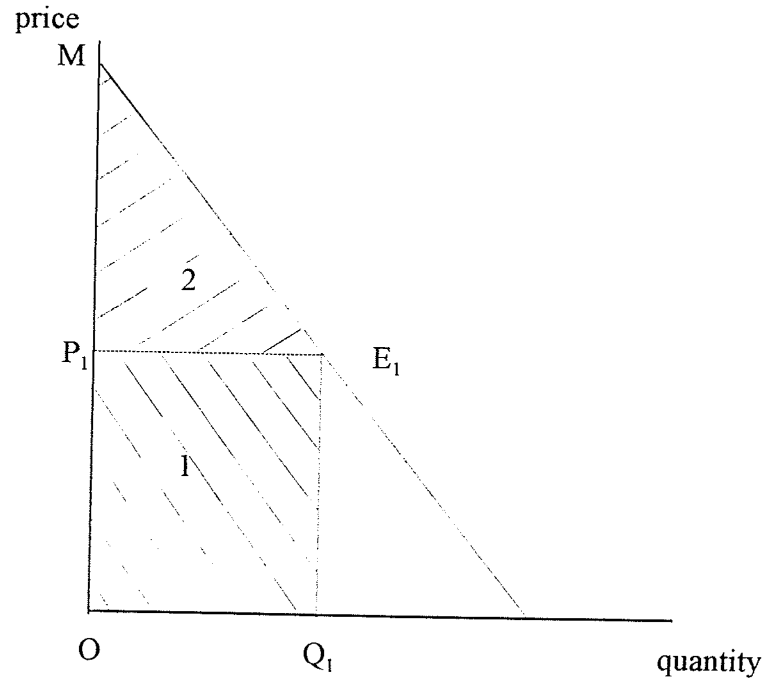


Figure F.1: Total Expenditure (Area 1), Consumer Surplus (Area 2), Total Benefit (Area 1 + 2)

have been willing to pay a higher price but instead were able to pay lower while still securing the desired amount of benefits.

An important requirement in the determination of these areas under the demand curve is that consumer income remains fixed all along the curve. For the purpose of this study it is enough to say that the demand curve is adjusted to assure this constancy. This characteristic defines the Marshallian demand curve. But to demonstrate what happens when there is a price change, the concepts of WTP and also willingness to accept (WTA) need a demand function that maintains constant consumer utility (welfare or "well-being") along its curve. The Hicksian income-compensated demand curve fulfils this requirement and is assumed to prevail in the explanation of price changes. In Figure F.2, the new price falls to P_2. As a result, the consumer surplus area increases, indicating an increase in consumer utility. The measurement of this benefit can be done in two different ways. First, the consumer can reveal what he/she is willing to pay (WTP) for the price fall from P_1 to P_2, thus insuring the gain in utility. This type of measurement is done in the context of the relative price and income associated with P_1, and is known as the compensating variation measure of benefit. Second, the consumer can reveal what he/she is willing to accept (WTA) in order to forego the price fall. This type of measurement is done in the context of the relative price and income associated with P_2, and is known as the equivalent variation measure of benefit. These are hypothetical situations, but they are considered valid in capturing the valuation of a benefit.

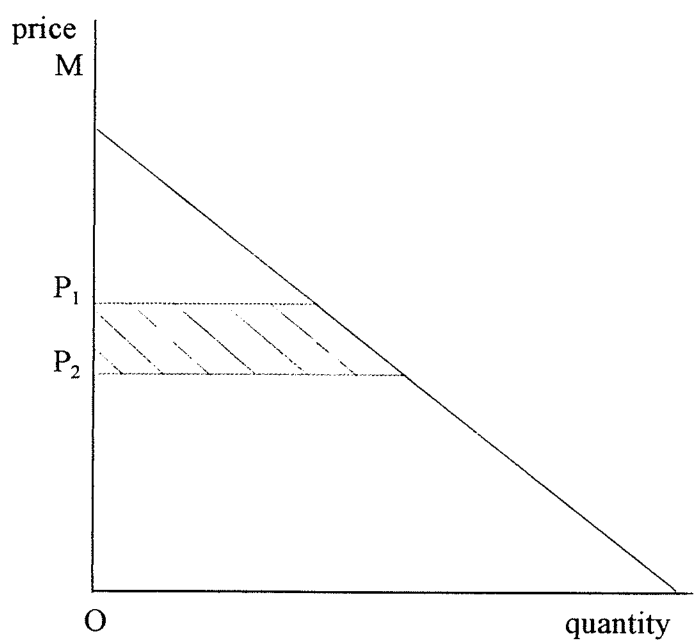


Figure F.2: WTP,WTA: Fall in Price

A consumer can reveal their WTP to gain environmental improvement or to prevent environmental degradation; he/she can also reveal a WTA to forego an improvement or tolerate degradation. The concepts of WTP and WTA are used in determining the value of an environmental gain (or loss) when there is a direct market, which is usually not the case. Instead, methodologies have been developed which try to compensate for the absence of markets.

F.1.2 Determining the Site Remediation Benefits

The remediation benefits would accrue from the reduction and/or complete removal of the following five site physical conditions described in Appendix A: 1.) soil contamination, 2.) surface water contamination, 3.) subsurface water contamination, 4.) ground-water contamination, and 5.) air contamination. With the nature of the physical medias just listed, it is obvious that the benefits of remediation would apply both onsite and offsite (adjacent to the site).

The most important benefits that will result from those discussed above are related to human health (beneficial changes in the environment for human health can be said to apply to animals and plants as well). But to actually place a monetary value on changes in human health resulting from environmental change, the link between environmental change and its valuation must be broken down into two relationships. First is the connection between the environmental change and the change in human health. An example of this would be the reduced incidence of illness when exposure to a particular contaminant is removed/reduced. Second is the relationship between this change in human health and its monetary equivalent. The wages associated with work days lost due to a worker's illness could be representative of such a value. Before proceeding with the methodologies for measuring these two relationships, how changes in health are defined and measured will be examined.

There are two definitions of a change in health: mortality and morbidity. Mortality is the change in health associated with the "well-defined" event of death. Morbidity is the change in health associated with a "departure from a state of physical or mental well-being, resulting from disease or injury, of which the affected individual is aware" (Freeman III, 1993, p. 316). With mortality, measuring a change in health is determining the risk of death; i.e., the probability of an individual dying. Measuring a change in health with respect to morbidity involves a further definition of what changes are considered adverse. Changes in health that are irreversible and cumulative (an example being repeated exposure to a carcinogen) are defined as adverse in the *economic sense* because an individual would behave in a manner as to reduce his/her risk of morbidity. The behaviour and choices made by the individual would reveal a value of reducing the risk. With morbidity, then, measuring a change in health is determining the risk of an adverse health effect.

A change in health is defined and measured in terms of the probability, or risk, of the change occurring. In other words, there is uncertainty involved because with most environmental changes, the expected changes in health do not occur with complete certainty. Exceptions to this uncertainty exist; for example, the change in health associated with the environmental change at ground zero of a nuclear explosion (i.e. 100% probability of death), but these are beyond the scope of environmental change discussed in the context of a contaminated site. Therefore, this study defines and measures changes in health with this dimension of risk. An individual's WTP (or WTA) would indicate his or her risk aversion to the change in health, and how much they are willing to pay to reduce it (or receive in compensation for accepting it).

Another point that must be made before proceeding with the measurement methodologies is the cumulative effect of each individual's WTP to reduce the mortality and morbidity risks. The benefits of risk reduction are the sum of what each affected individual is willing to pay *plus* the sum of what everyone else is willing to pay. This is often reflected in the costs of medical insurance and paid sick leave from work (the consumers eventually pay for this), two primary examples of the costs of illness being shifted from the individual to society at large. Also, an individual may derive benefits from knowing that other members of society, especially relatives, will have a reduced risk of mortality or morbidity. An individual's WTP would probably not include these two "exogenous" benefits, yet they nonetheless must be recognized as additional benefits arising from site remediation.

F.2 Measuring the Benefits: Methodologies

The benefits of environmental change in the direction of improvement can be revealed by how they reduce human health expenses. These benefits occur in at least five ways: 1.) savings in medical expenses associated with treating the adverse effects, *including* the opportunity cost of time that would have been used up in receiving the treatment; 2.) reductions in lost employment income; 3.) reduced defensive or averting expenditures associated with attempts to prevent the adverse effects; 4.) the regaining of utility (welfare, or "well-being") previously lost from less leisure time due to the adverse effects; and 5.) the improvement in well-being from the perceived decrease in risk of morbidity and/or mortality (Cropper and Freeman III in Braden and Kolstad, 1991). The first three benefits are determined by "regular" commodity markets and can therefore be measured in monetary terms directly. The last two benefits are not represented by such markets. But they cannot be ignored because of this; they are an integral part of the total benefits. The methodologies presented in this section show how these types of benefits can be measured.

In the previous section it was revealed that a monetary valuation of changes in human health resulting from environmental change required a breakdown into two relationships: 1.) environmental change and change in human health, and 2.) change in human health and its monetary valuation. Applying the concepts of valuing benefits (WTP,WTA) and changes to health (mortality, morbidity) to these relationships, two different approaches for performing a valuation of the benefits of site remediation will be examined.

F.2.1 Hedonic Property Value Method

Chapter 6 introduced the basic concept of the hedonic property values approach: the value of a property is determined by the attributes that make up that property (examples include size, location, agricultural output, shelter, and proximity of the property to an area of environmental degradation).

A relationship between the value of a property and its many attributes is defined through the use of regression analysis. Regression analysis attempts to link the dependent variable of property value with the many independent attributes of that property. Data on a mix of properties in the area at a single point in time would be a cross-sectional analysis; the same properties over time would be a time-series analysis. It is extremely important to capture as many of the attributes as possible that make up the value of a property, as determining what effect one attribute has is subject to the inclusion of all of the attributes. In the case of a contaminated site, emphasis must be placed on proximity to the site (Mendelsohn et al, 1992). If any relevant attribute is excluded from the analysis then the estimated effects on property value of the included attributes could be biased (Bartik, 1988, Frankel, 1985, Graves, 1988). The direction of the bias would depend on how the variables relate to each other (including the excluded one) and to the property value. If an irrelevant attribute is included, it would not cause a bias but it would lower the reliability of the estimates of the other attributes. Another issue with the hedonic price function would be the choice of functional form relating the dependent property value variable to the independent attribute variables (Milon et al, 1984). A linear function is not necessarily always the best; non-linear relationships may need to be tried to determine which best fits the relationship. In general the function would resemble the following:

property value (price) = f (property attributes, locational attributes, environmental attributes)

The estimation of the relationship between property values and environmental quality attributes can be used in the determination of how much an individual is willing to pay for an environmental improvement and also the resultant overall social benefit. There is typically a positive relationship between property values and environmental quality (OECD, 1989). Figure F.3 displays this relationship; notice that property values are observed to increase at a decreasing rate in response to the increase in environmental quality. PP is the hedonic price function. In order to isolate the demand for environmental quality, a relationship between what an individual is willing to pay and the demand for environmental quality is derived. The derivation of the relationship is accomplished through a process of inference. If the slope of the hedonic price function in Figure F.3 is plotted in Figure F.4 as AB, the marginal implicit price function is obtained. It represents the amount by which property values would increase with marginal increases in environmental quality, or, the amount of decrease if environmental quality decreased.

To determine the demand of an individual household for this commodity, the amount the household is willing to pay for it is needed. If a household chooses to live where the environmental quality level is Q_1, it is willing to pay P_1 (see Figure F.4). If the household demands Q_2, it pays P_2. If all the combinations of this household's demand for environmental quality and the willingness to pay for it are plotted on the

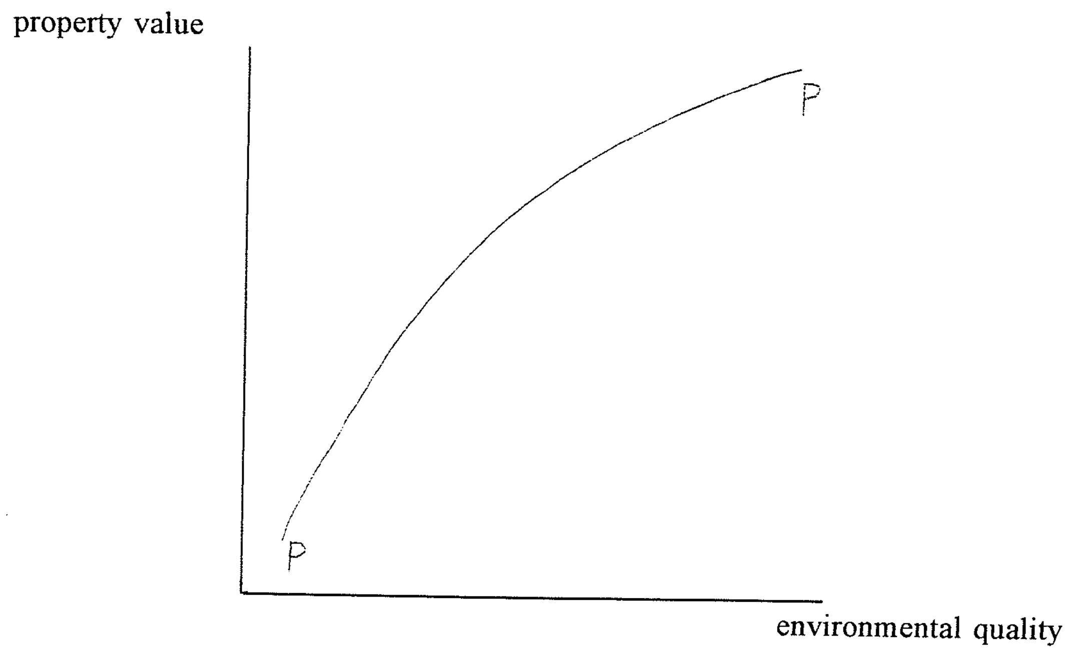


Figure F.3: Hedonic Price Function

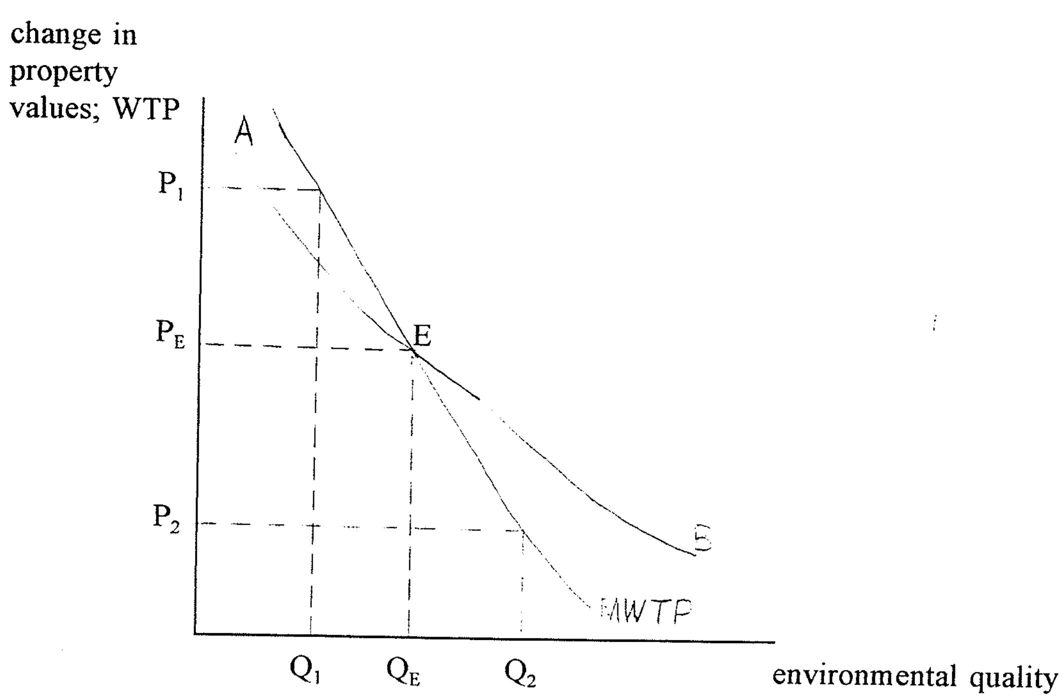


**Figure F.4: Marginal Implicit Price Function,
Marginal Willingness to Pay Curve**

graph of Figure F.4, the household's marginal willingness to pay (MWTP) curve is constructed. It shows the household's marginal willingness to pay for changes in environmental quality, holding all the other household characteristics constant. The MWTP curve consists of the locus of points satisfying marginal changes in Q values with their corresponding P values.

Where the marginal implicit price function and MWTP curves intersect represents a point of equilibrium, E. If the household is in equilibrium, these two curves must intersect because the combination of environmental quality and price (MWTP curve) that has been chosen (Q_E, P_E) by the household must equal the possible combinations of environmental quality and property values (marginal implicit price function). In other words, the price that the household is willing to pay must equal the "market" price determined by the hedonic price function for equilibrium to exist (Freeman III, 1993).

In the case of a site remediation, the hedonic property value method would be employed to those households directly adjacent to the site. But it would also be applied radiating out from the site to capture the diminishing property value differentials. Even though these offsite impacts would be small, in a large area they could incrementally add up to a substantial amount. As well, the benefits determined by this methodology could be extrapolated to estimate the property values on the actual site itself.

F.2.2 Contingent Valuation Method

Recall from Chapter 6 that the contingent valuation method (CVM) directly asks individuals what they are willing to pay or accept for an increase or decrease in the quantity of a commodity (environmental improvement or lack of), *contingent* upon a hypothetical market.

The methods of asking would be either through a direct questionnaire/survey or by experimental techniques in which individuals "respond to various stimuli in laboratory conditions" (OECD, 1989). The makeup of the hypothetical market - the questioner, questionnaire/survey, respondent, and/or laboratory settings - must resemble a real market as closely as possible. Therefore, the respondent must be familiar with the commodity in question, how it fits into the institutional framework, and how the WTP/WTA value would be hypothetically payed. In the case of a contaminated site, the respondent would need to know the whereabouts of the site in relation to his/her own environment, the environmental and health risks associated with the site, and perhaps the degree to which the remediation would reduce them. The respondent's familiarity with the institutional framework of the created market would aid in judging the functionality of the market (Randall, 1987). Examples of payment would be through taxation or direct compensation from the party responsible for the site.

In general then, the contingent market method consists of the following three parts: 1.) a detailed description of the commodity being valued and the hypothetical circumstances under which it is made available to the respondent; 2.) questions which elicit the respondents' WTP for the commodity being valued; and 3.) questions about respondents' characteristics, their preferences relevant to the commodity being valued, and their use of the commodity. The first part requires the researcher to construct a model of the market in considerable detail. This market is presented to the respondent and is meant to be as believable as possible. It describes the commodity to be valued, the "baseline level of provision", the structure under which the commodity is to be supplied, the range of available substitutes, and the financing vehicle. To create a demand curve for the hypothetical market, the respondent is asked to value several levels of supply of the commodity. The second part's questions must be designed to "facilitate the valuation process" without biasing the respondent's WTP amounts. The third part seeks to determine characteristics such as age, income, etc. of the respondent. This information is often elicited in parts, some before the market is presented and some after. These characteristics are used as independent variables in a regression analysis to estimate the commodity's valuation function. The choice of these variables are important as "successful estimations using variables which theory identifies as predictive of people's willingness to pay are partial evidence for reliability and validity" (Mitchell and Carson, 1989).

If the study is well designed and carefully pretested, the respondents' answers to the questions should represent valid WTP (or WTA) responses.There can be inherent biases in the CVM which affect the accuracy of the results obtained. These will be discussed next.

Contingent Valuation Method Biases

Determining the accuracy of a valuation methodology is often difficult since the underlying reason for using the methodology is the lack of a direct market for the commodity in question. The results, therefore, cannot be compared to any "real" values. Revealing the biases will help to understand the degree of accuracy of the CVM.

Strategic bias results from the free rider problem. This problem occurs when individuals behave in a strategic manner: they do not reveal their true preferences when they realize that by not telling the truth they will still secure a benefit in excess of the costs they have to pay (Pearce and Turner, 1990). If a respondent knows that the commodity will be provided regardless of his/her response but that the cost of the commodity will be dependent on the response, the incentive to state an undervaluation of the commodity is created. An overvaluation could result if the cost is not dependent on the response but the provision of the commodity is (Freeman III, 1993). The incentive to "free ride" arises when the commodity in question has the characteristics of a public good - it is difficult to exclude anyone from it and the cost of one individual consuming the commodity tends not to be at the cost of other consumers (OECD, 1989). Environmental quality has these attributes. With a site remediation, the improvement would be felt by all those affected, regardless of individual differences in WTP. And one consumer of this commodity would not cost the other consumers any extra.

Design bias is caused by the presentation of the hypothetical market and/or the procedure to elicit information from the respondent. When the first bid is presented, the respondent could be influenced to conceive a pre-defined range in which the bidding process would occur (Adamowicz, 1991). Or if the respondent is not informed enough about the commodity and/or sees the questionnaire as a waste of time, he/she may readily agree to the bid or something close to it in order to hasten the interview. This is referred to as starting point bias.

Vehicle bias results from the financing details of how a respondent would be expected to pay (or receive) in order to consume the commodity. The type of vehicle could influence the response of a consumer. For example, a tax reduction is often viewed differently then a direct compensation payment, even if their final monetary values are equal.

The CVM can also contain *informational bias*; the amount of information (too much could cause the respondent to desire to "get it over with"), the order in which it is presented (the respondent could unconsciously priorize commodity attributes accordingly), the order in which the questions are presented, the amount of time given to elicit a response, and the quality of the information can influence the respondent, especially if the total cost of the environmental improvement is indicated (Bergstrom et al, 1990, Boyle et al, 1993, Kealy et al, 1990, Whittington et al, 1992) .

The fact that a contingent market is being used to determine the value of a commodity removes two of the most basic real market attributes affecting consumer behaviour: the possibility of paying too much, and the ability to become completely informed about the commodity to be purchased. Because there is no risk of "losing" money as in an actual market, and the fact that environmental quality is often intangible in the more common definition of a commodity, *hypothetical bias* arises. However, a respondent does have something to "lose" in a contingent market: the opportunity to influence policy is wasted or misused (Randall, 1987). This means that if a respondent does not interpret the environmental and health risks of a contaminated site as a commodity, he/she may undervalue it and hence diminish the importance of the environmental policy enacted to remediate the site.

A final CVM accuracy determinant is *operational bias*. This stresses the importance of the "operating conditions" of the CVM approximating those of the real market. Researchers have tried to deal with this by standardizing a set of Reference Operating Conditions (ROCs), including respondent familiarity with the commodity they are being asked to value and also with the bidding system (Cummings et al, 1986).

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